**ANNA UNIVERSITY, CHENNAI**

**NON-AUTONOMOUS AFFILIATED COLLEGES**

**CHOICE BASED CREDIT SYSTEM**

**REGULATIONS 2021**

**B. E. CIVIL ENGINEERING (ENVIRONMENTAL ENGINEERING)**

**I TO VIII SEMESTER CURRICULUM AND I TO IV SYLLABUS**

Categorization of Courses Every B.E. / B. Tech. Programme will have a curriculum with syllabi consisting of theory and practical courses that shall be categorized as follows:

i. Humanities, Social Sciences and Management Courses **(HSMC)** include English, Human Values, Communication skills, management courses etc.

ii. Basic Sciences Courses **(BSC)** include Mathematics, Physics, Chemistry, Biology, Environmental Science etc.

iii. Engineering Sciences Courses **(ESC)** include Engineering Practices, Engineering Graphics, Basics of Civil / Mechanical / Electrical / Electronics / Instrumentation, Computer Engineering, etc.

iv. Professional Core Courses **(PCC)** include the core courses relevant to the chosen specialization/branch.

v. Professional Elective Courses **(PEC)** include the elective courses relevant to the chosen specialization/ branch.

vi. Employability Enhancement Courses **(EEC)** include Project Work, Seminar, Professional Practices, Case Study etc.,

vii. Open Elective Course **(OEC)** include Subject selected other branch

## SEMESTER - I

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | IP3151 | Induction Programme | - | - | - | - | - | 0 |
| **THEORY** | | | | | | | | |
| 2. | HS3152 | Professional English - I | HSMC | 3 | 0 | 0 | 3 | 3 |
| 3. | MA3151 | Matrices and Calculus | BSC | 3 | 1 | 0 | 4 | 4 |
| 4. | PH3151 | Engineering Physics | BSC | 3 | 0 | 0 | 3 | 3 |
| 5. | CY3151 | Engineering Chemistry | BSC | 3 | 0 | 0 | 3 | 3 |
| 6. | GE3151 | Problem Solving and Python Programming | ESC | 3 | 0 | 0 | 3 | 3 |
| 7. | GE3152 | தமிழர் மரபு /Heritage of Tamils | HSMC | 1 | 0 | 0 | 1 | 1 |
| **PRACTICALS** | | | | | | | | |
| 8. | GE3171 | Problem Solving and Python | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BS3171 | Physics and Chemistry Laboratory | BSC | 0 | 0 | 4 | 4 | 2 |
| 10. | GE3172 | English Laboratory[$] | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **16** | **1** | **10** | **27** | **22** |

**[$] Skill Based Course**

## SEMESTER - II

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | HS3252 | Professional English - II | HSMC | 2 | 0 | 0 | 2 | 2 |
| 2. | MA3251 | Statistics and Numerical Methods | BSC | 3 | 1 | 0 | 4 | 4 |
| 3. | PH3201 | Physics for Civil Engineering | BSC | 3 | 0 | 0 | 3 | 3 |
| 4. | BE3252 | Basic Electrical, Electronics and Instrumentation Engineering | ESC | 3 | 0 | 0 | 3 | 3 |
| 5. | GE3251 | Engineering Graphics | ESC | 2 | 0 | 4 | 6 | 4 |
| 6. | | NCC Credit Course Level 1[#] | - | 2 | 0 | 0 | 2 | 2 |
| 7. | GE3252 | தமிழரும் தொழில்நுட்பமும் / Tamils and Technology | HSMC | 1 | 0 | 0 | 1 | 1 |
| **PRACTICALS** | | | | | | | | |
| 8. | GE3271 | Engineering Practices Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 9. | BE3272 | Basic Electrical, Electronics and Instrumentation Engineering Laboratory | ESC | 0 | 0 | 4 | 4 | 2 |
| 10. | GE3272 | Communication Laboratory /Foreign Language [$] | EEC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **16** | **1** | **16** | **31** | **23** |

**[#] NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

**[$] Skill Based Course**

## SEMESTER - III

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA3351 | Transforms and Partial Differential Equations | BSC | 3 | 1 | 0 | 4 | 4 |
| 2. | ME3351 | Engineering Mechanics | ESC | 3 | 0 | 0 | 3 | 3 |
| 3. | CE3301 | Fluid Mechanics | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | CE3302 | Construction Materials and Technology | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | EN3301 | Environmental Chemistry | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | CE3351 | Surveying and Levelling | PCC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 7. | CE3361 | Surveying and Levelling Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 8. | EN3311 | Environmental Fluid Mechanics Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 9. | GE3361 | Professional Development $ | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **18** | **1** | **8** | **27** | **23** |

**$ Skill Based Course**

## SEMESTER - IV

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIOD S PER | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | CE3401 | Applied Hydraulics Engineering | PCC | 3 | 1 | 0 | 4 | 4 |
| 2. | CE3402 | Strength of Materials | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | ER3401 | Transportation Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | ER3402 | Soil Mechanics & Foundation | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | EN3302 | Environmental Microbiology | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | ER3403 | Environmental Legislations and Policies | PCC | 3 | 0 | 0 | 3 | 3 |
| 7. | | NCC Credit Course Level 2# | | 3 | 0 | 0 | 3 | 3 # |
| **PRACTICALS** | | | | | | | | |
| 8. | EN3411 | Environmental Chemistry and | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | CE3412 | Materials Testing Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 10. | CE3413 | Soil Mechanics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **21** | **1** | **12** | **3** | **25** |

## SEMESTER - V

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | ER3501 | Structural Analysis | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | ER3502 | Water Supply Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | ER3503 | Wastewater Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective I | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective II | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective III | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Mandatory Course-I[&] | MC | 3 | 0 | 0 | 3 | Non-credit course |
| 8. | ER3504 | Sustainable Engineering Practices | PCC | 2 | 0 | 0 | 2 | 2 |
| **PRACTICALS** | | | | | | | | |
| 8. | ER3511 | Environmental Engineering Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | CE3611 | Building Drawing and Detailing Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **20** | **0** | **8** | **28** | **24** |

**[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)**

## SEMESTER-VI

| S. NO. | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | ER3601 | Design of Structural Elements | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | ER3602 | Solid Waste Management | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | AI3404 | Hydrology and Water Resources Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective IV | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective V | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective VI | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Open Elective – I* | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | | Mandatory Course-I[&] | MC | 3 | 0 | 0 | 3 | Non- credit course |
| 9. | | NCC Credit Course Level 3[#] | | 3 | 0 | 0 | 3 | 3[#] |
| **PRACTICALS** | | | | | | | | |
| 10. | ER3611 | Environmental Engineering Design and Drawing | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **21** | **0** | **4** | **28** | **23** |

***Open Elective – I shall be chosen from the emerging technologies**

**[&] Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC-II)**

**[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA**

**SEMESTER – VII / VIII***

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | CCE333 | Environmental Impact Assessment | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | CCE331 | Air and Noise Pollution Control Engineering | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | GE3791 | Human Values and Ethics | HSMC | 2 | 0 | 0 | 2 | 2 |
| 4. | GE3752 | Total Quality Management | HSMC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Open Elective – II** | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Open Elective – III*** | OEC | 3 | 0 | 0 | 3 | 3 |
| | | | **TOTAL** | **20** | **0** | **0** | **17** | **17** |

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII**

****Open Elective – II shall be chosen from the emerging technologies**

*****Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes**

**SEMESTER-VIII / VII***

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICALS** | | | | | | | | |
| 1. | ER3811 | Project Work / Internship | EEC | 0 | 0 | 20 | 20 | 10 |
| | | | **TOTAL** | **0** | **0** | **20** | **20** | **10** |

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII**

**TOTAL CREDITS: 167**

**MANDATORY COURSES I***

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | MX3081 | Introduction to Women and Gender Studies | MC | 3 | 0 | 0 | 3 |
| 2. | MX3082 | Elements of Literature | MC | 3 | 0 | 0 | 3 |
| 3. | MX3083 | Film Appreciation | MC | 3 | 0 | 0 | 3 |
| 4. | MX3084 | Disaster Risk Reduction and Management | MC | 3 | 0 | 0 | 3 |

***Mandatory Courses are offered as Non-Credit Courses**

## MANDATORY COURSES II*

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | MX3085 | Well Being with Traditional Practices -Yoga, Ayurveda and Siddha | MC | 3 | 0 | 0 | 3 |
| 2. | MX3086 | History of Science and Technology in India | MC | 3 | 0 | 0 | 3 |
| 3. | MX3087 | Political and Economic Thought for a Humane Society | MC | 3 | 0 | 0 | 3 |
| 4. | MX3088 | State, Nation Building and Politics in India | MC | 3 | 0 | 0 | 3 |
| 5. | MX3089 | Industrial Safety | MC | 3 | 0 | 0 | 3 |

***Mandatory Courses are offered as Non-Credit Courses**

## PROFESSIONAL ELECTIVE COURSES – VERTICALS

| Vertical I Water and Wastewater Management | Vertical II Climate Resilience and Energy Systems | Vertical III Circular Resource Recovery | Vertical IV Sustainable Habitat and Infrastructure Systems | Vertical V Integrated Environmental Management and Smart Technologies |
|---|---|---|---|---|
| Groundwater and Rainwater Harvesting | Climate Change and Adaptation | Biochemical and Thermochemical Conversion of Biomass | Public Health Engineering Services in Buildings | Land reclamation management |
| Design, Operation and Maintenance, Monitoring of Water and Wastewater Treatment Plants | Carbon Sequestration, Utilization and Storage | Life Cycle Assessment | Environmental Health, Safety and Risk Assessment | Smart Disaster management |
| Sludge and Septage Management | Climatology and Meteorology | Landfill and Remediation Technology | Planning, Design and Management of Large Housing Complexes | Environmental Management System |
| Marine Pollution and Control | Energy Management in Industries | Plastic, C&D, biomedical and E- waste Management | Green Built Environment | Circular Economy |
| Reclamation and Reuse of wastewater | Renewable Energy | Environmental Sensitive Urban Design | Climate Resilient Buildings | Urban Stormwater Management |
| Surface and Groundwater Quality Modeling | Natural Resource Management and Accounting | Resource Recovery from Waste | Urban Water Infrastructure | Environmental Nanotechnology |

## PROFESSIONAL ELECTIVE COURSES : VERTICALS

### VERTICAL I: Water and Wastewater Management

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | ER3001 | Groundwater and Rainwater Harvesting | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | ER3002 | Design, Operation and Maintenance, Monitoring of Water and Wastewater Treatment Plants | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | EN3003 | Sludge and Septage Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | EN3004 | Marine Pollution and Control | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | ER3003 | Reclamation and Reuse of wastewater | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | EN3019 | Surface and Groundwater Quality Modeling | PEC | 3 | 0 | 0 | 3 | 3 |

### VERTICAL II: Climate Resilience and Energy Systems

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CAI332 | Climate Change and Adaptation | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | ER3004 | Carbon Sequestration, Utilization and Storage | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | ER3005 | Climatology and Meteorology | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | EN3023 | Energy Management in Industries | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | ER3006 | Natural Resource Management and Accounting | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL III: Circular Resource Recovery

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | CAI331 | Biochemical and Thermochemical Conversion of Biomass | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | EN3502 | Life Cycle Assessment | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | ER3007 | Landfill and Remediation Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | ER3008 | Plastic, C&D, biomedical and E- waste Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | ER3009 | Environmental Sensitive Urban Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | ER3010 | Resource Recovery from Waste | PEC | 3 | 0 | 0 | 3 | 3 |

## VERTICAL IV: Sustainable Habitat and Infrastructure Systems

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | EN3024 | Public Health Engineering Services in Buildings | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | ER3011 | Environmental Health, Safety and Risk Assessment | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | EN3022 | Planning, Design and Management of Large Housing Complexes | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | ER3012 | Green Built Environment | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | ER3013 | Climate Resilient Buildings | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | CE3040 | Urban Water Infrastructure | PEC | 3 | 0 | 0 | 3 | 3 |

**VERTICAL V: Integrated Environmental Management and Smart Technologies**

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | ER3014 | Land Reclamation Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | ER3015 | Smart Disaster Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | ER3016 | Environmental Management System | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | ER3017 | Circular Economy | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | ER3018 | Urban Stormwater Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | ER3019 | Environmental Nanotechnology | PEC | 3 | 0 | 0 | 3 | 3 |

## OPEN ELECTIVES

**(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories)**

**OPEN ELECTIVE I AND II**
**(EMERGING TECHNOLOGIES)**

To be offered other than Faculty of Information and Communication Engineering

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OCS351 | Artificial Intelligence and Machine Learning Fundamentals | OEC | 2 | 0 | 2 | 4 | 3 |
| 2. | OCS352 | IoT Concepts and Applications | OEC | 2 | 0 | 2 | 4 | 3 |
| 3. | OCS353 | Data Science Fundamentals | OEC | 2 | 0 | 2 | 4 | 3 |
| 4. | CCS333 | Augmented Reality /Virtual Reality | OEC | 2 | 0 | 2 | 4 | 3 |

**OPEN ELECTIVES – III**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OHS351 | English for Competitive Examinations | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OMG352 | NGOs and Sustainable Development | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3. | OMG353 | Democracy and Good Governance | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | CME365 | Renewable Energy Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OME354 | Applied Design Thinking | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | MF3003 | Reverse Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OPR351 | Sustainable Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | AU3791 | Electric and Hybrid Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OAS352 | Space Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | OIM351 | Industrial Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OIE354 | Quality Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | OSF351 | Fire Safety Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | OML351 | Introduction to Non-Destructive Testing | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OMR351 | Mechatronics | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | ORA351 | Foundation of Robotics | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OAE352 | Fundamentals of Aeronautical Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OGI351 | Remote Sensing Concepts | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OAI351 | Urban Agriculture | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OEN351 | Drinking Water Supply and Treatment | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OEE352 | Electric Vehicle Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OEI353 | Introduction to PLC Programming | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OCH351 | Nano Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OCH352 | Functional Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | OFD352 | Traditional Indian Foods | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | OFD353 | Introduction to Food Processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OPY352 | IPR for Pharma Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 27. | OTT351 | Basics of Textile Finishing | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | OTT352 | Industrial Engineering for Garment Industry | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OTT353 | Basics of Textile Manufacture | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OPE351 | Introduction to Petroleum Refining and Petrochemicals | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | CPE334 | Energy Conservation and Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OPT351 | Basics of Plastics Processing | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEC351 | Signals and Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OEC352 | Fundamentals of Electronic Devices and Circuits | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | CBM348 | Foundation Skills in Integrated Product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | CBM333 | Assistive Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OMA352 | Operations Research | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OMA353 | Algebra and Number Theory | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 39. | OMA354 | Linear Algebra | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | OBT352 | Basics of Microbial Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OBT353 | Basics of Biomolecules | OEC | 3 | 0 | 0 | 3 | 3 |
| 42. | OBT354 | Fundamentals of Cell and Molecular Biology | OEC | 3 | 0 | 0 | 3 | 3 |

## OPEN ELECTIVES – IV

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | OHS352 | Project Report Writing | OEC | 3 | 0 | 0 | 3 | 3 |
| 2. | OMA355 | Advanced Numerical Methods | OEC | 3 | 0 | 0 | 3 | 3 |
| 3. | OMA356 | Random Processes | OEC | 3 | 0 | 0 | 3 | 3 |
| 4. | OMA357 | Queuing and Reliability Modelling | OEC | 3 | 0 | 0 | 3 | 3 |
| 5. | OMG354 | Production and Operations Management for Entrepreneurs | OEC | 3 | 0 | 0 | 3 | 3 |
| 6. | OMG355 | Multivariate Data Analysis | OEC | 3 | 0 | 0 | 3 | 3 |
| 7. | OME352 | Additive Manufacturing | OEC | 3 | 0 | 0 | 3 | 3 |
| 8. | CME343 | New Product Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 9. | OME355 | Industrial Design & Rapid Prototyping Techniques | OEC | 3 | 0 | 0 | 3 | 3 |
| 10. | MF3010 | Micro and Precision Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 11. | OMF354 | Cost Management of Engineering Projects | OEC | 3 | 0 | 0 | 3 | 3 |
| 12. | AU3002 | Batteries and Management System | OEC | 3 | 0 | 0 | 3 | 3 |
| 13. | AU3008 | Sensors and Actuators | OEC | 3 | 0 | 0 | 3 | 3 |
| 14. | OAS353 | Space Vehicles | OEC | 3 | 0 | 0 | 3 | 3 |
| 15. | OIM352 | Management Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 16. | OIM353 | Production Planning and Control | OEC | 3 | 0 | 0 | 3 | 3 |
| 17. | OIE353 | Operations Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 18. | OSF352 | Industrial Hygiene | OEC | 3 | 0 | 0 | 3 | 3 |
| 19. | OSF353 | Chemical Process Safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 20. | OML352 | Electrical, Electronic and Magnetic Materials | OEC | 3 | 0 | 0 | 3 | 3 |
| 21. | OML353 | Nanomaterials and Applications | OEC | 3 | 0 | 0 | 3 | 3 |
| 22. | OMR352 | Hydraulics and Pneumatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 23. | OMR353 | Sensors | OEC | 3 | 0 | 0 | 3 | 3 |
| 24. | ORA352 | Concepts in Mobile Robots | OEC | 3 | 0 | 0 | 3 | 3 |
| 25. | MV3501 | Marine Propulsion | OEC | 3 | 0 | 0 | 3 | 3 |
| 26. | OMV351 | Marine Merchant Vessels | OEC | 3 | 0 | 0 | 3 | 3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 27. | OMV352 | Elements of Marine Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 28. | CRA332 | Drone Technologies | OEC | 3 | 0 | 0 | 3 | 3 |
| 29. | OGI352 | Geographical Information System | OEC | 3 | 0 | 0 | 3 | 3 |
| 30. | OAI352 | Agriculture Entrepreneurship Development | OEC | 3 | 0 | 0 | 3 | 3 |
| 31. | OEN352 | Biodiversity Conservation | OEC | 3 | 0 | 0 | 3 | 3 |
| 32. | OEE353 | Introduction to Control Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 33. | OEI354 | Introduction to Industrial Automation Systems | OEC | 3 | 0 | 0 | 3 | 3 |
| 34. | OCH353 | Energy Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 35. | OCH354 | Surface Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 36. | OFD354 | Fundamentals of Food Engineering | OEC | 3 | 0 | 0 | 3 | 3 |
| 37. | OFD355 | Food safety and Quality Regulations | OEC | 3 | 0 | 0 | 3 | 3 |
| 38. | OPY353 | Nutraceuticals | OEC | 3 | 0 | 0 | 3 | 3 |
| 39. | OTT354 | Basics of Dyeing and Printing | OEC | 3 | 0 | 0 | 3 | 3 |
| 40. | FT3201 | Fibre Science | OEC | 3 | 0 | 0 | 3 | 3 |
| 41. | OTT355 | Garment Manufacturing Technology | OEC | 3 | 0 | 0 | 3 | 3 |
| 42. | OPE353 | Industrial Safety | OEC | 3 | 0 | 0 | 3 | 3 |
| 43. | OPE354 | Unit Operations in Petro Chemical Industries | OEC | 3 | 0 | 0 | 3 | 3 |
| 44. | OPT352 | Plastic Materials for Engineers | OEC | 3 | 0 | 0 | 3 | 3 |
| 45. | OPT353 | Properties and Testing of Plastics | OEC | 3 | 0 | 0 | 3 | 3 |
| 46. | OEC353 | VLSI Design | OEC | 3 | 0 | 0 | 3 | 3 |
| 47. | CBM370 | Wearable Devices | OEC | 3 | 0 | 0 | 3 | 3 |
| 48. | CBM356 | Medical Informatics | OEC | 3 | 0 | 0 | 3 | 3 |
| 49. | OBT355 | Biotechnology for Waste Management | OEC | 3 | 0 | 0 | 3 | 3 |
| 50. | OBT356 | Lifestyle Diseases | OEC | 3 | 0 | 0 | 3 | 3 |
| 51. | OBT357 | Biotechnology in Health Care | OEC | 3 | 0 | 0 | 3 | 3 |

## SUMMARY

| S.No. | Subject Area | CREDITS PER SEMESTER | | | | | | | | CREDITS TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VII/VIII | VIII/VII | |
| 1. | HSMC | 4 | 3 | | | | | 5 | | 12 |
| 2. | BSC | 12 | 7 | 4 | | | | | | 23 |
| 3. | ESC | 5 | 11 | 3 | | | | | | 19 |
| 4. | PCC | | | 15 | 25 | 15 | 11 | 6 | | 72 |
| 5. | PEC | | | | | 9 | 9 | | | 18 |
| 6. | OEC | | | | | | 3 | 6 | | 9 |
| 7. | EEC | 1 | 2 | 1 | | | | | 10 | 14 |
| | Total | 22 | 23 | 23 | 25 | 24 | 23 | 17 | 10 | **167** |
| 8. | Mandatory Course (Noncredit) | | | | | ✔ | ✔ | | | |

| IP3151 | INDUCTION PROGRAMME |
|---|---|

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

**The induction programme has been introduced by AICTE with the following objective:**

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

**(i) Physical Activity**

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

**(ii) Creative Arts**

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and
also enhance creativity which would, hopefully, grow into engineering design later.

**(iii) Universal Human Values**

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty

mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

**(iv) Literary Activity**

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

**(v) Proficiency Modules**

This would address some lacunas that students might have, for example, English, computer familiarity etc.

**(vi) Lectures by Eminent People**

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

**(vii) Visits to Local Area**

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

**(viii) Familiarization to Dept./Branch & Innovations**

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

**(ix) Department Specific Activities**

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

**References:**

Guide to Induction program from AICTE

| HS3152 | Professional English I | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

**Unit I Introduction to Effective Communication 1**

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**Unit II Introduction to Fundamentals of Communication 8**

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**Unit II Narration and Summation 9**

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

**Unit III Description of a Process / Product 9**

Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

**Unit IV Classification and Recommendations 9**

Reading – Newspaper articles; Journal reports –and Non Verbal Communication (tables, pie charts etc,.). Writing – Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non verbal (chart, graph etc, to verbal mode)

Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.

**Unit V Expression 9**

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

**Total : 45 Periods**

**Learning Outcomes:**

At the end of the course, learners will be able
CO1: To use appropriate words in a professional context
CO2: To gain understanding of basic grammatical structures and use them in right context.
CO3: To read and infer the denotative and connotative meanings of technical texts
CO4: To read and interpret information presented in tables, charts and other graphic forms
CO5: To write definitions, descriptions, narrations and essays on various topics

**Text Books :**

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.
   Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**References:**


1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book on Technical English by Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.


**Assessment Pattern**

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

**CO's-PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 1 | 3 | - | 3 | - | - | - |
| **2** | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 1 | 3 | - | 3 | - | - | - |
| **3** | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| **4** | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| **5** | 2 | 3 | 3 | 3 | - | 3 | 3 | 3 | 2 | 3 | - | 3 | - | - | - |
| **AVg.** | **1.6** | **2.2** | **1.8** | **2.2** | **1.5** | **3** | **3** | **3** | **1.6** | **3** | **3** | **3** | **-** | **-** | **-** |

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

| MA3151 | Matrices and Calculus | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**Course Objectives:**

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

**Unit I Matrices 9+3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

**Unit II Differential Calculus 9+3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

**Unit III Functions of Several Variables 9+3**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

**Unit IV Integral Calculus 9+3**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

**Unit V Multiple Integrals 9+3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

**TOTAL : 60 PERIODS**

**Course Outcomes :**

At the end of the course the students will be able to

**CO1** Use the matrix algebra methods for solving practical problems.

**CO2** Apply differential calculus tools in solving various application problems.
**CO3** Able to use differential calculus ideas on several variable functions.
**CO4** Apply different methods of integration in solving practical problems.
**CO5** Apply multiple integral ideas in solving areas, volumes and other practical problems.

**Text Books :**

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal.B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, "Calculus : Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8 ].

**References :**


1. Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3. Jain. R.K. and Iyengar. S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K.,“Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics " Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.


**CO’s-PO’s & PSO’s MAPPING**

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO2** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO3** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO4** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO5** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **Avg** | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |

| PH3151 | Engineering Physics | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

**Unit I Mechanics 9**

Multiparticle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

**Unit II Electromagnetic Waves 9**

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

**Unit III Oscillations, Optics and Lasers 9**

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference –Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, $CO_2$ laser, semiconductor laser –Basic applications of lasers in industry.

**Unit IV Basic Quantum Mechanics 9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

**Unit V Applied Quantum Mechanics** **9**

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

**Total : 45 Periods**

**Course Outcomes:**

After completion of this course, the students should be able to

**CO1** Understand the importance of mechanics.

**CO2** Express their knowledge in electromagnetic waves.

**CO3** Demonstrate a strong foundational knowledge in oscillations, optics and lasers.

**CO4** Understand the importance of quantum physics.

**CO5** Comprehend and apply quantum mechanical principles towards the formation of energy bands.

**Text Books:**


1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.


**References:**


1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.


**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 3 | 2 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| 3 | 3 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | - | - | - |
| 4 | 3 | 3 | 1 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | |
| 5 | 3 | 3 | 1 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| AVG | 3 | 3 | 1.6 | 1.2 | 1.8 | 1 | - | - | - | - | - | 1 | - | - | - |

**1-Low,2-Medium,3-High,"-"-no correlation**

**Note: the average value of this course to be used for program articulation matrix.**

| CY3151 | Engineering Chemistry | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

**Unit I Water and its Treatment 9**

**Water:** Sources and impurities, **Water quality parameters:** Definition and significance of-colour, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. **Municipal water treatment:** primary treatment and disinfection (UV, Ozonation, break-point chlorination)**. Desalination of brackish water**: Reverse Osmosis. **Boiler troubles:** Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming &foaming. **Treatment of boiler feed water**: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralisation and zeolite process.

**Unit II Nanochemistry 9**

**Basics**: Distinction between molecules, nanomaterials and bulk materials; **Size-dependent properties** (optical, electrical, mechanical and magnetic); **Types of nanomaterials**: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. **Preparation of nanomaterials:** sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. **Applications** of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

**Unit III Phase Rule and Composites 9**

**Phase rule:** Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

**Composites: Introduction**: Definition & Need for composites; **Constitution**: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). **Properties and applications of**: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. **Hybrid composites** - definition and examples.

**Unit III Phase Rule and Composites 9**

**Phase rule:** Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

**Composites: Introduction**: Definition & Need for composites; **Constitution**: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). **Properties and applications of**: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. **Hybrid composites** - definition and examples.

**Unit IV Fuels and Combustion 9**

**Fuels: Introduction**: Classification of fuels; **Coal and coke**: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). **Petroleum and Diesel:** Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; **Power alcohol and biodiesel.**

**Combustion of fuels: Introduction**: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; **Ignition temperature**: spontaneous ignition temperature, Explosive range; **Flue gas analysis** - ORSAT Method. **$CO_2$ emission and carbon foot print.**

**Unit V Energy Sources and Storage Devices 9**

**Stability of nucleus: mass defect (problems), binding energy;Nuclear energy:** light water nuclear power plant, breeder reactor. **Solar energy conversion:** Principle, working and applications of solar cells**; Recent developments in solar cell materials. Wind energy; Geothermal energy;Batteries:** Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; **Electric vehicles-working principles; Fuel cells:** $H_2$-$O_2$ fuel cell, microbial fuel cell; **Supercapacitors:** Storage principle, types and examples.

**Total: 45 Periods**

**Course Outcomes:**

At the end of the course, the students will be able:

**CO1** To infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.

**CO2** To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.

**CO3** To apply the knowledge of phase rule and composites for material selection requirements.

**CO4** To recommend suitable fuels for engineering processes and applications.

**CO5** To recognize different forms of energy resources and apply them for suitable applications in energy sectors.

**Text books:**

1. P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.

2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, “A text book of Engineering Chemistry”, S. Chand Publishing, 12th Edition, 2018.

**References:**

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, “Text book of nanoscience and nanotechnology”, Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, “Engineering Chemistry” McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

**Co’s-Po’s & Pso’s Mapping**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 2 | 1 | - | 1 | 1 | - | - | - | - | 1 | - | - | - |
| 2 | 2 | - | - | 1 | - | 2 | 2 | - | - | - | - | - | - | - | - |
| 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | 3 | 1 | 1 | - | - | 1 | 2 | - | - | - | - | - | - | - | - |
| 5 | 3 | 1 | 2 | 1 | - | 2 | 2 | - | - | - | - | 2 | - | - | - |
| Avg. | 2.8 | 1.3 | 1.6 | 1 | - | 1.5 | 1.8 | - | | - | - | 1.5 | - | - | - |

- 1-low, 2-medium, 3-high, ‘-“- no correlation

| GE3151 | Problem Solving and Python Programming | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

**Unit I Computational Thinking and Problem Solving** **9**

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flowchart,programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

**Unit II Data types, expressions, statements** **9**

Python interpreter and interactive mode,debugging; values and types: int, float, bool ean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**Unit III Control Flow, Functions, Strings** **9**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**Unit IV Lists, Tuples, Dictionaries** **9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**Unit V Files, Modules, Packages** **9**

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

**Total : 45 Periods**

**Course Outcomes:**

Upon completion of the course, students will be able to

**CO1**: Develop algorithmic solutions to simple computational problems.
**CO2**: Develop and execute simple Python programs.
**CO3**: Write simple Python programs using conditionals and looping for solving problems.
**CO4**: Decompose a Python program into functions.
**CO5**: Represent compound data using Python lists, tuples, dictionaries etc.
**CO6**: Read and write data from/to files in Python programs.

**Text Books:**


1. Allen B. Downey, "Think Python : How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.


**References:**


1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data'', Third Edition, MIT Press 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
   https://www.python.org/
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill,2018.


**COs- PO's & PSO's MAPPING**

| \CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 2 | 3 | 3 | - |
| **2** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | 2 | 3 | - | - |
| **3** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | - | 3 | - | - |
| **4** | 2 | 2 | - | 2 | 2 | - | - | - | - | - | 1 | - | 3 | - | - |
| **5** | 1 | 2 | - | - | 1 | - | - | - | - | - | 1 | - | 2 | - | - |
| **6.** | 2 | 2 | - | - | 2 | - | - | - | - | - | 1 | - | 2 | - | - |
| **Avg.** | **2** | **3** | **3** | **3** | **2** | - | - | - | - | - | **2** | **2** | **3** | **3** | - |

**1 - low, 2 - medium, 3 - high, '-' - no correlation**

**GE3152** **தமிழர் மரபு** **L T P C**
**1 0 0 1**

**அலகு I மொழி மற்றும் இலக்கியம்**: **3**
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை**: **3**
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்**: **3**
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்**: **3**
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு**: **3**
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**GE3152 HERITAGE OF TAMILS L T P C**
**1 0 0 1**

**UNIT I LANGUAGE AND LITERATURE 3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

**UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT III FOLK AND MARTIAL ARTS 3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT IV THINAI CONCEPT OF TAMILS 3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)

11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

| GE3171 | Problem Solving and Python Programming Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

**EXPERIMENTS:**

**Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.**

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building – operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

**Total: 60 Periods**

**COURSE OUTCOMES:**

On completion of the course, students will be able to:

**CO1**: Develop algorithmic solutions to simple computational problems

**CO2**: Develop and execute simple Python programs.

**CO3**: Implement programs in Python using conditionals and loops for solving problems..

**CO4**: Deploy functions to decompose a Python program.

**CO5**: Process compound data using Python data structures.

**CO6**: Utilize Python packages in developing software applications.

**Text Books:**


1. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.


**References:**


1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data‘‘, Third Edition, MIT Press, 2021
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.


**COs- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 3 | 2 | 3 | 3 | - |
| **2** | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | 3 | 2 | 3 | - | - |
| **3** | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | 2 | - | 3 | - | - |
| **4** | 3 | 2 | - | 2 | 2 | - | - | - | - | - | 1 | - | 3 | - | - |
| **5** | 1 | 2 | - | - | 1 | - | - | - | - | - | 1 | - | 2 | - | - |
| **6** | 2 | - | - | - | 2 | - | - | - | - | - | 1 | - | 2 | - | - |
| **Avg.** | **2** | **3** | **3** | **3** | **2** | - | - | - | - | - | **2** | **2** | **3** | **3** | - |

**1 - low, 2 - medium, 3 - high, ‘-' - no correlation**

| BS3171 | Physics and Chemistry Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Physics Laboratory : (Any Seven Experiments)**

**Course Objectives:**

- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young's modulus
4. Uniform bending – Determination of Young's modulus
5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamics kit.

**Total: 30 Periods**

**Course Outcomes:**

Upon completion of the course, the students should be able to

**CO1** Understand the functioning of various physics laboratory equipment.

**CO2** Use graphical models to analyze laboratory data.

**CO3** Use mathematical models as a medium for quantitative reasoning and describing physical reality.

**CO4** Access, process and analyze scientific information.

**CO5** Solve problems individually and collaboratively.

**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | - |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3** | 3 | 2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| **4** | 3 | 3 | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| **5** | 3 | 2 | 3 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| **AVG** | 3 | 2.4 | 2.6 | 1 | 1 | | | | | | | | | | | |

- **1-Low,2-Medium,3-High,"-"-no correlation**
- **Note: the average value of this course to be used for program articulation matrix.**

**Chemistry Laboratory: (Any seven experiments to be conducted)**

**Course Objectives:**

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles

1. Preparation of $Na_2CO_3$ as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.
   - Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles ($TiO_2$/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**Total : 30 Periods**

**Course Outcomes :**

**CO1** To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.

**CO2** To determine the amount of metal ions through volumetric and spectroscopic techniques

**CO3** To analyse and determine the composition of alloys.

**CO4** To learn simple method of synthesis of nanoparticles

**CO5** To quantitatively analyse the impurities in solution by electroanalytical techniques''

**Text books:**


1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis (2009).


**COs- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | - | 1 | - | - | 2 | 2 | - | - | - | - | 2 | - | - | - |
| 2 | 3 | 1 | 2 | - | - | 1 | 2 | - | - | - | - | 1 | - | - | - |
| 3 | 3 | 2 | 1 | 1 | - | - | 1 | - | - | - | - | - | - | - | - |
| 4 | 2 | 1 | 2 | - | - | 2 | 2 | - | - | - | - | - | - | - | - |
| 5 | 2 | 1 | 2 | - | 1 | 2 | 2 | - | - | - | - | 1 | - | - | - |
| Avg. | 2.6 | 1.3 | 1.6 | 1 | 1 | 1.4 | 1.8 | - | - | - | - | 1.3 | - | - | - |

- **1-low, 2-medium, 3-high, '-"- no correlation**

| GE3172 | English Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 1 |

**Course Objectives :**

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

**Unit I Introduction to Fundamentals of Communication 6**

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions( filling out a bank application for example).

**Unit II Narration and Summation 6**

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations* - describing experiences and feelings- engaging in small talk- describing requirements and abilities.

**Unit III Description of a Process Product 6**

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

**Unit IV Classification and Recommendations 6**

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress-talking about positions and directions of movement-talking about travel preparations- talking about transportation

**Unit V Expression 6**

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions-understanding a website-describing processes

**Total : 30 Periods**

**Learning Outcomes:**

At the end of the course, learners will be able

**CO1** To listen to and comprehend general as well as complex academic information

**CO2** To listen to and understand different points of view in a discussion

**CO3** To speak fluently and accurately in formal and informal communicative contexts

**CO4** To describe products and processes and explain their uses and purposes clearly and accurately

**CO5** To express their opinions effectively in both formal and informal discussions

**Assessment Pattern**

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internal test and end semester exam.

**COs- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| **2** | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| **3** | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| **4** | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| **5** | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| **AVg.** | **3** | **3** | **3** | **3** | **1** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **-** | **-** | **-** |

●1-low, 2-medium, 3-high, '-"- no correlation

**Note:** The average value of this course to be used for program articulation matrix

| HS3252 | Professional English II | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

**Course Objectives:**

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professional context.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship and placements

**Unit I Making Comparisons 6**

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

**Unit II Expressing Causal Relations in Speaking and Writing 6**

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

**Unit III Problem Solving 6**

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Errorcorrection; If conditional sentences

**Unit IV Reporting of Events and Research 6**

Reading – Newspaper articles;Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech,Modals Vocabulary – Conjunctions- use of prepositions

**Unit V The Ability to Put Ideas or Information Cogently 6**

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

**Total : 30 Periods**

**Course Outcomes:**

At the end of the course, learners will be able

**CO1** To compare and contrast products and ideas in technical texts.

**CO2** To identify and report cause and effects in events, industrial processes through technical texts

**CO3** To analyse problems in order to arrive at feasible solutions and communicate them in the written format.

**CO4** To present their ideas and opinions in a planned and logical manner

**CO5** To draft effective resumes in the context of job search.

**Text books :**

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

**References:**


1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.


**Assessment Pattern**

two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

**COs- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| 4 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - |
| 5 | - | - | - | - | - | - | - | - | 3 | 3 | 3 | 3 | - | - | - |
| Avg. | 3 | 3 | 3 | 3 | 2.75 | 3 | 3 | 3 | 2.2 | 3 | 3 | 3 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation

**Note:** The average value of this course to be used for program articulation matrix

| MA3251 | Statistics and Numerical Methods | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**Course Objectives:**

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

**Unit I Testing of Hypothesis 9+3**

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

**Unit II Design of Experiments 9+3**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - $2^2$ factorial design.

**Unit III Solution of Equations and Eigenvalue Problems 9+3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

**Unit IV Interpolation, Numerical Differentiation and Numerical Integration 9+3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

**Unit V Numerical Solution of Ordinary Differential Equations 9+3**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

**Total: 60 Periods**

**Course Outcomes:**

Upon successful completion of the course, students will be able to:

**CO1** Apply the concept of testing of hypothesis for small and large samples in real life problems.

**CO2** Apply the basic concepts of classifications of design of experiments in the field of agriculture.

**CO3** Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

**CO4** Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

**CO5** Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

**Text Books:**


1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.


**References:**


1. Burden, R.L and Faires, J.D, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum’s Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., “Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.


**COs- PO’s & PSO’s MAPPING**

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO2** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO3** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO4** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **CO5** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |
| **Avg** | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | - | - | - |

| PH3201 | Physics for Civil Engineering | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To introduce the basics of heat transfer through different materials, thermal performance of building and various thermal applications
- To impart knowledge on the ventilation and air conditioning of buildings
- To introduce the concepts of sound insulation and lighting designs
- To give an introduction to the processing and applications of new engineering materials
- To create an awareness on natural disasters and safety measures

**Unit I Thermal Applications 9**

Principles of heat transfer, steady state of heat flow, conduction through compound media-series and parallel-conductivity of rubber tube and powder materials - heat transfer through fenestrations, thermal insulation and its benefits - heat gain and heat loss estimation - factors affecting the thermal performance of buildings, thermal measurements, thermal comfort, indices of thermal comfort, climate and design of solar radiation, shading devices - central heating.

**Unit II Ventilation and Refrigeration 9**

Requirements, principles of natural ventilation - ventilation measurements, design for natural ventilation - Window types and packaged air conditioners - chilled water plant - fan coil systems - water piping - cooling load - Air conditioning systems for different types of buildings - Protection against fire to be caused by A.C.Systems.

**Unit III Acoustics and Lighting Designs 9**

Methods of sound absorptions - absorbing materials - noise and its measurements, sound insulation and its measurements, impact of noise in multistored buildings. Visual field glare, colour - day light calculations - day light design of windows, measurement of day-light and use of models and artificial skies, principles of artificial lighting, supplementary artificial lighting.

**Unit IV New Engineering Materials 9**

Composites - Definition and Classification - Fibre reinforced plastics (FRP) and fiber reinforced metals (FRM) - Metallic glasses - Shape memory alloys - Ceramics - Classification - Crystalline - Non Crystalline - Bonded ceramics, Manufacturing methods - Slip casting - Isostatic pressing - Gas pressure bonding - Properties - thermal, mechanical, electrical and chemical ceramic fibres - ferroelectric and ferromagnetic ceramics - High Aluminium ceramics.

**Unit V Natural Disasters 9**

Seismology and Seismic waves - Earth quake ground motion - Basic concepts and estimation techniques - site effects - Probabilistic and deterministic Seismic hazard analysis - Cyclone and flood hazards - Fire hazards and fire protection, fire-proofing of materials, fire safety regulations and firefighting equipment - Prevention and safety measures.

**Total: 45 Periods**

**Course Outcomes:**

After completion of the course, the students should be able to

**CO1** acquire knowledge about heat transfer through different materials, thermal performance of building and thermal insulation.

**CO2** gain knowledge on the ventilation and air conditioning of buildings

**CO3** understand the concepts of sound absorption, noise insulation and lighting designs

**CO4** now about the processing and applications of composites, metallic glasses, shape memory alloys and ceramics

**CO5** get an awareness on natural disasters such as earth quake, cyclone, fire and safety measures

**Text Books:**


1. Marko Pinteric, Building Physics, Springer 2017.
2. D.S.Mathur. Elements of Properties of Matter. S Chand & Company, 2010.
3. Hugo Hens, Building Physics: Heat, Air and Moisture, Wiley, 2017


**References:**


1. W.R.Stevens. Building Physics: Lighting. Pergamon Press, 2013..
2. Hugo Hens, Applied Building Physics, Wiley, 2016
3. K.G.Budinski and M.K.Budinski. Engineering Materials: Properties and Selection. Pearson Education, 2016.
4. Peter A. Claisse, Civil Engineering Materials, Elsevier, 2016.
5. Patrick L. Abbott, Natural Disasters, McGraw-Hill, 2017.


**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 2 | - | 1 | 1 | - | - | - | - | - | - | - | - | - |
| 2 | 3 | 2 | 2 | - | 1 | 1 | - | - | - | - | - | - | - | - | - |
| 3 | 3 | 2 | 2 | - | 1 | 1 | - | - | - | - | - | - | - | - | - |
| 4 | 3 | - | 2 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - |
| 5 | 3 | 1 | - | - | 1 | 3 | - | - | - | - | - | - | - | - | - |
| AVG | 3 | 1.75 | 2 | 2 | 1.2 | 1.4 | | | | | | | | | |

**1-Low,2-Medium,3-High,"-"-no correlation**

**Note: the average value of this course to be used for program articulation matrix.**

| BE3252 | Basic Electrical, Electronics and Instrumentation Engineering | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To introduce the basics of electric circuits and analysis
- To impart knowledge in domestic wiring
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To introduce the functional elements and working of sensors and transducers.

**Unit I Electrical Circuits 9**

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)
Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only), Three phase supply – star and delta connection – power in three-phase systems

**Unit II Magnetic Circuits and Electrical Installations 9**

Magnetic circuits-definitions-MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.
Domestic wiring , types of wires and cables, earthing ,protective devices- switch fuse unit-Miniature circuit breaker-moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid

**Unit III Electrical Machines 9**

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

**Unit IV Analog Electronics 9**

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

**Unit V Sensors and Transducers 9**

Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors,Strain gauge, LVDT, differential pressure transducer,optical and digital transducers, Smart sensors, Thermal Imagers.

**Total: 45 periods**

**Course Outcomes:**

After completing this course, the students will be able to
**CO1:** Compute the electric circuit parameters for simple problems
**CO2:** Explain the concepts of domestics wiring and protective devices
**CO3:** Explain the working principle and applications of electrical machines
**CO4:** Analyze the characteristics of analog electronic devices
**CO5:** Explain the types and operating principles of sensors and transducers

**Text Books:**


1. D P Kothari and I.J Nagarath,"Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Second Edition, 2020
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
3. S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019
4. James A Svoboda, Richard C. Dorf, Dorf's Introduction to Electric Circuits, Wiley,2018.


**References:**


1. John Bird, "Electrical Circuit theory and technology", Routledge; 2017.
2. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
3. Albert Malvino, David Bates, '**Electronic Principles**, McGraw Hill Education; 7th edition, 2017
4. Muhammad H.Rashid, "Spice for Circuits and electronics", 4th Edition., Cengage India,2019.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010.


**CO's, PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| **2** | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| **3** | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| **4** | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| **5** | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |
| **Avg.** | 2 | 1 | 1 | | | | | 1 | | | | | - | - | - |

| GE3251 | Engineering Graphics | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 4 | 4 |

**Course Objectives:**

The main learning objective of this course is to prepare the students for:

- Drawing engineering curves.
- Drawing freehand sketch of simple objects.
- Drawing orthographic projection of solids and section of solids.
- Drawing development of solids
- Drawing isometric and perspective projections of simple solids.

**Concepts and Conventions (Not for Examination)**

Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

**Unit I Plane Curves 6+12**

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

**Unit II Projection of Points, Lines and Plane Surface 6+12**

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

**Unit III Projection of Solids and Freehand Sketching 6+12**

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles — Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

**Unit IV Projection of Sectioned Solids and Development of Surfaces 6+12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)

**Unit V Isometric and Perspective Projections 6+12**

Principles of isometric projection — isometric scale —Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

**Total: (L=30+P=60) 90 Periods**

**Course Outcomes:**

On successful completion of this course, the student will be able to

**CO1** Use BIS conventions and specifications for engineering drawing.

**CO2** Construct the conic curves, involutes and cycloid.

**CO3** Solve practical problems involving projection of lines.

**CO4** Draw the orthographic, isometric and perspective projections of simple solids.

**CO5** Draw the development of simple solids.

**Text Books:**


1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015


**References:**


1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2nd Edition, 2009.
6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.


**Publication of Bureau of Indian Standards:**

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

**Special points applicable to University Examinations on Engineering Graphics:**

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

**COs- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| 1 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| 2 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| 3 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| 4 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| 5 | 3 | 1 | 2 | | 2 | | | | | 3 | | 2 | 2 | 2 | |
| **Avg** | **3** | **1** | **2** | | **2** | | | | | **3** | | **2** | **2** | **2** | |
| Low (1) ; Medium (2) ; High (3) | | | | | | | | | | | | | | | |

| NX3251 | NCC Credit Course Level 1*<br>(ARMY WING) NCC Credit Course Level - I | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

| | | |
|---|---|---|
| **NCC General** | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |
| **National Integration and Awareness** | | **4** |
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |
| **Personality Development** | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **Leadership** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **Social Service and Community Development** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |
| | | **Total : 30 Periods** |

| NX3252 | NCC Credit Course Level 1*<br>(NAVAL WING) NCC Credit Course Level - I | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

| | | |
|---|---|---|
| **NCC General** | | **6** |
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |
| **National Integration and Awareness** | | **4** |
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |
| **Personality Development** | | **7** |
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |
| **Leadership** | | **5** |
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki Rani | 2 |
| **Social Service and Community Development** | | **8** |
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |
| | | **Total : 30 Periods** |

| NX3253 | NCC Credit Course Level 1*<br>(AIR FORCE WING) NCC Credit Course Level - I | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

**NCC General**

| | | |
|---|---|---|
| NCC 1 | Aims, Objectives & Organization of NCC | 1 |
| NCC 2 | Incentives | 2 |
| NCC 3 | Duties of NCC Cadet | 1 |
| NCC 4 | NCC Camps: Types & Conduct | 2 |

**National Integration and Awareness** **4**

| | | |
|---|---|---|
| NI 1 | National Integration: Importance & Necessity | 1 |
| NI 2 | Factors Affecting National Integration | 1 |
| NI 3 | Unity in Diversity & Role of NCC in Nation Building | 1 |
| NI 4 | Threats to National Security | 1 |

**Personality Development** **7**

| | | |
|---|---|---|
| PD 1 | Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving | 2 |
| PD 2 | Communication Skills | 3 |
| PD 3 | Group Discussion: Stress & Emotions | 2 |

**Leadership** **5**

| | | |
|---|---|---|
| L 1 | Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code | 3 |
| L 2 | Case Studies: Shivaji, Jhasi Ki ani | 2 |

**Social Service and Community Development** **8**

| | | |
|---|---|---|
| SS 1 | Basics, Rural Development Programmes, NGOs, Contribution of Youth | 3 |
| SS 4 | Protection of Children and Women Safety | 1 |
| SS 5 | Road / Rail Travel Safety | 1 |
| SS 6 | New Initiatives | 2 |
| SS 7 | Cyber and Mobile Security Awareness | 1 |

**1 0 0 1**

**அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்**: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தித் தொழில் நுட்பம்**: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

**TOTAL : 15 PERIODS**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

| GE3252 | Tamils and Technology | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | 1 |

**Weaving and Ceramic Technology:** Weaving Industry during Sangam Age, Ceramic technology, Black and Red Ware Potteries (BRW), Graffiti on Potteries.

**Design and Construction Technology:** Designing and Structural construction House & Designs in household materials during Sangam Age, Building materials and Hero stones of Sangam age, Details of Stage Constructions in Silappathikaram, Sculptures and Temples of Mamallapuram, Great Temples of Cholas and other worship places,Temples of Nayaka Period, Type study (Madurai Meenakshi Temple), Thirumalai Nayaka rMahal, Chetti Nadu Houses, Indo, Saracenic architecture at Madras during British Period.

**Manufacturing Technology:** Art of Ship Building , Metallurgical studies, Iron industry, Iron smelting, steel, Copper and gold Coins as source of history - Minting of Coins, Beads making, industries Stonebeads, Glass beads, Terracotta beads, Shell beads / bone beats, Archeological evidences, Gem stone types described in Silappathikaram.

**Agriculture and Irrigation Technology:** Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompuof Chola Period, Animal Husbandry - Wells designed for cattle use , Agriculture and Agro Processing -Knowledge of Sea -Fisheries, Pearl, Conche diving, Ancient Knowledge of Ocean -Knowledge Specific Society.

**Scientific Tamil & Tamil Computing:** Development of Scientific Tamil, Tamil computing, Digitalization of Tamil Books, Development of Tamil Software, Tamil Virtual Academy, Tamil Digital Library, Online Tamil Dictionaries, Sorkuvai Project.

**Text-Cum-Reference Books**


1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

| GE3271 | Engineering Practices Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives:**

The main learning objective of this course is to provide hands on training to the students in:

- Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
- Wiring various electrical joints in common household electrical wire work.
- Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
- Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

**GROUP – A (CIVIL & ELECTRICAL)**

**Part I** **Civil Engineering Practices** **15**

**Plumbing Work:**

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
b) Preparing plumbing line sketches.
c) Laying pipe connection to the suction side of a pump
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

**WOOD WORK:**

a) Sawing,
b) Planing and
c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

a) Studying joints in door panels and wooden furniture
b) Studying common industrial trusses using models.

**Part II** **Electrical Engineering Practices** **15**

a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
b) Staircase wiring
c) Fluorescent Lamp wiring with introduction to CFL and LED types.
d) Energy meter wiring and related calculations/ calibration
e) Study of Iron Box wiring and assembly
f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
g) Study of emergency lamp wiring/Water heater

**GROUP – B (MECHANICAL AND ELECTRONICS)**

**Part III** **Mechanical Engineering Practices** **15**

**Welding Work:**

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

**Basic Machining work:**

a) (simple)TURNING.
b) (simple)Drilling.
c) (simple)Tapping.

**Assembly Work:**

a) Assembling a centrifugal pump.
b) Assembling a household mixer.
c) Assembling an airconditioner.

**Sheet Metal Work:**

a) Making of a square tray

**Foundry Work:**

a) Demonstrating basic foundry operations**.**

**Part IV** **Electronic Engineering Practices** **15**

**Soldering work:**

**a)** Soldering simple electronic circuits and checking continuity**.**

**Electronic Assembly and Testing Work:**

**a)** Assembling and testing electronic components on a small PCB.

**Electronic Equipment Study:**

a) Study an elements of smart phone.
b) Assembly and dismantle of LED TV.
c) Assembly and dismantle of computer/ laptop

**Total : 60 Periods**

**Course Outcomes**:

Upon completion of this course, the students will be able to:

**CO1** Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

**CO2** Wire various electrical joints in common household electrical wire work.

**CO3** Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

**CO4** Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

**COs- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 2 | 1 | 1 |
| 2 | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 2 | 1 | 1 |
| 3 | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 2 | 1 | 1 |
| **Avg** | **3** | **2** | | | **1** | **1** | **1** | | | | | **2** | **2** | **1** | **1** |
| Low (1) ; Medium (2) ; High (3) | | | | | | | | | | | | | | | |

| BE3272 | BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To train the students in conducting load tests electrical machines
- To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers
- To train the students to measure three phase power and displacement

**List of Experiments**

1. Verification of ohms and Kirchhoff's Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

**Total: 60 Periods**

**Course Outcomes:**

After completing this course, the students will be able to

**CO1:** Use experimental methods to verify the Ohm's law and Kirchhoff's Law and to measure three phase power

**CO2:** Analyze experimentally the load characteristics of electrical machines

**CO3:** Analyze the characteristics of basic electronic devices

**CO4:** Use LVDT to measure displacement

**CO's, PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 3 | 1 | 2 | | | | 1.5 | 2 | | | | - | - | - |
| 2 | 2 | 3 | 1 | 2 | | | | 1.5 | 2 | | | | - | - | - |
| 3 | 2 | 3 | 1 | 2 | | | | 1.5 | 2 | | | | - | - | - |
| 4 | 2 | 3 | 1 | 2 | | | | 1.5 | 2 | | | | - | - | - |
| Avg. | 1.6 | 1.4 | 0.8 | 1.6 | | | | 1.2 | 1.6 | | | | | | |

| GE3272 | Communication Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives**

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To analyse concepts and problems and make effective presentations explaining them clearly and precisely.
- To be able to communicate effectively through formal and informal writing.
- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

**Unit I** **12**

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition-discussing progress toward goals-talking about experiences- talking about events in life-discussing past events-Writing: writing emails ( formal & semi-formal).

**Unit II** **12**

Speaking: discussing news stories-talking about frequency-talking about travel problems-discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

**Unit III** **12**

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios-talking about purchasing-discussing advantages and disadvantages- making comparisons-discussing likes and dislikes- discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

**Unit IV** **12**

Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-( example- discussing rental arrangements)- understanding technical instructions-Writing: writing instructions-writing a short article.

**Unit V** **12**

Speaking: describing things relatively-describing clothing-discussing safety issues (making recommendations) talking about electrical devices-describing controlling actions- Writing: job application (Cover letter + Curriculum vitae)-writing recommendations.

**Total: 60 Periods**

**Learning Outcomes**

At the end of the course, learners will be able

**CO1** Speak effectively in group discussions held in ~~a~~ formal/semi formal contexts.

**CO2** Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions

**CO3** Write emails, letters and effective job applications.

**CO4** Write critical reports to convey data and information with clarity and precision

**CO5** Give appropriate instructions and recommendations for safe execution of tasks

**Assessment Pattern**

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

**COs- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 2 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 3 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| **AVg.** | **2.4** | **2.8** | **3** | **3** | **1.8** | **3** | **3** | **3** | **3** | **3** | **3** | **3** | **-** | **-** | **-** |

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

| MA3351 | Transforms and Partial Differential Equations | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**Course Objectives**

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

**Unit I Partial Differential Equations 9 + 3**

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

**Unit II Fourier Series 9 + 3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

**Unit III Applications of Partial Differential Equations Classification 9 + 3**

of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

**Unit IV Fourier Transforms 9 + 3**

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**Unit V Z- Transforms and Difference Equations 9 + 3**

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

**Total: 60 Periods**

**Course Outcomes**

Upon successful completion of the course, students should be able to:

**CO1** Understand how to solve the given standard partial differential equations.

**CO2** Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.

**CO3** Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.

**CO4** Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.

**CO5** Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

**Text books:**


1. Grewal B.S.,"Higher Engineering Mathematics" 44$^{th}$Edition, Khanna Publishers,New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10$^{th}$ Edition, John Wiley, New Delhi, India, 2016.


**References:**


1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10$^{th}$ Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4$^{th}$Edition, Pearson Education, New Delhi, 2016.
4. Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
6. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.


**COs- PO's & PSO's MAPPING**

| | PO 01 | PO 02 | PO 03 | PO '04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 1 | | | | | 2 | 0 | 0 | 3 | - | - | - |
| CO2 | 3 | 3 | 1 | 1 | | | | | 2 | 0 | 0 | 3 | - | - | - |
| CO3 | 3 | 3 | 1 | 1 | | | | | 2 | 0 | 0 | 3 | - | - | - |
| CO4 | 3 | 3 | 1 | 1 | | | | | 2 | 0 | 0 | 3 | - | - | - |
| CO5 | 3 | 3 | 1 | 1 | | | | | 2 | 0 | 0 | 3 | - | - | - |
| Avg | 3 | 3 | 1 | 1 | | | | | 2 | 0 | 0 | 3 | - | - | - |

| ME3351 | Engineering Mechanics | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives**

- To Learn the use scalar and vector analytical techniques for analyzing forces in Statically determinate structures
- To introduce the equilibrium of rigid bodies
- To study and understand the distributed forces, surface, loading on beam and intensity.
- To learn the principles of friction, forces and to determine the apply the concepts of frictional forces at the contact surfaces of various engineering systems.
- To develop basic dynamics concepts – force, momentum, work and energy;

**Unit I Statics of Particles 9**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

**Unit II Equilibrium of Rigid Bodies 9**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

**Unit III Distributed Forces 9**

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

**Unit IV Friction 9**

The Laws of Dry Friction, Coefficients of Friction, Angles of Friction, Wedge friction, Wheel Friction, Rolling Resistance, Ladder friction.

**Unit V Dynamics of Particles 9**

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact of bodies.

**Total: 45 Periods**

**Course Outcomes:**

At the end of the course the students would be able to

**CO1** Illustrate the vectorial and scalar representation of forces and moments

**CO2** Analyse the rigid body in equilibrium

**CO3** Evaluate the properties of distributed forces

**CO4** Determine the friction and the effects by the laws of friction

**CO5** Calculate dynamic forces exerted in rigid body

**Text Books**:


1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, SanjeevSanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 11th Edition, 2017.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.


**References:**


1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and SukumarPati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.


**COs- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | 2 | 2 | 1 | 2 | | | | | | | 2 | 3 | 1 | 1 |
| **2** | 3 | 2 | 2 | 1 | 2 | | | | | | | 2 | 3 | 1 | 1 |
| **3** | 3 | 2 | 3 | 1 | 2 | | | | | | | 2 | 3 | 1 | 2 |
| **4** | 3 | 2 | 3 | 1 | 2 | | | | | | | 2 | 3 | 1 | 2 |
| **5** | 3 | 2 | 3 | 1 | 2 | | | | | | | 2 | 3 | 1 | 2 |
| **Avg** | **3** | **2** | **3** | **1** | **2** | | | | | | | **2** | **3** | **1** | **2** |
| Low (1); Medium (2); High (3) | | | | | | | | | | | | | | | |

| CE3301 | Fluid Mechanics | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives**:

- To introduce the students about properties and behaviour of the fluids under static conditions and to impart basic knowledge of the dynamics of fluids through the control volume approach and to expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends with an exposure to the significance of boundary layer theory and its applications.

**Unit I Fluids Properties and Fluid Statics 10**

Scope of fluid mechanics – Definitions of a fluid – Methods of analysis – Continuum hypothesis – System and Control volume approach – Reynold's transportation theorem – Fluid properties – Fluid statics – Manometry – Forces on plane and curved surfaces – Buoyancy and floatation – Stability of floating bodies.

**Unit II Basic Concepts of Fluid Flow 10**

Kinematics: Classification of flows – Streamline, streak-line and path-lines – Stream function and velocity potentials – Flow nets;
Dynamics : Application of control volume to continuity, energy and momentum – Euler's equation of motion along a stream line – Bernoulli's equation – Applications to velocity and discharge measurements – Linear momentum equation – Application to Pipe bends – Moment of momentum equation.

**Unit III Dimensional Analysis and Model Studies 7**

Fundamental dimensions – Dimensional homogeneity – Rayleigh's method and Buckingham Pi theorem – Dimensionless parameters – Similitude and model studies – Distorted and undistorted models.

**Unit IV Incompressible Viscous Flow 10**

Reynolds experiment – Laminar flow in pipes and between parallel plates – Development of laminar and turbulent flows in pipes – Darcy-Weisbach equation – Moody diagram – Major and minor losses of flow in pipes – Total energy line – Hydraulic grade line – Siphon – Pipes in series and parallel – Equivalent pipes.

**Unit V Boundary Layers 8**

Definition of boundary layers – Laminar and turbulent boundary layers – Displacement, momentum and energy thickness – Momentum integral equation – Applications – Separation of boundary layer – Drag and Lift forces.

**Total: 45 Periods**

**Course Outcomes:**
On completion of the course, the student is expected to

**CO1** Demonstrate the difference between solid and fluid, its properties and behaviour in static conditions.
**CO2** Apply the conservation laws applicable to fluids and its application through fluid kinematics and dynamics.
**CO3** Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performance of prototypes by model studies.

**CO4** Estimate the losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel.

**CO5** Explain the concept of boundary layer and its application to find the drag force excreted by the fluid on the flat solid surface.

**Text Books:**


1. Modi P.N and Seth Hydraulics and Fluid Mechanics including Hydraulic Machines Standard Book House New Delhi. 2015.
2. Streeter, V.L. Wylie, E. B. and Bedford K.W, Fluid Mechanics. (9th Ed.) Tata McGraw Hill, New Delhi, 1998.


**References:**


1. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
4. Narayana Pillai N. Principles of Fluid Mechanics and Fluid Machines, (3rd Ed.) University Press (India) Pvt. Ltd. 2009.


**COs- PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO 1 | CO2 | CO 3 | CO 4 | C O5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 2 | 2 | 3 | 3 | 2 |
| PO3 | Design / development of solutions | 1 | 1 | 3 | 3 | 2 | 3 |
| PO4 | Investigation | 1 | 1 | 2 | 2 | 2 | 2 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 1 | 1 | 1 |
| PO6 | Engineer and Society | 2 | 2 | 2 | 3 | 3 | 2 |
| PO7 | Environment and Sustainability | 2 | 2 | 2 | 2 | 2 | 2 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 1 | 1 |
| PO9 | Individual and Team work | 1 | 1 | 1 | 1 | 1 | 1 |
| PO10 | Communication | 1 | 1 | 1 | 1 | 1 | 1 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 3 | 3 | 2 |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 2 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 1 | 1 | 2 | 3 | 3 | 3 |

| CE3302 | Construction Materials and Technology | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To introduce students to various construction materials and the techniques that are commonly used in civil engineering construction.

**Unit I Stones - Bricks - Concrete Blocks - Lime 9**

Stone as building material – Criteria for selection – Tests on stones – Bricks – Classification – Manufacturing of clay bricks – Tests on bricks – Compressive strength – Water Absorption – Efflorescence – Lime – Preparation of lime mortar – Concrete hollow blocks – Lightweight concrete blocks.

**Unit II Other Materials 9**

Timber – Market forms – Plywood – Veneer – False ceiling materials – Steel – Mechanical treatment – Aluminum – Uses – Market forms – Glass – Ceramics – Refractories – Composite Materials – Types and applications – FRP – Fibre textiles – Geomembranes and Geotextiles for earth reinforcement.

**Unit III Construction Practices & Service Requirements 9**

Types of Foundations – Shallow and Deep Foundations – Stone Masonry – Brick Masonry – Plastering and Pointing – Cavity Walls – Diaphragm Walls – Formwork – Centering and Shuttering – Shoring – Scaffolding – Underpinning – Roofing – Flooring – Joints in concrete – Contraction/Construction/Expansion joints – Fire Protection – Thermal Insulation – Ventilation and Air conditioning – Acoustics and Sound Insulation – Damp Proofing.

**Unit IV Construction Equipments 9**

Selection of equipment for earthwork excavation, concreting, material handling and erection of structures – Dewatering and pumping equipment.

**Unit V Construction Planning 9**

Introduction to construction planning – Scheduling for activities – Critical path method (CPM) and PERT network modelling and time analysis – Case illustrations.

**Total: 45 Periods**

**Course Outcomes**

Students will be able to

**CO1** Identify the good quality brick, stone and blocks for construction.

**CO2** Recognize the market forms of timber, steel, aluminum and applications of various composite materials.

**CO3** Identify the best construction and service practices such as thermal insulations and air conditioning of the building

**CO4** Select various equipments for construction works conditioning of building

**CO5** Understand the construction planning and scheduling techniques

**Text Books**

1. Varghese.P.C, Building Materials, Second Edition PHI Learning Ltd., 2015.
2. Arora S.P and Bindra S.P Building construction, Dhanpat Rai and sons, 2013.

**References:**


1. Varghese.P.C, Building Construction, Second Edition PHI Learning ltd., 2016.
2. Punmia ,B.C Building construction , Laxmi publication (p)ltd..,2008.
3. Peurifoy R.L., Schexnayder,C.J., Shapira A., Schmitt.R., Construction Planning Equipment and Methods, Tata McGraw-hill, 2011.
4. Srinath L.S.,PERT and CPM -Principles and applications, Affliated East West Press 2001


**COs- PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of CO s to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 2 | 3 | 3 | 2 | 2 | 2 |
| PO2 | Problem analysis | 2 | | | | 3 | 2 |
| PO3 | Design / development of solutions | | | | | 2 | 1 |
| PO4 | Investigation | 3 | 2 | 2 | | 3 | 2 |
| PO5 | Modern Tool Usage | | | | | 2 | 1 |
| PO6 | Engineer and Society | 2 | | | | 2 | 1 |
| PO7 | Environment and Sustainability | 2 | 2 | 3 | | | 2 |
| PO8 | Ethics | | | | | | |
| PO9 | Individual and Team work | | | | | 2 | 1 |
| PO10 | Communication | | | | | | |
| PO11 | Project Management and Finance | | | 2 | 2 | 3 | 2 |
| PO12 | Life Long Learning | 2 | 2 | | | 2 | 2 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | | | | 3 | 3 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | | 2 | 2 | | 3 | 2 |

| EN3301 | Environmental Chemistry | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

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**Course Objectives:**

- To educate the students in the area of water, air and soil chemistry
- To explain the theoretical basis and observational methods for study of contaminants and interactions in the environment

**Unit I Fundamentals 9**

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product(Ksp) ,heavy metal precipitation, amphoteric hydroxides, $CO_2$ solubility in water and species distribution – Ocean acidification, Chemical kinetics , First order- 12 Principles of green chemistry.

**Unit II Aquatic Chemistry 9**

Water and wastewater quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals - Metals, complex formation, oxidation and reduction , pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation.

**Unit III Atmospheric Chemistry 9**

Atmospheric structure – chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO2 capture and sequestration – acid rain- origin and composition of particulates. black carbon, air quality parameters determination.

**Unit IV Soil Chemistry 9**

Nature and composition of soil - Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – agricultural chemicals in soil-reclamation of contaminated land; salt by leaching- Heavy metals by electrokinetic remediation.

**Unit V Emerging Pollutants 9**

Heavy metals-chemical speciation –Speciation of Hg & As- endocrine disturbing chemicals-Pesticides, Dioxins & Furan, PCBs , PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites, environmental applications

**Total : 45 Periods**

**Course outcomes:**

On completion of the course, the student is expected to

**CO1**: Gain competency in solving environmental issues of chemicals based pollution

**CO2**: Determine chemicals mobility in aquatic systems

**CO3**: Identify contaminating chemicals in air and their fate

**CO4**: Understand the type of soil contaminants and provide remediation

**CO5**: Identify emerging environmental contaminants including speciation

**References:**

1. Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2017.

2. Colin Baird„ Environmental Chemistry, Freeman and company, New York, 5th Edition, 2012.
3. Manahan, S.E., "Environmental Chemistry", Eleventh Edition, CRC press, 2022.
4. Ronald A. Hites,"Elements of Environmental Chemistry", Wiley, 2nd Edition, 2020.

**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | | | | | 3 | 3 | | 1 | 1 | | 1 | 3 | 2 | 2 |
| **2** | | 2 | | 2 | 2 | 3 | | | | | | 1 | 3 | 2 | 2 |
| **3** | | 3 | 3 | 3 | 2 | 3 | | | | | 2 | | 3 | 2 | 2 |
| **4** | | 3 | 2 | 2 | 2 | | | 2 | | | 2 | | 3 | 2 | 2 |
| **5** | | | 3 | 3 | | | | 2 | | | 2 | | 3 | 2 | 2 |
| **Avg.** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 1 | 3 | 2 | 2 |

| CE3351 | Surveying and Levelling | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To introduce the rudiments of plane surveying and geodetic principles to Civil Engineers and to learn the various methods of plane and geodetic surveying to solve the real world problems. To introduce the concepts of Control Surveying. To introduce the basics of Astronomical Surveying

**Unit I Fundamentals of Conventional Surveying 9**

Definition – Classifications – Basic principles – Equipment and accessories for ranging and chaining – Methods of ranging – Well conditioned triangles – Chain traversing – Compass – Basic principles – Types – Bearing – System and conversions – Sources of errors and Local attraction – Magnetic declination – Dip – compass traversing – Plane table and its accessories – Merits and demerits – Radiation – Intersection – Resection – Plane table traversing.

**Unit II Levelling 9**

Level line – Horizontal line – Datum – Benchmarks – Levels and staves – Temporary and permanent adjustments – Methods of leveling – Fly leveling – Check leveling – Procedure in leveling – Booking – Reduction – Curvature and refraction – Reciprocal leveling – Precise leveling - Contouring.

**Unit III Theodolite Surveying 9**

Horizontal and vertical angle measurements – Temporary and permanent adjustments – Heights and distances – Tacheometric surveying – Stadia Tacheometry – Tangential Tacheometry – Trigonometric leveling – Single Plane method – Double Plane method.

**Unit IV Control Surveying and Adjustment 9**

Horizontal and vertical control – Methods – Triangulation – Traversing – Gale‘s table – Trilateration – Concepts of measurements and errors – Error propagation and Linearization – Adjustment methods - Least square methods – Angles, lengths and levelling network.

**Unit V Modern Surveying 9**

Total Station: Digital Theodolite, EDM, Electronic field book – Advantages – Parts and accessories – Working principle – Observables – Errors - COGO functions – Field procedure and applications. GPS: Advantages – System components – Signal structure – Selective availability and antispoofing receiver components and antenna – Planning and data acquisition – Data processing – Errors in GPS – Field procedure and applications.

**Total :45 Periods**

**Course Outcomes:**

On completion of the course, the student is expected to

**CO1** Introduce the rudiments of various surveying and its principles.
**CO2** Imparts knowledge in computation of levels of terrain and ground features
**CO3** Imparts concepts of Theodolite Surveying for complex surveying operations
**CO4** Understand the procedure for establishing horizontal and vertical control
**CO5** Imparts the knowledge on modern surveying instruments

**Text Books:**

1. Dr. B. C. Punmia, Ashok K. Jain and Arun K Jain, Surveying Vol. I & II, Lakshmi Publications Pvt Ltd, New Delhi, Sixteenth Edition, 2016.
2. T. P. Kanetkarand S. V. Kulkarni, Surveying and Levelling, Parts 1 & 2, Pune Vidyarthi Griha Prakashan, Pune, 2008.

**References:**

1. R. Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.
2. James M. Anderson and Edward M. Mikhail, Surveying, Theory and Practice, Seventh Edition, Mc Graw Hill 2001.
3. Bannister and S. Raymond, Surveying, Seventh Edition, Longman 2004.
4. S. K. Roy, Fundamentals of Surveying, Second Edition, Prenticeˆ Hall of India2010.
5. K. R. Arora, Surveying Vol I & II, Standard Book house, Twelfth Edition 2013.
6. C. Venkatramaiah, Textbook of Surveying, Universities Press, Second Edition, 2011.

**COs- PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of CO s to POs |
|---|---|---|---|---|---|---|---|
| | | CO 1 | CO 2 | CO 3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES(PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 2 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 3 | 3 | 3 | 3 | 2 |
| PO3 | Design / development of solutions | 3 | 2 | 3 | 3 | 3 | 3 |
| PO4 | Investigation | 2 | 2 | 2 | 3 | 3 | 2 |
| PO5 | Modern Tool Usage | 2 | 2 | 3 | 3 | 3 | 3 |
| PO6 | Engineer and Society | 3 | 3 | 3 | 3 | 3 | 3 |
| PO7 | Environment and Sustainability | | | | 2 | 2 | 2 |
| PO8 | Ethics | 2 | 2 | 2 | 2 | 3 | 2 |
| PO9 | Individual and Team work | 2 | 2 | 2 | 3 | 2 | 2 |
| PO10 | Communication | | | | | | |
| PO11 | Project Management and Finance | 2 | 2 | 2 | 2 | 2 | 2 |
| PO12 | Life Long Learning | | | | 2 | 2 | 2 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering | 3 | 3 | 3 | 3 | 3 | 3 |

| CE3361 | Surveying and Levelling Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |

**Course objective:**

- At the end of the course the student will possess knowledge about survey field techniques

**List of Experiments:**

**Chain Survey**

1. Study of chains and its accessories, Aligning, Ranging, Chaining and Marking Perpendicular offset
2. Setting out works – Foundation marking using tapes single Room and Double Room

**Compass Survey**

3. Compass Traversing – Measuring Bearings & arriving included angles

**Levelling - Study of levels and levelling staff**

4. Fly levelling using Dumpy level &Tilting level
5. Check levelling

**Theodolite - Study of Theodolite**

6. Measurements of horizontal angles by reiteration and repetition and vertical angles
7. Determination of elevation of an object using single plane method when base is Accessible/inaccessible.

**Tacheometry – Tangential system – Stadia system**

8. Determination of Tacheometric Constants
9. Heights and distances by stadia Tacheometry
10. Heights and distances by Tangential Tacheometry

**Total Station - Study of Total Station, Measuring Horizontal and vertical angles**

11. Traverse using Total station and Area of Traverse
12. Determination of distance and difference in elevation between two inaccessible points using Total station

**Total: 45 Periods**

**Course Outcomes**

On completion of the course, the student is expected to

**CO1** Impart knowledge on the usage of basic surveying instruments like chain/tape, compass and levelling instruments

**CO2** Able to use levelling instrument for surveying operations

**CO3** Able to use theodolite for various surveying operations

**CO4** Able to carry out necessary surveys for social infrastructures

**CO5** Able to prepare planimetric maps

**References:**


1. T. P. Kanetkarand S. V. Kulkarni, Surveying and Levelling, Parts 1 & 2, Pune Vidyarthi Griha Prakashan, Pune, 24th Reprint, 2015.
2. Dr. B. C. Punmia, Ashok K. Jainand Arun K Jain, Surveying Vol. I & II, Lakshmi Publications Pvt Ltd, New Delhi, 17th Edition, 2016.
3. James M. Anderson and Edward M. Mikhail, Surveying, Theory and Practice, Seventh Edition, McGraw Hill 2001
4. Bannisterand S. Raymond, Surveying, Seventh Edition, Longman 2004 a. David Clark, Plane and Geodetic Surveying for Engineers, Volume I, Constable and Company Ltd, London, CBS, 6th Edition, 2004.
5. David Clark and James Clendinning, Plane and Geodetic Surveying for Engineers, VolumeII, Constable and Company Ltd, London, CBS, 6th Edition, 2004.
6. S. K. Roy, Fundamentals of Surveying, Second Edition, Prentice 'Hall of India 2004
7. K. R. Arora, Surveying Vol. I & II, Standard Book house, Eleventh Edition, 2013.


**COs- PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 2 | 1 | 3 | 3 | 2 |
| PO3 | Design / development of solutions | 3 | 3 | 2 | 2 | 3 | 3 |
| PO4 | Investigation | 3 | | | 3 | 2 | 3 |
| PO5 | Modern Tool Usage | 2 | 3 | 3 | 2 | 2 | 3 |
| PO6 | Engineer and Society | 3 | 3 | 2 | 3 | 3 | 3 |
| PO7 | Environment and Sustainability | 2 | 3 | | 3 | 3 | 3 |
| PO8 | Ethics | 3 | 3 | | 2 | 2 | 3 |
| PO9 | Individual and Team Work | 3 | 3 | 3 | 3 | 3 | 3 |
| PO10 | Communication | 3 | 3 | | 3 | 3 | 3 |
| PO11 | Project Management and Finance | 3 | 3 | | 3 | 3 | 3 |
| PO12 | Life Long Learning | 1 | 1 | 2 | 1 | 1 | 1 |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 3 | 3 | 3 | 3 | 3 | 3 |

| EN3311 | Environmental Fluid Mechanics Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |

**Course Objective**:

- To provide hands on experience in calibration of flow meters, performance characteristics of pumps and turbines.

**List of Experiments**

**A. Flow Measurement**

1. Bernoulli's Experiment
2. Calibration of Rotameter
3. Flow through Orifice meter/Mouthpiece,
4. Flow through Venturi meter and Notches

**B. Losses in Pipes**

5. Determination of friction factor in pipes.
6. Determination of minor losses

**C. Pumps**

7. Characteristics of Centrifugal pumps
8. Characteristics of Gear pump
9. Characteristics of Submersible pump
10. Characteristics of Reciprocating pump

**Total : 45 Periods**

**Course Outcomes:**

On completion of the course, the student is expected to be able to

**CO1** Understand and Apply the concept of Bernoulli equation in fluid flow
**CO2** Calibrate the flow measuring devices in a pipe line/channel
**CO3** Measure friction factor in pipes and compare with Moody diagram
**CO4** Determine the performance characteristics of rotodynamic pumps.
**CO5** Determine the performance characteristics of positive displacement pumps.

**References**:


1. Hydraulic Laboratory Manual
2. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics. Standard Book House. New Delhi, 2017.
3. Subramanya K, Fluid Mechanics and Hydraulic Machines, Tata McGraw Hill Edu. Pvt. Ltd. 2011

**CO's-PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering | 2 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 2 | 3 | 3 | 3 | 3 |
| PO3 | Design / development of | 1 | 1 | 2 | 2 | 2 | 2 |
| PO4 | Investigation | 3 | 3 | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 1 | 1 | 1 |
| PO6 | Engineer and Society | 2 | 2 | 2 | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 2 | 2 | 2 | 2 | 2 | 2 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 1 | 1 |
| PO9 | Individual and Team work | 2 | 2 | 3 | 3 | 3 | 2 |
| PO10 | Communication | 1 | 1 | 1 | 1 | 1 | 1 |
| PO11 | Project Management and | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO1 | Knowledge of Civil Engineering | 2 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and | 1 | 1 | 2 | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering | 1 | 1 | 1 | 1 | 1 | 1 |

| GE3361 | Professional Development | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 1 |

**Course Objectives:**

- To be proficient in important Microsoft Office tools: MS WORD, EXCEL, POWERPOINT.
- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

**MS word:** **10 Hours**

Create and format a document
Working with tables
Working with Bullets and Lists
Working with styles, shapes, smart art, charts
Inserting objects, charts and importing objects from other office tools
Creating and Using document templates
Inserting equations, symbols and special characters
Working with Table of contents and References, citations
Insert and review comments
Create bookmarks, hyperlinks, endnotes footnote
Viewing document in different modes
Working with document protection and security
Inspect document for accessibility

**MS Excel:** **10 Hours**

Create worksheets, insert and format data
Work with different types of data: text, currency, date, numeric etc.
Split, validate, consolidate, Convert data
Sort and filter data
Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,)
Work with Lookup and reference formulae
Create and Work with different types of charts
Use pivot tables to summarize and analyse data
Perform data analysis using own formulae and functions
Combine data from multiple worksheets using own formulae and built-in functions to generate results
Export data and sheets to other file formats
Working with macros
Protecting data and Securing the workbook

**MS Powerpoint:** **10 Hours**

Select slide templates, layout and themes
Formatting slide content and using bullets and numbering
Insert and format images, smart art, tables, charts
Using Slide master, notes and handout master
Working with animation and transitions
Organize and Group slides
Import or create and use media objects: audio, video, animation
Perform slideshow recording and Record narration and create presentable videos

**Total: 30 Periods**

**Course Outcomes:**

On successful completion the students will be able to

**CO1** Use MS Word to create quality documents, by structuring and organizing content for their day to day technical and academic requirements

**CO2** Use MS EXCEL to perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding

**CO3** Use MS PowerPoint to create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects.

| CE3401 | Applied Hydraulics Engineering | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**Course Objectives**:

- To impart basic knowledge to the students about the open channel flows with analysis of uniform flow, gradually varied flow and rapidly varied flow and to expose them to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, Centrifugal and Reciprocating pumps.

**Unit I Uniform Flow** **9+3**

Definition and differences between pipe flow and open channel flow - Types of Flow - Properties of open channel - Fundamental equations - Sub-critical, Super-critical and Critical flow - Velocity distribution in open channel - Steady uniform flow: Chezy's equation, Manning equation - Best hydraulic sections for uniform flow - Computation in Uniform Flow - Specific energy and specific force.

**Unit II Varied Flows** **9+3**

Dynamic equations of gradually varied - Water surface flow profile classifications: Hydraulic Slope, Hydraulic Curve - Profile determination by Numerical method: Direct step method and Standard step method – Change in Grades.

**Unit III Rapidly Varied Flows** **8+3**

Application of the momentum equation for RVF - Hydraulic jumps - Types - Energy dissipation – Positive and Negative surges.

**Unit IV Turbines** **9+3**

Turbines - Classification - Impulse turbine – Pelton wheel - Reaction turbines - Francis turbine - Kaplan turbine - Draft tube - Cavitation - Performance of turbine - Specific speed - Runaway speed – Minimum Speed to start the pump.

**Unit V Pumps** **9+3**

Centrifugal pumps - Minimum speed to start the pump - NPSH - Cavitation's in pumps - Operating characteristics - Multistage pumps - Reciprocating pumps - Negative slip - Indicator diagrams and its variations - Air vessels - Savings in work done.

**Total: (L: 45+ T: 15) 60 Periods**

**Course Outcomes:**

On completion of the course, the student is expected to

**CO1** Describe the basics of open channel flow, its classification and analysis of uniform flow in steady state conditions with specific energy concept and its application

**CO2** Analyse steady gradually varied flow, water surface profiles and its length calculation using direct and standard step methods with change in water surface profiles due to change in grades.

**CO3** Derive the relationship among the sequent depths of steady rapidly varied flow and estimating energy loss in hydraulic jump with exposure to positive and negative surges.

**CO4** Design turbines and explain the working principle

**CO5** Differentiate pumps and explain the working principle with characteristic curves and design centrifugal and reciprocating pumps.

**Text books:**

1. Jain. A.K., Fluid Mechanics, Khanna Publishers, Delhi, 2010.
2. Chandramouli P N, Applied Hydraulic Engineering, Yes Dee Publisher, 2017

**References:**

1. Ven Te Chow, Open Channel Hydraulics, McGraw Hill, New York, 2009.
2. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 19th edition, 2013.
3. Mays L. W., Water Resources Engineering, John Wiley and Sons (WSE), New York, 2019
4. Subramanya K., Flow in open channels, Tata McGraw Hill, New Delhi, 2019.

**COs- PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 3 | 3 | 3 | 3 | 3 | 3 |
| PO3 | Design / development of solutions | 2 | 2 | 2 | 3 | 3 | 2 |
| PO4 | Investigation | 3 | 3 | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | 1 | 2 | 1 | 1 | 1 | 1 |
| PO6 | Engineer and Society | 2 | 2 | 2 | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 2 | 2 | 2 | 2 | 2 | 2 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 1 | 1 |
| PO9 | Individual and Team work | 2 | 2 | 2 | 2 | 2 | 2 |
| PO10 | Communication | 1 | 1 | 1 | 1 | 1 | 1 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 2 | 2 | 3 | 3 | 3 | 3 |

| CE3402 | Strength of Materials | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To learn the fundamental concepts of Stress in simple and complex states and to know the mechanism of load transfer in beams and the induced stresses due to simple bending and unsymmetrical bending and to determine the deformation in determinate beams and to know the basic concepts of analysis of indeterminate beams.

**Unit I Simple and Compound Stresses 9**

Stresses in simple and compound bars – Thermal stresses – Elastic constants - Thin cylindrical and spherical shells – Biaxial state of stress – Principal stresses and principal planes – Mohr's circle of stresses - Torsion on circular shafts.

**Unit II Bending of Beams 9**

Types of beams and transverse loadings– Shear force and bending moment for simply supported, cantilever and over-hanging beams - Theory of simple bending – Bending stress distribution – Shear stress distribution.

**Unit III Deflection of Beams 9**

Double Integration method – Macaulay's method – Area moment method – Conjugate beam method - Strain energy method for determinate beams.

**Unit IV Indeterminate Beams 9**

Propped Cantilever and Fixed Beams – Fixed end moments reactions, slope and deflection for standard cases of loading –– Continuous beams – support reactions and moments – Theorem of three moments – Shear Force and Bending Moment Diagrams.

**Unit V Advanced Topics 9**

Unsymmetrical bending of beams - shear centerapplied - Thick cylinders - Theories of failure – Principal stress, principal strain, shear stress, strain energy and distortion energy theories – application problems.

**Total: 45 Periods**

**Course Outcomes:**

Students will be able to

**CO1** Understand the concepts of stress and strain, principal stresses and principal planes.

**CO2** Determine Shear force and bending moment in beams and understand concept of theory of simple bending.

**CO3** Calculate the deflection of beams by different methods and selection of method for determining slope or deflection.

**CO4** Analyze propped cantilever, fixed beams and continuous beams for external loadings and support settlements.

**CO5** Determine the stresses due to Unsymmetrical bending of beams, locate the shear center, and study the various theories of failure

**Text Books**


1. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 2018.
2. Rattan.S.S., "Strength of Materials", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2017.
3. Punmia B.C., Ashok Kumar Jain and Arun Kumar Jain,"Theory of Structures" (SMTS) Vol - II, Laxmi Publishing Pvt Ltd, New Delhi 2017.
4. Basavarajiah and Mahadevapa, Strength of Materials, University press, Hyderabad, 2016
5. Vazirani.V.N, Ratwani.M.M, Duggal .S.K Analysis of Structures: Analysis, Design and Detailing of Structures-Vol.1, Khanna Publishers, New Delhi 2014.


**References:**


1. Kazimi S.M.A, “Solid Mechanics”, Tata McGraw-Hill Publishing Co., New Delhi, 2017
2. William A .Nash, “Theory and Problems of Strength of Materials”, Schaum’s Outline Series, Tata McGraw Hill Publishing company, 2017.
3. Singh. D.K., “ Strength of Materials”, Ane Books Pvt. Ltd., New Delhi, 2021
4. Egor P Popov, “Engineering Mechanics of Solids”, 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015
5. Irwing H.Shames, James M.Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India, New Delhi, 2002
6. Beer. F.P. &Johnston.E.R.“Mechanics of Materials”, Tata McGraw Hill, Sixth Edition, New Delhi 2010.
7. James M.Gere., Mechanics of Materials, Thomas Canada Ltd., Canada, 2006.
8. Egor. P.Popov, Engineering Mechanics of Solids, Prentice Hall of India, Second Edition New Delhi 2015.


**COs- PO’s & PSO’s MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PROGRAM OUTCOMES(PO) | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 3 | 3 | 3 | 3 | 3 | 3 |
| PO3 | Design / development of solutions | 3 | 3 | 3 | 3 | 3 | 3 |
| PO4 | Investigation | 3 | 3 | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | 2 | 2 | 2 | 2 | 2 | 2 |
| PO6 | Engineer and Society | 3 | 3 | 3 | 3 | 3 | 3 |
| PO7 | Environment and Sustainability | 1 | 1 | 1 | 1 | 1 | 1 |
| PO8 | Ethics | 3 | 3 | 3 | 3 | 3 | 3 |
| PO9 | Individual and Team work | 2 | 2 | 2 | 2 | 2 | 2 |
| PO10 | Communication | 3 | 3 | 3 | 3 | 3 | 3 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 3 | 3 | 3 | 3 | 3 | 3 |

| PROGRAM SPECIFIC OUTCOMES(PSO) | | | | | | | |
|---|---|---|---|---|---|---|---|
| PSO1 | Knowledge of Civil engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Civil Engineering Performance Evaluation and coordination | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization of Civil Engineering Systems | 3 | 3 | 3 | 3 | 3 | 3 |

L T P C

**ER3401 Transportation Engineering** 3 0 0 3

**Course Objective:**

The objective of this course is to provide foundational knowledge on the planning, design, and construction of various transportation systems including highways, railways, airports, and harbours. It aims to equip students with the principles of geometric design, alignment, and functional elements of transportation infrastructure, while also familiarizing them with modern techniques and standards used for effective infrastructure development.

**Unit-I Highway Engineering** **9**

Institutions for Highway planning- Classification of highways- Typical cross sections of Urban and Rural roads- factors influencing highway alignment- Engineering surveys for alignment Conventional and Modern method.

**Unit-II Design of Highway Elements** **9**

Cross sectional elements – Horizontal curves, super elevation, transition curves, widening of curves – Sight distances – Vertical curves, gradients– pavement types, components and their role.

**Unit-III Railway Engineering** **9**

Permanent way - Gauges - Components - Functions and requirements - Geometric design- Urban Rail Transit Planning – MRTS – LRTS, Metro Rail – Monorail.

**Unit-IV Airport Engineering** **9**

Aircraft characteristics - -airport classification- airport site selection- typical Airport Layouts, Airport obstructions and zoning - Runway - Orientation of Runways and correction factors as ICAO stipulations, taxiways and aprons- Terminal area planning

**Unit-V Harbour Engineering** **9**

Docks and Harbours - Types - Layout and planning principles- breakwaters – docks wharves and quays - Transit sheds- warehouses- navigation aids

**Course Outcomes:**

1. Remember the institutions of highway planning and conventional and modern methods of engineering surveys for alignment fixing
2. Design the cross-section elements, sight distance, horizontal and vertical alignment
3. Remember the different elements/components of the Railway/Airport/Harbour/Urban Transit
4. Understand site selection, the functions of different components of the Railway/Airport/Harbour, the methods of construction of the railway and its components and visual aids
5. Design the geometry/layout of the Railway/Airport/Harbour and its components.

**References**


1. Khanna, S.K., Justo, C.E.G. G. and Veeraragavan A., Highway Engineering, Nem Chand and Bros, Roorkee, 2014.
2. Kadiyali, L.R., and Lal, N.B. Principles and Practice of Highway Engineering, Khanna Publishers, 2013.

3. Subramanian K.P., Highways, Railways, Airport and Harbour Engineering, Scitech Publications (India), Chennai, 2010 2. C.
4. Venkatramaiah., Transportation Engineering-Vol.2 Railways, Airports, Docks and Harbours, Bridges and Tunnels.,Universities Press (India) Private Limited, Hyderabad, 2015.

| ER3402 | Soil Mechanics and Foundation Engineering | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objective:**

To enable the students to acquire the essential knowledge about the soil exploration, index, and engineering properties of soils, types of foundations, and their carrying capacity.

**Unit-I Soil Exploration and Classification** **9**

Methods of exploration - Auguring and boring - Wash boring and rotary drilling - Sampling methods - Split spoon sampler, thin wall sampler, Stationary piston sampler - Penetration tests (SPT and SCPT) - Index properties and phase relations - BIS classification system.

**Unit-II Stresses and Settlement** **9**

Effective stress concepts in soils – Total, neutral and effective stresses – Stresses due to applied loads - Stress distribution in homogeneous and isotropic medium – Boussinesq theory – (Point loadand udl) - Computation of total settlement and time rate of settlement using Terzaghi's one dimensional consolidation theory.

**Unit-III Permeability and Seepage** **9**

Soil water – Static pressure in water – Capillary phenomena – Permeability interaction – Hydraulic conductivity – Darcy's law – Determination of Hydraulic Conductivity – Laboratory Determination (Constant head and falling head methods) and field measurement pumping out in unconfined and confined aquifer – Factors influencing permeability of soils – Seepage - Two-dimensional flow – Laplace's equation – Introduction to flow nets – Simple problems. (Sheet pile and weir)

**Unit-IV Foundations** **9**

Foundation – Functions and requisites – Footings and Rafts – Types – Contact pressure distribution - Piers and Caissons – Types – Piles – Classification - Functions – Carrying capacity of piles - Static formula – Selection Factors – Choice of foundation based on soil condition.

**Unit-V Shear Strength and Bearing Capacity** **9**

Shear strength of cohesive and cohesionless soils – Measurement of shear strength - Direct shear, Triaxial compression, UCC and Vane shear tests – Evaluation of Bearing capacity of shallow foundation using BIS formula.

**Total :45 periods**

**References:**


1. Murthy, V.N.S., "Soil Mechanics and Foundation Engineering", CBS Publishers and Distributers Ltd., New Delhi, 2015.
2. Das, B.M. "Principles of Foundation Engineering" (Eighth edition), Thompson Asia Pvt. Ltd., Singapore, 2013.
3. Kaniraj, S.R., "Design aids in Soil Mechanics and Foundation Engineering", Tata McGraw Hill publishing company Ltd., New Delhi, 2002
4. Gopal Ranjan and Rao, A.S.R., "Basic and Applied Soil Mechanics", New Age Ltd. International Publisher New Delhi (India) 2006.
5. Punmia, B.C., "Soil Mechanics and Foundations", Laxmi Publications Pvt. Ltd. New Delhi, 2005

**Relevant Indian standards**

- IS 2720, Indian Standards on methods of test for soils, Bureau of Indian Standards.

**Course Outcomes:**

On completion of the course, the student is expected to be able to

CO1: Outline the soil exploration programme and its significance in determining the properties of soils and their classification.

CO2: Calculate the stress distribution in the soil medium and apply it to the soil settlement analysis.

CO3: Evaluate the engineering properties of soils and understand their field applications.

CO4: Classify the types of foundation and determine their carrying capacity.

| | | L | T | P | C |
|---|---|---|---|---|---|

| EN3302 | Environmental Microbiology | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**Course Objectives:**

- The course provides a basic understanding on microbiology relevant to environmental engineering for candidates with little prior knowledge of the subject
- The morphology, behaviour and biochemistry of bacteria, fungi, protozoa, viruses, and algae are outlined.
- The microbiology of wastewater, sewage sludge and solid waste treatment processes is also provided. Aspects on nutrient removal and the transmission of disease causing organisms are also covered.
- An exposure to toxicology due to industrial products and by-products are also covered.

**Unit I Fundamentals of Microbiology 9**

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, importance, introduction to water, soil and air borne pathogens and Parasites and their effects on human, animal and plant health, transmission of pathogens, transmissible diseases – bacterial, viral, protozoan, and helminths parasites, concentration and detection of virus. control of microorganisms preservation of microorganisms, DNA, RNA, replication, recombinant DNA technology, their potential applications and intellectual property rights.

**Unit II Microbial Diversity and Nutrient Turnover 9**

Distribution of microorganisms in different environments – diversity of microorganisms – fresh and marine, terrestrial – microbes in surface soil, air – outdoor and Indoor, aerosols, bio safety in laboratory – extreme environment – archae bacteria – occurrence in water supplies – problems and control. biogeochemical cycles-nitrogen, carbon, phosphorus, sulphur – Role of Microorganism in nutrient cycle.

**Unit III Metabolism of Microorganisms 9**

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, bioenergetics, disruption in metabolism and disease. biodegradation of organic pollutants

**Unit IV Microbiology OF Wastewater Treatment Systems 9**

Microbiology of biological treatment processes – aerobic and anaerobic, α-oxidation, β-oxidation, nitrification and denitrification, eutrophication. nutrients removal – BOD, nitrogen, phosphate. microbiology of sewage sludge - indicator organisms of water – coliforms - total coliforms, E-coli, streptococcus, clostridium, Bioleaching

**Unit V Toxicology 9**

Ecotoxicology – toxicants and toxicity, factors influencing toxicity.effects – acute, chronic, test organisms – toxicity testing-lab and field testing methods, bioconcentration – Bioaccumulation, biomagnification, bioassay, biomonitoring.

**Total : 45 Periods**

**Course Outcomes:**

**On completion of the course, the student is expected to**

**CO1** Explain the basic importance and functional elements of environmental microbiology including the potential applications in the environment and intellectual property rights.

**CO2** Understand and describe the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.

**CO3** Understand the metabolic processes on carbohydrates, protein and lipids, importance of enzymes, production of energy and the various additional metabolic processes.

**CO4** Select and apply appropriate methods for assessing the water, air and soil borne pathogens, their health implications, importance of microbes in aerobic and anaerobic cycles and deterioration of water bodies.

**CO5** Conduct testing and research on toxicology, understand the importance of test organisms, environmental applications such as biomagnifications, biomonitoring and in developing risk based standards.

**References:**


1. Bhatia S.C. , "Hand Book of Environmental Microbiology", Part 1 and 2, Atlantic Publisher, 2008
2. Gabriel Bitton, Wastewater Microbiology, 3rd Edition, 2005
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press,3rd Edition 2014
4. Volodymyr Ivanov,Environmental Microbiology for Engineers 2nd Edition, CRC Press, 2021, ISBN 9781498702126
5. N duka Okafor, Environmental Microbiology of Aquatic and Waste systems. Springer Publishers, 2011, ISBN 978-94-007-1459-5
6. Stanley E. Manahan, "Environmental Science and Technology", Lewis Publishers, 2008.
7. Hurst, C.J. Manual of "Environmental Microbiology". 2nd Ed. ASM PRESS, Washington, D.C. ISBN 1-55581 - 199 - X. 2007
8. Frank C. Lu and Sam Kacew, LU"s Basic Toxicology, Taylor & Francis, London 5th Ed, 2009.


**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 2 | | | | | | 2 | | 2 | | | 2 | 2 | |
| 2 | | 2 | | 2 | 2 | 2 | | | | | | | 3 | 2 | |
| 3 | | | | 2 | | 2 | | | | | | | 3 | 2 | 3 |
| 4 | 3 | 2 | | | 2 | | | 2 | 2 | 2 | 2 | | 3 | 2 | 3 |
| 5 | | 2 | 3 | 2 | | | 1 | | | | | 1 | | 2 | |
| Avg. | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 |

| ER3403 | Environmental Legislations and Policies | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course objective:**

To impart knowledge on the policies, legislations, institutional frame work and enforcement mechanisms for environmental management in India.

**Unit-I Environmental Acts** **9**

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

**Unit-II WATER (Pollution, Control and Prevention) ACT, 1974** **9**

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation-Amendments

**Unit-III AIR (Pollution, Control and Prevention) ACT, 1981** **9**

Power & functions of regulatory agencies - responsibilities of Occupier Provision relating to prevention and control Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation- Amendments

**Unit-IV Environment (Protection) Act 1986** **9**

Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorisation – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards.

**Unit-V Other Environmental Acts in India** **9**

Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Writ petitions - Supreme Court Judgments in Landmark cases.

**Course Outcomes:**

CO1 : Explain the Indian policies and legislations pertaining to prevention and control of water pollution, air pollution and waste management

CO2 : Insight into the Environmental Protection Act and the associated Rules knowledge on the Institutional setup for Environmental management and pollution control.

**References**


1. CPCB, “Pollution Control acts, Rules and Notifications issued there under “Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
2. Shyam Divan and Armin Roseneranz “Environmental law and policy in India “Oxford University Press, New Delhi, 2001.
3. Greger I. Megregor, “Environmental law and enforcement”, Lewis Publishers, London. 1994.


| | CO Description | PO Mapping | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|
| **CO1** | Explain the Indian policies and legislations pertaining to prevention and control of water pollution, air pollution and waste management | PO1 (2)<br>PO2 (2)<br>PO6 (3)<br>PO11 (3) | 3 | | 2 |
| **CO2** | Insight into the Environmental Protection Act and the associated Rules knowledge on the Institutional setup for Environmental management and pollution control. | PO1 (2)<br>PO2 (2)<br>PO6 (3)<br>PO11 (3) | | 3 | 2 |

| EN3411 | Environmental Chemistry and Microbiology Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To train in the analysis of physico-chemical parameters with hands on experience
- To train the students in the analysis of various microbiological techniques, microbiological analysis, enzyme assay, pollutant analysis and operation of bioreactors.

**A: Environmental Chemistry**

1. Estimation of hardness in Water sample by volumetric titration
2. Estimation of Chloride in Water sample by volumetric titration
3. Determination of sulphate
4. Determination of phosphate
5. Determination of Total Solids, Total suspended solids, Total dissolved solids
6. Determination of COD in the wastewater sample
7. Determination of BOD in the wastewater sample

**B: Environmental Microbiology**

1. Preparation of culture media
2. Isolation and Culturing of Microorganisms
3. Gram Staining of bacteria
4. Bacteriological analysis of wastewater (Coliforms & Streptococcus) – MPN Technique
5. Bacteriological analysis of wastewater (Coliforms & Streptococcus MF technique

**Total: 60 Periods**

**Course Outcomes**

**CO1** Analyze the water quality parameters such as hardness chloride and sulphate
**CO2** Characterize the wastewater parameters like phosphate, solids COD and BOD
**CO3** Prepare culture media necessary for microbial growth
**CO4** Isolate and culture the bacteria - identify the bacteria -able to handle microscope
**CO5** Analyze the coliform count in the wastewater.

**References**

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 23rd Ed. Washington, 2017
2. "Laboratory Manual for the Examination of water, wastewater soil, Rump, H.H. and Krist, H. – Second Edition, VCH, Germany, 3rd Edition, 1999.
3. Charles P. Gerba, "Environmental Microbiology: A laboratory manual", Elsevier Publications, 3rd, 2014

**CO's, PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | 2 | | 3 | | 3 | 1 | 3 | | 3 | | 2 | 2 | 1 | |
| **2** | 3 | 2 | | 3 | 2 | 3 | 1 | 3 | | 3 | | 2 | 1 | | 2 |
| **3** | 2 | 2 | 1 | 3 | 2 | 3 | 1 | 3 | | 3 | | 2 | | | |
| **4** | 2 | 2 | | 3 | 2 | 3 | 1 | 3 | 2 | 3 | 1 | 2 | | | 1 |
| **5** | 3 | 2 | | 3 | 2 | 3 | 1 | 3 | | 3 | | 2 | | 1 | |
| **Avg.** | 3 | 2 | 1 | 3 | 2 | 3 | 1 | 3 | 2 | 3 | 1 | 2 | 1 | 1 | 2 |

**1.low, 2-medium, 3-high, '-"- no correlation**

**Note: The average value of this course to be used for program articulation matrix.**

| CE3412 | Materials Testing Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives**:

- To develop skills to test various construction materials.

**I. Tests on Metals**

a. Tension test on steel rod
b. Torsion test on mild steel rod
c. Deflection test on metal beam
d. Double shear test on metal
e. Impact test on metal specimen (Izod and Charpy)
f. Hardness test on metals (Rockwell and Brinell Hardness Tests)
g. Compression test on helical spring
h. Deflection test on carriage spring

**II. Tests on Cement**

a. Determination of fineness of cement
b. Determination of consistency of cement
c. Determination of specific gravity of cement
d. Determination of initial and final setting time of cement

**III. Tests on Fine Aggregate**

a. Determination of specific gravity and water absorption of fine aggregate
b. Determination of grading of fine aggregate
c. Determination of water absorption for fine aggregate

**IV. Tests on Coarse Aggregate**

a. Determination of compacted and loose bulk density of coarse aggregate
b. Determination of impact value of coarse aggregate
c. Determination of elongation index of coarse aggregate
d. Determination of flakiness index of coarse aggregate
e. Determination of aggregate crushing value of coarse aggregate
f. Determination of specific gravity and water absorption of coarse aggregate

**V. Tests on Bricks**

a. Determination of compressive strength of bricks
b. Determination of water absorption of bricks
c. Determination of efflorescence of bricks

**VI. Tests on Concrete**

a. Determination of slump of concrete
b. Determination of compressive strength of concrete
c. Determination of flowability of self-compacting concrete (Demo only)

**VII. Test on Wood**

Determination of Compression test on wood

**Total: 60 Periods**

**Course Outcomes:**

On completion of the course, the student is expected to

**CO1** Determine the mechanical properties of steel.

**CO2** Determine the physical properties of cement

**CO3** Determine the physical properties of fine and coarse aggregate.

**CO4** Determine the workability and compressive strength of concrete.

**CO5** Determine the strength of brick and wood.

**COs- PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES(PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 2 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 2 | 3 | 3 | 3 | 3 |
| PO3 | Design / development of solutions | 1 | 1 | 2 | 2 | 2 | 2 |
| PO4 | Investigation | 3 | 3 | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 1 | 2 | 1 |
| PO6 | Engineer and Society | 2 | 2 | 2 | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 2 | 2 | 2 | 2 | 2 | 2 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 1 | 1 |
| PO9 | Individual and Team work | 3 | 3 | 3 | 3 | 3 | 3 |
| PO10 | Communication | 1 | 1 | 1 | 1 | 1 | 1 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 2 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 2 | 2 | 2 | 2 | 2 | 2 |

| CE3413 | Soil Mechanics Laboratory | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To develop skills to test the soils for their index and engineering properties and to characterize the soil based on their properties.

**Exercises:**

**1. Determination of Index Properties**

a. Specific gravity of soil solids

b. Grain size distribution – Sieve analysis

c. Grain size distribution - Hydrometer analysis

d. Liquid limit and Plastic limit tests

e. Shrinkage limit and Differential free swell tests

**2. Determination of Insitu density and compaction characteristics**

a. Field density Test (Sand replacement method)

b. Determination of moisture – density relationship using standard proctor compaction test.

**3. Determination of Engineering Properties**

a. Permeability determination (constant head and falling head methods)

b. One dimensional consolidation test (Determination of co-efficient of consolidation only)

c. Direct shear test in cohesion less soil

d. Unconfined compression test in cohesive soil

e. Laboratory vane shear test in cohesive soil

f. Tri-axial compression test in cohesion less soil (Demonstration only)

g. California Bearing Ratio Test

**4. Test On Geosynthetics (Demonstration only)**

a. Determination of tensile strength and interfacial friction angle.

b. Determination of apparent opening sizes and permeability.

**Total: 45 Periods**

**Course Outcomes:**

On completion of the course, the student is expected to

**CO1** Conduct tests to determine the index properties of soils

**CO2** Determine the insitu density and compaction characteristics.

**CO3** Conduct tests to determine the compressibility, permeability and shear strength of soils.

**CO4** Understand the various tests on Geosynthetics.

**References:**


1. Soil Engineering Laboratory Instruction Manual" published by Engineering College Co-operative Society, Anna University, Chennai, 2010.
2. "Saibaba Reddy, E. Ramasastri, K. "Measurement of Engineering Properties of Soils", New age International (P) limited publishers, New Delhi, 2008.
3. Lambe T.W., "Soil Testing for Engineers", John Wiley and Sons, New York, 1951. Digitized 2008.
4. IS Code of Practice (2720) Relevant Parts, as amended from time to time, Bureau of Indian Standards, New Delhi.
5. G.Venkatappa Rao and Goutham .K. Potable, "Geosynthetics Testing – A laboratory Manual", Sai Master Geoenvironmental Services Pvt. Ltd., 1st Edition 2008.
6. Braja M.Das., "Soil Mechanics: Laboratory Manual", Oxford University Press, eighth edition, 2012.


**COs- PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | Overall Correlation of CO s to POs |
|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | |
| **PROGRAM OUTCOMES(PO)** | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 2 | 1 | 3 | 1 | 1 |
| PO2 | Problem analysis | 2 | 2 | 3 | 2 | 2 |
| PO3 | Design / development of solutions | 3 | 3 | 3 | 2 | 3 |
| PO4 | Investigation | 3 | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 2 | 1 |
| PO6 | Engineer and Society | 1 | 1 | 1 | 1 | 1 |
| PO7 | Environment andSustainability | 1 | 1 | 1 | 1 | 1 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 1 |
| PO9 | Individual and Team work | 3 | 3 | 3 | 3 | 3 |
| PO10 | Communication | 1 | 2 | 1 | 1 | 1 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 3 | 3 | 3 | 3 | 3 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 2 | 2 | 2 | 2 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 3 | 3 | 3 | 2 | 3 |
| PSO3 | Conceptualization and evaluation of Engineering solutions to Civil engineering issues | 3 | 2 | 3 | 3 | 3 |

| ER3501 | STRUCTURAL ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVE:**

- To know the behaviour of indeterminate structures using slope deflection and moment distribution method.
- To get exposed to flexibility and stiffness matrix method.
- To explore the behaviour of determinate and indeterminate structures under moving loads.
- To explore the behaviour of arches and suspension cable bridges.

**UNIT - I SLOPE DEFLECTION METHOD 9**

Degree of kinematic indeterminacy and degrees of freedom of beams, frames and trusses. Introduction of slope deflection method - Continuous beams up to a degree of indeterminacy of three, Continuous beams with settlements, Application of slope deflection method to solve non-sway and sway frames.

**UNIT - II MOMENT DISTRIBUTION METHOD 9**

Introduction of moment distribution method - Continuous beams up to a degree of indeterminacy of three, Continuous beams with settlements, Application of slope deflection method to solve non-sway and sway frames.

**UNIT - III FLEXIBILITY METHOD 9**

Introduction to direct flexibility matrix method - Application of flexibility matrix method to solve propped cantilever, fixed and continuous beam, Advantages of stiffness method over flexibility method.

**UNIT - IV STIFFNESS METHOD 9**

Introduction to Element stiffness method - coordinate systems - element and global, Derivation of element stiffness matrix for truss, beam, frame elements in local coordinates. Assembling global stiffness matrix for two span continuous beams, partitioning global stiffness matrix and finding the unknown displacements and reactions

**UNIT – V INFLUENCE LINES DIAGRAMS AND MOVING LOADS 9**

Introduction to influence line diagram (ILD) and Muller Breslau's principle, ILD for BM and SF for cantilever, simply supported, overhanging beams subject to moving point loads and UDL. Introduction to IRC trailer load, Concept of absolute maximum BM in simply supported beams, finding absolute maximum BM and SF in a simply supported beam subjected to series of moving loads, finding absolute maximum BM/SF in a simply supported beam subjected to UDL-shorter and longer than the span.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students will be able to

**CO-1** Apply slope deflection method to analyze determinate and indeterminate structures

**CO-2** Analyse the continuous beams and rigid frames by moment distribution method.

**CO-3** Understand the concept of moment distribution and analysis of continuous beams and rigid frames with and without sway.

**CO-4** Draw influence line diagrams for determinate and indeterminate structures and find stress resultants

**CO-5** Analyze the two hinged and three hinged arches and suspension bridges

**TEXTBOOKS:**


1. Menon,D, "Structural Analysis", Alpha Science International Limited, 2009
2. Punmía, B.C., Ashok Kumar Jain, Arun Kumar Jain, "Theory of Structures, Laxmi Publications, New Delhi, 13th Edition, 2017.
3. Bhavikatti. S. S., "Structural Analysis Vol-1", E-3, Vikas Publishing House Pvt Limited, 2009.
4. Vaidyanathan. R. "Comprehensive Structural Analysis", Volume 1, Laxmi Publications, New Delhi, 2005


**REFERENCES:**


1. Pandit. G.S., Gupta.S.P., Structural Analysis- A Matrix Approach", 2nd Edition, Tata McGraw-Hill Education, New Delhi. 2010
2. Wang.C. K, "Statically Indeterminate Structures", McGraw Hill International Book Company, 1984.
3. Negi L.S. and Jangid R.S., Structural Analysis, Tata McGraw Hill Publishing. Co. Ltd. 2004.


**COs- PO's & PSO's MAPPING**

| PO/ PSO | Description | COURSE OUTCOMES | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES(PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 3 | 3 | 3 | 3 | 3 | 3 |
| PO3 | Design / development of solutions | 2 | 2 | 3 | 2 | 3 | 2 |
| PO4 | Investigation | 2 | 2 | 3 | 3 | 2 | 2 |
| PO5 | Modern Tool Usage | 1 | 2 | 3 | 2 | 1 | 2 |
| PO6 | Engineer and Society | 1 | 1 | 1 | 1 | 1 | 1 |
| PO7 | Environment and Sustainability | 1 | 1 | 1 | 1 | 1 | 1 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 1 | 1 |
| PO9 | Individual and Team work | 1 | 1 | 1 | 1 | 1 | 1 |
| PO10 | Communication | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 2 | 3 | 3 | 3 | 3 | 3 |

**ER3502** **WATER SUPPLY ENGINEERING** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To equip the students with the principles and design of water treatment units and distribution system.

**UNIT I SOURCES OF WATER** **9**

Public water supply system - Planning, Objectives, Design period, Population forecasting; Water demand - Sources of water and their characteristics, Surface and Groundwater - Impounding Reservoir - Development and selection of source - Source Water quality - Characterization - Significance - Drinking Water quality standards.

**UNIT II CONVEYANCE FROM THE SOURCE** **9**

Water supply - intake structures - Functions; Pipes and conduits for water - Pipe materials - Hydraulics of flow in pipes - Transmission main design - Laying, jointing and testing of pipes - appurtenances - Types and capacity of pumps - Selection of pumps and pipe materials.

**UNIT III WATER TREATMENT** **9**

Objectives - Unit operations and processes - Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation - Clarifloccuator - Plate and tube settlers - Pulsator clarifier - sand filters - Disinfection - Residue Management - Construction, Operation and Maintenance aspects.

**UNIT IV ADVANCED WATER TREATMENT** **9**

Water softening - Desalination - R.O. Plant - demineralization - Adsorption - Ion exchange - Membrane Systems - RO Reject Management - Iron and Manganese removal - Defluoridation - Construction and Operation & Maintenance aspects - Recent advances - MBR process.

**UNIT V WATER DISTRIBUTION AND SUPPLY** **9**

Requirements of water distribution – Components - Selection of pipe material - Service reservoirs - Functions - Network design - Economics - Analysis of distribution networks - Computer applications- Appurtenances - Leak detection. Principles of design of water supply in buildings - House service connection - Fixtures and fittings, systems of plumbing and types of plumbing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

On Completion of the course the student is expected to

**CO1** Recognize the structure of drinking water supply systems, including water transport, treatment and distribution
**CO2** State and Recognize various unit operations and processes in water treatment
**CO3** Design the various functional units in water treatment
**CO4** Understand the water quality criteria and standards, and their relation to public health
**CO5** Design and evaluate water supply project alternatives on basis of chosen criteria

**TEXTBOOKS:**

1. Garg, S.K. Environmental Engineering, Vol.I Khanna Publishers, New Delhi, 2010.
2. Modi, P.N., Water Supply Engineering, Vol.I Standard Book House, New Delhi, 2010.
3. Punmia, B.C.,Ashok Jain and Arun Jain, Water Supply Engineering, Laxmi Publications(P) Ltd., New Delhi, 2014.

**REFERENCES:**

1. IS 10500:2012 – Drinking Water — Specification, Bureau of Indian Standards, New Delhi.
2. IS 2065:1983 – Code of Practice for Water Supply in Buildings, Bureau of Indian Standards, New Delhi.
3. IS 3589:2001 – Steel Pipes for Water and Sewage, Bureau of Indian Standards, New Delhi.
4. IS 4984:2016 – High Density Polyethylene (HDPE) Pipes for Water Supply — Specification, Bureau of Indian Standards, New Delhi.
5. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999
6. Syed R. Qasim and Edward M. Motley Guang Zhu, Water Works Engineering Planning, Design and Operation, Prentice Hall of India Learning Private Limited, New Delhi, 2009.

**COs - PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES (PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 2 | 2 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 3 | 3 | 3 | 3 | 3 | 3 |
| PO3 | Design / development of solutions | | | 3 | 3 | 3 | 3 |
| PO4 | Investigation | 2 | 2 | | | 2 | 2 |
| PO5 | Modern Tool Usage | | | | 2 | 2 | 2 |
| PO6 | Engineer and Society | | | 3 | 3 | 3 | 3 |
| PO7 | Environment and Sustainability | | | 2 | 3 | 3 | 3 |
| PO8 | Ethics | 1 | 1 | 2 | 2 | 2 | 2 |
| PO9 | Individual and Team work | 1 | 1 | 2 | 3 | 3 | 2 |
| PO10 | Communication | | | | | 2 | 2 |
| PO11 | Project Management and Finance | | | 2 | 2 | 2 | 2 |
| PO12 | Life Long Learning | 3 | 3 | 3 | 3 | 3 | 3 |
| **PROGRAM SPECIFIC OUTCOMES (PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering | | | | | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | | | | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | | | | 2 | 3 | 2 |

**ER3503 WASTEWATER ENGINEERING**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**OBJECTIVE:**

- The objectives of this course is to help students develop the ability to apply basic understanding of physical, chemical, and biological phenomena for successful design, operation and maintenance of sewage treatment plants.

**UNIT I PLANNING AND DESIGN OF SEWERAGE SYSTEM 9**

Characteristics and composition of sewage - population equivalent -Sanitary sewage flow estimation – Sewer materials – Hydraulics of flow in sanitary sewers – Sewer design – Storm drainage-Storm runoff estimation – sewer appurtenances – corrosion in sewers – prevention and control – sewage pumping-drainage in buildings-plumbing systems for drainage.

**UNIT II PRIMARY TREATMENT OF SEWAGE 9**

Objectives – Unit Operations and Processes – Selection of treatment processes –- Onsite sanitation - Septic tank- Grey water harvesting – Primary treatment – Principles, functions and design of sewage treatment units - screens - grit chamber-primary sedimentation tanks – Construction, Operation and Maintenance aspects.

**UNIT III SECONDARY TREATMENT OF SEWAGE 9**

Objectives – Selection of Treatment Methods – Principles, Functions, - Activated Sludge Process and Extended aeration systems -Trickling filters– Sequencing Batch Reactor(SBR) – Membrane Bioreactor - UASB – Waste Stabilization Ponds – Other treatment methods -Reclamation and Reuse of sewage - Recent Advances in Sewage Treatment – Construction, Operation and Maintenance aspects**.**

**UNIT IV DISPOSAL AND REUSE OF TREATED SEWAGE 9**

Standards for– Disposal - Methods – dilution – Mass balance principle - Self purification of river- Oxygen sag curve – deoxygenation and reaeration - Streeter–Phelps model - Land disposal – Sewage farming – sodium hazards - Soil dispersion system – Reuse options.

**UNIT V SLUDGE TREATMENT AND DISPOSAL 9**

Objectives - Sludge characterization – Thickening - Design of gravity thickener- Sludge digestion – Standard rate and High rate digester design- Biogas recovery – Sludge Conditioning and Dewatering – Sludge drying beds- ultimate residue disposal – recent advances.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

The students completing the course will have

CO1: An ability to estimate sewage generation and design sewer system including sewage pumping stations

CO2: The required understanding on the characteristics and composition of sewage, self purification of streams

CO3: An ability to perform basic design of the unit operations and processes that are used in sewage treatment

CO4: Understand the standard methods for disposal of sewage.  Gain knowledge on sludge treatment and disposal.

**TEXTBOOKS:**


1. Garg, S.K., Environmental Engineering Vol. II, Khanna Publishers,New Delhi, 2015.
2. Duggal K.N., “Elements of Environmental Engineering” S.Chand and Co. Ltd., New Delhi, 2014.
3. Punmia, B.C., Jain, A.K., and Jain.A.K.., Environmental Engineering, Vol.II, Laxmi Publications, 2010.


**REFERENCES:**


1. IS 2490 (Part 1):1981 – Tolerance Limits for Industrial Effluents Discharged into Inland Surface Waters, Bureau of Indian Standards, New Delhi.
2. IS 2490 (Part 2):1982 – Tolerance Limits for Industrial Effluents Discharged into Public Sewers, Bureau of Indian Standards, New Delhi.
3. IS 2470 (Part 1):1985 – Code of Practice for Installation of Septic Tanks – Design Criteria and Construction, Bureau of Indian Standards, New Delhi.
4. IS 2470 (Part 2):1985 – Code of Practice for Septic Tanks – Secondary Treatment and Disposal of Septic Tank Effluent, Bureau of Indian Standards, New Delhi.
5. IS 4111 (Part 1):1967 – Code of Practice for Ancillary Structures in Sewerage System – Part 1: Manholes, Bureau of Indian Standards, New Delhi.
6. IS 4111 (Part 2):1967 – Code of Practice for Ancillary Structures in Sewerage System – Part 2: Flushing Tanks, Bureau of Indian Standards, New Delhi.
7. IS 4111 (Part 3):1967 – Code of Practice for Ancillary Structures in Sewerage System – Part 3: Ventilating Shafts, Bureau of Indian Standards, New Delhi.
8. Manual on Sewerage and Sewage Treatment Systems Part A,B and C, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
9. Metcalf and Eddy- Wastewater Engineering–Treatment and Reuse, Tata Mc.Graw-Hill Company, New Delhi, 2010.
10. Syed R. Qasim “Wastewater Treatment Plants”, CRC Press, Washington D.C.,2010 4. Gray N.F, “Water Technology”, Elsevier India Pvt. Ltd., New Delhi, 2006.


***COs- PO’s & PSO’s MAPPING***

| POs/PSOs | | Course Outcome | | | | | Overall Correlation of COs to |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 2 | 2 | 2 | 2 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PO3 | Design / development of solutions | - | - | - | - | - | - |
| PO4 | Investigation | 1 | 2 | 2 | - | 2 | 2 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 3 | - | 1 |
| PO6 | Engineer and Society | - | 2 | 2 | - | 2 | 2 |
| PO7 | Environment and Sustainability | 1 | 2 | 2 | - | 2 | 2 |
| PO8 | Ethics | - | 1 | 1 | - | 3 | 1 |
| PO9 | Individual and Team work | 1 | 1 | 1 | 3 | - | 1 |
| PO10 | Communication | 2 | 2 | 2 | 2 | 3 | 2 |
| PO11 | Project Management and Finance | - | 1 | 1 | 2 | 2 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO1 | Knowledge of Civil Engineering | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | - | 1 | 1 | 2 | 2 | 1 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | - | 1 | 1 | 2 | 2 | 1 |

**ER3504 SUSTAINABLE ENGINEERING PRACTICES L T P C**
**2 0 0 2**

**Objectives**:

- To impart basic knowledge to the students about the principles of sustainable engineering, environmental issues and resource conservation, environmental management tools, sustainable infrastructure practices, renewable energy resources and green technologies for achieving sustainable development.

**UNIT I INTRODUCTION TO SUSTAINABLE ENGINEERING 6**

Sustainable development, concepts of sustainable development: three pillar model, egg of sustainability model, Atkisson's pyramid model, prism model, principles of sustainable development, SDG, sustainable engineering, threats for sustainability – International treaties related to sustainability.

**UNIT II ENVIRONMENTAL ISSUES 6**

Solid waste, impact of solid waste on natural resources, zero waste concept and three R concept, waste to energy technology: thermo-chemical conversion, biochemical conversion. air pollution, climate change and global warming, ozone layer depletion, carbon footprint, carbon trading.

**UNIT III TOOLS FOR SUSTAINABILITY 6**

Environmental management System (EMS), concept of ISO14000, life cycle assessment (LCA): basic components, advantages, disadvantages, case study. Environmental impact assessment (EIA), environmental auditing, bio mimicking, case studies.

**UNIT IV SUSTAINABLE HABITAT 6**

Concept of green building, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA), leader ship in energy and environmental design (LEED) rating, energy efficient buildings

**UNIT V RENEWABLE ENERGY RESOURCES 6**

Conventional and non- conventional forms of energy, solar energy, fuel cells, wind energy, small hydroplants, biogas systems, biofuels, energy from ocean, geothermal energy, conservation of energy.

**TOTAL: 30 PERIODS**

**Course Outcomes:**

On completion of the course, the student is expected to

**CO1:** Explain the concepts of sustainable development, principles of sustainability and environmental laws related to sustainable engineering.

**CO2:** Identify environmental issues, waste management practices and resource conservation techniques for sustainable development.

**CO3:** Apply environmental management tools such as EMS, LCA and EIA in sustainable engineering practices.

**CO4:** Analyze sustainable habitat concepts including green buildings, green materials and energy efficient infrastructure systems.

**CO5:** Discuss renewable energy resources, energy conservation methods and green technologies for achieving sustainable future.

**TEXT BOOKS:**

1. R.L. Ragand Lekshmi Dinachandran Remesh. Introduction to Sustainable Engineering. 2ndEdition, PHI Learning Pvt. Ltd., 2016.

**REFERENCES:**

1. D.T.Allenand D.R.Shonnard. Sustainability Engineering : Concepts ,Design and Case Studies, 1st Edition, Prentice Hall, 2011.
2. A.S.Bradley,A.O.Adebayo,P.Maria.Engineering applications in sustainable design and development, 1st Edition, Cengage learning, 2016.

**COs-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 |
| 2 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |
| 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 3 |
| 4 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 3 |
| 5 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 2 | 3 | 3 | 2 | 3 |
| Avg. | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 |

- 1.low, 2-medium,3-high,'-"-no correlation

**Note:** The average value of this course to be used for program articulation matrix

| ER3511 | ENVIRONMENTAL ENGINEERING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**Course Objectives:**

- To estimate important characteristics of water and wastewater through laboratory experiments and to understand their significance in water and wastewater quality assessment.

**List of Experiments:**

1. Determination of pH and Electrical Conductivity (Salinity) of water and soil.
2. Determination of Total Hardness, Calcium and Magnesium in water.
3. Determination of Alkalinity and Acidity.
4. Determination of Chlorides in water and soil.
5. Determination of Total Solids, Organic Solids, Inorganic Solids and Settleable Solids using an Imhoff Cone.
6. Determination of Iron content in water.
7. Determination of Dissolved Oxygen using D.O. Meter and Winkler Method, and determination of B.O.D.
8. Determination of N, P and K values in solid waste.
9. Measurement of physical parameters – Temperature, Colour, Odour, Turbidity and Taste.
10. Determination of C.O.D.
11. Determination of Optimum Coagulant Dose by Jar Test
12. Determination of Chlorine Demand.
13. Presumptive Coliform Test for water quality assessment.

**TOTAL:60 PERIODS**

**Course Outcomes:**

On completion of the course, the student is expected to

**CO1** Determine the physical characteristics of water, wastewater and soil samples.

**CO2** Analyze chemical characteristics such as hardness, alkalinity, chlorides, iron, C.O.D. and B.O.D.

**CO3** Evaluate water quality using standard laboratory procedures and instruments.

**CO4** Assess wastewater and solid waste characteristics through experimental analysis.

**CO5** Apply treatment and monitoring techniques for water and wastewater quality management.

**TEXT BOOKS**

1. Standard Methods for the Examination of Water and Wastewater, APHA.
2. K.V.S.G. Murali Krishna, Chemical Analysis of Water and Soil, Reemm Publications, New Delhi.

**REFERENCES:**

1. IS 3025 (Parts 1 to 65) – Methods of Sampling and Test (Physical and Chemical) for Water and Wastewater.
2. APHA Standard Methods for the Examination of Water and Wastewater.
3. C.N. Sawyer, P.L. McCarty and G.F. Parkin, Chemistry for Environmental Engineering and Science, McGraw-Hill

**COs-PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation Of Cos to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PROGRAM OUTCOMES(PO) | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 3 | 3 | 2 | 3 | 3 |
| PO3 | Design/development of solutions | 1 | 2 | 2 | 2 | 3 | 2 |
| PO4 | Investigation | 2 | 3 | 3 | 2 | 2 | 2 |
| PO5 | Modern Tool Usage | 2 | 2 | 3 | 2 | 3 | 2 |
| PO6 | Engineer and Society | 2 | 2 | 2 | 2 | 3 | 2 |
| PO7 | Environment and Sustainability | 2 | 2 | 2 | 3 | 3 | 2 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 2 | 1 |
| PO9 | Individual and Teamwork | 1 | 1 | 2 | 1 | 2 | 2 |
| PO10 | Communication | 1 | 1 | 2 | 1 | 2 | 2 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| PROGRAM SPECIFIC OUTCOMES(PSO) | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 3 | 3 | 2 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 2 | 2 | 3 | 2 | 3 | 2 |

**CE3611 BUILDING DRAWING AND DETAILING LABORATORY L T P C**

**0 0 4 2**

**COURSE OBJECTIVE:**

To impart knowledge and skill relevant to Building drawing and Detailing lab using computer software

**LIST OF EXPERIMENTS**

1. Principles of planning and orientation
2. Buildings with load bearing structures (Plan, section, elevation)
3. Buildings with sloping roof
4. Buildings with Framed structures.
5. Building information modeling.
6. Reinforcement details of RCC structural elements (slab, beam and column)
7. Reinforcement details of footings (Isolated, stepped, combined footing)
8. Steel structures (Steel Connections detailing, beam to column connection, beam to beam connection – bolt & Weld, Roof truss & purlin)

**TOTAL: 60 PERIODS**

**REFERENCES:**


1. V.B.Sikka, “A course in Civil Engineering Drawing” S.K.Kataria & Sons Publishers, Seventh Edition, 2015.
2. D.N.Ghose, ”Civil Engineering Drawing and Design” CBS Publishers & Distributors Pvt.Ltd., 2nd Edition, 2010.
3. National Building Code of India 2016 (NBC 2016)
4. Unnikrishna Pillai and Devdas Menon, Reinforced Concrete Design (Third Edition), Tata Mc Graw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2017.
5. Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi, 2016


**COURSE OUTCOME**

On completion of the course, the student is expected to be able to,

**CO1:** Draft the plan, elevation and sectional view of the load bearing and framed buildings

**CO2:** Draw the structural detailing of RCC elements

**CO3:** Draw the structural detailing of RCC water tanks, footings and retaining walls

**CO4:** Draw the structural detailing of steel structures

**CO5:** Draft the structural detailing of Industrial structures

## COs- PO's & PSO's MAPPING

| PO/PSO | | Course Outcome | | | | | Overall Correlation of CO s to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES(PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | - | 2 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | - | - | - | - | - | - |
| PO4 | Investigation | - | - | | 2 | 2 | 2 |
| PO5 | Modern Tool Usage | 2 | 2 | 2 | 2 | 2 | 2 |
| PO6 | Engineer and Society | - | 3 | 3 | 3 | 3 | 3 |
| PO7 | Environment and Sustainability | - | - | - | - | - | - |
| PO8 | Ethics | 1 | 2 | 2 | 1 | 2 | 2 |
| PO9 | Individual and Team work | - | 3 | 3 | 3 | 3 | 3 |
| PO10 | Communication | - | 2 | 2 | 2 | 2 | 2 |
| PO11 | Project Management and Finance | - | - | - | - | - | - |
| PO12 | Life Long Learning | 1 | 2 | 2 | 2 | 2 | 2 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | - | 2 | 2 | 2 | 2 | 2 |

**ER3601** **DESIGN OF STRUCTURAL ELEMENTS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

To introduce the different design philosophy for reinforced concrete and steel structures, discuss the limit state of flexure, shear, torsion, and bond and to design RC beams, slabs, columns, footings as per provisions of current code of practice (IS 456 - 2000). To design steel structural connections and elements including plastic analysis as per provisions of current code of practice (IS 800 — 2007).

**UNIT I LIMIT STATE DESIGN OF RC BEAMS 9**

Design Philosophies - Reinforced concrete and steel structures - properties of concrete and steel - Concept of Elastic method, Ultimate load method and Limit State Method – Limit state of Collapse and Serviceability – load combinations – permissible limits – IS rolled sections - Limit state of flexure, shear, torsion and bond – Analysis and Design - singly and doubly reinforced beams - flanged beams.

**UNIT II LIMIT STATE DESIGN OF SLABS 9**

One way and two-way slabs – boundary condition- reinforcement detailing – check for permissible limits as per IS code.

**UNIT III LIMIT STATE DESIGN OF RC COLUMNS AND FOOTINGS 9**

Limit state of compression - Analysis and Design – Short columns under axial, uniaxial and biaxial loading – Interaction diagram – Isolated and combined rectangular footings – Reinforcement detailing.

**UNIT IV DESIGN OF CONNECTIONS AND TENSION MEMBERS 9**

Design of simple bolted and welded connections – Tension members

**UNIT V DESIGN OF COMPRESSION MEMBERS AND BEAMS 9**

Design of compression members – lug angles, tension splice, columns, lacing and battens – Design of laterally supported beams– plate girders – column bases.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the student will be able to

**CO1** Know the various design concepts of reinforced concrete structures and steel structures.

**CO2** Design a RC beams and slabs and draw the reinforcement detailing.

**CO3** Design a RC columns and footings and draw the reinforcement detailing.

**CO4** Design of steel structural elements and connections.

**CO5** Find out ultimate load of steel beams and portal frames using plastic analysis.

**TEXT BOOKS:**

1. Gambhir.M.L., "Fundamentals of Reinforced Concrete Design", Prentice Hall of India Private Limited, New Delhi, 2006.

2. Krishnaraju.N " Design of Reinforced Concrete Structurres ", CBS Publishers & Distributors Pvt. Ltd., New Delhi.
3. Duggal S.K., Design of Steel Structures, Tata McGraw Hill, Publishing Co. Ltd., New Delhi, 2010
4. Bhavikatti S.S, Design of Steel Structures, Ik International Publishing House, New Delhi, 2017.

**REFERENCES:**

1. IS 456:2000 – Plain and Reinforced Concrete – Code of Practice, Bureau of Indian Standards, New Delhi.
2. IS 800:2007 – General Construction in Steel – Code of Practice, Bureau of Indian Standards, New Delhi.
3. IS 875 (Part 1):1987 – Code of Practice for Design Loads (Dead Loads) for Buildings and Structures, Bureau of Indian Standards, New Delhi.
4. IS 875 (Part 2):1987 – Imposed Loads, Bureau of Indian Standards, New Delhi.
5. IS 875 (Part 3):2015 – Wind Loads on Buildings and Structures, Bureau of Indian Standards, New Delhi.
6. IS 875 (Part 5):1987 – Special Loads and Load Combinations, Bureau of Indian Standards, New Delhi.
7. SP 16 – Design Aids for Reinforced Concrete to IS 456, Bureau of Indian Standards, New Delhi.
8. SP 34 – Handbook on Concrete Reinforcement and Detailing, Bureau of Indian Standards, New Delhi.
9. SP 6 (Part 1):1964 – Handbook for Structural Engineers – Structural Steel Sections, Bureau of Indian Standards, New Delhi.
10. Sinha, S.N., "Reinforced Concrete Design", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2017
11. Unnikrishna Pillai, S., Devdas Menon, "Reinforced Concrete Design", Tata McGraw Hill Publishing Company Ltd., 2021
12. Punmia.B.C., Ashok Kumar Jain, Arun Kumar Jain, "Limit State Design of Reinforced Concrete",Laxmi Publication Pvt. Ltd., New Delhi, 2016
13. Shah V L Karve S R., "Limit State Theory and Design of Reinforced Concrete", Structures Publilcations, Pune, 2013
14. Gambhir M L, Fundamentals of Structural Steel Design, McGraw Hill Education India Pvt Limited, 2013
15. Jack C. McCormac and Stephen F Csernak, Structural Steel Design, Pearson Education Limited, 2013.
16. Sarwar Alam Raz, Structural Design in Steel, New Age International Publishers, 2014
17. Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi, 2016

## COs- PO's & PSO's MAPPING

| PO/PSO | | Course Outcome | | | | | Overall Correlation of CO s to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES(PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 3 | 3 | 3 | 3 | 3 | 3 |
| PO3 | Design / development of solutions | 3 | 3 | 3 | 3 | 3 | 3 |
| PO4 | Investigation | 3 | 3 | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 1 | 1 | 1 |
| PO6 | Engineer and Society | 3 | 3 | 3 | 3 | 3 | 3 |
| PO7 | Environment and Sustainability | 1 | 1 | 1 | 1 | 1 | 1 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 1 | 1 |
| PO9 | Individual and Team work | 3 | 3 | 3 | 3 | 3 | 3 |
| PO10 | Communication | 2 | 2 | 2 | 2 | 2 | 2 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 3 | 3 | 3 | 3 | 3 | 3 |

**ER3602 SOLID WASTE MANAGEMENT L T P C**
**3 0 0 3**

**OBJECTIVES**

- To make the students conversant with the types, sources, generation, storage, collection, transport, processing and disposal of solid wastes.

**UNIT I SOURCES AND CHARACTERISTICS 9**

Sources and types of solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics - Elements of integrated solid waste management – Requirements and salient features of Solid waste management rules (2016) –- Role of public and NGO"s- Public Private participation – Elements of Municipal Solid Waste Management Plan.

**UNIT II SOURCE REDUCTION, WASTE STORAGE AND RECYCLING 8**

Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste – On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – case studies under Indian conditions – Recycling of Plastics and Construction/Demolition wastes.

**UNIT III COLLECTION AND TRANSFER OF WASTES 8**

Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions – Field problems- solving.

**UNIT IV PROCESSING OF WASTES 12**

Objectives of waste processing – Physical Processing techniques and Equipment; Resource recovery from solid waste composting and biomethanation; Thermal processing options – case studies under Indian conditions.

**UNIT V WASTE DISPOSAL 8**

Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor – Dumpsite Rehabilitation

**TOTAL: 45 PERIODS**

**OUTCOMES:**

The students completing the course will demonstrate

**CO1:** understanding of the nature and characteristics of solid wastes and the regulatory requirements regarding solid waste management.
**CO2:** Reduction, reuse and recycling of waste.
**CO3:** ability to plan and design systems for storage, collection, transport, processing and disposal of solid waste.
**CO4:** knowledge on the issues on solid waste management from an integrated and holistic perspective, as well as in the local and international context.
**CO5:** Design and operation of sanitary landfill.

**TEXTBOOKS:**

1. William A. Worrell, P. Aarne Vesilind (2012) Solid Waste Engineering, Cengage Learning, 2012.
2. John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial – CRC Press, Taylor and Francis, New York.

**REFERENCES:**

1. CPHEEO (2014), "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi.
2. George Tchobanoglous and FrankKreith (2002).Handbook of Solid waste management, McGraw Hill, New York.

**COs- PO's & PSO's MAPPING**

| POs/PSOs | | Course Outcome | | | | | Overall Correlation of COs to |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | - | - | 2 |
| PO2 | Problem analysis | - | 2 | 2 | - | 2 | 2 |
| PO3 | Design / development of solutions | - | 2 | 2 | - | 2 | 2 |
| PO4 | Investigation | 1 | 2 | 2 | - | 2 | 2 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 3 | - | 1 |
| PO6 | Engineer and Society | - | 2 | 2 | - | 2 | 2 |
| PO7 | Environment and Sustainability | 1 | 2 | 2 | - | 2 | 2 |
| PO8 | Ethics | - | 1 | 1 | - | 3 | 1 |
| PO9 | Individual and Team work | 3 | 1 | 1 | 3 | 3 | 2 |
| PO10 | Communication | 2 | 2 | 2 | 2 | 3 | 2 |
| PO11 | Project Management and Finance | - | 1 | 1 | 2 | 2 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO1 | Knowledge of Civil Engineering | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 1 | 2 | 2 | 1 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | 1 | 2 | 2 | 2 | 2 | 2 |

**AI3404 HYDROLOGY AND WATER RESOURCES ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce to the students, the concepts of hydrological processes, hydrological extremes and groundwater.
- To prepare the students to quantify, regulate and manage water resources.

**UNIT I PRECIPITATION AND ABSTRACTIONS 9**

Hydrological cycle - Meteorological measurements – Types and forms of precipitation - Rain gauges - Spatial analysis of rainfall data using Thiessen polygon and Iso-hyetal methods - Interception – Evaporation: Measurement, Evaporation suppression methods – Infiltration: Horton‟s equation - Double ring infiltrometer - Infiltration indices.

**UNIT II RUNOFF 9**

Catchment: Definition, Morphological characteristics - Factors affecting runoff - Run off estimation using Strange's table and empirical methods - SCS-CN method – Stage discharge relationship - Flow measurements - Hydrograph — Unit Hydrograph — IUH.

**UNIT III HYDROLOGICAL EXTREMES 9**

Natural Disasters - Frequency analysis - Flood estimation - Flood management - Definitions of drought: Meteorological, Hydrological, Agricultural and Integrated - IMD method - NDVI analysis - Drought Prone Area Programme (DPAP).

**UNIT IV RESERVOIRS 9**

Classification of reservoirs - Site selection - General principles of design - Spillways -Elevation-Area- Capacity curve - Storage estimation - Sedimentation - Life of reservoirs – Rule curve.

**UNIT V GROUNDWATER AND MANAGEMENT 9**

Origin - Classification and types - Properties of aquifers - Governing equations - Steady and unsteady flow - Artificial recharge - RWH in rural and urban areas.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**


1. Subramanya K, "Engineering Hydrology"- Tata McGraw Hill, 2010
2. Jayarami Reddy P, "Hydrology", Tata McGraw Hill, 2008.


**REFERENCES**


1. David Keith Todd. "Groundwater Hydrology", John Wiley & Sons, Inc. 2007
2. Ven Te Chow, Maidment, D.R. and Mays, L.W. "Applied Hydrology", McGraw Hill International Book Company, 1998.
3. Raghunath. H.M., "Hydrology", Wiley Eastern Ltd., 1998.
4. Bhagu R. Chahar, Groundwater Hydrology, McGraw Hill Education (India) Pvt Ltd, New Delhi, 2017.

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

CO1: Define the hydrological processes and their integrated behaviour in catchments

CO2: Apply the knowledge of hydrological processes to address basin characteristics, runoff and hydrograph

CO3: Explain the concept of hydrological extremes and its management strategies

CO4: Describe the principles of storage reservoirs

CO5: Understand and apply the concepts of groundwater management

**CO – PO MAPPING: HYDROLOGY AND WATER RESOURCES ENGINEERING**

| | | **COURSE OUTCOMES:** | | | | | |
|---|---|---|---|---|---|---|---|
| **PO/PSO** | | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** | **Overall Correlation of COs to POs** |
| PO1 | Knowledge of Engineering Sciences | 2 | 2 | 2 | 2 | 2 | 2 |
| PO2 | Problem analysis | 2 | 3 | 2 | 2 | 2 | 2 |
| PO3 | Design/development of solutions | - | 2 | 2 | 1 | 2 | 1 |
| PO4 | Investigation | 2 | 2 | 1 | 1 | 2 | 2 |
| PO5 | Modern Tool Usage | 1 | 1 | - | 1 | 1 | 1 |
| PO6 | Engineer and Society | 2 | 2 | 2 | 3 | 3 | 2 |
| PO7 | Environment and Sustainability | 2 | 2 | 2 | 2 | 2 | 2 |
| PO8 | Ethics | - | - | - | 2 | 2 | 1 |
| PO9 | Individual and Team work | 2 | 3 | 2 | 2 | 3 | 2 |
| PO10 | Communication | 2 | 2 | 2 | 2 | 2 | 2 |
| PO11 | Project Management and Finance | - | - | 2 | - | 2 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 3 | 3 | 2 |
| PSO1 | To bring expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO2 | To enhance the ability of students to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies. | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO3 | To inculcate entrepreneurial skills through strong Industry-Institution linkage. | 2 | 3 | 2 | 3 | 3 | 3 |

**ER3611 ENVIRONMENTAL ENGINEERING DESIGN AND DRAWING L T P C**
**0 0 4 2**

**COURSE OBJECTIVES:**

- To train the students on preparing layout to for water and wastewater treatment plants as well as general arrangement diagrams for units in water and wastewater treatment.

**LIST OF DRAWINGS**

i. Layout of Water treatment plant
ii. Infiltration gallery and pumping station.
iii. Flash mixer
iv. Clariflocculator
v. Slow and rapid sand filters
vi. Layout foe Sewage Treatment Plants
vii. Primary and secondary settling tanks
viii. Activated sludge process, Sequencing Batch Reactor
ix. Sludge digestion tank
x. Septic tank with dispersion trench

**TOTAL: 60 PERIODS**

**REFERENCES**


1. Birde.G.SandBirde.J.S,"Water supply and sanitary Engineering",DhanpatRai Publications Pvt.Ltd New Delhi,2001.
2. Rangwala.S.C, "Fundamentals of water supply and sewerage Engineering", Charotar Publishing,2000.
3. Mannualon wastewater and treatment CPHEECO, Ministry of Urban Affairs and Employment, Govt.ofIndia,NewDelhi,1990.
4. Shah.C.S., "Water supply and Sanitation", Galgotia publishing company, NewDelhi,1994.
5. Metcalf and Eddy,"WasteWaterEngineering–Treatment and reuse",TataMcGraw Hill,New Delhi,20


**COURSE OUTCOMES**

CO1: Ability to prepare flow charts and layouts of water and waste water treatment plants
CO2: Ability to draw the filtration units required for treatment
CO3: Ability to design and detail structures and reactors required for water and wastewater treatment
CO4: Ability to design the pumping station and infiltration gallery
CO5: Ability to prepare flow charts for ETP and CETP

**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | | 3 | | | | | | | | | | 2 | | 3 |
| 2 | | 2 | 2 | | | 3 | | 2 | 1 | 2 | 3 | | 2 | 3 | 2 |
| 3 | 2 | | | | | | | | | | 3 | | 3 | 3 | 2 |
| 4 | | 3 | | | | | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 | 3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 3 | | 3 | 2 | | | 3 | | | | | 3 | 2 | 3 | 3 |
| Avg. | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 |

1-low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix.

**CCE333 ENVIRONMENTAL IMPACT ASSESSMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**:

- To expose the students to the need, methodology, documentation and usefulness of environmental impact assessment and to develop the skill to prepare environmental management plan.
- To participate in the performance of an environmental assessment process (EIA or SEA), given the disciplinary knowledge and skills in natural sciences and engineering the student have achieved in other courses.

**UNIT I INTRODUCTION 9**

Historical development of Environmental Impact Assessment (EIA). EIA Notifications - Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

**UNIT II IMPACT IDENTIFICATION AND PREDICTION 10**

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modelling for impact prediction – assessment of impacts – air – water – soil – noise – biological –— cumulative impact assessment

**UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 8**

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

**UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9**

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

**UNIT V CASE STUDIES 9**

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, building and construction projects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

**CO1:** carry out scoping and screening of developmental projects for environmental and social assessments

**CO2:** explain different methodologies for environmental impact prediction and assessment

**CO3:** asses socio-economic investigation of the environment in a project

**CO4:** plan environmental impact assessments and environmental management plans

**CO5:** knowledge to prepare environmental impact assessment reports for various projects

**REFERENCES:**


1. Canter, L.W., "Environmental Impact Assessment", McGraw Hill, New York. 1996
2. Lawrence, D.P., "Environmental Impact Assessment – Practical solutions to recurrent problems", Wiley-Interscience, New Jersey. 2003
3. World Bank –Source book on EIA
4. Cutter, S.L., "Environmental Risk and Hazards", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
5. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff “Risk Assessment and Management Handbook”, McGraw Hill Inc., New York,1996.
6. K. V. Raghavan and A A. Khan, "Methodologies in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control, 4th Edition, Butterworth Heineman, 2012.


**COs- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | | | | | | 2 | 3 | 3 | | | | | 2 | | |
| **2** | 3 | 2 | 3 | 2 | 2 | | | 3 | 2 | | | 1 | | 2 | 2 |
| **3** | | 2 | 3 | 2 | 2 | | | 3 | 2 | | | 1 | | 2 | |
| **4** | | | 3 | | 3 | 2 | 2 | 2 | 2 | 1 | 1 | | | 2 | 2 |
| **5** | 3 | | | 2 | | | | 2 | | | | | | | |
| **Avg.** | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | 2 | 2 |

1-low, 2-medium, 3-high.

**CCE331 AIR AND NOISE POLLUTION CONTROL ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To impart knowledge on the sources, effects and control techniques of air pollutants and noise pollution.

**UNIT I GENERAL 9**

Atmosphere as a place of disposal of pollutants — Air Pollution — Definition - Air Pollution and Global Climate - Units of measurements of pollutants - Air quality criteria - emission standards - National ambient air quality standards - Air pollution indices - Air quality management in India.

**UNIT II SOURCES, CLASSIFICATION AND EFFECTS 9**

Sources and classification of air pollutants - Man made - Natural sources - Type of air pollutants - Pollution due to automobiles - Analysis of air pollutants - Chemical, Instrumental and biological methods.Air pollution and its effects on human beings, plants and animals - Economic effects of air pollution - Effect of air pollution on meteorological conditions - Changes on the Meso scale, Micro scale and Macro scale.

**UNIT III SAMPLING, METEOROLOGY AND AIR QUALITY MODELLING 9**

Sampling and measurement of particulate and gaseous pollutants - Ambient air sampling - Stack sampling. Environmental factors - Meteorology - temperature lapse rate and stability — Adiabatic lapse rate - Wind Rose - Inversion — Wind velocity and turbulence - Plume behavior - Dispersion of air pollutants- Air Quality Modeling.

**UNIT IV AIR POLLUTION CONTROL MEASURES 9**

Control - Source correction methods - Control equipments - Particulate control methods – Bag house filter - Settling chamber - cyclone separators - inertial devices - Electrostatic precipitator - scrubbers - Control of gaseous emissions - Absorption - Absorption equipments - adsorption and combustion devices (Theory and working of equipments only).

**UNIT V NOISE POLLUTION AND ITS CONTROL 9**

Sources of noise — Units and Measurements of Noise - Characterization of Noise from Construction, Mining, Transportation and Industrial Activities, Airport Noise — General Control Measures — Effects of noise pollution — auditory effects, non-auditory effects. Noise Menace– Prevention and Control of Noise Pollution — Control of noise at source, control of transmission, protection of exposed person - Control of other types of Noise Sound Absorbent

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

**CO1:** Understand various types and sources of air pollution and its effects
**CO2:** Know the dispersion of air pollutants and their modeling
**CO3:** Know about the principles and design of control of particulate pollutants
**CO4:** Understand the principles and design of control of gaseous pollutant
**CO5:** Know the sources, effects and control of vehicular, indoor air and noise pollution

**TEXTBOOKS:**


1. C. S. Rao, “Environmental Pollution Control Engineering”, Wiley Eastern Limited, 2006.
2. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 2017
3. Dr. Y. Anjaneyulu, “Air Pollution and Control Technologies”, Allied publishers Pvt. Ltd., 2019.


**REFERENCES:**


1. Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition, McGraw Hill Inc, New Delhi, 2000.
2. Air Pollution act, India, 1987
3. Peterson and E.Gross Jr., “Hand Book of Noise Measurement”, 7th Edition, 1974
4. Mukherjee, "Environmental Pollution and Health Hazards", causes and effects, 1986
5. Antony Milne, “Noise Pollution: Impact and Counter Measures”, David & Charles PLC, 1979.
6. Kenneth wark, Cecil F.Warner, “Air Pollution its Origin and Control”, Harper and Row Publishers, New York, 1998.


**COs- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | | | | 3 | | | 2 | 1 | 2 | | | 2 | | |
| 2 | 2 | | | 3 | | 2 | | | | | | 2 | 1 | 2 | 2 |
| 3 | 2 | | 3 | | 3 | | 1 | | | | 2 | | 2 | 2 | 2 |
| 4 | 2 | | 3 | | 3 | | 1 | | | | 2 | | 2 | 2 | 2 |
| 5 | 3 | 3 | 2 | 3 | 2 | | | | | 2 | | | 2 | | |
| Avg. | 2 | 3 | 3 | 3 | 3 | | | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |

1-low, 2-medium, 3-high, ‘-“- no correlation

Note: The average value of this course to be used for program articulation matrix

| GE3791 | HUMAN VALUES AND ETHICS | L T P C |
|---|---|---|
| | | 2 0 0 2 |

**COURSE DESCRIPTION**

This course aims to provide a broad understanding about the modern values and ethical principles that have evolved and are enshrined in the Constitution of India with regard to the democratic, secular and scientific aspects. The course is designed for undergraduate students so that they could study, understand and apply these values in their day to day life.

**COURSE OBJECTIVES:**

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

**UNIT I DEMOCRATIC VALUES 6**

Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.
*Reading Text: Excerpts from John Stuart Mills' On Liberty*

**UNIT II SECULAR VALUES 6**

Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.
*Reading Text: Excerpt from Secularism in India: Concept and Practice by Ram Puniyani*

**UNIT III SCIENTIFIC VALUES 6**

Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, Validating facts using evidence based approach – Skepticism and Empiricism – Rationalism and Scientific Temper.
*Reading Text: Excerpt from The Scientific Temper by Antony Michaelis R*

**UNIT IV SOCIAL ETHICS 6**

Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.
*Reading Text: Excerpt from 21 Lessons for the 21st Century by Yuval Noah Harari*

**UNIT V SCIENTIFIC ETHICS 6**

Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.
*Reading Text: Excerpt from American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer by Kai Bird and Martin J. Sherwin.*

**TOTAL: 30 PERIODS**

**REFERENCES:**


1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022


**COURSE OUTCOMES**

Students will be able to

CO1: Identify the importance of democratic, secular and scientific values in harmonious functioning of social life

CO2: Practice democratic and scientific values in both their personal and professional life. CO3: Find rational solutions to social problems.

CO4: Behave in an ethical manner in society

CO5: Practice critical thinking and the pursuit of truth.

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | – | – | – | – | – | 2 | 2 | 3 | 2 | 2 | – | 1 | – | – | 2 |
| **2** | – | – | – | – | – | 2 | 2 | 3 | 2 | 2 | – | 1 | – | – | 2 |
| **3** | 2 | 2 | 2 | 2 | – | 2 | 2 | 2 | 1 | 1 | – | 2 | 1 | 1 | 2 |
| **4** | – | – | – | – | – | 3 | 2 | 3 | 2 | 2 | – | 1 | – | – | 3 |
| **5** | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | 1 | 1 | – | 3 | 2 | 2 | 2 |
| **Avg.** | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | | 2 | 1 | 1 | 2 |

| GE3752 | TOTAL QUALITY MANAGEMENT | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES:**

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

**UNIT I INTRODUCTION 9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

**UNIT II TQM PRINCIPLES 9**

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

**UNIT III TQM TOOLS & TECHNIQUES I 9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

**UNIT IV TQM TOOLS & TECHNIQUES II 9**

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

**UNIT V QUALITY MANAGEMENT SYSTEM 9**

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation-Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** Ability to apply TQM concepts in a selected enterprise.
**CO2:** Ability to apply TQM principles in a selected enterprise.
**CO3:** Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
**CO4:** Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.
**CO5:** Ability to apply QMS and EMS in any organization.

**TEXT BOOKS:**

1. Dale H.Besterfiled, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

**REFERENCES:**

1. Joel.E. Ross, "Total Quality Management – Text and Cases", Routledge., 2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, Third Edition,2003.
4. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd.,2006 .

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 3 | | | | | | | | | | 3 | 2 | | 3 |
| 2 | | | | | | 3 | | | | | | 3 | | 2 | |
| 3 | | | | | 3 | | | | 3 | | | | | 2 | 3 |
| 4 | | 2 | | | 3 | 2 | 3 | 2 | | | | 3 | 3 | 2 | |
| 5 | | | 3 | | | 3 | 3 | 2 | | | | | | | |
| Avg. | | 2.5 | 3 | | 3 | 2.6 | 3 | 2 | 3 | | | 3 | 2.5 | 2 | 3 |

**PROJECT WORK/INTERNSHIP**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 20 | 10 |

**COURSE OBJECTIVE:**

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

**STRATEGY:**

The student works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction. The student will be evaluated based on the report and the viva voce examination by a team of examiners including one external examiner.

**TOTAL: 300 PERIODS**

**COURSE OUTCOMES:**

- On Completion of the project works students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

**CO1:** Identify civil engineering problems reviewing available literature.

**CO2:** Identify appropriate techniques to analyze complex civil engineering problems.

**CO3:** Apply engineering and management principles through efficient handling of Project have a clear idea of his/her area of work and they are in a position to carry out the work in a systematic way.

**COs- PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | Overall Correlation of Cos to POs |
|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 2 | 3 |
| PO2 | Problem analysis | 1 | 3 | 2 | 2 |
| PO3 | Design/development of solutions | 1 | 1 | 2 | 1 |
| PO4 | Investigation | 3 | 3 | | 3 |
| PO5 | Modern Tool Usage | | | | |
| PO6 | Individual and Teamwork | 3 | 3 | 2 | 3 |
| PO7 | Communication | 2 | | 2 | 2 |
| PO8 | Engineer and Society | 2 | | 2 | 2 |
| PO9 | Ethics | 2 | | 2 | 2 |
| PO10 | Environment and Sustainability | 1 | 1 | 1 | 1 |
| PO11 | Project Management and Finance | 1 | 1 | 1 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| PO12 | Life Long Learning | 3 | 3 | 3 | 3 |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 1 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 3 | 3 | 1 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 3 | 3 | 1 | 3 |

# PROFESSIONAL ELECTIVE COURSES

**ER3001 GROUNDWATER AND RAINWATER HARVESTING**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVE:**

- To understand the occurrence, movement and development of groundwater resources.
- To study hydrological principles related to rainwater harvesting and artificial recharge.
- To learn the planning, design and construction of rainwater harvesting structures.
- To analyse groundwater quality, exploration and sustainable management practices.
- To understand modern tools and case studies related to groundwater conservation and recharge.

**UNIT I GROUNDWATER AND RAINWATER HARVESTING 9**

Water resources and water conservation – Need for groundwater management– Precipitation and rainfall measurement – Types of aquifers and aquifer properties - Water budget equation – National Water Policy – Rainwater harvesting concepts, objectives and benefits – Legislation on rainwater harvesting in India and Tamil Nadu.

**UNIT II GROUNDWATER HYDRAULICS AND FLOW MECHANICS 9**

Governing equations for groundwater flow – Flow through confined and unconfined aquifers – Steady radial flow into wells – Dupuit and Theim equations – Recharge mechanisms and artificial recharge principles - Seawater intrusion: causes, effects and control measures.

**UNIT III RAINWATER HARVESTING METHODS 9**

Rainwater harvesting potential assessment – Rooftop runoff estimation – Traditional and Rooftop rainwater harvesting systems – Groundwater recharge techniques – Site selection criteria for recharge structures – Contour bund – Gully plug – Percolation tank – Check dam – Efficiency of rainwater harvesting systems.

**UNIT IV DESIGN, CONSTRUCTION AND SUBSURFACE EXPLORATION 9**

Components of rainwater harvesting systems – Design considerations for storage and recharge structures – Design of rooftop water collection systems – Open wells and tube wells – Pumping and recuperation tests – Electrical resistivity and seismic refraction methods – Remote sensing and GIS applications in groundwater exploration.

**UNIT V GROUNDWATER QUALITY AND MANAGEMENT 9**

Sources and types of groundwater contamination – Groundwater quality analysis and monitoring – Groundwater recharge and fluctuation – Groundwater management strategies – Maintenance and modernization of rainwater harvesting systems – Urban and rural case studies on successful rainwater harvesting practices in India.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students will be able to

CO 1: Explain the principles of groundwater occurrence, recharge and rainwater harvesting.
CO 2: Apply groundwater flow equations and hydrological concepts in water resource analysis.
CO 3: Design suitable rainwater harvesting and artificial recharge structures.
CO 4: Analyze groundwater exploration methods and evaluate groundwater quality.
CO 5: Develop sustainable groundwater management strategies using modern tools and case studies.

**TEXTBOOKS:**

1. H. M. Raghunath, Ground Water, New Age International Publishers, New Delhi.
2. K. R. Arora, Irrigation, Water Power and Water Resources Engineering, Standard Publishers and Distributors, New Delhi.
3. C. S. P. Ojha, R. Berndtsson and P. N. Bhunya, Engineering Hydrology, Oxford University Press, New Delhi.
4. P. N. Modi, Irrigation Water Resources and Water Power Engineering, Standard Book House, New Delhi.

**REFERENCES:**

1. David Keith Todd and Larry W. Mays, Groundwater Hydrology, Wiley India Pvt. Ltd.
2. S. K. Garg, Hydrology and Water Resources Engineering, Khanna Publishers, New Delhi.
3. Manual on Artificial Recharge of Ground Water, Central Ground Water Board (CGWB), Government of India.
4. R. K. Sivanappan, Rainwater Harvesting and Groundwater Recharge, Dhanalakshmi Publications.
5. K. Subramanya, Engineering Hydrology, McGraw Hill Education, India.

**COs- PO's & PSO's MAPPING**

| PO/ PSO | Description | COURSE OUTCOMES | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES(PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 2 | 2 | 2 | 2 |
| PO2 | Problem analysis | 2 | 3 | 2 | 3 | 2 | 2 |
| PO3 | Design / development of solutions | 1 | 2 | 3 | 1 | 2 | 2 |
| PO4 | Investigation | 1 | 2 | 2 | 3 | 2 | 2 |
| PO5 | Modern Tool Usage | - | 1 | 2 | 3 | 3 | 2 |
| PO6 | Engineer and Society | - | - | 1 | 1 | 2 | 1 |
| PO7 | Environment and Sustainability | 3 | 2 | 3 | 2 | 3 | 3 |
| PO8 | Ethics | - | - | - | - | 1 | 1 |
| PO9 | Individual and Team work | - | - | - | - | 1 | 1 |
| PO10 | Communication | - | - | - | - | 1 | 1 |
| PO11 | Project Management and Finance | - | - | 1 | 1 | 1 | 1 |
| PO12 | Life Long Learning | 1 | 1 | - | 1 | 2 | 1 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 3 | 2 | 3 | 2 | 3 | 3 |

| ER3002 | DESIGN, OPERATION AND MAINTENANCE, MONITORING OF WATER AND WASTEWATER TREATMENT PLANTS | L T P C 3 0 0 3 |
|---|---|---|

**COURSE OBJECTIVES:**

- Gain knowledge of design principles for water and wastewater treatment plants.
- Learn strategies for effective operation and maintenance of treatment units.
- Use laboratory and field methods to ensure water quality and process efficiency.
- Implement safe practices in chemical handling, energy conservation, and environmental protection.
- Acquire skills in planning, organizing, and controlling treatment plant operations.

**UNIT I ELEMENTS OF DESIGN, OPERATION AND MAINTENANCE 9**

Strategy for effective design and operation of treatment plants - Preventive and corrective maintenance scheduling - Operation and maintenance planning - Proper and adequate tools, spare units and parts - Training requirements for plant personnel - Laboratory control, records and reports - Sampling procedures and analytical techniques - Code of practice for analytical laboratories - Measurement of flows, pressures, and levels - Management Information Systems (MIS) - Measures for conservation of energy.

**UNIT II DESIGN, OPERATION AND MAINTENANCE OF WATER SUPPLY SYSTEMS 9**

Design considerations for reservoirs, intakes, and wells - Operational problems and O&M practices for water supply systems - Causes of failure of wells and rehabilitation of tube wells & bore wells - Prevention of incrustation and corrosion - Problems in transmission mains, maintenance of pipelines, and leakage control - Repair methods for different types of pipes - Preventive and corrective maintenance of water pumps - Problems in water distribution systems and remedies - Water quality monitoring and surveillance

**UNIT III DESIGN, OPERATION AND MAINTENANCE OF WASTEWATER COLLECTION SYSTEMS ` 9**

Design and layout of sewerage systems - Operational problems in sewer networks - Maintenance of manholes, pumping stations, and rising mains - Infiltration and exfiltration issues - Methods of pipeline inspection and rehabilitation - Records of operation and maintenance practices - Case studies on sewer rehabilitation.

**UNIT IV DESIGN, OPERATION AND MAINTENANCE OF PHYSICO-CHEMICAL TREATMENT UNITS 9**

Design and operation of screen chambers, grit chambers, and clarifiers - Troubleshooting guidelines and record keeping for clarifiers, equalization basins, and neutralization units - Chemical storage, mixing, and metering equipment - Flash mixers, filters, thickeners, centrifuges, and filter presses - Start-up and maintenance inspection of motors and pumps - Hazards in chemical handling - Jar test procedures and chlorination equipment - Membrane process systems (RO, UF, NF) - SDI and LSI determination - Process chemistry and chemical dosage calculations - SOPs and case studies

**UNIT V DESIGN, OPERATION AND MAINTENANCE OF BIOLOGICAL TREATMENT UNITS 9**

Construction, design, and operation of activated sludge process, trickling filters, anaerobic digesters, SBR, UASBR, and MBRs - Startup and shutdown procedures - Monitoring parameters: DO, MLSS, SVI - Troubleshooting guidelines for biological systems - Planning, organizing, and controlling of plant operations - Capacity building and retrofitting case studies - SOPs and case studies

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

At the end of the course, students will be able to:

- Explain O&M strategies for water and wastewater treatment plants.
- Design treatment units with consideration for operational and maintenance requirements.
- Diagnose and troubleshoot operational problems in physico-chemical and biological systems.
- Monitor water quality using analytical techniques and laboratory practices.
- Evaluate performance of treatment plants and recommend improvements for efficiency and sustainability.

**REFERENCES:**


1. Metcalf & Eddy, Wastewater Engineering: Treatment and Resource Recovery, McGraw Hill Education.
2. Hammer, M.J. & Hammer, M.J. Jr., Water and Wastewater Technology, Prentice Hall.
3. Droste, R.L., Theory and Practice of Water and Wastewater Treatment, Wiley.
4. Peavy, H.S., Rowe, D.R., Tchobanoglous, G., Environmental Engineering, McGraw Hill.
5. Qasim, S.R., Water and Wastewater Treatment Plant Design, CRC Press.


**COs- PO's & PSO's MAPPING**

| POs/PSOs | | Course Outcome | | | | | Overall Correlation of COs to |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 2 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | - | - | - | - | - | - |
| PO4 | Investigation | 1 | 2 | 2 | - | 2 | 2 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 3 | - | 1 |
| PO6 | Engineer and Society | - | 2 | 2 | - | 2 | 2 |
| PO7 | Environment and Sustainability | 1 | 2 | 2 | - | 2 | 2 |
| PO8 | Ethics | - | 1 | 1 | - | 3 | 1 |
| PO9 | Individual and Team work | 1 | 1 | 1 | 3 | - | 1 |
| PO10 | Communication | 2 | 2 | 2 | 2 | 3 | 2 |
| PO11 | Project Management and Finance | - | 1 | 1 | 2 | 2 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO1 | Knowledge of Civil Engineering | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | - | 1 | 1 | 2 | 2 | 1 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | - | 1 | 1 | 2 | 2 | 1 |

**EN3003 SLUDGE AND SEPTAGE MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To gain knowledge and skills on sources, characteristics and treatment of sludge
- To understand the importance of septage management.

**UNIT I SOURCES AND CHARACTERISTICS OF SLUDGE 9**

Objectives of sludge treatment – sources of sludge- Sludge from WTP, STP and CETP- Sludge-Quantification-generation from various treatment plants – Characteristics in each stage of treatment –Physico-chemical and biological-- Mass balance in sludge treatment

**UNIT II SLUDGE THICKENING AND DEWATERING 9**

Sludge thickening- Gravity thickening - Drum thickener - Air floatation – Centrifugation- conditioning -Sludge Dewatering- Centrifuge- Vacuum Filtration-Sludge drying bed- performance of thickener and dewatering systems-operation and maintenance

**UNIT III SLUDGE STABILIZATION 9**

Objectives-Aerobic and Anaerobic Sludge digestion processes – Types of anaerobic digesters – design of Low rate and High rate digesters – Two stage digester-Aerobic digestion- Pure oxygen and thermophilic aerobic digestion - Chemical and Thermal stabilization process

**UNIT IV REUSE AND LAND APPLICATION OF SEWAGE SLUDGE 9**

Introduction- beneficial use-requirements and associated risks-handling and management- storage - operation aspects of transport and application of biosolids application land- Lagooning- Landfilling- land farming-Composting-windrow composting -Vermicomposting - Laws and regulations on sludge management

**UNIT V SEPTAGE MANAGEMENT 9**

Sources of Septage – characteristics- Public health and environmental hazards- Elements of septage management- Pumping and Desludging Septic Tanks-Transportation- Treatment- Dewatered septage sludge reuse- Operation and maintenance - Planning and implementation of septage management schemes-Case studies

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**:

On completion of the course, the student is expected to be able to

CO1 Understand sources and characteristics of various sources of sludge.
CO2 Design sludge thickening and dewatering units
CO3 Design of sludge stabilization units
CO4 Know about the requirements and associated risk while reusing sewage sludge
CO5 Plan and implement septage management scheme

**REFERENCES**


1. Septage management in urban India, National Urban Sanitation policy, Ministry of Urban Development Government of India,2013
2. National Policy on Faecal Sludge and Septage Management (FSSM) Ministry of Urban Development Government of India,2017
3. A.F. Ismail, Takeshi Matsuura, Membrane Technology for Water and Wastewater Treatment, Energy and Environment, CRC Press, 2016

4. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.2 liquid process.
5. Michael D. Nelson, Chair, Operation of municipal waste water treatment plants, Water environment federation, vol.1Management and support systems, sixth edition.
6. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse fourth Edition, McGraw-Hill, 2017

**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 2 | 3 | 3 | 1 | 3 | | | | | 2 | | 2 | | 2 |
| 2 | 2 | 3 | 3 | 3 | | 2 | 2 | | 2 | | | | | 2 | |
| 3 | 2 | | 2 | | 2 | | 2 | 2 | 3 | 2 | 2 | | 3 | | 3 |
| 4 | 2 | 3 | 3 | 2 | 2 | | | | | 2 | | 2 | | 3 | |
| 5 | 2 | 3 | 3 | | 1 | 3 | | 2 | | | 2 | 2 | 2 | | 2 |
| Avg. | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |

**1. low, 2-medium, 3-high,**

**EN3004** **MARINE POLLUTION AND CONTROL** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To educate the Coastal and Marine environment.
- To educate the ocean dynamics
- To sources of marine pollution and methods for monitoring, modeling and control.

**UNIT I MARINE AND COASTAL ENVIRONMENT 9**

Seas and oceans, continental area, coastal zone, properties of sea water, principles of marine geology, coastal features — beaches, estuaries, lagoons, salt marshes, mangroves and sand dunes–the oceans and climate, coastal zone regulation in india- national and international treaties.

**UNIT II OCEAN HYDRODYNAMICS 9**

Wave theory, waves in shallow waters — refraction, diffraction and shoaling, approximations for deep and shallow water conditions – tidal classification - general circulation of ocean waters - ocean currents - coastal sediment transport - onshore offshore sediment transport - beach formation and coastal processes - Tsunamis, storm surge, El Nino effect.

**UNIT III MARINE POLLUTION 9**

Sources of marine pollution — point and non-point sources, pollution caused by effluent discharge, oil exploration, dredging, offshore mining, port and harbour activities, power plants, agriculture runoff, plastic waste, marine debris and marine litter - effects of marine pollution on marine water quality and coastal ecosystems.

**UNIT IV MARINE POLLUTION MONITORING 9**

Basic measurements - sounding boat, echo sounders – current meters - tide gauge - use of GPS — measurement of coastal water characteristics — sea bed sampling — modelling of pollutant transport and dispersion - oil spill models - ocean monitoring satellites – applications of remote sensing and GIS in monitoring marine pollution – online marine pollution monitoring.

**UNIT V MARINE POLLUTION CONTROL MEASURES 9**

Marine discharges and effluent standards, pollution control strategies – marine outfall design selection of optimal marine outfall locations - Total Maximum Daily Load (TMDL) applications — protocols in marine pollution control– Integrated Coastal Zone Management (ICZM) and sustainable development.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1: Ability to know about marine environment.
CO2: Understand the physical concepts lying behind the oceanic currents and natural processes of various activities happening over the marine environment.
CO3: Acquired knowledge on the marine pollution and the effect of the same on the ecology.
CO4: Should have gained knowledge on remote sensing and various other techniques for measuring and monitoring oceanic environment parameters.
CO5: Should have acquired knowledge on control of marine pollution and sustainable development.

**REFERENCES:**

1. "Marine Pollution (5th Edition) R.B. Clark, C. Frid and M Atttrill Oxford Science Publications, 2001

2. Marine pollution Dr.P.C.Sinha , Anmol Publications Pvt. Ltd, 1998.
3. "Problems of Marine Pollution" : India and Canada, Raghavan, Sudha , Eastern Book Corporation, Delhi, India, 2005
4. Laws, E.A., "Aquatic pollution", an introductory text. John Wiley and Sons, Inc., New York, 2018.

**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | | | | | | | | | | | 2 | | | |
| 2 | 3 | | | | | | | | | | | 2 | 2 | 2 | 1 |
| 3 | 3 | | | | | | | | | | | 2 | | | 2 |
| 4 | | 3 | | | 3 | 3 | | 2 | 2 | 2 | 2 | | | 3 | 2 |
| 5 | 2 | | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | | 3 | 2 | |
| Avg. | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |

**1-low, 2-medium, 3-high,**

| ER3003 | RECLAMATION AND REUSE OF WASTEWATER | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

- To understand the principles and importance of wastewater reclamation and reuse.
- To study advanced wastewater treatment technologies for reuse applications.
- To gain knowledge on wastewater quality criteria, reuse standards and health aspects.
- To analyze planning, design and operation of wastewater reuse systems.
- To apply sustainable wastewater reuse practices for agriculture, industry and urban sectors.

**UNIT I WASTEWATER RECLAMATION AND REUSE 9**

Need for wastewater reclamation and reuse – Wastewater characteristics – Water scarcity and sustainable water management – Sources and types of reclaimed water – Concepts of water reuse and recycling – Benefits and limitations of wastewater reuse – Regulations and reuse standards – Health and environmental aspects – National and international guidelines for reclaimed water use.

**UNIT II ADVANCED WASTEWATER TREATMENT TECHNOLOGIES 9**

Preliminary, primary and secondary treatment review – Advanced treatment processes for reuse – Filtration systems – Membrane technologies – Microfiltration, ultrafiltration, nanofiltration and reverse osmosis – Activated carbon adsorption – Ion exchange – Nutrient removal – Advanced oxidation processes – Disinfection methods – Sludge management in reuse systems.

**UNIT III WASTEWATER REUSE APPLICATIONS 9**

Agricultural reuse of wastewater – Landscape irrigation – Industrial reuse applications – Urban non-potable reuse – Groundwater recharge – Indirect and direct potable reuse – Dual plumbing systems – Reclaimed water distribution systems – Water conservation and resource recovery – Case studies on wastewater reuse projects.

**UNIT IV DESIGN AND OPERATION OF REUSE SYSTEMS 9**

Planning and design of wastewater reclamation systems – Storage and conveyance systems – Hydraulic and process design considerations – Monitoring and control systems – Operation and maintenance of reuse facilities – Risk assessment and management – Economic analysis of reuse systems – Public acceptance and stakeholder participation.

**UNIT V SUSTAINABILITY AND EMERGING TRENDS IN WASTEWATER REUSE 9**

Sustainable wastewater management – Circular economy concepts – Energy and nutrient recovery – Climate resilience and integrated water management – Smart water reuse systems – Environmental impacts of wastewater reuse – Emerging contaminants and microplastics – Recent advances in wastewater reclamation technologies – Policies and future perspectives.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

CO1: Explain the concepts, significance and standards related to wastewater reclamation and reuse.
CO2: Describe advanced treatment technologies used for wastewater reuse applications.

CO3: Apply wastewater reuse principles for agricultural, industrial and urban water management systems.
CO4: Analyze the design, operation and economic aspects of wastewater reclamation systems.
CO5: Evaluate sustainable practices, emerging technologies and environmental impacts associated with wastewater reuse.

**TEXTBOOKS:**


1. Metcalf and Eddy, Inc., Wastewater Engineering: Treatment and Resource Recovery, 5th Edition, McGraw Hill Education, New York, 2014.
2. Asano, T., Burton, F.L., Leverenz, H.L., Tsuchihashi, R. and Tchobanoglous, G., Water Reuse: Issues, Technologies and Applications, McGraw Hill, New York, 2007.
3. Spellman, F.R., Handbook of Water and Wastewater Treatment Plant Operations, CRC Press, Boca Raton, 2013.
4. Lazarova, V., Asano, T., Bahri, A. and Anderson, J., Milestones in Water Reuse: The Best Success Stories, IWA Publishing, London, 2013.
5. Henze, M., Van Loosdrecht, M.C.M., Ekama, G.A. and Brdjanovic, D., Biological Wastewater Treatment: Principles, Modelling and Design, IWA Publishing, London, 2008.
6. Qasim, S.R., Wastewater Treatment Plants: Planning, Design and Operation, CRC Press, Boca Raton, 1998.
7. CPHEEO, Manual on Sewerage and Sewage Treatment Systems, Ministry of Housing and Urban Affairs, Government of India, New Delhi.


**COs - PO's & PSO's MAPPING**

| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | - | 1 | 2 | 3 | 1 | - | - | - | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | - | - | - | - | 3 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | - | - | - | 1 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | - | - | - | 2 | 3 | 3 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 3 | 3 |

**EN3019 SURFACE AND GROUNDWATER QUALITY MODELLING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the fundamentals of mathematical models for water quality and the importance of model building.
- To educate about the water parameters modeling and various ground water quality modelling.
- To demonstrate the features and the use of most widely used computerized models for water quality

**UNIT I MODELING PERCEPTIONS 9**

Engineers and Mathematical Models-Water quality models – Historical development - Different types of models-- Steps in model development - Importance of model building. - Calibration and verification of models-conservation of mass and momentum - Chemical reaction kinetics – Law of mass action, Rate constants, reaction order, types of reactions, equilibrium principles.

**UNIT II POLLUTANT TRANSPORT AND REACTOR MODELING 10**

Transport phenomena – Advection, diffusion, dispersion- simple transport models – Plug flow models-Application of PFR and MFR model - Steady state and time variable solutions-completely mixed systems, concept and models in Completely Stirred Tank Reactors, mass balance equations, loading types, feed forward vs. feedback reactor systems

**UNIT III SURFACE WATER QUALITY MODELING 10**

Water quality modelling of Streams, Lakes and impoundments and Estuaries – Water quality–model sensitivity – assessing model performance; Models for dissolved oxygen, pathogens and BOD-Streeter Phelps model for point and distributed sources - Modified Streeter Phelps equations -Toxicant modelling in flowing water.

**UNIT IV GROUNDWATER QUALITY MODELING 8**

Groundwater flow and mass transport of solutes, Degradation of organic compounds, application of concepts to predict groundwater contaminant movement, seawater intrusion – basic concepts and modelling

**UNIT V WATER QUALITY MODELING SOFTWARE 8**

Exposure to surface water and groundwater quality modelling software – MIKE 21, QUAL2E and MODFLOW Models and their application, Case studies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

CO1: Know about the principles of water quality modelling.
CO2: Understand the pollutant transport phenomena in surface and groundwater.
CO3: Apply the knowledge of surface water quality modelling to predict the water quality of rivers, lakes and estuary.
CO4: Predict the groundwater contamination transport.
CO5: Predict water quality of surface and sub surface water using numerical solution.

**REFERENCES:**

1. Steven C. Chapra, “Surface Water Quality Modeling”, Tata McGraw-Hill Companies,Inc., New Delhi, 2008.
2. “Water Quality Modelling for Rivers and Streams” Authors: Benedini, Marcello, Tsakiris, George, Springer Netherlands 2013.

3. “Hydrodynamics and Water Quality: Modelling Rivers, Lakes, and Estuaries”, Zhen-Gang Ji, John Wiley & Sons, 2008.
4. “Modelling Groundwater Flow and Contaminant Transport By Jacob Bear, A. H.-D. Cheng, Springer Science & Business Media, 2010.
5. “Mathematical Modelling of Groundwater Pollution” Ne-Zheng Sun, Alexander Sun, Springer New York, 2012.

**CO’s-PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | | | | | | | | | | | 3 | | | |
| 2 | 3 | | | 3 | | | | | | | | 2 | | | 2 |
| 3 | | | | 2 | | 2 | | 2 | | | 2 | | | | 3 |
| 4 | | 2 | 3 | 3 | 3 | 3 | 3 | 2 | | 2 | 2 | | | 3 | |
| 5 | | 3 | 2 | | 2 | 3 | 3 | | 2 | | 2 | 3 | 3 | 2 | |
| Avg. | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |

**1-low, 2-medium, 3-high,**

**CAI332** **CLIMATE CHANGE AND ADAPTATION** **L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To know the basics, importance of global warming
- To know the concept of mitigation measures against global warming
- To learn about the global warming and climate change

**UNIT I EARTHS CLIMATE SYSTEM 9**

Role of ozone in environment ozone layer ozone depleting gases Green House Effect, Radiative effects of Greenhouses Gases Hydrological Cycle Green House Gases and Global Warming Carbon Cycle.

**UNIT II ATMOSPHERE AND ITS COMPONENTS 9**

Importance of Atmosphere - Physical Chemical Characteristics of Atmosphere - Vertical structure of the atmosphere- Composition of the atmosphere Atmospheric stability- Temperature profile of the atmosphere - Lapse rates - Temperature inversion - effects of inversion on pollution dispersion.

**UNIT III IMPACTS OF CLIMATE CHANGE 9**

Causes of Climate change : Change of Temperature in the environment Melting of ice Pole- sea level rise- Impacts of Climate Change on various sectors Agriculture, Forestry and Ecosystem Water Resources Human Health Industry, Settlement and Society Methods and Scenarios Projected Impacts for Different Regions Uncertainties in the Projected Impacts of Climate Change Risk of Irreversible Changes.

**UNIT IV CLIMATE CHANGES AND ITS CAUSES 9**

Climate change and Carbon credits - CDM - Initiatives in India-Kyoto Protocol Intergovernmental Panel on Climate change - Climate Sensitivity and Feedbacks - The Montreal Protocol - UNFCCCIPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India.

**UNIT V CLIMATE CHANGE AND MITIGATION MEASURES 9**

Clean Development Mechanism -Carbon Trading -examples of future Clean Technology - Biodiesel - Natural Compost - Eco-Friendly Plastic - Alternate Energy -Hydrogen - Bio-fuels - Solar Energy - Wind - Hydroelectric Power -Mitigation Efforts in India and Adaptation funding Key Mitigation Technologies and Practices-Energy Supply - Transport - Buildings

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

CO1 Demonstrate an understanding of how the threats and opportunities of predicted climate changes will influence specific sectors at global and regional scale
CO2 Identify the relationship between atmosphere and its components
CO3 Analyze the impacts of climate change on environment parameters
CO4 Evaluate the scientific insights underlying the assessment reports of the IPCC, with a focus on impacts, adaptation and mitigation
CO5 Critically evaluate the relative opportunities and needs for mitigation and adaptation (including vulnerability assessments) in a variety of sectoral contexts

**TEXTBOOKS**

1. Sangam Shrestha, Mukand S. Babel and Vishnu Prasad Pandey,2014, Climate Change and Water Resources, CRC Press an imprint of the Taylor & Francis Group.
2. Intergovernmental Panel on Climate Change: https://www.ipcc.ch/

**REFERENCES**

1. Adaptation and mitigation of climate Scientific Technical Analysis, Cambridge University Press, Cambridge, 2006
2. Atmospheric Science, J.M. Wallace and P.V. Hobbs, Elsevier / Academic Press 2006
3. Jan C. van Dam, Impacts of Climate Change and Climate Variability on Hydrological Regimes, Cambridge University Press, 2003

**CO's-PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | **Overall correlation of CO s to POs** |
|---|---|---|---|---|---|---|---|
| | | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** | |
| PO1 | Knowledge of Engineering Sciences | 2 | 3 | 2 | 3 | 2 | 2 |
| PO2 | Problem Analysis | 2 | 2 | 1 | 3 | 1 | 2 |
| PO3 | Design/ Development of Solutions | 2 | 2 | 1 | 2 | 1 | 2 |
| PO4 | Investigations | 2 | 3 | 2 | 1 | 2 | 2 |
| PO5 | Modern Tool Usage | 2 | 3 | 3 | 2 | 3 | 3 |
| PO6 | Individual and Team work | 1 | 1 | 2 | 2 | 3 | 2 |
| PO7 | Communication | 2 | 2 | 3 | 1 | 2 | 2 |
| PO8 | The Engineer and Society | 3 | 3 | 2 | 3 | 3 | 3 |
| PO9 | Ethics | 1 | 1 | 2 | 1 | 2 | 1 |
| PO10 | Environment and Sustainability | 2 | 3 | 2 | 1 | 1 | 2 |
| PO11 | Project Management and Finance | 2 | 3 | 2 | 2 | 1 | 2 |
| PO12 | Life Long Learning | 2 | 2 | 3 | 2 | 2 | 2 |
| PSO1 | To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill | 1 | 1 | 2 | 2 | 3 | 2 |
| PSO2 | To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies. | 1 | 1 | 2 | 2 | 3 | 2 |
| PSO3 | To inculcate entrepreneurial skills through strong Industry-Institution linkage. | 1 | 1 | 2 | 2 | 3 | 2 |

| ER3004 | CARBON SEQUESTRATION, UTILIZATION AND STORAGE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- Understand the fundamentals of carbon cycle, greenhouse gas emissions and climate change.
- Study various carbon capture and sequestration techniques.
- Learn carbon utilization technologies in construction and industrial applications.
- Analyze geological, biological and engineered carbon storage systems.
- Evaluate sustainable carbon management strategies and environmental policies.

**UNIT I FUNDAMENTALS OF CARBON EMISSIONS AND CLIMATE CHANGE 9**

Global carbon cycle – Sources and sinks of carbon dioxide – Greenhouse gases and global warming – Climate change impacts – Anthropogenic carbon emissions – Carbon footprint assessment – Industrial and construction sector emissions – National and international climate agreements – Net zero concepts and sustainable development goals.

**UNIT II CARBON CAPTURE AND SEQUESTRATION TECHNOLOGIES 9**

Principles of carbon capture – pre-combustion, post-combustion and oxy-fuel combustion capture methods – Chemical absorption and adsorption techniques – Membrane separation – Cryogenic separation – Direct air capture technologies – Bio-sequestration – Afforestation and reforestation – Soil carbon sequestration – Blue carbon ecosystems.

**UNIT III CARBON UTILIZATION TECHNOLOGIES 9**

Carbon dioxide utilization concepts – $CO_2$ conversion into fuels and chemicals – Mineral carbonation – Carbon curing in concrete – Utilization in cement and construction materials – Algae-based utilization systems – Circular carbon economy – Industrial applications and recent innovations – Case studies on low carbon construction materials.

**UNIT IV CARBON STORAGE AND MONITORING 9**

Geological carbon storage – Saline aquifers – Depleted oil and gas reservoirs – Coal seam storage – Ocean carbon storage – Enhanced oil recovery using $CO_2$ – Site selection and characterization – Injection and transport systems – Leakage risks and environmental impacts – Monitoring, verification and risk assessment techniques.

**UNIT V SUSTAINABLE CARBON MANAGEMENT AND POLICIES 9**

Carbon management strategies – Carbon trading and carbon credits – Life Cycle Assessment (LCA) – Environmental Impact Assessment (EIA) – Policies and regulations for carbon management – Sustainable infrastructure practices – Role of renewable energy in emission reduction – Emerging technologies in carbon neutrality – Case studies on global carbon sequestration projects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

CO1: Explain the principles of carbon cycle, greenhouse gas emissions and climate change.

CO2: Describe various carbon capture and sequestration technologies.

CO3: Analyze carbon utilization methods in industrial and construction applications.

CO4: Evaluate geological and engineered carbon storage systems and monitoring techniques

CO5: Develop sustainable carbon management strategies considering environmental and policy aspects

**REFERENCES:**


1. Carbon Capture and Storage: Principles and Practice, Cambridge University Press.
2. IPCC Reports on Carbon Capture and Storage.
3. Research articles on carbon-neutral and low-carbon infrastructure technologies.
4. Carbon Dioxide Utilization: Fundamentals and Technologies, Elsevier.


**COs- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 3 | 2 | | | | 2 | 3 | | | | | 1 | 2 | 1 | 3 |
| **2** | 3 | 3 | 2 | 2 | 2 | | 3 | | | | | 1 | 2 | 3 | 3 |
| **3** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | | | | | 1 | 3 | 2 | 3 |
| **4** | 3 | 2 | 2 | 3 | 3 | 2 | 3 | | | | | 1 | 3 | 3 | 2 |
| **5** | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| **Avg.** | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |

1-low, 2-medium, 3-high.

| ER3005 | CLIMATALOGY AND METEOROLOGY | L T P C<br>3 0 0 3 |
|---|---|---|

**COURSE OBJECTIVES:**

- To understand the fundamentals of Earth's climate system and atmospheric processes.
- To study observed climate change patterns, causes and global environmental changes.
- To analyze the impacts of climate change on ecosystems, water resources and society.
- To familiarize students with meteorological parameters, weather systems and climate data interpretation.
- To understand climate modelling, extreme weather events and climate adaptation strategies for sustainable development.

**UNIT I EARTH'S CLIMATE SYSTEM 9**

Introduction- Climate in the spotlight- The Earth‟s Climate Machine- Climate Classification-Global Wind Systems- Trade Winds and the Hadley Cell- The Westerlies- Cloud Formation and Monsoon Rains- Storms and Hurricanes- The Hydrological Cycle- Global Ocean Circulation- EI Nino and its Effect- Solar Radiation- The Earth‟s Natural Green House Effect- Green House Gases and Global Warming- Carbon Cycle.

**UNIT II OBSERVED CHANGES AND ITS CAUSES 9**

Observation of Climate Change- Changes in patterns of temperature- Precipitation and sea level rise- Observed effects of Climate Changes- Patterns of Large scale Variability-Drivers of Climate change- Climate Sensitivity and Feedbacks- The Montreal Protocol-UNFCCC- IPCC- Evidences of changes in Climate and Environment- On a Global Scale and in Indian.

**UNIT III IMPACTS OF CLIMATE CHANGE 9**

Impacts of Climate Change on Various sectors- Agriculture, Forestry and Ecosystem-Water Resources- Human Health- Industry, Settlement and Society- Methods and Scenarios- Projected Impacts for Different Regions- Uncertainties in the Projected Impacts of Climate change- Risk of Irreversible Changes.

**UNIT IV METEOROLOGY 9**

Introduction to meteorology – Composition and structure of atmosphere – Atmospheric layers and stability – Heat transfer in atmosphere – Atmospheric pressure, humidity, temperature, rainfall and wind – Weather systems and forecasting – Atmospheric inversion – Microclimate and urban climate – Meteorological instruments – Global and regional weather patterns – Meteorological data collection and interpretation.

**UNIT V CLIMATE MODELING AND ADAPTATION STRATEGIES 9**

Climate modelling concepts – Global Climate Models (GCMs) and Regional Climate Models (RCMs) – Climate data analysis and interpretation – Online methodologies- Climate projections and future scenarios – Extreme weather events: heat waves, floods, droughts, cyclones and cloudbursts – Urban climate change – Disaster preparedness and climate resilience – Early warning systems – Climate adaptation and sustainable development strategies – Role of meteorology in climate risk assessment.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

The students completing the course will have ability to

**CO1** Understand earth's climate system

**CO2** describe the pattern of changes in climate

**CO3** Understand the impacts of climate change

**CO4** Understand meteorological parameters and weather systems.

**CO5** Analyze climate models, extreme weather events and adaptation strategies.

**TEXTBOOKS:**


1. Stanley E.Manahan, "Environmental Science and Technology", Lewis Publisher, 1997


**REFERENCES:**


1. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press 2003
2. Dash Sushil Kumar, "Climate Change — An Indian Perspective",Cambridge University Press Indian Pvt.Ltd, 2007
3. IPCC, Fourth Assessment Report- the AR4 synthesis report.
4. IPCC, "Climate Change Assessment Reports", Cambridge University Press, Latest Editions.
5. India Meteorological Department (IMD), "Climatological Tables and Meteorological Reports", Ministry of Earth Sciences, Government of India, Latest Editions.


| PO/PSO | CO1 | CO2 | CO3 | CO4 | CO5 | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|
| **PROGRAM OUTCOMES (PO)** | | | | | | |
| **PO1** Engineering Knowledge | 3 | 3 | 2 | 3 | 2 | 3 |
| **PO2** Problem Analysis | 2 | 3 | 3 | 2 | 3 | 3 |
| **PO3** Design / development of solutions | 1 | 1 | 2 | 1 | 3 | 2 |
| **PO4** Investigation | 1 | 2 | 2 | 2 | 3 | 2 |
| **PO5** Modern Tool Usage | 1 | 1 | 1 | 2 | 3 | 2 |
| **PO6** Engineer and Society | 2 | 2 | 3 | 1 | 2 | 2 |
| **PO7** Environment and Sustainability | 3 | 3 | 3 | 2 | 3 | 3 |
| **PO8** Ethics | 1 | 1 | 1 | 1 | 1 | 1 |
| **PO9** Individual and Team work | 1 | 1 | 1 | 1 | 1 | 1 |
| **PO10** Communication | 1 | 1 | 1 | 1 | 1 | 1 |
| **PO11** Project Management and Finance | 1 | 1 | 1 | 1 | 1 | 1 |
| **PO12** Life Long Learning | 2 | 2 | 2 | 2 | 3 | 2 |
| **PROGRAM SPECIFIC OUTCOMES (PSO)** | | | | | | |
| **PSO1** Knowledge of Civil Engineering discipline | 2 | 2 | 2 | 2 | 2 | 2 |
| **PSO2** Critical analysis of Civil Engineering problems and innovation | 2 | 2 | 3 | 2 | 3 | 2 |
| **PSO3** Conceptualization and evaluation of Engineering solutions to Civil Engineering issues | 1 | 2 | 2 | 2 | 3 | 2 |

| EN3023 | ENERGY MANAGEMENT IN INDUSTRIES | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES:**

- To provide an understanding of the basics of energy conservation method and energy auditing in industries
- To understand the environmental and economical benefits associated management.

**UNIT I INTRODUCTION 8**

Energy Scenario – India and World – Energy Resources in India – Energy consumption Pattern, Energy Conservation and Energy Efficiency – Needs and Advantages, Role of Energy Manager – Energy Conservation Act.

**UNIT II AUDITING AND INSTRUMENTATION IN ENERGY MANAGEMENT 9**

Energy Audit – Purpose, Types, Methodologies, Barriers with respect to Process Industries, Power Plants, Boilers and Certain Energy Intensive Industries; Energy Audit Questionnaire – Role of instrumentation in energy conservation – total energy systems – concept of total energy – advantages, limitations & Application.

**UNIT III ENERGY MANAGEMENT 11**

Thermal energy management-Various Energy management Measures in Steam Systems – Losses in Boiler – Methodology of upgrading Boiler programme – Energy Conservation in Refrigeration and Air-conditioning Systems – Electrical Energy management- Potential Areas for Electrical Energy management in Various Industries-Energy Management Opportunities in Electrical Heating, Lighting system, Cable selection – Energy Efficient Motors – Factors involved in Determination of Motor Efficiency Adjustable AC Drives, Applications & its use variable speed Drives/Belt Drives.

**UNIT IV ENERGY ECONOMICS 9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Costing, risk and Sensitivity Analysis, Financing Options, Energy Performance Contract and Role of ETCOS.

**UNIT V APPLICATIONS 8**

Case studies on sugar Industry –Co generation, Thermal power plant; Petrochemical Industries.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

On completion of this course, the students will be able to exhibit

CO1. Conceptual knowledge of the Energy consumption Pattern, Energy Conservation and Energy Efficiency

CO2. Understand the basics of energy conservation method and energy auditing.

CO3. Capability to integrate various options for energy management in various Industries.

CO4. Understand energy economics

CO5. Energy management studies with respect to industries

**REFERENCES:**


1. Handbook on Energy Efficiency, TERI, New Delhi, 2001
2. Jefferson W. Tester, Elisabeth M. Drake, Michael J Driscoll, Michael W. Golay, William A Peters, Sustainable Energy – Choosing among options, Prentice Hall of India, 2006
3. Murphy W.R. and Mckay G., Energy Management, Elsevier, 2007.
4. Roger A. Hinrichs and Merlin H. Kleinbach, Energy: Its Use and the Environment, Cengage Learning, 2012.

5. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, Guide to Energy Management, 7th Ed., Keinnedu Fairmant Press, 2011.

## COs- PO's & PSO's MAPPING

| POs/PSOs | | Course Outcome | | | | | Overall Correlation of COs to |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 2 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | - | - | - | - | - | - |
| PO4 | Investigation | 1 | 2 | 2 | - | 2 | 2 |
| PO5 | Modern Tool Usage | 1 | 1 | 1 | 3 | - | 1 |
| PO6 | Engineer and Society | - | 2 | 2 | - | 2 | 2 |
| PO7 | Environment and Sustainability | 1 | 2 | 2 | - | 2 | 2 |
| PO8 | Ethics | - | 1 | 1 | - | 3 | 1 |
| PO9 | Individual and Team work | 1 | 1 | 1 | 3 | - | 1 |
| PO10 | Communication | 2 | 2 | 2 | 2 | 3 | 2 |
| PO11 | Project Management and Finance | - | 1 | 1 | 2 | 2 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO1 | Knowledge of Civil Engineering | 2 | 2 | 2 | 2 | 2 | 2 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | - | 1 | 1 | 2 | 2 | 1 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | - | 1 | 1 | 2 | 2 | 1 |

**ER3006 NATURAL RESOURCE MANAGEMENT AND ACCOUNTING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To understand the principles and importance of natural resource management for sustainable development.
- To study the classification, utilization and conservation of natural resources.
- To gain knowledge on environmental and natural resource accounting systems.
- To analyze resource economics, valuation and sustainability indicators.
- To apply resource management strategies and accounting tools in environmental planning and policy.

**UNIT I NATURAL RESOURCE MANAGEMENT 9**

Natural resources – Classification and characteristics – Renewable and non-renewable resources – Resource depletion and environmental degradation – Principles of sustainable development – Ecosystem approach to resource management – Resource conservation strategies – Environmental ethics and policies – Global and Indian perspectives on resource management..

**UNIT II MANAGEMENT OF LAND, WATER AND FOREST RESOURCES 9**

Land resources and land use planning – Soil conservation and watershed management – Surface and groundwater resources – Integrated water resources management – Forest resources and biodiversity conservation – Deforestation and afforestation – Wetland management – Community participation in resource management – Case studies on resource conservation practices.

**UNIT III ENERGY AND MINERAL RESOURCE MANAGEMENT 9**

Conventional and non-conventional energy resources – Energy conservation and efficiency – Sustainable energy management – Mineral resources and extraction impacts – Resource recovery and recycling – Circular economy concepts – Industrial ecology – Waste minimization and cleaner production – Sustainable resource utilization strategies.

**UNIT IV NATURAL RESOURCE ACCOUNTING 9**

Concepts and objectives of environmental and natural resource accounting – Green accounting – Environmental economics and valuation methods – Resource accounting frameworks – System of Environmental-Economic Accounting (SEEA) – Cost-benefit analysis – Environmental auditing – Sustainability indicators – Carbon accounting and ecological footprint assessment.

**UNIT V POLICY, GOVERNANCE AND SUSTAINABLE RESOURCE MANAGEMENT 9**

Environmental laws and policies related to natural resources – Institutional framework for resource governance – Environmental impact assessment and strategic environmental assessment – Climate change and resource management – Sustainable urban and rural resource management – GIS and remote sensing applications in resource monitoring – Case studies on integrated resource management.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

CO1 Explain the concepts, classification and conservation principles of natural resources.

CO2 Apply appropriate management strategies for land, water and forest resources.

CO3 Analyze sustainable utilization and management of energy and mineral resources.

CO4 Evaluate natural resource accounting methods, environmental valuation and sustainability indicators.

CO5 Assess policies, governance mechanisms and technological tools for sustainable resource management.

**TEXTBOOKS:**


1. Cunninghum, W.P. and Cunningham, M.A., Principles of Environmental Science and Engineering, McGraw Hill Education, New York, 2015.
2. Tietenberg, T. and Lewis, L., Environmental and Natural Resource Economics, Pearson Education, New Delhi, 2018.
3. Rajagopalan, R., Environmental Studies: From Crisis to Cure, Oxford University Press, New Delhi, 2016.
4. Shyam Divan and Armin Rosencranz, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2020.


## COs - PO's & PSO's MAPPING

| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PS03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | 1 | 2 | 3 | 1 | - | - | - | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 3 | 3 | - | - | - | - | 3 | 2 | 1 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 2 | 3 | - | - | - | 1 | 3 | 2 | 1 |
| **CO4** | 3 | 3 | 2 | 3 | 2 | 2 | 3 | 1 | - | - | 2 | 2 | 3 | 1 |
| **CO5** | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 3 | 2 |

| CAI331 | BIOCHEMICAL AND THERMOCHEMICAL CONVERSION OF BIOMASS | L T P C 3 0 0 3 |
|---|---|---|

**COURSE OBJECTIVE:**

- To expose the students with different bio and thermal conversion of biomass.

**UNIT I BIOMASS CHARACTERIZATION 9**

Biomass – types – fuels from biomass. Terms and units used in biomass production. Biomass fuel characterization – physical, chemical and thermal – energy release. Supply chain – harvesting / collection – transportation and processing. Briquetting – types – pelletizing.

**UNIT II BIOCHEMICAL CONVERSION 9**

Biochemical degradation – factors affecting biogas production – types of biogas plants – construction details – operation and maintenance – utilization of biogas – slurry handling, utilization and enrichment – high rate bio methanation process – landfills – bioethanol – feedstock – process – utilization – composting – methods – machinery.

**UNIT III THERMOCHEMICAL CONVERSION BY COMBUSTION 9**

Thermochemical degradation, stoichiometric air requirement – Combustion process – chemistry of combustion – combustion zones – emissions. Cofiring of biomass. Incinerators – layout. Combustion of wastes and MSW. Wood burning stoves – types - operation.

**UNIT IV THERMOCHEMICAL CONVERSION BY GASIFICATION AND PYROLYSIS 9**

Biomass gasification – chemistry of gasification – types of gasifier – Gas cleaning & conditioning – utilization of producer gas – emissions – commercial gasifiers plants. Pyrolysis – product recovery – types – biochar – bio oil – operation – recovery.

**UNIT V COGENERATION AND WASTE HEAT RECOVERY 9**

Cogeneration technologies – cycles – topping – bottoming – problems – applications – selection. Waste heat recovery – plate heat exchangers – waste heat boilers – heat pumps – thermic fluid heaters – selection of waste heat recovery.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

CO1 Biomass identification and classes
CO2 Biomass characters and biochemical conversion.
CO3 Thermo chemical conversion techniques and cogeneration from waste
CO4 To know about application of biomass conversion
CO5 Analyse the energy generated from waste

**TEXTBOOKS:**


1. Chawla, O.P.1986. “Advances in Biogas Technology”. ICAR Publication, New Delhi.
2. Rao. S and B.B. Parulekar. 2000. Energy Technology – Non-conventional, Renewable and Conventional. Khanna Publishers, New Delhi.
3. Horlock JH, 1987. Cogeneration – Heat and Power, Thermodynamics and Economics, Oxford Press.


**REFERENCES:**


1. Khandelwal K.C. and Mahdi, S.S. 1986. Biogas Technology. Tata Mc Graw Hill Pub. Co. Ltd., New Delhi.
2. Srivastava, P.K., Shukla, B.D. and Ojha, T.P. 1993. Technology and application of biogas. Jain Brothers, New Delhi.
3. Mathur,A.N.and Rathore,N.S.1993.,Biogas production Management and Utilisation. Himanshu Publication. New Delhi.

4. Chakraverty, A. 1993. Biotechnology and other alternate technologies for utilisation of biomass. Oxford and IBH Publishing Co., New Delhi.

**COs- PO's & PSO's MAPPING**

| PO/ PSO | Description | COURSE OUTCOMES | | | | | Overall Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES(PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem analysis | 2 | 3 | 3 | 3 | 3 | 3 |
| PO3 | Design / development of solutions | 1 | 2 | 3 | 3 | 3 | 2 |
| PO4 | Investigation | 2 | 2 | 3 | 3 | 2 | 2 |
| PO5 | Modern Tool Usage | 1 | 2 | 2 | 3 | 2 | 2 |
| PO6 | Engineer and Society | 1 | 2 | 2 | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO8 | Ethics | 1 | 1 | 1 | 1 | 1 | 1 |
| PO9 | Individual and Team work | 1 | 1 | 1 | 1 | 1 | 1 |
| PO10 | Communication | 1 | 1 | 1 | 1 | 1 | 1 |
| PO11 | Project Management and Finance | 1 | 1 | 2 | 2 | 3 | 2 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 3 | 2 |
| **PROGRAM SPECIFIC OUTCOMES(PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 1 | 2 | 3 | 3 | 3 | 2 |

**EN3502** **LIFE CYCLE ASSESSMENT** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To impart knowledge and skills on the concept and methodology of Life Cycle Assessment as per international standards and its potential applications to develop sustainable products and promote sustainable consumption.

**UNIT I LIFE CYCLE THINKING AND LIFE CYCLE MANAGEMENT 8**

Introduction to Life Cycle Thinking — Industrial ecology — Life cycle management (LCM) and Stakeholder Expectations - LCM drivers and issues - materials flow analysis - Life cycle of Products and services- International organizations and networks –Value creation along the life cycle– technical characteristics – applications – limitations

**UNIT II LCA GOAL, SCOPE AND INVENTORY 9**

Impact assessment in Life Cycle Assessment (LCA) – Selection of impact categories and characterization models – Classification and characterization – Normalization and weighting – Data quality and uncertainty analysis – Simplified and streamlined LCA approaches – Contribution and comparative analysis – Sensitivity analysis – Sustainability analysis – Introduction to life cycle costing and eco-efficiency – Integration of LCA and LCC – Case studies..

**UNIT III LIFE CYCLE IMPACT ANALYSIS AND INTERPRETATION 9**

Concepts of sustainable consumption and eco-efficiency – Green consumerism and product stewardship – Extended producer responsibility – Design for Environment (DfE) principles and strategies – Eco-design and design for disassembly – Reuse and recycling concepts and constraints – Green procurement and green distribution – Environmental product declarations and eco-labelling – Indian Eco-mark scheme – Environmental marketing and communication of life cycle information.

**UNIT IV DESIGN FOR ENVIRONMENT AND ECOLABELLING 10**

Sustainable consumption — Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility — Design For Environment Strategies, Practices, Guidelines, Methods, And Tools .Eco design strategies –Design for Disassembly - Dematerialization, re materialization, trans materialization — Green procurement and green distribution - Analysis framework for reuse and recycling — Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian eco mark scheme – Environmental product declarations — Environmental marketing

**UNIT V LCA SOFTWARES AND CASE STUDIES 9**

LCA Softwares - LCA Software Demo: SimaPro, GREET, BEES, CMU EIO,GABI - Advances in LCA: Hybrid LCA, Thermodynamic LCA - LCA case studies on Product Design, Product Improvement, Product Comparison and Policy development.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

On completion of the course, the student is expected to be able to

**CO1** Explain the various functional elements of Life Cycle Analysis and Design for Environment

**CO2** Apply the knowledge of science and engineering fundamentals to characterize the environmental interactions of products and services

**CO3** Design of engineering systems taking into account the material flow and pollutant interactions between engineering decisions and the environment

**CO4** Select appropriate LCA tools to support product/process design and decision making, taking into account the impact of the solutions in a sustainability context

**CO5** Conduct research pertinent to Life Cycle Management and communicate effectively to different stakeholders in terms of eco labels as well as engage in independent life-long learning

**REFERENCES:**


1. ISO 14040-2016-Environmental management - Life cycle assessment - Principles and framework, International Organization for Standardization, 2016
2. Ralph Horne, Tim Grant, Karli Verghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing, 2009
3. ISO/TR 14047:2003, Environmental management - Life cycle impact assessment - Examples of application of ISO 14042, International Organization for Standardization, 2007.
4. International Organization for Standardization: ISO TR 14062 Environmental management-Integrating environmental aspects into product design and development, 2002.
5. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook — General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union; 2010
6. Catherine Benoit, UQAM/CIRAIG, and Bernard Mazijn, Guidelines for Social Life Cycle Assessment of Products, United Nations Environment Programme,2009


**CO's-PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | | | 2 | | | | | 3 | | 2 | | 2 | 3 | 3 |
| 2 | 2 | | | | | 2 | | | | | 3 | | 2 | 3 | 3 |
| 3 | 3 | 2 | 2 | | | 3 | | | | | 2 | 3 | 3 | 3 | 3 |
| 4 | | | | | | | 3 | | 3 | 2 | | 2 | 3 | 3 | 3 |
| 5 | 2 | | | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | | 3 | 3 | 3 |
| Avg. | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |

**1. low, 2-medium, 3-high, '-"- no correlation**

| ER3007 | LANDFILL AND REMEDIATION TECHNOLOGY | L T P C<br>3 0 0 3 |
|---|---|---|

**COURSE OBJECTIVE:**

- To understand the important characteristics and design principles of the waste containment and remediation industry as well as know the relevant regulations and engineering design requirements of landfills and contaminated site remediation

**UNIT I LANDFILL BASICS 8**

Waste management Hierarchy- Need for landfills –Environmental Protection by Landfills- Landfill Classification – Sanitary and Secure Landfills - Components and Configuration - Legal frame work for landfilling – Landfill Site investigation- Regional Landfills- Environmental control using site design —- Landfill Design Tasks

**UNIT II LANDFILL LINERS AND COVER SYSTEMS 10**

Components of landfill barrier systems – Compacted clay liners – Geosynthetic clay liners and geomembranes– Composite liner systems – Liner construction and quality control – Mechanisms of liner leakage and diffusion – Landfill cover systems: daily, intermediate and final covers – Flow through landfill covers – Slope stability and erosion control measures – Anchor trenches and access ramps.

**UNIT III LEACHATE AND LANDFILL GAS MANAGEMENT 9**

Waste decomposition in landfills - Factors affecting leachate and landfill gas generation — Leachate Drainage Layer – Geotextile and Geonet design — leachate Collection and Removal systems-Temporal trends in leachate composition – Design of Landfill gas collection and removal systems- Gas condensate issues & knockouts.

**UNIT IV LANDFILL OPERATION AND CLOSURE 8**

Landfill Construction and Operational Controls – Fill Sequencing Plans -Selection of Landfill Equipment- Landfill Administration- Record Keeping - Topographic mapping– Ground and Surface water Monitoring – Methane Gas monitoring - Audits of landfill environmental performance and management – Post Closure care and use of landfills — Landfill Economics- landfill construction and operational cost estimation – establishing tipping fees

**UNIT V CONTAMINATED SITE REMEDIATION 10**

Contaminated sites — Site Characterization - Migration Covers, Cutoff Walls, Solidification / Stabilization - Pump-and-Treat Systems - Solvent Vapor Extraction, Air Sparging, Soil Flushing – Bioremediation - Natural Attenuation - Remedy Selection and Risk Assessment — Geotechnical Aspects of In Situ Remediation Technology - Specific case studies in contaminated site remediation – Rehabilitation of Open dumps- Landfill Mining

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**On completion of the course, the student is expected to be able to**

**CO1** Have an overview of the Indian and international landfill regulations and guidelines for the design, construction, operation and management of landfills

**CO2** Understand the design and construction of landfills, processes in landfills, methods for management and treatment of landfill gas and leachate

**CO3** Have an in-depth understanding of the key pollutants in leachate and gas, their potential environmental impacts and the

**CO4** Make engineering design and study performance of control systems used to manage and treat pollutant and waste emissions from sites.

**CO5** Be able to apply a risk based assessment of contaminated sites and implement site remediation technologies

**REFERENCES:**


1. Robert M. Koerner and Donald H Gray (2002), "Geotechnical aspects of Landfill Design and Construction", Prentice Hall, New Jersey.
2. Neal Bolton P.E (1995), “The Handbook of Landfill Operations”, Blue Ridge Services Inc., Atascadro, CA — ISBN 0-9646956-0-x
3. David E Daniel and Robert M. Koerner (2007), “Waste Containment Facilities – Guidance for construction Quality Assurance and Construction Quality Control of Liner and Cover Systems, American Socirty of Civil Engineers, ASCE Press.
4. Donald L Wise and Debra J Trantolo (2018), “Remediation of Hazardous Waste Contaminated Soils, Marcel Dekker Inc., New York
5. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, “Integrated Solid Waste Management, Mc-Graw Hill International edition, New York, 1993.
6. Hari D Sharma and Krishna R. Reddy (2004), Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Techonolgies, John Wiely, New Jersy
7. Oweis, I.S. and Khera, R.P (1998) *Geotechnology of Waste Management*, 2nd Edition, PWS Publishing Co., Boston, MA


**CO’s-PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | | | | | | | | | | | 1 | 3 | | |
| 2 | 3 | | 3 | | | | 2 | | 2 | | | | 2 | | 3 |
| 3 | 3 | 3 | | 2 | | 3 | 2 | | | | 1 | | 2 | 2 | 2 |
| 4 | 3 | | 3 | | 2 | 3 | 2 | | 2 | | | | 2 | 2 | 2 |
| 5 | 3 | 3 | 3 | | 2 | 3 | 2 | | 2 | | 1 | | 3 | 2 | 2 |
| Avg. | 3 | 3 | 3 | 2 | 2 | 3 | 2 | | 2 | | 1 | 1 | 2 | 2 | 2 |

**1.low, 2-medium, 3-high, ‘-“- no correlation**

**ER3008 PLASTIC, C&D, BIOMEDICAL AND E-WASTE MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To understand the characteristics, sources and environmental impacts of plastic, construction and demolition (C&D), biomedical and electronic wastes.
- To study collection, segregation, treatment and disposal methods for different categories of special wastes.
- To gain knowledge on recycling, recovery and sustainable waste management practices.
- To analyze regulations, policies and health aspects associated with hazardous and special wastes.
- To apply integrated waste management strategies for environmental protection and resource conservation.

**UNIT I SPECIAL WASTE MANAGEMENT 9**

Solid waste management hierarchy – Classification of special wastes – Sources, characteristics and generation of plastic, C&D, biomedical and e-waste – Environmental and health impacts – Waste minimization concepts – Segregation, storage and transportation – Circular economy and resource recovery – Regulatory framework and national policies related to special waste management.

**UNIT II PLASTIC WASTE MANAGEMENT 9**

Types and characteristics of plastics – Sources and generation of plastic waste – Collection and segregation methods – Recycling and reuse techniques – Mechanical and chemical recycling – Plastic waste processing technologies – Energy recovery from plastic waste – Microplastics and environmental concerns – Extended Producer Responsibility (EPR) – Plastic Waste Management Rules in India.

**UNIT III CONSTRUCTION AND DEMOLITION (C&D) WASTE MANAGEMENT 9**

Sources and characteristics of C&D waste – Quantification and composition – Collection, storage and transportation – Recycling and reuse of construction materials – Processing technologies for concrete, bricks, wood, metals and asphalt – Sustainable construction practices – C&D waste utilization in civil engineering applications – C&D Waste Management Rules and case studies.

**UNIT IV BIOMEDICAL WASTE MANAGEMENT 9**

Sources and classification of biomedical waste – Segregation and color coding – Collection, storage and transportation – Treatment technologies: incineration, autoclaving, microwaving and chemical disinfection – Sharps and infectious waste management – Occupational safety and health aspects – Biomedical Waste Management Rules – Environmental monitoring and risk assessment.

**UNIT V E-WASTE MANAGEMENT 9**

Sources and composition of electronic waste – Hazardous components and environmental impacts – Collection and recycling systems – Recovery of valuable materials – Dismantling and processing technologies – Informal recycling sector and associated risks – E-waste legislation and Extended Producer Responsibility – Sustainable e-waste management practices – Emerging trends and case studies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

CO1 Explain the sources, characteristics and environmental impacts of plastic, C&D, biomedical and e-wastes.

CO2 Describe collection, segregation, recycling and treatment methods for plastic waste management.

CO3 Apply sustainable management and resource recovery practices for C&D waste in civil engineering applications.

CO4 Analyze biomedical waste treatment technologies, regulations and associated health risks.

CO5 Evaluate e-waste management systems, recycling technologies and sustainable waste management strategies.reuse.

**TEXTBOOKS:**


1. Tchobanoglous, G., Theisen, H. and Vigil, S., Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, New York, 1993.
2. George Tchobanoglous and Frank Kreith, Handbook of Solid Waste Management, 2nd Edition, McGraw Hill, New York, 2002.
3. Peavy, H.S., Rowe, D.R. and Tchobanoglous, G., Environmental Engineering, McGraw Hill Education, New York, 2017.
4. CPHEEO, Manual on Municipal Solid Waste Management, Ministry of Housing and Urban Affairs, Government of India, New Delhi, 2016.
5. Kumar, S., Biomedical Waste Management and Handling Rules, PHI Learning, New Delhi, 2018.


**COs - PO's & PSO's MAPPING**

| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | - | 1 | 3 | 3 | 1 | - | - | - | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | - | - | - | - | 3 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | - | - | - | 1 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 1 | - | - | 1 | 2 | 3 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 3 | 3 |

**ER3009 ENVIRONMENTAL SENSITIVE URBAN DESIGN L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To understand the principles and concepts of environmentally sensitive urban design.
- To study sustainable urban planning and green infrastructure techniques.
- To gain knowledge on water-sensitive and climate-resilient urban development practices.
- To analyze environmental impacts of urbanization and sustainable mitigation measures.
- To apply integrated urban design approaches for sustainable and resilient cities.

**UNIT I ENVIRONMENTALLY SENSITIVE URBAN DESIGN 9**

Urbanization and environmental issues – Principles of environmentally sensitive urban design – Sustainable urban development – Urban ecology and ecosystem services – Environmental impacts of land use change – Compact city concept – Smart and resilient cities – Urban sustainability indicators – Environmental policies and planning approaches.

**UNIT II GREEN INFRASTRUCTURE AND SUSTAINABLE LAND USE 9**

Green infrastructure concepts – Urban green spaces and ecological corridors – Sustainable land use planning – Green buildings and sustainable construction materials – Urban heat island mitigation – Energy-efficient urban planning – Transit-oriented development – Low carbon urban development – Nature-based solutions in cities.

**UNIT III WATER SENSITIVE URBAN DESIGN 9**

Urban hydrology and storm water management – Water Sensitive Urban Design (WSUD) principles – Sustainable urban drainage systems (SUDS) – Rainwater harvesting – Permeable pavements – Bioswales and rain gardens – Urban flood mitigation – Wastewater reuse in urban areas – Integrated urban water management.

**UNIT IV URBAN ENVIRONMENTAL QUALITY AND CLIMATE RESILIENCE 9**

Urban air and noise pollution – Solid waste management in urban areas – Climate change impacts on cities – Urban resilience and adaptation strategies – Disaster risk reduction – Environmental monitoring and assessment – Carbon footprint and urban sustainability assessment – Public health and environmental quality.

**UNIT V SMART CITIES, GIS AND SUSTAINABLE URBAN MANAGEMENT 9**

GIS and remote sensing applications in urban planning – Smart city concepts and technologies – Environmental information systems – Urban mobility and sustainable transportation – Resource-efficient infrastructure – Community participation in urban planning – Sustainable urban governance – Case studies on environmentally sensitive urban development.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

CO1: Explain the principles and environmental aspects of sustainable urban design and planning.
CO2: Apply green infrastructure and sustainable land use strategies in urban development.
CO3: Analyze water-sensitive urban design and sustainable urban drainage systems.
CO4: Evaluate urban environmental quality, climate resilience and disaster mitigation measures.
CO5: Utilize GIS, smart technologies and sustainable governance approaches for environmentally sensitive urban management.

**TEXTBOOKS:**


1. Farr, D., Sustainable Urbanism: Urban Design with Nature, John Wiley & Sons, New Jersey, 2018.
2. Calthorpe, P., Urbanism in the Age of Climate Change, Island Press, Washington D.C., 2011.
3. Lehmann, S., The Principles of Green Urbanism: Transforming the City for Sustainability, Earthscan, London, 2010.
4. Beatley, T., Green Urbanism: Learning from European Cities, Island Press, Washington D.C., 2012.
5. Newman, P. and Jennings, I., Cities as Sustainable Ecosystems, Island Press, Washington D.C., 2013.
6. Wheeler, S.M. and Beatley, T., The Sustainable Urban Development Reader, Routledge, London, 2014.
7. Watson, D. and Adams, M., Design for Flooding: Architecture, Landscape and Urban Design for Resilience to Climate Change, Wiley, New Jersey, 2011.


**COs - PO's & PSO's MAPPING**

| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | - | 1 | 3 | 3 | 1 | - | - | - | 2 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | - | - | - | 1 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | - | - | 1 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 1 | - | - | 1 | 2 | 3 | 3 |
| CO5 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 3 | 3 |

**ER3010 RESOURCE RECOVERY FROM WASTE L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To understand the principles and design of recovering materials and energy from wastes through mechanical, biological and thermal methods and manage the undesirable by- products.

**UNIT I MECHANICAL PROCESSING FOR MATERIAL RECYCLING 10**

Resource recovery for a sustainable development- Material and energy flow management and analysis - Systems and processes for reduction, reuse and recycling -Objectives of Waste Processing-Source Segregation and Hand Sorting-Waste Storage and Conveyance — Shredding – Pulping - Size Separation by Screens- Density Separation by Air Classification – magnetic and electromechanical separation processes- Design Criteria and Equipment selection

**UNIT II BIOLOGICAL PROCESSING FOR RESOURCE RECOVERY 10**

Mechanisms of Biological Processing — Aerobic Processing of Organic fraction - Composting methods and processes- factors affecting- Design of Windrow Composting Systems- In Vessel Composting- Compost Quality Control- Vermiculture: definition, scope and importance - common species for culture - Environmental requirements - culture methods- Applications of vermiculture- Potentials and constraints for composting in India-Largescale and decentralized plants.

**UNIT III BIO-CHEMICAL CONVERSION OF WASTE TO ENERGY 9**

Principles and Design of Anaerobic Digesters — Process characterization and control- The biochemistry and microbiology of anaerobic treatment - Toxic substances in anaerobic treatment - Methane generation by Anaerobic Digestion- Anaerobic reactor technologies -Commercial anaerobic Technologies- Single stage and multistage digesters- Digester design and performance-Gas collection systems-Methane Generation and Recovery in Landfills — Biofuels from Biomass

**UNIT IV THERMO-CHEMICAL CONVERSION OF WASTE TO ENERGY 9**

Principles of waste-to-energy conversion – Energy recovery facilities – Incineration process and types of incinerators – Mass burn and RDF systems – Composition and calorific value of waste – Basic combustion principles and stoichiometric air requirement – Flue gas composition – Boiler and heat recovery systems – Emission control methods: flue gas cleaning, scrubbers and DeNOx processes – Pyrolysis and gasification – Bottom ash generation, treatment and disposal – Planning and operation of waste-to-energy plants.

**UNIT V CASE STUDIES ON WASTE RECYCLING 7**

Recycling technologies for paper, glass, metal, plastic — Used Lead Acid Battery Recycling — End of Life Vehicle Recycling — Electronic Waste Recycling — Waste Oil Recycling — Solvent Recovery - Drivers and barriers for material recycling: social, legal and economic factors - Environmental impacts of waste recycling - Design for the environment: the life cycle approach.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

On Completion of the Course, the Candidate should:

**CO1** Understand the fundamental principles of existing and emerging technologies for the treatment of waste and recovery of materials and energy from waste

**CO2** Appreciate the increasing importance of waste and resource management in achieving environmental sustainability

**CO3** Be able to analyze and describe the potential of solid waste as a secondary raw material, and the associated problems and possibilities in a sustainable society.

**CO4** Understand thermo-chemical conversion of waste to energy

**CO5** Conceptualize recycling options foe waste to energy

**REFERENCES:**


1 Aarne Veslind and Alan E Rimer (1981), “Unit operations in Resource Recovery Engineering “, Prentice Hall Inc., London

2 Manser A G R, Keeling A A (1996). Practical handbook of processing and recycling on municipal waste. Pub CRC Lewis London, ISBN 1-56670-164

3 Chiumenti, Chiumenti, Diaz, Savage, Eggerth, and Goldstein, *Modern Composting Technologies* JG Press October 2005

4 Charles R Rhyner (1995), Waste Management and Resource Recovery, Lewis Publishers

5 Gary C. Young (2010) Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons, John Wiley & Sons


**CO’s-PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| **1** | 2 | 2 | | 2 | | 1 | 3 | | 3 | | 3 | | 2 | | |
| **2** | 2 | | 2 | | 2 | 2 | 2 | | | 2 | | 2 | 2 | | 2 |
| **3** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | | 3 | | 2 | 3 | |
| **4** | 2 | 2 | 2 | 3 | 3 | 2 | | | 2 | | | 2 | 2 | 2 | |
| **4** | 2 | 2 | 1 | | 1 | | 2 | 2 | | | 2 | | 2 | | 2 |
| **Avg.** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 |

**1. low, 2-medium, 3-high, ‘-“- no correlation**

**EN3024 PUBLIC HEALTH ENGINEERING SERVICES IN BUILDINGS L T P C**
**3 0 0 3**

## COURSE OBJECTIVES

- To introduce and give knowledge about the different public health engineering services for human environment- water supply, sewerage, drainage, waste management and plumbing systems.
- To give familiarity about sustainable practices and systems for public health engineering services.
- To enable the conceptual design of large housing complexes for public health engineering services.

### UNIT I WATER SUPPLY 9

Water supply system at macro level - sources, pumping, reservoirs, water treatment, tanks, piping systems and materials. Quantitative and qualitative requirements of water for different activities in a small building/campus of simple typologies. Overhead tanks, underground sumps, fire fighting storage, water meter, R.O. Plant, water heating systems, solar water heaters, fixtures and fittings for a small building/ campus. Design calculations for the same and related mechanical equipment. Sustainable practices and systems.

### UNIT II SEWERAGE 9

Sewage and sullage. Sewerage systems. Different types/stages of sewage treatment at city level-Sewer line, gradients, manholes, inspection chambers. One pipe/ two pipe plumbing systems. Sewage treatment at campus/ building level -sewage treatment plants, septic tank, leach pits. Sustainable practices and systems.

### UNIT III DRAINAGE AND WASTE MANAGEMENT 9

Storm water drains at city level. Types of pipe. Storm water gutter. Drainage systems in small building and large housing complexes Roof drainage. Rain water harvesting and storage sumps. Sustainable practices and systems.Solid waste- types, segregation and refuse collection. Disposal - Incinerator, composting, vermicomposting, sanitary land filling, bio gas system, modern renewable energy system. Site visits with documentation in the form of sketches/ drawings/ photos.

### UNIT IV PLUMBING SYSTEMS IN BUILDINGS 9

Basic principles of plumbing. Plumbing, sanitary fittings and their requirements for a small building and large housing complexes- wash basins, water closets, urinals, bidets, sinks, gate valve, float valve, flap valve, ball valve, flush valve, etc, different types of taps, faucets, stop cocks, bib cocks, ‘P’, ‘Q’, ‘S’, floor/bottle traps. Understanding of products, product catalogues, service drawings.

### UNIT V DESIGN FOR ENVIRONMENTAL SERVICES 9

Site planning, building and room design principles for water supply, sewage and storm water in an integrated manner for a small building and campus. Understanding of service drawings. Site visits and documentation in the form of sketches/ drawings. Conceptual design for a small building and large housing complexes

**TOTAL: 45 PERIODS**

**COURSE OUTCOME**

**CO1**: Ability to understand environmental services from macro to micro level human environment.

**CO2**: Ability to adopt sustainable practices and systems for public health engineering services.

**CO3**: Understand drainage systems in small building and large housing complexes

**CO4**: Understand Plumbing, sanitary fittings and their requirements for a small building and large housing complexes

**CO5**: Ability to design environmental services in a small buildings and large housing complexes.

**TEXT BOOKS:**


1. Manual on “Sewerage and Sewage Treatment Systems Part A, Part B &Part C” CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013.
2. AFE Wise, JA Swaffied Water, 'Sanitary and Waste Services in buildings', V Edition, Mitchell Publishing, Co. Ltd., 2002.
3. Punmia B.C, 'Waste Water Engineering', Laxmi Publications, 2009.
4. Arceivala S.J, 'Waste Water Treatment for Pollution Control', Tata McGraw Hill, 2008.
5. ‘ National Building Code’, Bureau of Indian Standards.
6. 'Indian Standard Code of Practice for Water Supply in Buildings, IS :2065 – 1983'


**REFERENCES**


1. G.M. Fair, J.C. Geyer and D.Okin, 'Water and Waste Water Engineering Volume II', John Wiley and Sons, Inc. New York, 2010.
2. S.C.Rangwala, 'Water Supply and Sanitary Engineering', Charotar Publishing House, 2016.


**CO’s-PO’s & PSO’s MAPPING**

| CO’ | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | | 2 | 3 | | 2 | | 2 | | 2 | | | | 2 | 1 | |
| **2** | | 2 | | 3 | 2 | | 2 | | 2 | | | | 2 | 2 | |
| **3** | 2 | | 3 | 3 | 2 | 3 | | | | | | 3 | | | 3 |
| **4** | 3 | 2 | | 3 | | 3 | | | 2 | | | 2 | 3 | 1 | 1 |
| **5** | 2 | 2 | | 2 | | 2 | | | | | | 2 | 2 | 1 | 2 |
| **Avg** | 2 | 2 | 3 | 3 | 2 | 3 | 2 | | 2 | | | 3 | 2 | 1 | 2 |

**1. low, 2-medium, 3-high**

**ER3011 ENVIRONMENTAL HEALTH SAFETY AND RISK ASSESSMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To educate overview of EHS in industries and related Indian regulations, types of Health hazards, effect, assessment and control methods and EHS Management System

**UNIT I INTRODUCTION 9**

Need for developing Environment, Health and Safety systems in work places- International initiatives, National Policy and Legislations on EHS in India - Regulations and Codes of Practice - Role of trade union safety representatives - Ergonomics.

**UNIT II OCCUPATIONAL HEALTH AND HYGIENE 10**

Definition of occupational health and hygiene - Categories of health hazards – Exposure pathways and human responses–Exposure Assessment-occupational exposure limits - Hierarchy of control measures - Role of personal protective equipment and the selection criteria

**UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 11**

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and color, Ventilation and Heat Control, Noise, Chemical and Radiation Safety – Electrical Safety – Fire Safety – Safety at Construction sites, ETP – Machine guarding – Process Safety, Working at different levels

**UNIT IV HAZARDS AND RISK ASSESMENT 8**

Safety appraisal – Job Safety Analysis-Control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques –Onsite and Offsite emergency Plans. Employee Participation- Education and Training- Case Studies

**UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 7**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students are expected to be able to understand:

CO1 Need for EHS in industries and related Indian regulations
CO2 Various types of Health hazards, effect, assessment and control methods
CO3 Various safety systems in working environments
CO4 The methodology for preparation of Emergency Plans and Accident investigation
CO5 EHS Management System and its elements

**REFERENCES**


1. Industrial Health and Safety Acts and Amendments, by Ministry of Labour and Employment, Government of India
2. Fundamentals of Industrial Safety and Health by Dr.K.U.Mistry, Siddharth Prakashan, 2012
3. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
4. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services, 2005.
5. Environmental and Health and Safety Management by Nicholas P.Cheremisinoff and Madelyn
6. L. Graffia, William Andrew Inc. NY, 1995

**COs- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | | 3 | | 3 | | 3 | | 3 | 2 | | 1 | 2 | | 2 | |
| **2** | 2 | 2 | 2 | 3 | | | | | 2 | | | 3 | 2 | 2 | |
| **3** | | | 2 | | 3 | 3 | 1 | 1 | 2 | | 2 | 3 | | | |
| **4** | | | 3 | 2 | | 1 | 2 | | | | | | 2 | 2 | 2 |
| **5** | 1 | | | | 2 | | | | 1 | | 1 | | 1 | | |
| **Avg.** | 2 | 3 | 2 | 3 | 3 | 3 | 1 | 2 | 2 | | 1 | 2 | 2 | 2 | 2 |

1-low, 2-medium, 3-high,

| EN3022 | PLANNING, DESIGN AND MANAGEMENT OF LARGE HOUSING COMPLEXES | L T P C 3 0 0 3 |
|---|---|---|

**COURSE OBJECTIVES:**

- Expose students about origin growth and development of human settlements.
- Understand the character of rural and urban housing.
- Outline the issues concerning housing in the Indian context.
- Understand the housing policies and agencies responsible for housing development.

**UNIT I EVOLUTION OF HUMAN SETTLEMENTS 9**

Early settlement pattern – Physical form and growth of settlements – Population growth, Urban and rural settlements – Impact of urbanization on housing.

**UNIT II RURAL AND URBAN HOUSING 9**

Rural housing in India - Typology of housing and housing character in Indian context — Early urban centers / cities, Mughal period, Before independence and After independence — Industrial townships - Satellite towns / New towns — Residential neighborhoods.

**UNIT III HOUSING AND INFRASTRUCTURE 9**

Formal and informal settlements – Homelessness - Housing standards for various income category – Housing development – Slum housing and redevelopment programmes – Sites and services schemes – Socio - economic and special aspects of housing – Community facilities.

**UNIT IV HOUSING DESIGN AND CONCEPTS 9**

Traditional housing, Row housing, Cluster housing - Affordable housing – Green house and eco-friendly housing – Gated community – Housing density – Layout preparation.

**UNIT V HOUSING GOVERNACE 9**

National housing policy – Demand and supply – Housing development agencies and their role — Finance– Housing information system — Cost effective materials and technologies for housing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

Students are introduced to

**CO1** The evolution of settlements housing and community living.
**CO2** Understand the types of housing during various time period.
**CO3** Explore the past and relate with the technology and culture towards living environment of modern society.
**CO4** Understand the design concepts of housing
**CO5** Comprehend housing governance

**REFERENCES:**


1. Bridget Franklin, ‘Housing Transformations Shaping the Space of Twenty-First Century Living, Rout ledge Publishers, UK, 2006.
2. ConstantinodA.Doxiadis, ‘Ekistics’, Hutchinson of London, 1968.
3. Graham Towers, ‘Introduction to Urban Housing Design, Routledge, London, 2005.
4. Jain A.K, ‘Urban Housing and Slums, Readworthy Publications, Delhi, 2009.
5. Mark Tewdwr-Jones, ‘Spatial Planning and Governance, Palgrae Macmillan Publication, London, 2012.
6. Nair K. N. & G. Gopikuttan, ‘Studies in Local-Level Development- Housing in Kerala: Impact of Investment, Technology and Institutions, Danish Books, Delhi, 2012.
7. Sabir Ali, ‘Environment and Resettlement Colonies of Delhi, Har-Anand Publications. New Delhi,

1995.

**CO's-PO's & PSO's MAPPING**

| CO' | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 2 | 3 | | 2 | | 2 | | 2 | | | | 2 | 1 | |
| 2 | | 2 | | 3 | 2 | | 2 | | 2 | | | | 2 | 2 | |
| 3 | 2 | | 3 | 3 | 2 | 3 | | | | | | 3 | | | 3 |
| 4 | 3 | 2 | | 3 | | 3 | | | 2 | | | 2 | 3 | 1 | 1 |
| 5 | 2 | 2 | | 2 | | 2 | | | | | | 2 | 2 | 1 | 2 |
| Avg | 2 | 2 | 3 | 3 | 2 | 3 | 2 | | 2 | | | 3 | 2 | 1 | 2 |

**1.low, 2-medium, 3-high, '-"- no correlation**

**ER3012 GREEN BUILT ENVIRONMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- The course enables students to understand the definition, concepts and objectives of green construction and sustainability, apply cost effective techniques, technologies and methods in construction, understand the problems associated with global warming, study the concept of green buildings, and understand green building rating systems.

**UNIT I INTRODUCTION TO GREEN BUILDING 9**

Introduction to the concept of cost effective construction, Uses of alternate types of materials and their availability, Green construction, Sustainable building concepts, Green building blocks, Low carbon concrete, Gypsum board, Light weight mortar, Fiber reinforced cement concrete, Pozzolanic materials, Bamboo panels, Brick blocks, Fly ash, Industrial waste utilization, Recycled paver blocks, Composite panels, Environmental issues related to quarrying of building materials

**UNIT II ENERGY EFFICIENT BUILDINGS 9**

Environmental friendly and cost effective building technologies, External additives for wall construction, Ferro cement roofing, Rat trap bond, Arches, Panels, Cavity wall, Eco cement and foam concrete construction, Different put earth materials using steel matrix, Wall and roof cooling systems, Filler slab, Compost boards and panel roof, Pre-engineered and ready to install systems, Wood products, Waste and plastic, Construction agencies, Confined masonry.

**UNIT III GREEN BUILDING AND GLOBAL WARMING 9**

Global warming, Definition, Causes and effects, Contribution of buildings towards global warming, Carbon footprint, Global efforts to reduce carbon emissions, Green buildings, Definition, Features, Benefits, Environmental issues of buildings, Building materials and their impacts, Major energy efficient areas for buildings, Embodied energy in materials, Green rating for buildings, Green roofs.

**UNIT IV GREEN STAR RATING 9**

Green building rating systems for new buildings, GRIHA, LEED, Energy rating of buildings, Green computing for assessment, Energy saving in buildings, Pipe siphon with integrated light assessment for

green buildings, Principles of sustainable development in built environment, Green design principles, Occupant sustainably adapted materials, Integrated life cycle design of materials and structure.

**UNIT V SUSTAINABLE CITIES 9**

Utility of solar energy in buildings, Low energy approaches for buildings, Water utilization in buildings, Low energy approaches to water management, Grey water and sewage, Waste management, Green buildings, Green buildings and green building movements, Green city concepts for buildings, Smart buildings, Green building movements, Green building movements in India.

**Total : 45 Periods**

**Course Outcomes**:

On completion of the course, the student is expected to

CO1 : Explain green building concepts, sustainable construction materials and environmental issues related to construction activities.

CO2 :Apply energy efficient and cost effective building technologies for sustainable construction practices.

CO3 :Analyze the impacts of global warming, carbon footprint and the role of green buildings in environmental protection.

CO4 : Understand green building rating systems, sustainable development principles and integrated green design approaches.

CO5 : Evaluate sustainable city concepts, water and waste management practices, and renewable energy applications in buildings.

**Text Books**


1. Alternative Building Materials and Technologies – New Age International Publishers, 2nd Edition, 2007.
2. Non-Conventional Energy Resources – New Age International Publishers, 2nd Edition, 2010.
3. Integrated Life Cycle Design of Structures – Spon Press, 1st Edition, 2006.


**Reference Books**


1. Green Building Handbook – Routledge, 1st Edition, 1997.
2. Sustainable Construction: Green Building Design and Delivery – Wiley, 4th Edition, 2016.
3. Fundamentals of Sustainable Dwellings – CRC Press, 1st Edition, 2018.


**COs-PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation Of Cos to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 2 | 2 | 2 | 2 | 2 |
| PO2 | Problem analysis | 2 | 3 | 3 | 2 | 2 | 2 |
| PO3 | Design/development of solutions | 1 | 3 | 2 | 3 | 2 | 2 |
| PO4 | Investigation | | 1 | 2 | 1 | 1 | 1 |
| PO5 | Modern Tool Usage | | 2 | | 1 | 1 | 1 |
| PO6 | Engineer and Society | 2 | 2 | 3 | 2 | 3 | 2 |
| PO7 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO8 | Ethics | | | 1 | | 1 | 1 |
| PO9 | Individual and Team work | | | 1 | | 1 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PO10 | Communication | | | | 1 | 2 | 1 |
| PO11 | Project Management and Finance | | | | | | |
| PO12 | Life Long Learning | | | | | | |
| SO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 2 | 3 | 2 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 1 | 2 | 2 | 2 | 3 | 2 |

**ER3013** **CLIMATE RESILIENT BUILDINGS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- The course enables students to understand the definition, concepts and objectives of green construction and sustainability, apply cost effective techniques, technologies and methods in construction, understand the problems associated with global warming, study the concept of green buildings, and understand green building rating systems.

**UNIT I INTRODUCTION TO GREEN BUILDING 9**

Introduction to the concept of cost effective construction, Uses of alternate types of materials and their availability, Green construction, Sustainable building concepts, Green building blocks, Low carbon concrete, Gypsum board, Light weight mortar, Fiber reinforced cement concrete, Pozzolanic materials, Bamboo panels, Brick blocks, Fly ash, Industrial waste utilization, Recycled paver blocks, Composite panels, Environmental issues related to quarrying of building materials

**UNIT II ENERGY EFFICIENT BUILDINGS 9**

Environmental friendly and cost effective building technologies, External additives for wall construction, Ferro cement roofing, Rat trap bond, Arches, Panels, Cavity wall, Eco cement and foam concrete construction, Different put earth materials using steel matrix, Wall and roof cooling systems, Filler slab, Compost boards and panel roof, Pre-engineered and ready to install systems, Wood products, Waste and plastic, Construction agencies, Confined masonry.

**UNIT III GREEN BUILDING AND GLOBAL WARMING 9**

Global warming, Definition, Causes and effects, Contribution of buildings towards global warming, Carbon footprint, Global efforts to reduce carbon emissions, Green buildings, Definition, Features, Benefits, Environmental issues of buildings, Building materials and their impacts, Major energy efficient areas for buildings, Embodied energy in materials, Green rating for buildings, Green roofs.

**UNIT IV GREEN STAR RATING 9**

Green building rating systems for new buildings, GRIHA, LEED, Energy rating of buildings, Green computing for assessment, Energy saving in buildings, Pipe siphon with integrated light assessment for green buildings, Principles of sustainable development in built environment, Green design principles, Occupant sustainably adapted materials, Integrated life cycle design of materials and structure.

**UNIT V SUSTAINABLE CITIES 9**

Utility of solar energy in buildings, Low energy approaches for buildings, Water utilization in buildings, Low energy approaches to water management, Grey water and sewage, Waste management, Green buildings, Green buildings and green building movements, Green city concepts for buildings, Smart buildings, Green building movements, Green building movements in India.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**:

On completion of the course, the student is expected to

CO1 : Explain green building concepts, sustainable construction materials and environmental issues related to construction activities.

CO2 :Apply energy efficient and cost effective building technologies for sustainable construction practices.

CO3 :Analyze the impacts of global warming, carbon footprint and the role of green buildings in environmental protection.

CO4 : Understand green building rating systems, sustainable development principles and integrated green design approaches.

CO5 : Evaluate sustainable city concepts, water and waste management practices, and renewable energy applications in buildings.

**TEXT BOOKS**

4. Alternative Building Materials and Technologies – New Age International Publishers, 2nd Edition, 2007.
5. Non-Conventional Energy Resources – New Age International Publishers, 2nd Edition, 2010.
6. Integrated Life Cycle Design of Structures – Spon Press, 1st Edition, 2006.

**REFERENCE BOOKS**

4. Green Building Handbook – Routledge, 1st Edition, 1997.
5. Sustainable Construction: Green Building Design and Delivery – Wiley, 4th Edition, 2016.
6. Fundamentals of Sustainable Dwellings – CRC Press, 1st Edition, 2018.

**COs-PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Overall Correlation Of Cos to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Knowledge of Engineering Sciences | 3 | 2 | 2 | 2 | 2 | 2 |
| PO2 | Problem analysis | 2 | 3 | 3 | 2 | 2 | 2 |
| PO3 | Design/development of solutions | 1 | 3 | 2 | 3 | 2 | 2 |
| PO4 | Investigation | | 1 | 2 | 1 | 1 | 1 |
| PO5 | Modern Tool Usage | | 2 | | 1 | 1 | 1 |
| PO6 | Engineer and Society | 2 | 2 | 3 | 2 | 3 | 2 |
| PO7 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO8 | Ethics | | | 1 | | 1 | 1 |
| PO9 | Individual and Team work | | | 1 | | 1 | 1 |
| PO10 | Communication | | | | 1 | 2 | 1 |
| PO11 | Project Management and Finance | | | | | | |
| PO12 | Life Long Learning | | | | | | |
| SO1 | Knowledge of Civil Engineering discipline | 3 | 3 | 2 | 3 | 2 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering Issues | 1 | 2 | 2 | 2 | 3 | 2 |

| CE3040 | URBAN WATER INFRASTRUCTURE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

## COURSE OBJECTIVE:

- To impart knowledge and skills relevant to water management in the context of urbanization and relate engineering principles to water supply, storm water and wastewater management, along with related regulations and best management practices from around the world.

**UNIT I URBAN ECOSYSTEM 9**

Cities as Ecological system – hybrid ecosystem – Resilience in urban ecosystem. Human components of Ecosystem – Urban pattern and Ecosystem function. Population and Community dynamics, functions of Urban Ecosystem.

**UNIT II URBAN HYDROLOGY 9**

The urban hydrological cycle – Function – Human induced changes in urban watershed –Hydrological calculation – Runoff – Infiltration – hydrograph.

**UNIT III URBAN STORM WATER MANAGEMENT 9**

Design of Drainage System – Roadway Drainage Analysis – Types of inlet – inlet design – Design of storm drain - Storm water management regulations - structural storm management systems – Newer trends in storm water management (Green infrastructure) – installation – operation and maintenance.

**UNIT IV WATER CONSERVATION AND REUSE 9**

Trends in supply and demand – indoor conservation – outdoor conservation – water reuse –Rainwater harvesting – public education.

**UNIT V WATER GOVERNANCE 9**

Challenges in water sector - Institutional setting, Supply Management, Demand Management, Waste water management – Private sector participation, urban service delivery, customer satisfaction, financial resource management – case studies of best practices in cities across the world.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

On completion of the course, the student is expected to be able to
CO1 Explain various functional elements of urban ecosystem.
CO2 Calculate urban runoff, compute supply and demand of water, draw hydrograph.
CO3 Compare advantages of Newer techniques of green infrastructure and illustrate benefits.
CO4 Assess the Operation and Maintenance needs of urban water systems.
CO5 Propose best management practices for Indian context.

## TEXTBOOKS:


1. Anand Chiplunkar, K Seetharam and Cheon Kheong (ed) (2012), "Good Practices in urban water management" ADB, National University Singapore.
2. Marina Alberti (2008), "Advances in Urban Ecology", Springer.
3. Mohammad Karamouz, Ali Moridi, Sara Nazif (2010), Urban Water Engineering and Management, 1st Edition, CRC Press.
4. Monzur A. Imteaz , (2019), Urban Water Resources, CRC Press.


## REFERENCES:


1. Hormoz Pazwash (2016), "Urban storm water management", CRC Press
2. Larry W. Mays, (2004), Urban Stormwater Management Tools, McGraw-Hill Companies
3. Parkinson, O Mark (2005) Urban Stormwater Management in Developing Countries, IWA Publishing.

**COs - PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Over all Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES (PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 2 | 2 | 3 |
| PO2 | Problem analysis | 2 | 3 | 3 | 2 | 1 | 3 |
| PO3 | Design / development of solutions | 1 | 3 | 2 | 2 | 1 | 2 |
| PO4 | Investigation | - | - | - | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | - | - | 2 | - | - | 2 |
| PO6 | Engineer and Society | - | - | - | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 2 | - | - | 2 | 2 | 2 |
| PO8 | Ethics | 3 | 3 | 3 | 3 | 3 | 3 |
| PO9 | Individual and Team work | 1 | 1 | - | - | 2 | 1 |
| PO10 | Communication | 3 | 3 | 3 | 3 | 3 | 3 |
| PO11 | Project Management and Finance | - | - | - | 2 | 2 | 2 |
| PO12 | Life Long Learning | - | - | - | 2 | 2 | 2 |
| **PROGRAM SPECIFIC OUTCOMES (PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering | - | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | - | - | - | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | - | - | 2 | - | 2 | 2 |

**ER3014** **LAND RECLAMATION MANAGEMENT** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To provide knowledge on the principles and practices involved in reclamation, rehabilitation and sustainable management of degraded lands through engineering, biological and environmental restoration techniques.

**UNIT I INTRODUCTION TO LAND RECLAMATION 9**

Land degradation – Causes and impacts of land degradation – Types of degraded lands – Mining affected lands – Industrial contaminated sites – Municipal solid waste dump sites – Coastal and saline soils – Environmental and socio-economic impacts – Principles and objectives of land reclamation – Sustainable land management concepts – Environmental regulations and standards related to reclamation projects.

**UNIT II SITE INVESTIGATION AND CHARACTERIZATION 9**

Site assessment methods – Soil and groundwater characterization – Physical, chemical and biological properties of contaminated land – Sampling and monitoring techniques – Hydrogeological and geotechnical investigations – Risk assessment procedures – GIS and remote sensing applications in land reclamation – Environmental impact assessment.

**UNIT III LAND RECLAMATION TECHNIQUES 9**

Physical reclamation methods – Land grading and contouring – Soil stabilization techniques – Drainage improvement methods – Chemical remediation processes – Biological reclamation methods – Bioremediation and phytoremediation – Revegetation and afforestation techniques – Reclamation of mining and landfill sites – Soil amendments and conditioners.

**UNIT IV REHABILITATION AND POST-RECLAMATION MANAGEMENT 9**

Restoration of ecosystem functions – Erosion and sediment control – Surface and groundwater protection – Monitoring and maintenance of reclaimed lands – Long-term stability assessment – Sustainable land use planning – Institutional and environmental management practices – Socio-economic benefits of reclaimed land – Redevelopment and utilization of reclaimed sites.

**UNIT V EMERGING TECHNOLOGIES AND CASE STUDIES 9**

Nature-based reclamation approaches – Geoenvironmental engineering applications – Carbon sequestration in reclaimed lands – Resource recovery from degraded sites – Brownfield redevelopment – Landfill biomining – Sustainable remediation principles – National and international case studies on land reclamation projects – Emerging trends and future challenges in land reclamation management.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On Completion of the Course, the student should able to:

CO1 Understand the causes, impacts and principles of land degradation and reclamation. CO2 Analyze contaminated and degraded lands using suitable investigation and assessment methods.

CO3 Apply engineering, biological and environmental techniques for land reclamation and restoration.

CO4 Evaluate rehabilitation and post-reclamation management strategies for sustainable land use.

CO5 Assess emerging technologies and sustainable approaches in land reclamation management.

**REFERENCES:**


1. Rajaram, Vasudevan, Faisal Zia Siddiqui, and Mohd Emran Khan. From landfill gas to energy: Technologies and challenges. CRC press, 2011.
2. Manoj Datta, Waste Disposal in Engineered landfills, Narosa Publishing House, 2001.

3. Reddy, K.R., and Adams, J.A., Sustainable Remediation of Contaminated Sites, Momentum Press, New York, 2015.
4. K.Westlake, Landfill Waste pollution and Control, Albion Publishing Ltd., England, 1995.
5. Qian, X., Koerner, R., and Gray, D.H., Geotechnical aspects of landfill design and construction, Prentice Hall, 2002.
6. Sarsby, R., Environmental Geotechnics, Thomas Telford, 2000.
7. Daniel, D.E., Geotechnical practice for waste disposal, Chapman and Hall, 1993.
8. Bagchi, Amalendu. Design of landfills and integrated solid waste management. John Wiley & Sons, 2004.
9. USEPA Landfill Manuals and Tech Documents, https://www.epa.gov/landfills
10. Townsend, T.G., Powell, J., Jain, P., Xu, Q., Tolaymat, T., and Reinhart, D., Sustainable Practices for Landfill Design and Operation (Waste Management Principles and Practice, Springer Nature (1st ed.) 2015.
11. Yong, R. N., Catheriene, M., and Fukue, M., Geoenvironmental Sustainability, CRC Press, 2007.

**COs - PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Over all Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES (PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 2 | 3 | 2 | 2 | 2 |
| PO2 | Problem analysis | 2 | 3 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | 1 | 2 | 3 | 3 | 2 | 2 |
| PO4 | Investigation | 1 | 2 | 2 | 3 | 2 | 2 |
| PO5 | Modern Tool Usage | — | 2 | 2 | 2 | 3 | 2 |
| PO6 | Engineer and Society | 1 | 1 | 2 | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO8 | Ethics | 1 | 1 | 1 | 2 | 1 | 1 |
| PO9 | Individual and Team work | — | 1 | 1 | 2 | 1 | 1 |
| PO10 | Communication | 1 | 1 | 1 | 2 | 1 | 1 |
| PO11 | Project Management and Finance | — | — | 1 | 2 | 2 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 3 | 2 |
| **PROGRAM SPECIFIC OUTCOMES (PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering | 3 | 3 | 3 | 2 | 2 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 3 | 3 | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | 2 | 2 | 3 | 3 | 2 | 2 |

**ER3015** **SMART DISASTER MANAGEMENT** **L T P C**
**3 0 0 3**

**Course Objectives:**

- To understand the fundamentals of disaster management and disaster risk reduction.
- To study natural and anthropogenic disasters affecting civil and environmental systems.
- To familiarize students with smart technologies and GIS-based disaster management tools.
- To understand disaster preparedness, mitigation and resilience planning.
- To develop sustainable and technology-driven approaches for disaster management and environmental protection.

**UNIT I INTRODUCTION TO DISASTER MANAGEMENT 9**

Disaster – Hazard – Vulnerability – Risk – Capacity concepts – Types of disasters – Natural and man-made disasters – Disaster management cycle – Disaster risk reduction – Climate change and disasters – Environmental impacts of disasters – National Disaster Management Authority (NDMA) guidelines – Sendai Framework for Disaster Risk Reduction – Sustainable and resilient infrastructure concepts.

**UNIT II GEOLOGICAL AND HYDRO-METEOROLOGICAL DISASTERS 9**

Earthquakes – Landslides – Tsunami – Floods – Cyclones – Droughts – Heat waves – Urban flooding – Causes, impacts and mitigation measures – Disaster-resistant construction practices – Watershed management and flood control – Coastal zone management – Environmental consequences of disasters – Case studies on Indian disasters.

**UNIT III SMART TECHNOLOGIES IN DISASTER MANAGEMENT 9**

GIS and Remote Sensing applications – Internet of Things (IoT) in disaster monitoring – Artificial Intelligence and Machine Learning applications – Early warning systems – Smart sensors and communication systems – Drone applications in disaster assessment – Mobile applications for emergency response – Disaster data management – Smart city and resilient infrastructure concepts.

**UNIT IV DISASTER PREPAREDNESS, RESPONSE AND RECOVERY 9**

Disaster preparedness planning – Emergency response systems – Incident command system – Search and rescue operations – Community participation – Evacuation planning – Relief and rehabilitation – Environmental health and sanitation during disasters – post-disaster waste management – Damage assessment and reconstruction – Psychological and social impacts of disasters.

**UNIT V SUSTAINABLE AND RESILIENT DISASTER MANAGEMENT 9**

Climate-resilient infrastructure – Nature-based solutions – Sustainable urban drainage systems – Integrated water resource management during disasters – Environmental Impact Assessment in disaster-prone areas – Risk-informed land use planning – Disaster resilience indicators – Smart governance and policy frameworks – NDMA and NIDM guidelines – Case studies on resilient cities and infrastructure.

**COURSE OUTCOMES:**

On Completion of the Course, the student should be able to:

CO1 Explain disaster management principles, hazards and risk reduction strategies.

CO2 Understand geological and hydro-meteorological disasters and their environmental impacts.

CO3 Apply smart technologies and GIS tools in disaster monitoring and management.

CO4 Analyze disaster preparedness, response and recovery mechanisms.

CO5 Evaluate sustainable and resilient approaches for smart disaster management.

**References:**


1. Rajib Shaw and ShonK. Mitra, “Disaster Management: Global Challenges and Local Solutions”, Universities Press, 2012.
2. Singhal J.P., “Disaster Management”, Laxmi Publications, New Delhi, 2010.
3. Satendra, “Disaster Management in Hills”, Concept Publishing Company, New Delhi, 2003.
4. Pardeep Sahni and Madhavi Malalgoda, “Disaster Risk Reduction in South Asia”, PHI Learning, 2013.
5. Cuny F.C., “Disaster and Development”, Oxford University Press, 1983.
6. NDMA, “National Disaster Management Guidelines”, National Disaster Management Authority, Government of India, Latest Editions.


## COs - PO’s & PSO’s MAPPING

| PO/PSO | | Course Outcome | | | | | Over all Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES (PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 2 | 3 | 2 | 2 | 2 |
| PO2 | Problem analysis | 2 | 3 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | 1 | 2 | 3 | 3 | 2 | 2 |
| PO4 | Investigation | 1 | 2 | 2 | 3 | 2 | 2 |
| PO5 | Modern Tool Usage | — | 2 | 2 | 2 | 3 | 2 |
| PO6 | Engineer and Society | 1 | 1 | 2 | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO8 | Ethics | 1 | 1 | 1 | 2 | 1 | 1 |
| PO9 | Individual and Team work | — | 1 | 1 | 2 | 1 | 1 |
| PO10 | Communication | 1 | 1 | 1 | 2 | 1 | 1 |
| PO11 | Project Management and Finance | — | — | 1 | 2 | 2 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 3 | 2 |
| **PROGRAM SPECIFIC OUTCOMES (PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering | 3 | 3 | 3 | 2 | 2 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 3 | 3 | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | 2 | 2 | 3 | 3 | 2 | 2 |

| ER3016 | ENVIRONMENTAL MANAGEMENT SYSTEM | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To understand the concepts, principles and applications of Environmental Management Systems (EMS).
- To study ISO 14000 standards and the implementation of environmental management practices in organizations.
- To learn environmental auditing, environmental performance evaluation and environmental decision-making tools.
- To understand life cycle assessment, sustainable production and corporate environmental management practices.
- To develop knowledge on sustainability approaches, environmental responsibility and environmental protection strategies.

**UNIT I INTRODUCTION TO ENVIRONMENTAL MANAGEMENT SYSTEMS 9**

Environmental management, overview of the global environment, earth's natural systems, sustainability and sustainable development, introduction to environmental management systems (EMS), organizational barriers, management responsibility, EMS structure and applications, environmental management principles, case studies.

**UNIT II CODES AND REGULATIONS 9**

ISO 14000 background, ISO 14000 series, business and environmental standards, voluntary standards and WTO/GATT, ISO practices in developed and developing countries, ISO 14001 requirements, environmental policy, planning, implementation and operation, checking and corrective actions, management review, EMS implementation strategies, case studies.

**UNIT III ENVIRONMENTAL AUDITING AND PERFORMANCE EVALUATION 9**

Scope and objectives of environmental auditing, auditing standards, registration and certification, audit procedures, environmental auditing , environmental performance evaluation, data collection and analysis, reporting and communication systems - case studies.

**UNIT IV LIFE CYCLE ASSESSMENT AND SUSTAINABLE PRODUCTION 9**

Life cycle assessment concepts, life cycle stages of products, environmental impact assessment through LCA, boundaries and functional units, benefits of LCA, strategic framework for LCA, clean production principles, sustainable procurement, eco-labelling, packaging systems, carbon and ecological footprints, ISO 14064 and ISO 14065, case studies.

**UNIT V CORPORATE ENVIRONMENTAL MANAGEMENT AND SUSTAINABILITY 9**

Corporate environmental management concepts, product stewardship, environmental planning and management, social responsibility of corporations, sustainable environmental practices, environmental decision-making tools, environmental communication systems, sustainable development approaches, minor project and presentations, case studies.

**COURSE OUTCOMES:**

On Completion of the Course, the student should be able to:
CO1 Understand the concepts, principles and structure of Environmental Management Systems (EMS).
CO2 Apply ISO 14000 standards and EMS implementation strategies in organizations.
CO3 Analyze environmental auditing procedures and environmental performance evaluation methods.
CO4 Evaluate life cycle assessment tools and sustainable production practices for environmental management.

CO5 Understand corporate environmental management practices and sustainability approaches for environmental protection.

**References:**


1. Installing Environmental Management Systems: A Step-by-Step Guide — Christopher Sheldon & Mark Yoxon, 3rd Edition, Earthscan Publications, 2007.
2. ISO 14000 Environmental Management — David L. Goetsch & Stanley Davis, 1st Edition, Prentice Hall, 2001.
3. Introduction to Environmental Engineering and Science — M.M. Gilbert, 2nd Edition, Pearson Education, 2004.
4. Environmental Planning and Management — C.N. Madu, 1st Edition, Imperial College Press, 2007.
5. Corporate Environmental Management: Systems and Strategies — Richard Welford, 1st Edition, Earthscan Publications, 1996.
6. Pollution: Causes, Effects and Control — R.M. Harrison, 4th Edition, Royal Society of Chemistry, 2001.
7. Hazardous Waste Management — M.D. LaGrega, P.L. Buckingham & J.C. Evans, 1st Edition, McGraw Hill International Edition, 1994.
8. Tools to Aid Environmental Decision Making — Virginia H. Dale & Mary R. English, 1st Edition, Springer, 1999.


## COs - PO's & PSO's MAPPING

| PO/PSO | | Course Outcome | | | | | Over all Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES (PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 2 | 3 | 2 | 2 | 2 |
| PO2 | Problem analysis | 2 | 3 | 2 | 2 | 2 | 2 |
| PO3 | Design / development of solutions | 1 | 2 | 3 | 3 | 2 | 2 |
| PO4 | Investigation | 1 | 2 | 2 | 3 | 2 | 2 |
| PO5 | Modern Tool Usage | — | 2 | 2 | 2 | 3 | 2 |
| PO6 | Engineer and Society | 1 | 1 | 2 | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 3 | 3 | 3 | 3 | 3 | 3 |
| PO8 | Ethics | 1 | 1 | 1 | 2 | 1 | 1 |
| PO9 | Individual and Team work | — | 1 | 1 | 2 | 1 | 1 |
| PO10 | Communication | 1 | 1 | 1 | 2 | 1 | 1 |
| PO11 | Project Management and Finance | — | — | 1 | 2 | 2 | 1 |
| PO12 | Life Long Learning | 2 | 2 | 2 | 2 | 3 | 2 |
| **PROGRAM SPECIFIC OUTCOMES (PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering | 3 | 3 | 3 | 2 | 2 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | 2 | 3 | 3 | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | 2 | 2 | 3 | 3 | 2 | 2 |

| ER3017 | CIRCULAR ECONOMY | L T P C |
|---|---|---|
| | | 3 0 0 3 |

## COURSE OBJECTIVES

- To understand the concepts and principles of circular economy.
- To study material recovery, waste reduction and sustainable resource utilization practices.
- To learn circular design concepts, innovation approaches and life cycle assessment methods.
- To understand circular business models, industrial symbiosis and waste management practices.
- To study legal frameworks, policy strategies and sustainability approaches related to circular economy.

**UNIT I INTRODUCTION TO CIRCULAR ECONOMY 9**

Linear economy and its emergence, Economic and ecological disadvantages of linear economy, Replacing linear economy by circular economy, Development of concept of circular economy, Differential between linear and circular economy.

**UNIT II CHARACTERISTICS OF CIRCULAR ECONOMY 9**

Material recovery, Waste reduction, Reduction of negative externalities, Butterfly diagram, Concept of loops, Sustainable resource management, Circular material flow concepts.

**UNIT III CIRCULAR DESIGN, INNOVATION AND ASSESSMENT 9**

Zero waste concepts, Waste management in context of circular economy, Circular design principles, Research and innovation in circular economy, Life Cycle Assessment (LCA), Circular business models, Sustainable product development.

**UNIT IV CASE STUDIES IN CIRCULAR ECONOMY 9**

Business models in circular economy, Solid waste management, Wastewater management, Plastics management case studies, Extended Producer Responsibility (EPR), Polluter pays principle, Industrial symbiosis, Eco parks.

**UNIT V LEGAL AND POLICY FRAMEWORK FOR CIRCULAR ECONOMY 9**

Role of governments and networks, Sharing best practices, Universal circular economy policy goals, India and circular economy strategy, Environmental Social Governance (ESG), Sustainability policies and regulations.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

On completion of the course, the student is expected to be able to
CO1 Understand the concepts, principles and characteristics of circular economy.
CO2 Apply circular economy approaches for waste reduction, material recovery and sustainable resource management.
CO3 Analyze circular design principles, life cycle assessment methods and circular business .
CO4 Evaluate industrial symbiosis, waste management practices and circular economy case studies.
CO5 Understand legal frameworks, ESG principles and policy strategies related to circular economy and sustainability.

**TEXTBOOKS:**

1. Conceptualizing the Circular Economy: An Analysis of 114 Definitions — Julian Kirchherr, Denise Reike & Marko Hekkert, Resources, Conservation and Recycling, Elsevier, Vol. 127, 1st Edition,

2017.
2. Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition — Ellen MacArthur Foundation, Ellen MacArthur Foundation Publications, 1st Edition, 2015.
3. The Circular Economy: A User's Guide — Walter R. Stahel, Routledge Publications, 1st Edition, 2019.
4. Waste to Wealth: The Circular Economy Advantage — Peter Lacy & Jakob Rutqvist, Palgrave Macmillan, 1st Edition, 2015.
5. The Circular Economy – A New Sustainability Paradigm? — Martin Geissdoerfer, Paulo Savaget, Nancy M.P. Bocken & Erik J. Hultink, Journal of Cleaner Production, Elsevier, Vol. 143, 1st Edition, 2017.

**COs - PO's & PSO's MAPPING**

| PO/PSO | | Course Outcome | | | | | Over all Correlation of COs to POs |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| **PROGRAM OUTCOMES (PO)** | | | | | | | |
| PO1 | Knowledge of Engineering Sciences | 3 | 3 | 3 | 2 | 2 | 3 |
| PO2 | Problem analysis | 2 | 3 | 3 | 2 | 1 | 3 |
| PO3 | Design / development of solutions | 1 | 3 | 2 | 2 | 1 | 2 |
| PO4 | Investigation | - | - | - | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | - | - | 2 | - | - | 2 |
| PO6 | Engineer and Society | - | - | - | 2 | 2 | 2 |
| PO7 | Environment and Sustainability | 2 | - | - | 2 | 2 | 2 |
| PO8 | Ethics | 3 | 3 | 3 | 3 | 3 | 3 |
| PO9 | Individual and Team work | 1 | 1 | - | - | 2 | 1 |
| PO10 | Communication | 3 | 3 | 3 | 3 | 3 | 3 |
| PO11 | Project Management and Finance | - | - | - | 2 | 2 | 2 |
| PO12 | Life Long Learning | - | - | - | 2 | 2 | 2 |
| **PROGRAM SPECIFIC OUTCOMES (PSO)** | | | | | | | |
| PSO1 | Knowledge of Civil Engineering | - | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Civil Engineering problems and innovation | - | - | - | 2 | 2 | 2 |
| PSO3 | Conceptualization and evaluation of engineering solutions to Civil Engineering issues | - | - | 2 | - | 2 | 2 |

**ER3018** **URBAN STROMWATER MANAGEMENT** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To understand the fundamentals of urban hydrology and storm water management systems.
- To gain knowledge on planning, design and operation of urban drainage infrastructure.
- To study sustainable storm water management practices and low impact development techniques.
- To analyze urban flooding, storm water quality and climate resilience measures.
- To apply modern tools and management practices for integrated urban storm water management.

**UNIT I INTRODUCTION TO URBAN STORM WATER MANAGEMENT 9**

Urbanization and hydrologic cycle – Characteristics of urban catchments – Rainfall analysis and runoff estimation – Storm water quantity and quality – Impacts of urban flooding – Urban drainage systems – Combined and separate sewer systems – Design storm and Intensity-Duration-Frequency (IDF) curves – Climate change impacts on urban drainage.

**UNIT II STORM WATER DRAINAGE SYSTEMS 9**

Components of storm water drainage systems – Storm water inlets, gutters and conveyance systems – Hydraulics of storm sewers – Design of storm drains and open channels – Culverts and detention structures – Pumping systems – Urban drainage network analysis – Operation and maintenance of drainage systems.

**UNIT III SUSTAINABLE STORM WATER MANAGEMENT 9**

Principles of sustainable urban drainage systems (SUDS) – Low impact development (LID) concepts – Green infrastructure – Rain gardens – Bioswales – Permeable pavements – Green roofs – Infiltration trenches – Rainwater harvesting – Urban watershed management – Best management practices for storm water control.

**UNIT IV URBAN FLOOD MANAGEMENT AND WATER QUALITY 9**

Causes and impacts of urban flooding – Flood forecasting and warning systems – Flood mitigation measures – Storm water pollution and water quality management – Sediment and pollutant transport – First flush phenomenon – Storm water treatment methods – Wetlands and retention ponds – Climate resilient drainage planning.

**UNIT V MODELING, GIS AND SMART STORM WATER MANAGEMENT 9**

Hydrologic and hydraulic modeling concepts – Application of SWMM and GIS in storm water management – Remote sensing applications – Smart drainage systems – Real-time monitoring and sensor networks – Asset management – Integrated urban water management – Case studies on urban storm water management in Indian cities.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to

CO1 Explain the principles of urban hydrology and storm water management systems.
CO2 Design and analyze urban storm water drainage infrastructure components.
CO3 Apply sustainable storm water management and low impact development techniques for urban areas.
CO4 Evaluate urban flooding problems, storm water quality and climate resilience measures.
CO5 Utilize modern modeling tools, GIS and smart technologies for integrated storm water management.text.

**TEXTBOOKS:**


1. Akan, A.O. and Houghtalen, R.J., Urban Hydrology, Hydraulics and Stormwater Quality, John Wiley & Sons, New Jersey, 2003.
2. Viessman, W., Lewis, G.L. and Knapp, J.W., Introduction to Hydrology, Pearson Education, New Delhi, 2017.
3. Butler, D. and Davies, J.W., Urban Drainage, CRC Press, London, 2018.
4. Mays, L.W., Stormwater Collection Systems Design Handbook, McGraw Hill, New York, 2001.
5. Ellis, J.B. and Marsalek, J., Urban Drainage and Flood Control District Handbook, Springer, London, 2010.

6. James, W., Advances in Modeling the Management of Stormwater Impacts, CRC Press, London, 2017.
7. Novotny, V. and Olem, H., Water Quality: Prevention, Identification and Management of Diffuse Pollution, Wiley, New York, 1994.
8. CPHEEO, Manual on Storm Water Drainage Systems, Ministry of Housing and Urban Affairs, Government of India, New Delhi.

**COs - PO's & PSO's MAPPING**

| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PS03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | - | 1 | 2 | 2 | - | - | - | - | 2 | 1 | 2 |
| CO2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | - | - | - | - | 3 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 1 | - | - | - | 3 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 1 | - | - | - | 2 | 3 | 1 |
| CO5 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | - | - | - | 1 | 2 | 3 | 2 |

**ER3019 ENVIRONMENTAL NANOTECHNOLOGY L T P C**
**3 0 0 3**

**Course Objectives:**

- Understand the fundamental concepts of nanoscience and nanotechnology relevant to environmental engineering.
- Gain knowledge on synthesis, properties, and applications of nanomaterials for environmental protection and sustainability.
- Apply nanotechnology concepts in environmental remediation and pollution control.
- Evaluate the fate, transport, toxicity, and ecological impacts of nanomaterials in natural and engineered systems.

**UNIT I INTRODUCTION TO ENVIRONMENTAL NANOTECHNOLOGY 9**

Introduction to nanoscience and nanotechnology – Classification and properties of nanomaterials – Nanomaterials for environmental protection – Physico-chemical synthesis methods – Microbial synthesis of nanomaterials – Biological synthesis of nano-emulsions using bacteria, fungi and actinomycetes – Plant-based nanoparticle synthesis – Nanotechnology as a tool for sustainability – Health, safety and environmental issues associated with nanotechnology.

**UNIT II NANOMATERIALS FOR REMEDIATION 9**

Nano membranes – Nano meshes – Nano fibres – Nano clays and adsorbents – Zeolites – Nano catalysts – Carbon nanotubes – Biopolymers – Bimetallic iron nanoparticles – Nano semiconductors – Photocatalysis – Nano sensors and their environmental applications.

**UNIT III NANO REMEDIATION TECHNOLOGIES 9**

Thermal, physico-chemical and biological remediation methods – Nanomaterials as adsorbents – Membrane processes – Nanofiltration – Nanotechnology for water purification and wastewater treatment – Environmental benefits of nanomaterials – Sustainable remediation technologies.

**UNIT IV TRANSPORT AND PROPERTIES OF NANOPARTICLES 9**

Nanoparticle transport mechanisms – Physico-chemical interactions – Aggregation and deposition – Behaviour in heterogeneous systems – Airborne nanoparticles – Energy applications of nanomaterials – Mechanical, thermal and magnetic properties of nanomaterials.

**UNIT V ECOTOXICOLOGICAL IMPACTS OF NANOMATERIALS 9**

Ecotoxicological impacts of nanomaterials – Biodistribution and bioavailability – Antibacterial activity – Biotransformation – Toxicological effects of nanomaterials in soil and sediments – Nanomaterial toxicity assessment – Life-cycle risks and contemporary issues in nanotechnology.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to be able to
CO1 Explain the fundamentals, synthesis methods, properties and sustainability aspects of nanomaterials used in environmental engineering applications.
CO2 Describe various nanomaterials and nano-based systems used for environmental remediation and pollution control.
CO3 Apply nanotechnology concepts for water purification, wastewater treatment and sustainable environmental remediation.
CO4 Analyze the transport mechanisms, physico-chemical behaviour and engineering properties of nanoparticles in environmental systems.
CO5 Evaluate the ecotoxicological impacts, bioavailability and risks associated with nanomaterials in the environment.

**TEXTBOOKS:**

1. Wiesner, M.R. and Bottero, J.Y., Environmental Nanotechnology: Applications and Impacts of Nanomaterials, McGraw-Hill Professional, New York, 2007.

2. Dasgupta, N., Ranjan, S. and Lichtfouse, E. (Eds.), Environmental Nanotechnology, Volume 1, Springer International Publishing, Switzerland, 2018.
3. Dasgupta, N., Ranjan, S. and Lichtfouse, E. (Eds.), Environmental Nanotechnology, Volume 2, Springer International Publishing, Switzerland, 2019.
4. Karri, R.R., Koduru, J.R., Mubarak, N.M. and Bandala, E.R. (Eds.), Sustainable Nanotechnology for Environmental Remediation, Elsevier, Netherlands, 2022.
5. Desimone, M.F., Jotania, R.B. and Khomane, R.B. (Eds.), Nanotechnology: Applications for Environmental Protection and Sustainability, Springer Nature, Singapore, 2024.
6. Shanker, U., Hussain, C.M. and Rani, M. (Eds.), Handbook of Green and Sustainable Nanotechnology, Springer Nature, Singapore, 2022.
7. Grassian, V.H. (Ed.), Nanoscience and Nanotechnology: Environmental and Health Impacts, John Wiley & Sons, New Jersey, 2008.
8. Fan, M., Huang, C.P., Bland, A.E., Wang, Z., Slimane, R. and Wright, I. (Eds.), Environanotechnology, Elsevier, Oxford, 2010.

**COs - PO's & PSO's MAPPING**

| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PS03 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | 1 | 2 | 3 | 1 | - | - | - | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 1 | 2 | 2 | 3 | - | - | - | - | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | - | - | - | - | 3 | 3 | 1 |
| **CO4** | 3 | 3 | 2 | 3 | 2 | 2 | 2 | - | - | - | - | 2 | 3 | 2 |
| **CO5** | 2 | 3 | 1 | 2 | 1 | 3 | 3 | 2 | - | - | - | 2 | 2 | 2 |

## MANDATORY COURSES I

**MX3081 INTRODUCTION TO WOMEN AND GENDER STUDIES L T P C**
**3 0 0 0**

**COURSE OUTLINE**

**UNIT I CONCEPTS**
Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

**UNIT II FEMINIST THEORY**
Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

**UNIT III WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL**
Rise of Feminism in Europe and America.
Women's Movement in India.

**UNIT IV GENDER AND LANGUAGE**
Linguistic Forms and Gender.
Gender and narratives.

**UNIT V GENDER AND REPRESENTATION**
Advertising and popular visual media.

Gender and Representation in Alternative Media.
Gender and social media.

**TOTAL : 45 PERIODS**

**MX3082 ELEMENTS OF LITERATURE**
**L T P C**

**3 0 0 0**
**OBJECTIVE:**

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.

**1. COURSE CONTENTS**

Introduction to Elements of Literature

1. **Relevance of literature**
   a) Enhances Reading, thinking, discussing and writing skills.
   b) Develops finer sensibility for better human relationship.
   c) Increases understanding of the problem of humanity without bias.
   d) Providing space to reconcile and get a cathartic effect.

2. **Elements of fiction**

a) Fiction, fact and literary truth.
b) Fictional modes and patterns.
c) Plot character and perspective.

**3. Elements of poetry**

a) Emotions and imaginations.
b) Figurative language.
c) (Simile, metaphor, conceit, symbol, pun and irony).
d) Personification and animation.
e) Rhetoric and trend.

**4. Elements of drama**

a) Drama as representational art.
b) Content mode and elements.
c) Theatrical performance.
d) Drama as narration, mediation and persuasion.
e) Features of tragedy, comedy and satire.

**3. READINGS:**


1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.


3.1 Textbook:

3.2 *Reference Books:: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

**4. OTHER SESSION:**

4.1*Tutorials:

4.2*Laboratory:

4.3*Project: The students will write a term paper to show their understanding of a particular piece of literature

**5. *ASSESSMENT:**

5.1 HA:

5.2 Quizzes-HA:

5.3 Periodical Examination: one

5.4 Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5 Final Exam:

**TOTAL: 45 PERIODS**

**OUTCOME OF THE COURSE:**

- Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.

**MX3083** **FILM APPRECIATION** **L T P C**
**3 0 0 0**

In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form. It will also discuss the language of cinema as it evolved over a century. The students will be taught as to how to read a film and appreciate the various nuances of a film as a text. The students will be guided to study film joyfully.

**Theme - A: The Component of Films**

A-1: The material and equipment
A-2: The story, screenplay and script
A-3: The actors, crew members, and the director
A-4: The process of film making… structure of a film

**Theme - B: Evolution of Film Language**

B-1: Film language, form, movement etc.
B-2: Early cinema… **silent film** (Particularly French)
B-3: The emergence of feature films: **Birth of a Nation**
B-4: Talkies

**Theme - C: Film Theories and Criticism/Appreciation**

C-1: Realist theory; Auteurists
C-2: Psychoanalytic, Ideological, Feminists
C-3: How to read films?
C-4: Film Criticism / Appreciation

**Theme – D: Development of Films**

D-1: Representative Soviet films
D-2: Representative Japanese films
D-3: Representative Italian films
D-4: Representative Hollywood film and the studio system

**Theme - E: Indian Films**

E-1: The early era
E-2: The important films made by the directors
E-3: The regional films
E-4: The documentaries in India

**READING:**

A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.

**MX3084 DISASTER RISK REDUCTION AND MANAGEMENT L T P C**
**3 0 0 0**

**COURSE OBJECTIVE**

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

**UNIT I HAZRADS, VULNERABILITY AND DISASTER RISKS 9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals

**UNIT II DISASTER RISK REDUCTION (DRR) 9**

Sendai Framework for Disaster Risk Reduction**,** Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

**UNIT III DISASTER MANAGEMENT 9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

**UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

**UNIT V DISASTER MANAGEMENT: CASE STUDIES 9**

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**

1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications

3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
4 Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]

**REFERENCES**

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

**COURSE OUTCOME:**

**CO1:** To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)
**CO2:** To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction
**CO3:** To develop disaster response skills by adopting relevant tools and technology
**CO4:** Enhance awareness of institutional processes for Disaster response in the country and
**CO5:** Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

**CO’s – PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 3 | 2 | 3 | - | - | 2 | 2 | - | - | 2 | - | 2 | - | 1 |
| 2 | 3 | 3 | 3 | 3 | - | - | 2 | 1 | - | - | 2 | - | 2 | - | 1 |
| 3 | 3 | 3 | 3 | 3 | - | - | 2 | 2 | - | - | - | - | 2 | - | 1 |
| 4 | 3 | 3 | 2 | 3 | - | - | 2 | 1 | - | - | 2 | - | 2 | - | 1 |
| 5 | 3 | 3 | 2 | 3 | - | - | 2 | 2 | - | - | 2 | - | 3 | - | 1 |
| AVG | 3 | 3 | 3 | 3 | - | - | 2 | 2 | - | - | 2 | - | 2 | - | 1 |

## MANDATORY COURSES II

**MX3085 WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA** **L T P C**
**3 0 0 0**

**COURSE OBJECTIVES:**

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

**UNIT I HEALTH AND ITS IMPORTANCE** **2+4**

**Health: Definition - Importance of maintaining health -** More importance on prevention than treatment

Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath.

**Present health status -** The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

**Types of diseases and disorders -** Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

**Causes of the above diseases / disorders - Importance of prevention of illness -** Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

**Simple lifestyle modifications to maintain health -** Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

**UNIT II DIET 4+6**

**Role of diet in maintaining health -** energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

**Balanced Diet and its 7 Components -** Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

**Food additives and their merits & demerits -** Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

**Definition of BMI and maintaining it with diet**

Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

**Common cooking mistakes**

Different cooking methods, merits and demerits of each method

**UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH**

**4+4**

**AYUSH systems and their role in maintaining health -** preventive aspect of AYUSH - AYUSH as a soft therapy.

**Secrets of traditional healthy living -** Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens

(Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

**Principles of Siddha & Ayurveda systems -** Macrocosm and Microcosm theory - Pancheekarana Theory / **(**Five Element Theory) 96 fundamental Principles - Uyir Thathukkal **(**Tri-Dosha Theory) - Udal Thathukkal

**Prevention of illness with our traditional system of medicine**
Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

**UNIT IV MENTAL WELLNESS 3+4**

**Emotional health -** Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

**Stress management -** Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

**Sleep -** Sleep and its importance for mental wellness - Sleep and digestion.
**Immunity -** Types and importance - Ways to develop immunity

**UNIT V YOGA 2+12**

**Definition and importance of yoga -** Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**


1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California


**REFERENCES:**


1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts
   A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England
2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by
   The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001
   1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/
   2. **Simple lifestyle modifications to maintain health**

https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.

3. **Read more**: https://www.legit.ng/1163909-classes-food-examples-functions.html
4. https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926
5. **Benefits of healthy eating** https://www.cdc.gov/nutrition/resources-publications/benefits-of-healthy-eating.html
6. **Food additives** https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/food-additives
7. **BMI** https://www.hsph.harvard.edu/nutritionsource/healthy-weight/ https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations
8. **Yoga** https://www.healthifyme.com/blog/types-of-yoga/ https://yogamedicine.com/guide-types-yoga-styles/
   **Ayurveda** : https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-in-ayurveda
9. **Siddha** : http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp
10. **CAM :** https://www.hindawi.com/journals/ecam/2013/376327/
11. **Preventive** herbs : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/

**COURSE OUTCOMES:**

After completing the course, the students will be able to:

- Learn the importance of different components of health
- Gain confidence to lead a healthy life
- Learn new techniques to prevent lifestyle health disorders
- Understand the importance of diet and workouts in maintaining health

**MX3086 HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA L T P C**
**3 0 0 0**

**UNIT-I CONCEPTS AND PERSPECTIVES**

Meaning of History

Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history

Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

**UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA**

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

**UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA**

Technology in pre-historic period

Beginning of agriculture and its impact on technology

Science and Technology during Vedic and Later Vedic times

Science and technology from 1$^{st}$ century AD to C-1200.

**UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA**

Legacy of technology in Medieval India, Interactions with Arabs
Development in medical knowledge, interaction between Unani and Ayurveda and alchemy Astronomy and Mathematics: interaction with Arabic Sciences
Science and Technology on the eve of British conquest

**UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA**

Science and the Empire
Indian response to Western Science
Growth of techno-scientific institutions

**UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA**

Science, Technology and Development discourse
Shaping of the Science and Technology Policy
Developments in the field of Science and Technology
Science and technology in globalizing India
Social implications of new technologies like the Information Technology and Biotechnology

**TOTAL : 45 PERIODS**

**MX3087 POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY L T P C**
**3 0 0 0**

Pre-Requisite**:** None. (Desirable: Universal Human Values 1, Universal Human Values 2)

**OBJECTIVES:**

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fullfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.

**COURSE TOPICS:**

Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. **(9 lectures, 1 hour each)**

(Refs: A Nagaraj, M K Gandhi, JC Kumarappa)

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. **(5 lectures)**

(Refs: Adam smith, J S Mill)

Fascism and totalitarianism. World war I and II. Cold war. **(2 lectures)**

Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.

(Refs: Marx, Lenin, Mao, M N Roy) **(5 lectures)**

Welfare state. Relation with human desires. Empowered human beings, satisfaction. **(3 lectures)**

Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. **(6 lectures)**

(Refs: M K Gandhi, Schumacher, Kumarappa)

Essential elements of Indian civilization. **(3 lectures)**

(Refs: Pt Sundarlal, R C Mazumdar, Dharampal)

Technology as driver of society, Role of education in shaping of society. Future directions. **(4 lectures)** (Refs: Nandkishore Acharya, David Dixon, Levis Mumford)
**Conclusion (2 lectures)**

**Total lectures: 39**

**Preferred Textbooks:** See Reference Books

**Reference Books:** Authors mentioned along with topics above. Detailed reading list will be provided.

**GRADING:**

| | |
|---|---|
| Mid sems | 30 |
| End sem | 20 |
| Home Assign | 10 |
| Term paper | 40 |

**TOTAL : 45 PERIODS**

**OUTCOME:**

- The students will get an understanding of how societies are shaped by philosophy, political and economic system, how they relate to fulfilling human goals & desires with some case studies of how different attempts have been made in the past and how they have fared.

**MX3088 STATE, NATION BUILDING AND POLITICS IN INDIA L T P C**
**3 0 0 0**

**OBJECTIVE:**
The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

**TOPICS:**
Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government-unitary-federal, Presidential-Parliamentary,
The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India.
Goals, objective and philosophy.
Why a federal system?
National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari) New social movements.
The changing nature of Indian Political System, the future scenario. What can we do?

**TOTAL : 45 PERIODS**

**OUTCOME OF THE COURSE:**

It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.

**SUGGESTED READING:**


i. Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.
ii. Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.
iii. Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.
iv. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.
v. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.
vi. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.
vii. Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

**MX3089** **INDUSTRIAL SAFETY** **L T P C**
**3 0 0 0**

## OBJECTIVES

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

## UNIT I SAFETY TERMINOLOGIES

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators-lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)-acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment-Health and Safety Policy-Material Safety Data Sheet MSDS

## UNIT II STANDARDS AND REGULATIONS

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

## UNIT III SAFETY ACTIVITIES

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

## UNIT IV WORKPLACE HEALTH AND SAFETY

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards-Crane Safety- Toxic gas Release

## UNIT V HAZARD IDENTIFICATION TECHNIQUES

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis-Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis-and Hazard Identification and Risk Assessment

**TOTAL : 45 PERIODS**

## COURSE OUTCOMES

on completion of this course the student will be able:

- Understand the basic concept of safety.
- Obtain knowledge of Statutory Regulations and standards.
- Know about the safety Activities of the Working Place.
- Analyze on the impact of Occupational Exposures and their Remedies
- Obtain knowledge of Risk Assessment Techniques.

## TEXTBOOKS


1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education


## REFERENCES


1. Frank Lees (2012) ‘Lees’ Loss Prevention in Process Industries.Butterworth-Heinemann publications, UK, 4th Edition.

2. John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring.(1996).Safety management system: Chapman &Hall,England
5. Society of Safety Engineers, USA

**ONLINE RESOURCES**

ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization https://www.iso.org/standard/63787.html

Indian Standard code of practice on occupational safety and health audit https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf

Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf

**CO's – PO's & PSO's MAPPING**

| Course Outcomes | Statement | Program Outcome | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 | PSO3 |
| CO1 | Understand the basic concept of safety. | 3 | 3 | 3 | 1 | 1 | 3 | 2 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 3 |
| CO2 | Obtain knowledge of Statutory Regulations and standards. | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| CO3 | Know about the safety Activities of the Working Place. | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 3 |
| CO4 | Analyze on the impact of Occupational Exposures and their Remedies | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| CO5 | Obtain knowledge of Risk Assessment Techniques. | 3 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **Industrial safety** | | 3 | 3 | 3 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |

## OPEN ELECTIVE I AND II

### OCS351 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS

**L T P C**

**2 0 2 3**

**COURSE OBJECTIVES**:

The main objectives of this course are to:

- Understand the importance, principles, and search methods of AI
- Provide knowledge on predicate logic and Prolog.
- Introduce machine learning fundamentals
- Study of supervised learning algorithms.
- Study about unsupervised learning algorithms.

**UNIT I INTELLIGENT AGENT AND UNINFORMED SEARCH 6**

**Introduction** - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - **Intelligent Agents** - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - **Uninformed Search** - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search

**UNIT II PROBLEM SOLVING WITH SEARCH TECHNIQUES 6**

**Informed Search** - Greedy Best First - A* algorithm - Adversarial Game and Search - **Game theory** - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - **Constraint Satisfaction Problems (CSP)** - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

**UNIT III LEARNING 6**

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - **Regression**: Linear Regression - Logistic Regression

**UNIT IV SUPERVISED LEARNING 6**

**Neural Network:** Introduction, Perceptron Networks – Adaline - Back propagation networks - **Decision Tree:** Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - **Naïve Bayesian classification** - **Support Vector Machines** (SVM)

**UNIT V UNSUPERVISED LEARNING 6**

**Unsupervised Learning** – Principle Component Analysis - **Neural Network**: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – **Clustering**: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm

**TOTAL : 30 PERIODS**

**PRACTICAL EXERCISES**: 30 PERIODS

**Programs for Problem solving with Search**

1. Implement breadth first search
2. Implement depth first search
3. Analysis of breadth first and depth first search in terms of time and space
4. Implement and compare Greedy and A* algorithms.

**Supervised learning**

5. Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs

6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.

**Unsupervised learning**

9. Implementing neural network using self-organizing maps
10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:

- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (https://archive.ics.uci.edu/ml/datasets.html) or constructed by the students.

**COURSE OUTCOMES:**

**CO1**: Understand the foundations of AI and the structure of Intelligent Agents
**CO2**: Use appropriate search algorithms for any AI problem
**CO3**: Study of learning methods
**CO4**: Solving problem using Supervised learning
**CO5**: Solving problem using Unsupervised learning

**TOTAL : 60 PERIODS**

**TEXT BOOK**

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

**REFERENCES**

1. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
2. I. Bratko, “Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

**OCS352 IOT CONCEPTS AND APPLICATIONS L T P C**
**2 0 2 3**

**COURSE OBJECTIVES:**

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

**UNIT I INTRODUCTION TO INTERNET OF THINGS 5**

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

**UNIT II COMPONENTS IN INTERNET OF THINGS 5**

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

**UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT 6**

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

**UNIT IV OPEN PLATFORMS AND PROGRAMMING 7**

IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

**UNIT V IOT APPLICATIONS 7**

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5 Introduction to Raspberry PI platform and python programming
6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10. Design an IOT based system

**TOTAL PERIODS:60**

**COURSE OUTCOMES:**

**CO1:**Explain the concept of IoT.
**CO2:**Understand the communication models and various protocols for IoT.
**CO3:**Design portable IoT using Arduino/Raspberry Pi /open platform
**CO4:**Apply data analytics and use cloud offerings related to IoT.
**CO5:**Analyze applications of IoT in real time scenario.

**TEXTBOOKS**

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

**REFERENCES**

1. Perry Lea, "Internet of things for architects", Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. ArshdeepBahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015
6. https://www.arduino.cc/
   https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet

**OCS353 DATA SCIENCE FUNDAMENTALS L T P C**
**2 0 2 3**

**COURSE OBJECTIVES:**

- Familiarize students with the data science process.
- Understand the data manipulation functions in Numpy and Pandas.
- Explore different types of machine learning approaches.
- Understand and practice visualization techniques using tools.
- Learn to handle large volumes of data with case studies.

**UNIT I INTRODUCTION 6**

Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data

**UNIT II DATA MANIPULATION 9**

Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance

**UNIT III MACHINE LEARNING 5**

The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis

**UNIT IV DATA VISUALIZATION 5**

Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn

**UNIT V HANDLING LARGE DATA 5**

Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.

**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

**LAB EXERCISES**

1. Download, install and explore the features of Python for data analytics.
2. Working with Numpy arrays
3. Working with Pandas data frames
4. Basic plots using Matplotlib
5. Statistical and Probability measures
    a) Frequency distributions
    b) Mean, Mode, Standard Deviation
    c) Variability
    d) Normal curves
    e) Correlation and scatter plots
    f) Correlation coefficient
    g) Regression
6. Use the standard benchmark data set for performing the following:

a) Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.

b) Bivariate Analysis: Linear and logistic regression modelling.

7. Apply supervised learning algorithms and unsupervised learning algorithms on any data set.
8. Apply and explore various plotting functions on any data set.

**Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.**

**COURSE OUTCOMES:**

**At the end of this course, the students will be able to:**

**CO1:** Gain knowledge on data science process.
**CO2:** Perform data manipulation functions using Numpy and Pandas.
**CO3** Understand different types of machine learning approaches.
**CO4:** Perform data visualization using tools.
**CO5:** Handle large volumes of data in practical scenarios.

**TOTAL:60 PERIODS**

**TEXT BOOKS**


1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
2. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016.


**REFERENCES**

1. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
2. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press, 2014.

**CCS333 AUGMENTED REALITY/VIRTUAL REALITY L T P C**
**2 0 2 3**

**COURSE OBJECTIVES:**

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the internals of the hardware and software components involved in the development of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures.
- To gain knowledge about AR/VR application development.
- To know the technologies involved in the development of AR/VR based applications.

**UNIT I INTRODUCTION 7**

Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space-Three I’s of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System**.**

**UNIT II VR MODELING 6**

Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.

**UNIT III VR PROGRAMMING 6**

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D

**UNIT IV APPLICATIONS 6**

Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.

**UNIT V AUGMENTED REALITY 5**

Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation-Navigation-Wearable devices

**30 PERIODS**

**PRACTICAL EXERCISES: 30 PERIODS**

1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection types by handling camera.
3. Download objects from asset store and apply various lighting and shading effects.

4. Model three dimensional objects using various modelling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9. Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10. Develop simple MR enabled gaming applications.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**On completion of the course, the students will be able to:**

**CO1:** Understand the basic concepts of AR and VR
**CO2:** Understand the tools and technologies related to AR/VR
**CO3**: Know the working principle of AR/VR related Sensor devices
**CO4:** Design of various models using modeling techniques
**CO5:** Develop AR/VR applications in different domains

**TEXTBOOKS:**


1. Charles Palmer, John Williamson, “Virtual Reality Blueprints: Create compelling VR experiences for mobile”, Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, “Augmented Reality: Principles & Practice”, Addison Wesley, 2016
3. John Vince, “Introduction to Virtual Reality”, Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design”, Morgan Kaufmann, 2003’


**CO’s – PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | |
| 1 | 3 | 2 | 2 | - | 3 | - | - | - | 2 | 2 | 1 | 2 | 2 | 1 | 2 | |
| 2 | 3 | 2 | 2 | 1 | 3 | - | - | - | 3 | 2 | 2 | 3 | 3 | 1 | 2 | |
| 3 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 1 | 2 | 3 | 2 | 2 | |
| 4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 2 | 3 | 3 | 2 | 2 | |
| 5 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| AVg. | 3.00 | 2.60 | 2.40 | 2.00 | 3.00 | - | - | - | 2.80 | 2.20 | 1.80 | 2.60 | 2.80 | 1.80 | 2.20 | |

## OPEN ELCTIVE III

**OHS351 ENGLISH FOR COMPETITIVE EXAMINATIONS L T P C**
**3 0 0 3**

**Course Description:**

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

**COURSE OBJECTIVES:**

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

**UNIT I** **9**

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

**UNIT II** **9**

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

**UNIT III** **9**

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

**UNIT IV** **9**

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

**UNIT V** **9**

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

**TOTAL: 45 PERIODS**

**Learning Outcomes:**

At the end of the course, learners will be able

**CO1** expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required

**CO2** identify errors with precision and write with clarity and coherence

**CO3** understand the importance of task fulfilment and the usage of task-appropriate vocabulary

**CO4** communicate effectively in group discussions, presentations and interviews

**CO5** write topic based essays with precision and accuracy

**Teaching Methods:**

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

**Evaluative Pattern:**

Internal Tests – 50%

End Semester Exam - 50%

**TEXTBOOKS:**

1. R.P.Bhatnagar - *General English for Competitive Examinations.* Macmillan India Limited, 2009.

**REFERENCES:**

1. Educational Testing Service - The Official Guide to the GRE Revised General Test, Tata McGraw Hill, 2010.
2. The Official Guide to the TOEFL Test, Tata McGraw Hill, 2010.
3. R Rajagopalan- General English for Competitive Examinations, McGraw Hill Education (India) Private Limited, 2008.

**Websites**

http://www.examenglish.com/, http://www.ets.org/ , http://www.bankxams.com/
http://civilservicesmentor.com/, http://www.educationobserver.com
http://www.cambridgeenglish.org/in/

**COs- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 1 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 1 | 3 | 1 | 3 | - | - | - |
| 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | - | - | - |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | - | - | - |
| 5 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | - | - | - |
| AVg. | 2 | 2.6 | 2.6 | 2 | 2.6 | 2.6 | 2.6 | 2.6 | 2 | 3 | 2.4 | 3 | - | - | - |

1-low, 2-medium, 3-high, '-"- no correlation

**Note:** The average value of this course to be used for program articulation matrix.

**OMG352 NGOS AND SUSTAINABLE DEVELOPMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To understand the importance of sustainable development
- To acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management
- To comprehend the role of NGOs in attaining sustainable development

**UNIT I ENVIRONMENTAL CONCERNS 9**

Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes

**UNIT II ROLE OF NGOS 9**

Role of NGO's in national development, NGO's and participatory management, Challenges and limitations of NGO's, Community Development programmes, Role of NGO's in Community Development programmes, Participation of NGO's in environment management, Corporate Social responsibility, NGO's and corporate social responsibility

**UNIT III SUSTAINABLE DEVELOPMENT 9**

Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators

**UNIT IV NGO'S FOR SUSTAINABILITY 9**

Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food security and Water security, NGOs and Sustainable Development strategies

**UNIT V LEGAL FRAMEWORKS 9**

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

**TOTAL 45 PERIODS**

**COURSE OUTCOMES :**

Upon completion of this course, the student will :

**CO1** Have a thorough grounding on the issues and challenges being faced in attaining sustainable development

**CO2** have a knowledge on the role of NGOs towards sustainable developemnt

**CO3** present strategies for NGOs in attaining sustainable development

**CO4** recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment

**CO5** understand the environmental legislations

**REFERENCES**


1. Kulsange, S and Kamble, R. (2019). Environmental NGO's: Sustainability Stewardship, Lap Lambert Academic Publishing, India, ISBN-13: .6200442444-978
2. Dodds, F. (2007). NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations. Mit Press, Cambridge, ISBN-13: -978 .0262524766
3. Ghosh, S. (Ed.). (2019). Indian environmental law: Key concepts and principles. Orient BlackSwan, India, ISBN-13: .9352875795-978
4. Alan Fowler and Chiku Malunga (2010) NGO Management: The Earthscan Companion, Routledge, ISBN-13 : . 978-1849711197


**OMG353 DEMOCRACY AND GOOD GOVERNANCE L T P C**
**3 0 0 3**

**UNIT I (9)**

Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance

**UNIT II (9)**

Regulatory Institutions – SEBI, TRAI, Competition Commission of India,

**UNIT III (9)**

Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.

**UNIT IV (9)**

Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance

**UNIT V (9)**

Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.

**TOTAL : 45 PERIODS**

**REFERENCES:**


1. Atul Kohli (ed.): The Success of India's Democracy, Cambridge University Press, 2001.
2. Corbridge, Stuart and John Harris: Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy, Oxford University Press, 2000.
3. J.Dreze and A.Sen, India: Economic Development and Social Opportunity, Clarendon, 1995.
4. Saima Saeed: Screening the Public Sphere: Media and Democracy in India,2013
5. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.
6. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993.
7. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.

**CME365 RENEWABLE ENERGY TECHNOLOGIES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To know the Indian and global energy scenario
- To learn the various solar energy technologies and its applications.
- To educate the various wind energy technologies.
- To explore the various bio-energy technologies.
- To study the ocean and geothermal technologies.

**UNIT I ENERGY SCENARIO 9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

**UNIT II SOLAR ENERGY 9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

**UNIT III WIND ENERGY 9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

**UNIT IV BIO-ENERGY 9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

**UNIT V OCEAN AND GEOTHERMAL ENERGY 9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students would be able to

**CO1** Discuss the Indian and global energy scenario.
**CO2** Describe the various solar energy technologies and its applications.
**CO3** Explain the various wind energy technologies.
**CO4** Explore the various bio-energy technologies.
**CO5** Discuss the ocean and geothermal technologies.

**TEXT BOOKS:**

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India : Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 8120344707

**REFERENCES:**


1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.


**CO’s – PO’s & PSO’s MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 2 | 1 | 2 |
| 2 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 2 |
| 3 | 3 | 2 | 3 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 2 |
| 4 | 2 | 2 | 2 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 2 |
| 5 | 2 | 1 | 2 | 1 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 3 | 2 | 1 | 2 |
| Low (1) ; Medium (2) ; High (3) | | | | | | | | | | | | | | | |

**OME354 APPLIED DESIGN THINKING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**:

The course aims to

- Introduce tools & techniques of design thinking for innovative product
- development Illustrate customer-centric product innovation using on simple
- use cases Demonstrate development of Minimum usable Prototypes
- Outline principles of solution concepts & their evaluation
- Describe system thinking principles as applied to complex systems

**UNIT I DESIGN THINKING PRINCIPLES 9**

Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies

**UNIT II ENDUSER-CENTRIC INNOVATION 9**

Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit

**UNIT III APPLIED DESIGN THINKING TOOLS 9**

Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design

**UNIT IV CONCEPT GENERATION 9**

Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts

**UNIT V SYSTEM THINKING 9**

System Thinking, Understanding Systems, Examples and Understandings, Complex Systems

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

**CO1** Define & test various hypotheses to mitigate the inherent risks in product innovations.

**CO2** Design the solution concept based on the proposed value by exploring alternate solutions to achieve value-price fit.

**CO3** Develop skills in empathizing, critical thinking, analyzing, storytelling & pitching

**CO4** Apply system thinking in a real-world scenario

**TEXT BOOKS**


1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Donella H. Meadows, (2015), “Thinking in Systems -A Primer”, Sustainability Institute.
5. Tim Brown,(2012) “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”, Harper Business.


**REFERENCES**


1. https://www.ideou.com/pages/design-thinking#process
2. https://blog.forgefor ward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca86_24
3. https://blog.forgefor ward.in/product-innovation-rubric-adf5ebdfd356
4. https://blog.forgefor ward.in/evaluating-product-innovations-e8178e58b86e
5. https://blog.forgefor ward.in/user-guide-for-product-innovation-rubric-857181b253dd
6. https://blog.forgefor ward.in/star tup-failure-is-like-true-lie-7812cdfe9b85

**MF3003** **REVERSE ENGINEERING** **LT P C**
**3 0 0 3**

## COURSE OBJECTIVES:

- The main learning objective of this course is to prepare students for:
- Applying the fundamental concepts and principles of reverse engineering in product design and development
- Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
- Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
- Analysing the various legal aspect and applications of reverse engineering in product design and development.
- Understand about 3D scanning hardware & software operations and procedure to generate 3D model

## UNIT I INTRODUCTION & GEOMETRIC FORM 9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.

## UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9

.Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

## UNIT III DATA PROCESSING 9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.

## UNIT IV 3D SCANNING AND MODELLING 9

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

## UNIT V INDUSTRIAL APPLICATIONS 9

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering.Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.

**TOTAL : 45 PERIODS**

## COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

**CO1** Apply the fundamental concepts and principles of reverse engineering in product design and development.

**CO2** Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.

**CO3** Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.

**CO4** Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.

**CO5** Analyze the various legal aspect
**CO6** Applications of reverse engineering in product design and development.

**TEXT BOOKS:**
1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

**REFERENCES:**
1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001
3. Kathryn, A. Ingle, “Reverse Engineering”, McGraw-Hill, 1994.
4. Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, Springer-Verlag London Limited 2008.

**OPR351 SUSTAINABLE MANUFACTURING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**
- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

**UNIT I ECONOMIC SUSTAINABILITY 9**
Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability -Assessments of economic sustainability

**UNIT II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9**
Social sustainability – Introduction-Work management -Human rights - Societal commitment -Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

**UNIT III SUSTAINABILITY PRACTICES 9**
Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements –Cost and time model.

**UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9**

Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

**UNIT V TRENDS IN SUSTAINABLE OPERATIONS 9**

Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1**: Discuss the importance of economic sustainability.
**CO2**: Describe the importance of sustainable practices.
**CO3**: Identify drivers and barriers for the given conditions.
**CO4**: Formulate strategy in sustainable manufacturing.
**CO5**: Plan for sustainable operation of industry with environmental, cost consciousness.

**TEXT BOOKS**:


1. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
2. Davim J.P., “Sustainable Manufacturing”, John Wiley & Sons., United States, 2010,ISBN: 978-1-848-21212-1.


**REFERENCES:**


1. Jovane F, Ęmper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.
2. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
3. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.


**CO’s – PO’s & PSO’s MAPPING**

| COs/Pos &PSOs | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | 3 | - | 2 | - | - | - | 2 | 2 | - | 1 | 1 | 2 | 2 | 2 | 1 |
| CO2 | 3 | - | - | - | - | - | 2 | - | - | 1 | 1 | 2 | 1 | 2 | 2 |
| CO3 | 3 | - | - | - | - | - | 2 | 3 | - | 1 | 1 | 2 | 1 | 2 | 2 |
| CO4 | 3 | - | 3 | - | - | - | 2 | | - | 1 | 1 | 2 | 2 | 2 | 1 |
| CO5 | 3 | - | 3 | - | - | - | 2 | 2 | - | 1 | 1 | 2 | 2 | 2 | 1 |
| CO/PO & PSO Average | 3 | - | 3 | - | - | - | 2 | 2 | - | 1 | 1 | 2 | 2 | 2 | 1 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**AU3791 ELECTRIC AND HYBRID VEHICLES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.

**UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES 9**

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

**UNIT II ENERGY SOURCES 9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.

**UNIT III MOTORS AND DRIVES 9**

Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.

**UNIT IV POWER CONVERTERS AND CONTROLLERS 9**

Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes

**UNIT V HYBRID AND ELECTRIC VEHICLES 9**

Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, the student will be able to

**CO1** Understand the operation and architecture of electric and hybrid vehicles
**CO2** Identify various energy source options like battery and fuel cell
**CO3** Select suitable electric motor for applications in hybrid and electric vehicles.
**CO4** Explain the role of power electronics in hybrid and electric vehicles
**CO5** Analyze the energy and design requirement for hybrid and electric vehicles.

**TEXT BOOKS:**

1. Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.

**REFERENCES:**

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
3. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

**CO's – PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| 2 | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| 3 | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| 4 | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| 5 | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |
| Avg. | 1 | 1 | 2 | 1 | | 3 | 2 | | | | | 2 | | 1 | 3 |

**OAS352 SPACE ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

**UNIT I STANDARD ATMOSPHERE 6**

History of aviation – standard atmosphere - pressure, temperature and density altitude.

**UNIT II AERODYNAMICS 10**

Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.

**UNIT III PERFORMANCE AND PROPULSION 9**

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations - thrust/power available and thrust/power required.

**UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY 10**

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

**UNIT V SPACE APPLICATIONS 10**

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** Illustrate the history of aviation & developments over the years
**CO2** Ability to identify the types & classifications of components and control systems
**CO3** Explain the basic concepts of flight & Physical properties of Atmosphere
**CO4** Identify the types of fuselage and constructions.
**CO5** Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS:**

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York,2015.
2. E Rathakrishnan, “Introduction to Aerospace Engineering: Basic Principles of Flight”, John Wiley, NJ, 2021.
3. Stephen. A. Brandt, " Introduction to Aeronautics: A design perspective " American Institute of Aeronautics & Astronautics,1997.

**REFERENCE:**

1. Kermode, A.C., “Mechanics of Flight”, Himalayan Book, 1997.

**OIM351 INDUSTRIAL MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce fundamental concepts of industrial management
- To understand the approaches to the study of Management
- To learn about Decision Making, Organizing and leadership
- To analyze the Managerial Role and functions
- To know about the Supply Chain Management’

**UNIT I INTRODUCTION 9**

Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,-Financial-Legal-Trade Union

**UNIT II FUNCTIONS OF MANAGEMENT 9**

Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.

**UNIT III ORGANIZATIONAL BEHAVIOUR 9**

Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour-Learning Curves, Work Design and approaches.

**UNIT IV GROUP DYNAMICS 9**

Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization -

Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics.

**UNIT V MODERN CONCEPTS 9**

Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re-engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Understand the basic concepts of industrial management
**CO2**: Identify the group conflicts and its causes.
**CO3**: Perform swot analysis
**CO4** : Analyze the learning curves
**CO5** : Understand the placement and performance appraisal

**REFERENCES:**

Maynard H.B, “Industrial Engineering Hand book”, McGraw-Hill, sixth 2008

**CO’s – PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 1 | | | | | | | | | | | 2 | 1 | |
| 2 | | 3 | 2 | 3 | | | | | | | | | | | 2 |
| 3 | 2 | 3 | 2 | 3 | | | | | | | | | 1 | 2 | 3 |
| 4 | 2 | 2 | 3 | 3 | | | | | | | | | | 3 | 3 |
| 5 | 2 | 2 | | | | | | | | | | | 2 | | |
| AVg. | 2 | 2.2 | 2.3 | 3 | | | | | | | | | 1.8 | 2 | 2.6 |

**OIE354 QUALITY ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- Developing a clear knowledge in the basics of various quality concepts.
- Facilitating the students in understanding the application of control charts and its techniques.
- Developing thespecialcontrolproceduresforserviceandprocessorientedindustries.
- Analyzing and understanding the process capability study.
- Developing the acceptance sampling procedures for incoming raw material.

**UNIT I INTRODUCTION 9**

Quality Dimensions–Quality definitions–Inspection-Quality control–Quality Assurance–Quality planning-Quality costs–Economics of quality– Quality loss function

**UNIT II CONTROLCHARTS 9**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- $\bar{X}$ , R and S charts, attribute control charts - p, np, c and u-Construction and application.

**UNIT III SPECIAL CONTROL PROCEDURES 9**

Warning and modified control limits, control chart for individual measurements, multi-vari chart, *X*chart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV STATISTICALPROCESSCONTROL 9**

Process stability, process capability analysis using a Histogram or probability plots and control chart.Gauge capability studies,setting specification limits.

**UNITV ACCEPTANCESAMPLING 9**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables,MIL-STD-105DandMIL-STD-414E&IS2500 standards.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students will be able to:

**CO1**: Control the quality of processes using control charts for variables in manufacturing industries.

**CO2:** Control the occurrence of defective product and the defects in manufacturing companies.

**CO3:** Control the occurrence of defects in services.

**CO4:** Analyzing and understanding the process capability study.

**CO5:** Developing the acceptance sampling procedures for incoming raw material.

**CO's – PO's & PSO's MAPPING**

| | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO's** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | 2 | 3 | 3 | | 3 | | | 1 | 2 | | | 2 | 1 | | |
| **2** | | 3 | 3 | | 3 | 3 | | | 3 | | | 3 | | 2 | |
| **3** | 3 | 3 | 3 | | 3 | | | | 3 | | | 3 | 1 | | |
| **4** | 3 | | 2 | | 3 | | | | | | 1 | | 1 | | |
| **5** | | 2 | | | 3 | | | | 3 | | | 3 | | | 1 |
| **AVg.** | 2.6 | 2.7 | 2.7 | | 3 | 3 | | 1 | 2.7 | | 1 | 2.7 | 1 | 2 | 1 |

**OSF351 FIRE SAFETY ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To enable the students to acquire knowledge of Fire and Safety Studies
- To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
- To learn about fire area, fire stopped areas and different types of fire-resistant doors
- To learn about the method of fire protection of structural members and their repair due to fire damage.
- To develop safety professionals for both technical and management through systematic and quality-based study programmes

**UNIT I INHERENT SAFETY CONCEPTS 9**

Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

**UNIT II PLANT LOCATIONS 9**

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements-standard heating condition, Indian standard test method, performance criteria.

**UNIT III WORKING CONDITIONS 9**

Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors;

**UNIT IV FIRE SEVERITY AND REPAIR TECHNIQUES 9**

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

**UNIT V WORKING AT HEIGHTS 9**

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps- Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

On completion of the course the student will be able to

**CO1**:Understand the effect of fire on materials used for construction

**CO2**:Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.

**CO3**:To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.

**CO4**:To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.

**CO5**:Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.

**TEXT BOOKS**

1. Roytman, M. Y,"Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi,1975
2. John A. Purkiss,"Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK,2009.

**REFERENCES:**

1. Smith, E.E. and Harmathy, T.Z. (Editors),"Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston,

U.S.A,1979.
2. Butcher, E. G. and Parnell, A. C, ”Designing of fire safety”. JohnWiley and Sons Ltd., New York, U.S.A.1983.
3. Jain, V.K,”Fire safety in buildings” (2nd edn.). New Age International(P) Ltd., New Delhi,2010. 4. Hazop&Hazan,”Identifying and Assessing Process Industry Hazards”, Fourth Edition ,1999
4. Frank R. Spellman, Nancy E. Whiting,”The Handbook of Safety Engineering: Principles and Applications”, 2009

**CO’s- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - |
| 2 | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | 1 | - | 2 | - | - | - | 3 | - | - | 1 | - | - | - | - | - |
| 4 | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - |
| 5 | 2 | - | 1 | - | - | 1 | 1 | 1 | - | 1 | - | 1 | - | - | - |
| AVg. | 1.3 | - | 1.75 | - | - | 1 | 1.3 | 1 | | 1 | - | 1 | - | - | - |

**OML351 INTRODUCTION TO NON-DESTRUCTIVE TESTING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

**UNIT I INTRODUCTION TO NDT & VISUAL TESTING 9**

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes – light sources and special lighting.

**UNIT II LIQUID PENETRANT & MAGNETIC PARTICLE TESTING 9**

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation.

Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

**UNIT III EDDY CURRENT TESTING & THERMOGRAPHY 9**

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation.

Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

**UNIT IV ULTRASONIC TESTING & AET 9**

Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration.

Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.

**UNIT V RADIOGRAPHY TESTING 9**

Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

**CO1** Realize the importance of NDT in various engineering fields.

**CO2** Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.

**CO3** Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.

**CO4** Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.

**CO5** Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.

**TEXT BOOKS:**


1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.
2. J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.
3. Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.


**REFERENCES:**


1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.
2. Barry Hull and Vernon John,"Nondestructive Testing", Macmillan, 1989.
3. Chuck Hellier, “Handbook of Nondestructive Evaluation”, Mc Graw Hill, 2012.
4. Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

**CO's- PO's & PSO's MAPPING**

| | PO1 | PO2 | PO3 | PO 4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO1 1 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 2 | 2 | 2 | 3 | | | 2 | 2 | | | | 2 | 1 | 2 | |
| C02 | 3 | 1 | 2 | 2 | | | 2 | 2 | | | | 2 | 2 | 2 | 1 |
| C03 | 3 | 2 | 1 | 2 | | | 2 | 2 | | | | 2 | 2 | 2 | |
| CO4 | 3 | 1 | 2 | 2 | | | 2 | 2 | | | | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 2 | | | 2 | 2 | | | | 2 | 2 | 2 | 1 |
| Avg | 2.8 | 1.6 | 1.8 | 2.2 | | | 2 | 2 | | | | 2 | 1.8 | 2 | 1.3 |

**OMR351 MECHATRONICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Selecting sensors to develop mechatronics systems.
- Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
- Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
- Applying PLC as a controller in mechatronics system.
- Designing and develop the apt mechatronics system for an application.

**UNIT I INTRODUCTION AND SENSORS 9**

Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor –Temperature Sensors – Light Sensors.

**UNIT II 8085 MICROPROCESSOR 9**

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

**UNIT III PROGRAMMABLE PERIPHERAL INTERFACE 9**

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLER 9**

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

**UNIT V ACTUATORS AND MECHATRONICS SYSTEM DESIGN 9**

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

**CO1**: Select sensors to develop mechatronics systems.

**CO2**: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.

**CO3**: Design appropriate interfacing circuits to connect I/O devices with microprocessor.

**CO4**: Apply PLC as a controller in mechatronics system.

**CO5**: Design and develop the apt mechatronics system for an application.

## TEXT BOOKS


1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.


## REFERENCES


1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.


## CO’s- PO’s & PSO’s MAPPING

| COs/POs & PSOs | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO2 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO3 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO4 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO5 | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| CO/PO & PSO Average | 3 | 2 | 1 | 3 | | 2 | | | | | | 2 | 3 | 2 | 3 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**ORA351 FOUNDATION OF ROBOTICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To study the kinematics, drive systems and programming of robots.
- To study the basics of robot laws and transmission systems.
- To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
- To familiarize students with the various Programming and Machine Vision application in robots.
- To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

**UNIT I FUNDAMENTALS OF ROBOT 9**

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

**UNIT II ROBOT KINEMATICS 9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

**UNIT III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

**UNIT IV SENSORS IN ROBOTICS 9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

**UNIT V PROGRAMMING AND APPLICATIONS OF ROBOT 9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

At the end of the course, students will be able to:

**CO1**: Interpret the features of robots and technology involved in the control.

**CO2**: Apply the basic engineering knowledge and laws for the design of robotics.
**CO3**: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.
**CO4**: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.
**CO5**: Demonstrate the image processing and image analysis techniques by machine vision system.

**TEXT BOOKS:**

1. Ganesh.S.Hedge,"A textbook of Industrial Robotics", Lakshmi Publications, 2006.
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition 2012.

**REFERENCES**:

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

**CO's- PO's & PSO's MAPPING**

| COs/POs& PSOs | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO2 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO3 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO4 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO5 | 3 | 2 | 1 | 1 | | | | | | | | 1 | | | 3 |
| CO/PO & PSO Average | | | | | | | | | | | | | | | |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**OAE352 FUNDAMENTALS OF AERONAUTICAL ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To acquire the knowledge on the Historical evaluation of Airplanes
- To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight
- To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

**UNIT I HISTORY OF FLIGHT 8**

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

**UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS 10**

Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control
actuation.

**UNIT III BASICS OF AERODYNAMICS 9**

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment.
Aerofoils, Mach number, Maneuvers.

**UNIT IV BASICS OF AIRCRAFT STRUCTURES 9**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium,
stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams- elastic constants-Factor of Safety.

**UNIT V BASICS OF PROPULSION 9**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** Illustrate the history of aircraft & developments over the years
**CO2** Ability to identify the types & classifications of components and control systems
**CO3** Explain the basic concepts of flight & Physical properties of Atmosphere
**CO4** Identify the types of fuselage and constructions.
**CO5** Distinguish the types of Engines and explain the principles of Rocket

**TEXT BOOKS**

**1.** Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition 2015
2. . E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

**REFERENCE**

1. SADHU SINGH, "INTERNAL COMBUSTION ENGINES AND GAS TURBINE"-, SS Kataraia & sons, 2015
2. KERMODE , "FLIGHT WITHOUT FORMULAE", -, Pitman; 4th Revised edition 1989

**OGI351 REMOTE SENSING CONCEPTS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

**UNIT I REMOTE SENSING AND ELECTROMAGNETIC RADIATION 9**

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck‘s law, Wien’s Displacement Law, Stefan’s Boltzmann law, Kirchoff‘s law – Radiation sources: active & passive - Radiation Quantities

**UNIT II EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL 9**

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.

**UNIT III ORBITS AND PLATFORMS 9**

Motions of planets and satellites – Newton‘s law of gravitation - Gravitational field and potential - Escape velocity - Kepler‘s law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.

**UNIT IV SENSING TECHNIQUES 9**

Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites

**UNIT V DATA PRODUCTS AND INTERPRETATION 9**

Photographic and digital products – Types, levels and open source satellite data products –- selection and procurement of data– Visual interpretation: basic elements and interpretation keys -Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the student is expected to

**CO1** Understand the concepts and laws related to remote sensing

**CO2** Understand the interaction of electromagnetic radiation with atmosphere and earth material

**CO3** Acquire knowledge about satellite orbits and different types of satellites

**CO4** Understand the different types of remote sensors

**CO5** Gain knowledge about the concepts of interpretation of satellite imagery

**TEXTBOOKS:**

1. Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing andImage interpretation, John Wiley and Sons, Inc, New York,2015.
2. George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third EditionUniversities Press (India) Private limited, Hyderabad, 2018

**REFERENCES:**

1. Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of Photogrametry, Virginia, USA, 2002.

2. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995
3. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.
4. Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and JacobVan Zyl, 2006 Edition II, Wiley Publication.
5. *Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011*

**CO's- PO's & PSO's MAPPING**

| | Graduate Attribute | Course Outcome | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | CO1 | CO2 | CO3 | CO4 | CO5 | |
| PO1 | Engineering Knowledge | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem Analysis | | | | 3 | 3 | 3 |
| PO3 | Design/Development of Solutions | | | | 3 | 3 | 3 |
| PO4 | Conduct Investigations of Complex Problems | | | | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | | | | 3 | 3 | 3 |
| PO6 | The Engineer and Society | | | | | | |
| PO7 | Environment and Sustainability | | | | | | |
| PO8 | Ethics | | | | | | |
| PO9 | Individual and Team Work | | | | | | |
| PO10 | Communication | | | | | | |
| PO11 | Project Management and Finance | | | | | | |
| PO12 | Life-long Learning | 3 | | 3 | 3 | 3 | 3 |
| PSO1 | Knowledge of Geoinformatics discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Geoinformatics Engineering problems and innovations | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of Design solutions | 3 | 3 | 3 | 3 | 3 | 3 |

**OAI351 URBAN AGRICULTURE L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices.

**UNIT I INTRODUCTION 9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

**UNIT II VERTICAL FARMING 9**

**Vertical farming- types,** green facade, living/green wall-modular green wall **,** vegetated mat wall**-** Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plants

**UNIT III SOIL LESS CULTIVATION 9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

**UNIT IV MODERN CONCEPTS 9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops

**UNIT V WASTE MANAGEMENT 9**

Concept, scope and maintenance of waste management- **r**ecycle of organic waste, garden wastes- solid waste management-scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1** Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
**CO2** Explain different methods of crop production on roof tops
**CO3** Explain nutrient and pest management for crop production on roof tops
**CO4** Illustrate crop water requirement and irrigation water management on roof tops
**CO5** Explain the concept of waste management on roof tops

**TEXT BOOKS:**


1. Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.
2. Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3. Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.


**REFERENCES:**


1. Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.
2. Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri-urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329. https:// www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24.
3. Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.


**CO's- PO's & PSO's MAPPING**

| PO/PSO | | CO 1 | CO 2 | CO 3 | CO 4 | CO 5 | Overall correlation of COs with POs |
|---|---|---|---|---|---|---|---|
| PO1 | Engineering Knowledge | 1 | 2 | 1 | 1 | 2 | 1 |
| PO2 | Problem Analysis | 1 | 1 | 1 | 1 | 1 | 2 |
| PO3 | Design/ Development of Solutions | 1 | 2 | 1 | 1 | 3 | 2 |
| PO4 | Conduct Investigations of Complex Problems | 1 | 1 | 2 | 2 | 1 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PO5 | Modern Tool Usage | 1 | 2 | 1 | 1 | 1 | 2 |
| PO6 | The Engineer and Society | 1 | 2 | 1 | 2 | 1 | 1 |
| PO7 | Environment and sustainability | 1 | 2 | 1 | 1 | 2 | 1 |
| PO8 | Ethics | 2 | 1 | 1 | 1 | 2 | 1 |
| PO9 | Individual and team work: | 1 | 1 | 2 | 1 | 1 | 1 |
| PO10 | Communication | 1 | 2 | 1 | 1 | 2 | 1 |
| PO11 | Project management and finance | 1 | 1 | 1 | 1 | 1 | 2 |
| PO12 | Life-long learning: | 1 | 2 | 1 | 1 | 3 | 2 |
| PSO 1 | To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill | 1 | 2 | 1 | 1 | 2 | 1 |
| PSO 2 | To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies. | 2 | 1 | 2 | 1 | 1 | 1 |
| PSO 3 | To inculcate entrepreneurial skills through strong Industry-Institution linkage. | 1 | 2 | 1 | 2 | 1 | 2 |

**OEN351 DRINKING WATER SUPPLY AND TREATMENT L T P C**

**3 0 0 3**

## COURSE OBJECTIVE:

- To equip the students with the principles and design of water treatment units and distribution system.

**UNIT I SOURCES OF WATER 9**

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards.

**UNIT II CONVEYANCE FROM THE SOURCE 9**

Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.

**UNIT III WATER TREATMENT 9**

Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation –- sand filters - Disinfection -– Construction, Operation and Maintenance aspects.

**UNIT IV ADVANCED WATER TREATMENT 9**

Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange– Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects

**UNIT V WATER DISTRIBUTION AND SUPPLY 9**

Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection - Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1**: an understanding of water quality criteria and standards, and their relation to public health
**CO2**: the ability to design the water conveyance system
**CO3**: the knowledge in various unit operations and processes in water treatment
**CO4**: an ability to understand the various systems for advanced water treatment
**CO5**: an insight into the structure of drinking water distribution system

**TEXTBOOKS :**


1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.


**REFERENCES :**


1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.


**CO's- PO's & PSO's MAPPING**

| | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO's | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 3 | | | | | | 3 | | 3 | | | 3 | | |
| 2 | | 3 | | 2 | | 2 | | | | 3 | | | 3 | | |
| 3 | | | | 2 | | 2 | | | | 3 | | | 3 | | |
| 4 | | | 3 | 2 | | | | 3 | 2 | 3 | | | 3 | | |
| 5 | | | 3 | 2 | | | 1 | | 2 | 3 | | 1 | | | |
| Avg. | | 3 | 3 | 2 | | 2 | 1 | 3 | 2 | 3 | | 1 | 3 | | |

1.low, 2-medium, 3-high, '-"- no correlation

Note: The average value of this course to be used for program articulation matrix.

**OEE352 ELECTRIC VEHICLE TECHNOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

**UNIT I ROTATING POWER CONVERTERS 9**

Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

**UNIT II STATIC POWER CONVERTERS 9**

Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

**UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9**

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

**UNIT IV HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9**

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

**UNIT V MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES 9**

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Able to understand the principles of conventional and special electrical machines.
**CO2**: Acquired the concepts of power devices and power converters
**CO3**: Able to understand the control for DC and AC drive systems.
**CO4**: Learned the electric vehicle architecture and power train components.
**CO5**: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

**REFERENCES:**


1 Stephen D. Umans, “Fitzgerald & Kingsley’s Electric Machinery”, Tata McGraw Hill, 7th Edition, 2020.
2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek “Analysis of Electric Machinery and Drive Systems”, 3rd Edition, Wiley-IEEE Press, 2013.
4 Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.
5 Iqbal Husain, ‘Electric and Hybrid Electric Vehicles’, CRC Press, 2021.
6 Wei Liu, ‘Hybrid Electric Vehicle System Modeling and Control’, Second Edition, WILEY, 2017
7 James Larminie and John Lowry, ‘Electric Vehicle Technology Explained’, Second Edition, Wiley, 2012


**CO’s- PO’s & PSO’s MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | | | 3 | | | | | | | | 3 | 3 | 3 |
| CO2 | 3 | 2 | 2 | | | 3 | | | 3 | | | | 3 | 3 | 3 |
| CO3 | 3 | | | 3 | | 2 | 2 | | | | | | 3 | 3 | 3 |
| CO4 | 3 | 2 | 2 | | 3 | | | | | | | | 3 | 3 | 3 |
| CO5 | 3 | | 2 | | | | | | | | 2 | | 3 | 3 | 3 |
| Avg | 3 | 2 | 2 | 3 | 3 | 1 | 2 | | 3 | | 2 | | 3 | 3 | 3 |

**OEI353 INTRODUCTION TO PLC PROGRAMMING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- Understand basic PLC terminologies digital principles, PLC architecture and operation.
- Familiarize different programming language of PLC.
- Develop PLC logic for simple applications using ladder logic.
- Understand the hardware and software behind PLC and SCADA.
- Exposures about communication architecture of PLC/SCADA.

**UNIT I INTRODUCTION TO PLC 9**

Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.

**UNIT II PLC INSTRUCTIONS 9**

PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays- Interlock examples- Timers, Counters, Examples.

**UNIT III PLC PROGRAMMING 9**

Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions

**UNIT IV COMMUNICATION OF PLC AND SCADA 9**

Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Communication architectures

**UNIT V CASE STUDIES 9**

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control- Interlocking Problems

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**
**5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Communication Network Used for PLC/SCADA.

**COURSE OUTCOMES:**

**CO1** Know the basic requirement of a PLC input/output devices and architecture. (L1)
**CO2** Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)
**CO3** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function BIock.(L3)
**CO4** Able to develop a PLC logic for a specific application on real world problem. (L5)
**CO5** Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

**TEXT BOOKS:**

1. Frank Petruzzula, Programmable Logic Controllers, Tata Mc-Graw Hill Edition
2. John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES:**

1. MadhuchanndMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles andApplications, Pearson publication

**List of Open Source Software/ Learning website:**

1. https://nptel.ac.in/courses/108105063

2. https://www.electrical4u.com/industrial-automation/
3. https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf
4. https://www.electrical4u.com/industrial-automation/

**CO's- PO's & PSO's MAPPING**

| PO, PSO CO | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | | | | 1 | | 1 | | | | | |
| **CO2** | 3 | 3 | 2 | | | | | 1 | | 1 | 2 | | | | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 1 | | | 1 | | 1 | | | | | |
| **CO4** | 3 | 3 | | 3 | 3 | | | 1 | | 1 | | | 3 | 3 | |
| **CO5** | 3 | 3 | 3 | 2 | 1 | | | 1 | | 1 | | | 3 | 3 | 3 |
| **Avg** | 3 | 2.9 | 2.25 | 2.6 | 1.6 | | | 1 | | 1 | | | 3 | 3 | 2.9 |

**OCH351 NANO TECHNOLOGY L T P C**
**3 0 0 3**

**UNIT I INTRODUCTION 8**

General definition and size effects–important nano structured materials and nano particles- importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

**UNIT II SYNTHESIS OF NANOMATERIALS 8**

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

**UNIT III NANO COMPOSITES 10**

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

**UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES 10**

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

**UNIT V APPLICATIONS OF NANO MATERIALS 9**

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.

**CO2** able to acquire knowledge about the different types of nano material synthesis

**CO3** describes about the shape, size, structure of composite nano materials and their interference

**CO4** understand the different characterization techniques for nanomaterials

**CO5** develop a deeper knowledge in the application of nanomaterials in different fields.

**TEXT BOOKS**


1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press
2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties &Applications" Imperial College Press, 2004
3. William A Goddard "Handbook of Nanoscience, Engineering and Technology", 3rd Edition, CRC Taylor and Francis group 2012.


**REFERENCES**


1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gibtl & Co
3. Ivor Brodie and Julius J.Muray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010


**CO's- PO's & PSO's MAPPING**

| Course Outcomes | Statement | Program Outcome | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications | 2 | 3 | 2 | 3 | 3 | - | - | - | 1 | 1 | - | 3 | 1 | 1 | 3 |
| CO2 | acquire knowledge about the different types of nano material synthesis | 2 | 3 | 1 | 3 | 3 | - | - | - | 1 | 1 | - | 3 | 2 | 1 | 3 |
| CO3 | describes about the shape, size,structure | 2 | 2 | 2 | 3 | 3 | 1 | 1 | - | 1 | 1 | - | 3 | 2 | 1 | 3 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | of composite nano materials and their interference | | | | | | | | | | | | | | | |
| **CO4** | understand the different characterization techniques for nanomaterials | **2** | **2** | **1** | **3** | **3** | **1** | **1** | **1** | **1** | **-** | **1** | **3** | **1** | **1** | **3** |
| **CO5** | develop a deeper knowledge in the application of nanomaterials in different fields | **2** | **2** | **1** | **3** | **3** | **1** | **1** | **1** | **1** | **-** | **1** | **3** | **2** | **1** | **3** |
| | Overall CO | **3** | **2** | **2** | **1** | **3** | **3** | **1** | **1** | **1** | **1** | **1** | **1** | **3** | **2** | **1** |

**OCH352 FUNCTIONAL MATERIALS L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- The course emphasis on the molecular safe assembly and materials for polymer electronics

**UNIT I INTRODUCTION**
**9**

Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact.

**UNIT II MOLECULAR SELF ASSEMBLY 9**

Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly-Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.

**UNIT III BIO-INSPIRED MATERIALS 9**

Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, ‘Bionics’-Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology.

**UNIT IV SMART OR INTELLIGENT MATERIALS 9**

Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composities.

**UNIT V MATERIALS FOR POLYMER ELECTRONICS 9**

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.

**TEXT BOOK:**

1. Vijayamohanan K. Pillai and MeeraParthasarathy, “Functional Materials: A chemist’s perpective”, Universities Press Hyderabad (2012).

**REFERENCE:**

1. Stephen Manne “Biomimetic Materials Chemistry” Wiley-VCH Newyork, 1966.

**OFD352 TRADITIONAL INDIAN FOODS L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods.

**UNIT I HISTORICAL AND CULTURAL PERSPECTIVES 9**

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

**UNIT II TRADITIONAL METHODS OF FOOD PROCESSING 9**

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

**UNIT III TRADITIONAL FOOD PATTERNS 9**

Typical breakfast, meal and snack foods of different regions of India.Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods,pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

**UNIT IV COMMERCIAL PRODUCTION OF TRADITIONAL FOODS 9**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and

multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

**UNIT V HEALTH ASPECTS OF TRADIONAL FOODS 9**

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** To understand the historical and traditional perspective of foods and food habits

**CO2** To understand the wide diversity and common features of traditional Indian foods and meal patterns.

**TEXT BOOKS:**

1. Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.
2. Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

**OFD353 INTRODUCTION TO FOOD PROCESSING L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- The course aims to introduce the students to the area of Food Processing. This is necessary for effective understanding of a detailed study of food processing and technology subjects. This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

**UNIT I PROCESSING OF FOOD AND ITS IMPORTANCE 9**

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

**UNIT II METHODS OF FOOD HANDLING AND STORAGE 9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

**UNIT III LARGE-SCALE FOOD PROCESSING 12**

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

**UNIT IV FOOD WASTES IN VARIOUS PROCESSES 6**

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

**UNIT V FOOD HYGIENE 9**

Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training& Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course the students are expected to

**CO1** Be aware of the different methods applied to processing foods.

**CO2** Be able to understand the significance of food processing and the role of foodand beverage industries in the supply of foods.

**TEXT BOOKS/REFERENCES:**


1. Karnal, Marcus and D.B. Lund “Physical Principles of Food Preservation”. Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M “Food Preservation and Safety Principles and Practice”.Surbhi Publications, 2001.
3. Sivasankar, B. “Food Processing & Preservation”, Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, “Food Processing and Preservation”, Daya Publications, 2005.

**OPY352 IPR FOR PHARMA INDUSTRY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

**UNIT I INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS 9**

Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.

**UNIT II PATENTS 9**

Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non-obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.

**UNIT III PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS 9**

Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications – Justification for protection, National and International position.

**UNIT IV ENFORCEMENT AND PRACTICAL ASPECTS OF IPR 9**

Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.

**UNIT V INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY 9**

International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).

**TOTAL:45 PERIODS**

**TEXT BOOKS:**


1. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, “Intellectual Property Rights” Edu creation Publishing, New Delhi, 2017.
2. The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.
3. B.S. Rao, P.V. Appaji, “Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice”, 2015.


**REFERENCES:**


1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.
2. Basic Principles of patent law – Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005

3. S. Lakshmana Prabu, TNK. Suriyaprakash, “Intellectual Property Rights”, 1st ed., In Tech open access, Croatia, 2017.

**COURSE OUTCOMES**

The student will be able to

**CO1** Understand and differentiate the categories of intellectual property rights.

**CO2** Describe about patents and procedure for obtaining patents.

**CO3** Distinguish plant variety, traditional knowledge and geographical indications under IPR.

**CO4** Provide the information about the different enforcements and practical aspects involved in protection of IPR.

**CO5** Provide different organizations role and responsibilities in the protection of IPR in the international level.

**CO6** Understand the interrelationships between different Intellectual Property Rights on International Society

**CO’s- PO’s & PSO’s MAPPING**

| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **C1** | 3 | 3 | | 2 | | | | | 2 | 2 | | |
| **C2** | | 3 | 3 | | | | 2 | 2 | | | | |
| **C3** | 3 | 3 | | | | | 2 | 2 | | | | 1 |
| **C4** | | | | | 2 | | 3 | 3 | | 2 | 2 | |
| **C5** | | 3 | | | | | 3 | | | 2 | | 1 |
| **C6** | 3 | 2 | | | | 2 | 2 | | | | | 2 |

**OTT351 BASICS OF TEXTILE FINISHING L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.

**UNIT I RESIN FINISHING 9**

Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.

**UNIT II FLAME PROOF & WATERPROOF 9**

Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.

**UNIT III SOIL RELEASE AND ANTISTATIC FINISHES 9**

Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.

**UNIT IV MECHANICAL FINISHES 9**

Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.

**UNIT V STIFFENING AND SOFTENING 9**

Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand the

**CO1** Basics of Resin Finishing Process.

**CO2** Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.

**CO3** Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.

**CO4** Concept of Mechanical finishing.

**CO5** Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.

**TEXT BOOKS:**

1. V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai
2. Perkins, W.S., “Textile colouration and finishing”, Carolina Academic Press., U.K, ISBN: 0890898855.2004.

**REFERENCES:**

1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.

**OTT352 INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry

**UNIT I INTRODUCTION**

**9**

Scope of industrial engineering in apparel Industry, role of industrial engineers.

**Productivity:** Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.

**UNIT II WORK STUDY 9**

Definition, Purpose, Basic procedure and techniques of work-study.

**Work environment** – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment

**Material Handling** – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.

**UNIT III METHOD STUDY 9**

Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart

**MOTION STUDY:** Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.

**UNIT IV WORK MEASUREMENT 9**

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.

**UNIT V WORK STUDY APPLICATION 9**

Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of the course the student shall be able to understand

**CO1**: Fundamental concepts of industrial Engineering and productivity
**CO2**: Method study
**CO3**: Motion analysis
**CO4**: Work measurement and SAM
**CO5**: Ergonomics and its application to garment industry

**TEXTBOOKS:**


1. George Kanwaty, “Introduction to Work Study “, ILO, Geneva, 1996, ISBN: 9221071081 |ISBN-13: 9789221071082
2. Enrick N. L., “Time study manual for Textile industry”, Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 | ISBN-13: 9780898740448
3. Khanna O. P., and Sarup A., “Industrial Engineering and Management”, Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353


**REFERENCES**


1. Norberd Lloyd Enrick., “Industrial Engineering Manual for Textile Industry”, Wiley Eastern (P) Ltd., New Delhi, 1988, ISBN: 0882756311 | ISBN-13: 9780882756318
2. Chuter A. J., “Introduction to Clothing Production Management”, Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 | ISBN-13: 9780632039395
3. GordanaColovic., “Ergonomics in the garment industry”, Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 | ISBN-13: 9780857098221
4. Rajesh Bheda, “Managing Productivity in Apparel Industry “CBS Publishers & Distributors, 2008


**CO’s- PO’s & PSO’s MAPPING**

| Course Outcomes | Statement | Program Outcome | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO’ 6 | PO’ 7 | PO 8 | PO’ 9' | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | Fundamental concepts of industrial Engineering and productivity | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | - |
| CO2 | Method study | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | - |
| CO3 | Motion analysis | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | - |
| CO4 | Work measurement and SAM | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 | 1 | - |
| CO5 | Ergonomics and itsapplication to garment industry | 1 | 2 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 1 | - |
| | **Overall CO** | 1.2 | 2 | 3 | 3 | 2 | 1 | 1.2 | 2 | 2 | 1 | 2.4 | 2 | 1 | 1 | - |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OTT353 BASICS OF TEXTILE MANUFACTURE L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing

**UNIT I NATURAL FIBRES 9**

Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute – physical and chemical structure of these fibres..

**UNIT II REGENERATED AND SYNTHETIC FIBRES 9**

Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres – chemical structure, fibre forming polymers, production principles.

**UNIT III BASICS OF SPINNING 9**

Spinning – principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations

**UNIT IV BASICS OF WEAVING 9**

Woven fabric – warp, weft, weaving, path of warp; looms – classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,

**UNIT V BASICS OF KNITTING AND NONWOVEN 9**

Knitting – classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

On completion of this course, the students shall have the basic knowledge on

**CO1**: Classification of fibres and production of natural fibres
**CO2**: Regenerated and synthetic fibres
**CO3**: Yarn spinning
**CO4**: Weaving
**CO5**: Knitting and nonwoven

**TEXTBOOKS**


1. Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505
2. Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.
3. Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.


**REFERENCES:**


1. Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., “Clothing Technology: From Fibre to Fabric”, Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978-3808562253.
2. Wynne A., “Motivate Series-Textiles”, Maxmillan Publications, London, 1997.
3. Carr H. and Latham B., “The Technology of Clothing Manufacture” Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., “The Rieter Manual of Spinning, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.

4. Klein W., “The Rieter Manual of Spinning, Vol.2”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.
5. Klein W., “The Rieter Manual of Spinning, Vol.1-3”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.
6. Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., “Weaving: Machines, Mechanisms, Management”, Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.
7. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
8. Gohl E. P. G., “Textile Science”, CBS Publishers and distributors, 1987, ISBN 0582685958

**CO’s- PO’s & PSO’s MAPPING**

| Course Outcomes | Statement | Program Outcome | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO’ 6 | PO’ 7 | PO 8 | PO’ 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O 2 | PS O3 |
| CO1 | Classification of fibres and production of natural fibres | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO2 | Regenerated and synthetic fibres | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO3 | Yarn spinning | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO4 | Weaving | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| CO5 | Knitting and nonwoven | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| | Overall CO | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

## OPE351 INTRODUCTION TO PETROLEUM REFINING AND PETROCHEMICALS

**L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

The course is aimed to

- Gain knowledge about petroleum refining process and production of petrochemical products.

**UNIT I ORIGIN, FORMATION AND REFINING OF CRUDE OIL 9**

Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.

**UNIT II CRACKING 9**

Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen

**UNIT III REFORMING AND HYDROTREATING 9**

Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.

**UNIT IV INTRODUCTION TO PETROCHEMICALS 9**

Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylen e, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.

**UNIT V PRODUCTION OF PETROCHEMICALS 9**

Production of Petrochemicals like Dimethyl Terephathalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On the completion of the course students are expected to

**CO1:** Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.

**CO2:** Understand the insights of primary treatment processes to produce the precursors.

**CO3:** Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.

**CO4:** Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.

**CO5:** Understand the societal impact of petrochemicals and learn their manufacturing processes.

**CO6:** Learn the importance of optimization of process parameters for the high yield of petroleum products.

**TEXT BOOKS**


1. Nelson, W. L., “Petroleum Refinery Engineering”, 4th Edition., McGraw Hill, New York,1985.
2. Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons,1986.


**REFERENCES**


1. Bhaskara Rao, B. K., “Modern Petroleum Refining Processes”, 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2. Bhaskara Rao, B. K. “A Text on Petrochemicals”, 1st Edition, Khanna Publishers

**CPE334 ENERGY CONSERVATION AND MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

**UNIT I INTRODUCTION 9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II ELECTRICAL SYSTEMS 9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III THERMAL SYSTEMS 9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES 9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems –Cooling Towers – D.G. sets

**UNIT V ECONOMICS 9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students can able to analyze the energy data of industries.

**CO1**: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.
**CO2**: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.
**CO3**: Skills on combustion thermodynamics and kinetics.
**CO4**: Apply calculation and design tube still heaters.
**CO5**: Studied different heat treatment furnace.
**CO6**: Practical and theoretical knowledge burner design.

**TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at www.energy manager raining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

**REFERENCES:**


1. Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., “The Efficient Use of Energy” Butterworths, London, 1982
4. Turner. W.C., “Energy Management Hand book”, Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, “Energy Management”, Butterworths, London 1987


**OPT351 BASICS OF PLASTICS PROCESSING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

**UNIT I INTRODUCTION TO PLASTICS PROCESSING 9**

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

**UNIT II EXTRUSION 9**

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooing. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

**UNIT III INJECTION MOLDING 9**

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures-Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection

moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

**UNIT IV COMPRESSION AND TRANSFER MOLDING 9**

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould- positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

**UNIT V BLOW MOLDING, THERMOFORMING AND CASTING 9**

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

**TOTAL 45 PERIODS**

**COURSE OUTCOMES**

**CO1** Ability to find out the correlation between various processing techniques with product properties.

**CO2** Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.

**CO3** Acquire knowledge on additives for plastic compounding and methods employed for the same

**CO4** Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.

**CO5** Select an appropriate processing technique for the production of a plastic product

**REFERENCES**


1. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).
2. F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).
3. W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).
4. M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).
5. I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
6. D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
7. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
8. B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
9. D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).

**OEC351 SIGNALS AND SYSTEMS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform domain

**UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

**UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9**

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

**UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9**

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

**UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9**

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties

**UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9**

Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course, the student will be able to:**

**CO1**: determine if a given system is linear/causal/stable
**CO2**: determine the frequency components present in a deterministic signal
**CO3**: characterize continuous LTI systems in the time domain and frequency domain
**CO4**: characterize discrete LTI systems in the time domain and frequency domain
**CO5**: compute the output of an LTI system in the time and frequency domains

**TEXT BOOKS:**


1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002


**REFERENCES :**


1. B. P. Lathi, “Principles of Linear Systems and Signals”, 2nd Edition, Oxford, 2009.
2. M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw- Hill Education, 2018.
3. John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.

**CO's- PO's & PSO's MAPPING**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | - | 3 | - | 3 | 2 | - | - | - | - | | 3 | - | - | 1 |
| 2 | 3 | - | 3 | - | - | 2 | - | - | - | - | | 3 | - | 3 | - |
| 3 | 3 | 3 | - | - | 3 | 2 | - | - | - | - | | 3 | 2 | - | - |
| 4 | 3 | 3 | - | - | 3 | 2 | - | - | - | - | | 3 | - | 3 | 1 |
| 5 | 3 | 3 | - | 3 | 3 | 2 | - | - | - | - | | 3 | - | 3 | 1 |
| **Avgg** | **3** | **3** | **3** | **3** | **3** | **2** | **-** | **-** | **-** | **-** | **-** | **3** | **2** | **3** | **1** |

**OEC352 FUNDAMENTALS Of ELECTRONIC DEVICES AND CIRCUITS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of multi vibrators

**UNIT I SEMICONDUCTOR DEVICES 9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

**UNIT II AMPLIFIERS 9**

Load line, operating point, biasing methods for BJT and MOSFET**,** BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

**UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

**UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9**

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

**UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS 9**

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES :**

At the end of the course the students will be able to

**CO1**: Explain the structure and working operation of basic electronic devices.

**CO2**: Design and analyze amplifiers.

**CO3**: Analyze frequency response of BJT and MOSFET amplifiers
**CO4**: Design and analyze feedback amplifiers and oscillator principles.
**CO5**: Design and analyze power amplifiers and supply circuits

**TEXT BOOKS :**

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

**REFERENCES :**

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

**CO’s- PO’s & PSO’s MAPPING**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 3 | 3 | 3 | 2 | 1 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| 2 | 3 | 2 | 2 | 3 | 2 | 2 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| 3 | 3 | 3 | 3 | 2 | 1 | 2 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| 4 | 3 | 3 | 2 | 3 | 2 | 2 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| 5 | 3 | 2 | 3 | 2 | 2 | 1 | - | - | - | - | - | 1 | 2 | 1 | 1 |
| C | **3** | **3** | **3** | **3** | **2** | **2** | - | - | - | - | - | **1** | **2** | **1** | **1** |

**CBM348 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

**UNIT I BASICS OF PRODUCT DEVELOPMENT 9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

**UNIT II REQUIREMENTS AND SYSTEM DESIGN 9**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

**UNIT III DESIGN AND TESTING 9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

**UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to:

**CO1** Define, formulate, and analyze a problem

**CO2** Solve specific problems independently or as part of a team

**CO3** Gain knowledge of the Innovation & Product Development process in the Business Context

**CO4** Work independently as well as in teams

**CO5** Manage a project from start to finish

**TEXT BOOKS**:


1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.


**REFERENCES**:


1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”,

Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 3 | 1 | | | | | | 1 | | 1 | | | |
| 2 | 3 | 2 | 3 | 1 | | | | | | 1 | | 1 | | | |
| 3 | 3 | 2 | 3 | 1 | 1 | | | 1 | 1 | 1 | | 1 | | | |
| 4 | 3 | 2 | 3 | 1 | 1 | | | 1 | 1 | 1 | | 1 | | | |
| 5 | 3 | 2 | 3 | 1 | 1 | | | 1 | 1 | 1 | | 1 | | | |
| AVg. | | | | | | | | | | | | | | | |

**CBM333 ASSISTIVE TECHNOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**
**The student should be made to:**
- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

**UNIT I CARDIAC ASSIST DEVICES 9**
Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

**UNIT II HEMODIALYSERS 9**
Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

**UNIT III HEARING AIDS 9**
Anatomy of ear, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

**UNIT IV PROSTHETIC AND ORTHODIC DEVICES 9**
Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices.

**UNIT V RECENT TRENDS 9**
Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery
**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

**On successful completion of this course, the student will be able to**

**CO1**: Interpret the various mechanical techniques that will help in assisting the heart functions.

**CO2**: Describe the underlying principles of hemodialyzer machine.

**CO3**: Indicate the methodologies to assess the hearing loss.

**CO4**: Evaluate the types of assistive devices for mobilization.

**CO5**: Explain about TENS and biofeedback system.

**TEXT BOOKS**


1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.


**REFERENCES**


1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1stedition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1


**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 2 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 3 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 4 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| 5 | 3 | 1 | 1 | 1 | 1 | | | | | | | | | | |
| AVg. | | | | | | | | | | | | | | | |

**OMA352 OPERATIONS RESEARCH L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

This course will help the students to

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques to solve them.
- acquire the knowledge of optimality, formulation and computation of integer programming problems.
- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

**UNIT I LINEAR PROGRAMMING 9**

Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.

**UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEMS 9**

Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .

**UNIT III INTEGER PROGRAMMING 9**

Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

**UNIT IV DYNAMIC PROGRAMMING PROBLEMS 9**

Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .

**UNIT V NON - LINEAR PROGRAMMING PROBLEMS 9**

Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES :**

At the end of the course, students will be able to

**CO1** Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.

**CO2** analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.

**CO3** solve the integer programming problems using various methods.

**CO4** conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.

**CO5** determine the optimum solution for non linear programming problems.

**TEXT BOOKS:**


1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research – An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.


**REFERENCES :**


1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " ( Schaum's Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.L.td, New Delhi , 2014.
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

**CO's- PO's & PSO's MAPPING**

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO2** | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO3** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO4** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO5** | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **Avg** | 3 | 3 | 1 | 0.8 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |

**OMA353 ALGEBRA AND NUMBER THEORY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES :**

- To introduce the basic notions of groups, rings, fields which will then be used to solve related problems.
- To examine the key questions in the Theory of Numbers.
- To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

**UNIT I GROUPS AND RINGS 9**

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.

Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism.

**UNIT II FINITE FIELDS AND POLYNOMIALS 9**

Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.

**UNIT III DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS 9**

Division algorithm- Base-b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.

**UNIT IV DIOPHANTINE EQUATIONS AND CONGRUENCES 9**

Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2x2 linear systems.

**UNIT V CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS 9**

Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

**CO2** Demonstrate accurate and efficient use of advanced algebraic techniques.

**CO3** The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements proven by the text

**TEXT BOOKS :**

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5th Edition, New Delhi, 2007.
2. Thomas Koshy, “Elementary Number Theory with Applications”, Elsevier Publications , New Delhi , 2002.

**REFERENCES:**

1. San Ling and Chaoping Xing, “Coding Theory – A first Course”, Cambridge Publications, Cambridge, 2004.
2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., “An Introduction to Theory of Numbers” , John Wiley and Sons , Singapore, 2004.
3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2nd Edition ,2006.

**CO’s- PO’s & PSO’s MAPPING**

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | 2 | - | - | - | 2 | 1 | - | 1 | 2 | 2 | - | - | - |
| **CO2** | 3 | 3 | 1 | 1 | 3 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | - | - | - |
| **CO3** | 3 | 3 | 2 | 1 | 3 | 1 | 3 | 1 | 1 | 1 | 2 | 3 | - | - | - |
| **CO4** | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 3 | - | - | - |
| **CO5** | 2 | 2 | 1 | - | 3 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | - | - | - |
| **Avg** | 2.8 | 2.4 | 1.6 | 0.8 | 2.4 | 1 | 2.2 | 1 | 0.8 | 1 | 2.2 | 2.6 | - | - | - |

**OMA354** **LINEAR ALGEBRA** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**UNIT I MATRICES AND SYSTEM OF LINEAR EQUATIONS 9**

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

**UNIT II VECTOR SPACES 9**

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

**UNIT III LINEAR TRANSFORMATION 9**

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

**UNIT IV INNER PRODUCT SPACES 9**

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.

**UNIT V EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION 9**

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

After the completion of the course the student will be able to

**CO1** Test the consistency and solve system of linear equations.
**CO2** Find the basis and dimension of vector space.
**CO3** Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
**CO4** Find orthonormal basis of inner product space and find least square approximation.
**CO5** Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

**TEXT BOOKS**


1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5th Edition,2019.


**REFERENCES**


1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8th Edition, 2009.
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7th Edition, 2007.
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi, Reprint, 2010.
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4th Edition, 2005.
6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.

**CO's- PO's & PSO's MAPPING**

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **Avg** | 3 | 3 | 3 | 3 | 2.8 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |

**OBT352 BASICS OF MICROBIAL TECHNOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- Enable the Non-biological student's to understand about the basics of life science and their pro and cons for living organisms.

**UNIT I BASICS OF MICROBES AND ITS TYPES 9**

Introduction to microbes, existence of microbes, inventions of great scientist and history, types of microorganisms – Bacteria, Virus, Fungi.

**UNIT II MICROBIAL TECHNIQUES 9**

Sterilization – types – physical and chemical sterilization, Decontamination, Preservation methods, fermentation, Cultivation and growth of microbes, Diagnostic methods.

**UNIT III PATHOGENIC MICROBES 9**

Infectious Disease – Awareness, Causative agent, Prevention and control - Cholera, Dengu, Malaria, Diarrhea, Tuberculosis, Typhoid, Covid, HIV.

**UNIT IV BENEFICIAL MICROBES 9**

Applications of microbes – Clinical microbiology, agricultural microbiology, Food Microbiology, Environmental Microbiology, Animal Microbiology, Marine Microbiology.

**UNIT V PRODUCTS FROM MICROBES 9**

Fermentedproducts – Fermented Beverages, Curd, Cheese, Mushroom, Agricultural products – Biopesticide, Biofertilizers, Vermi compost, Pharmaceutical products - Antibiotics, Vaccines

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

At the end of the course the students will be able to
**CO1** Microbes and their types
**CO2** Cultivation of microbes
**CO3** Pathogens and control measures for safety
**CO4** Microbes in different industry for economy.

**TEXT BOOKS**


1. Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. Brown Publishers, 1993.
2. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.
3. Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 1996.


**OBT353 BASICS OF BIOMOLECULES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- The objective is to offer basic concepts of biochemistry to students with diverse background in life sciences including but not limited to the structure and function of various biomolecules and their metabolism.

**UNIT I CARBOHYDRATES 9**

Introduction to carbohydrate, classification, properties of monosaccharide, structural aspects of monosaccharides. Introduction to disaccharide (lactose, maltose, sucrose) and polysaccharide (Heparin, starch, and glycogen) biological function of carbohydrate.

**UNIT II LIPID AND FATTY ACIDS 9**

Introduction to lipid, occurrence, properties, classification of lipid. Importance of phospholipids, sphingolipid and glycerolipid. Biological function of lipid. Fatty acid, Introduction, Nomenclature and classification of fatty acid Essential and non essential fatty acids.

**UNIT III AMINO ACIDS AND PROTEIN. 9**

Introduction to amino acid, structure, classification of protein based on polarity. Introduction to protein, classification of protein based on solubility, shape, composition and Function. Peptide bond– Structure of peptide bond. Denauration – renaturation of protein, properties of protein. Introduction to lipoprotein, glycoprotein and nucleoprotein.Biological function of protein.

**UNIT IV NUCLEIC ACIDS 9**

Introduction to nucleic acid, Difference between nucleotide and nucleoside, composition of DNA & amp; RNA Structure of Nitrogen bases in DNA and RNA along with the nomenclature· DNA double helix (Watson and crick) model, types of DNA, RNA.

**UNIT V VITAMINS AND HORMONES 9**

Different types of vitamins, their diverse biochemical functions and deficiency related diseases. Overview of hormones. Hormone mediated signaling. Mechanism of action of steroid hormones, epinephrine, glucagons and insulin.Role of vitamins and hormones in metabolism; Hormonal disorders; Therapeutic uses ofvitamins and hormones.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** Students will learn about various kinds of biomolecules and their physiological role.

**CO2** Students will gain knowledge about various metabolic disorders and will help them to know the importance of various biomolecules in terms of disease correlation.

**TEXT BOOKS**


1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H.Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, “Biochemistry” 3rd Rev. Edition, Books & Allied (P) Ltd., 2006. 3. Rastogi, S.C. “Biochemistry” 2nd Edition, Tata McGraw-Hill, 2003.
3. Conn, E.E., etal., “Outlines of Biochemistry” 5th Edition, John Wiley & Sons, 1987.
4. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi.pp 693. John Wiley and Sons, New York. 1987.


**REFERENCES**


1. Berg, Jeremy M. et al. “Biochemsitry”, 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., etal “Harper’s Illustrated Biochemistry”, 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., “Biochemistry”, 4th Edition, John Wiley & Sons Inc., 2010.


**OBT354 FUNDAMENTALS OF CELL AND MOLECULAR BIOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**:

- To provide knowledge on the fundamentals of cell biology.
- To understand the signalling mechanisms.
- Understand basic principles of molecular biology at intracellular level to regulate growth, division and development.

**UNIT I INTRODUCTION TO CELL 9**

Cell, cell wall and Extracellular Matrix (ECM), composition, cellular dimensions, Evolution, Organisation, differentiation of prokaryotic and Eukaryotic cells, Virus, bacteria,cyanobacteria,
mycoplasma and prions.

**UNIT II CELL ORGANELLES 9**

Molecular organisation, biogenesis and functin Mitochondria, endoplasmic reticulam, golgi apparatus, plastids, chloroplast, leucoplast, centrosome, lysosome, ribosome, peroxisome, Nucleus and nucleolus. Endo membrane system, concept of compartmentalisation.

**UNIT III BIO-MEMBRANE TRANSPORT 9**

Physiochemical properties of cell membranes. Molecular constitute of membranes, asymmetrical organisation of lipids and proteins. Solute transport across membrane’s-fick’s law, simple diffusion, passive-facilitated diffusion, active transport- primary and secondary, group translocation, transport ATPases, membrane transport in bacteria and animals. Transportmechanism- mobile carriers and pores mechanisms. Transport by vesicle formation, endocytosis, exocytosis, cell respiration.

**UNIT IV CELL CYCLE 9**

Cell cycle- Cell division by mitosis and meosis, Comparision of meosis and mitosis, regulation of cell cycle, cell lysis, Cytokinesis, Cell signaling, Cell communication, Cell adhesion and Cell junction, cell cycle checkpoints.

**UNIT V CENTRAL DOGMA 9**

Overview of Central dogma DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments. Structure and function of mRNA, rRNA and tRNA. RNA synthesis: Initiation, elongation and termination of RNA synthesis Introduction to Genetic code- Steps in translation: Initiation, Elongation and termination of protein synthesis.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**:

**CO1** Understanding of cell at structural and functional level.
**CO2** Understand the central dogma of life and its significance.
**CO3** Comprehend the basic mechanisms of cell division.

**TEXTBOOKS:**

1. Cooper, G.M. and R.E. Hansman “The Cell: A Molecular Approach”, 8th Edition, Oxford University Press, 2018
2. Friefelder, David. “Molecular Biology.” Narosa Publications, 1999
3. Weaver, Robert F. “Molecular Biology” IInd Edition, Tata McGraw-Hill, 2003.

**REFERENCES:**

1. Lodish H, Berk A, MatsudairaP,Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.
2. Becker, W.M. etal., “The World of the Cell”, 9th Edition, Pearson Education, 2003.
3. Campbell, N.A., J.B. Recee and E.J. Simon “Essential Biology”, VIIrd Edition, Pearson International, 2007.
4. Alberts, Bruce etal., “Essential Cell Biology”, 4th Edition, W.W. Norton, 2013.

## OPEN ELECTIVE IV

**OHS352 PROJECT REPORT WRITING L T P C**
**3 0 0 3**

**COURSE OBJECTIVE**

The Course will enable Learners to,

- Understand the essentials of project writing.
- Perceive the difference between general writing and technical writing
- Assimilate the fundamental features of report writing.
- Understand the essential differences that exist between general and technical writing.
- Learn the structure of a technical and project report.

**UNIT I** **9**

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

**UNIT II** **9**

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

**UNIT III** **9**

Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

**UNIT IV** **9**

Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings – Limitations -Recommendations – Conclusion – Bibliography.

**UNIT V** **9**

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES**

By the end of the course, learners will be able to

**CO1** Write effective project reports.
**CO2** Use statistical tools with confidence.
**CO3** Explain the purpose and intension of the proposed project coherently and with clarity.
**CO4** Create writing texts to suit achieve the intended purpose.
**CO5** Master the art of writing winning proposals and projects.

**REFERENCES**


1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
3. Daniel Riordan - Technical Report Writing Today (1998)
   Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell
   Publishers.


**CO's- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | 1 | 1 | 1 | 1 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | - | - |
| 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 3 | 2 | 3 | - | - | - |
| 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 3 | - | - | - |
| 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| AVg. | 2.4 | 2.2 | 2.4 | 2.2 | 2 | 2.6 | 2.4 | 2.2 | 2.6 | 3 | 2.6 | 3 | - | - | - |

- 1-low, 2-medium, 3-high, '-"- no correlation
- **Note:** The average value of this course to be used for program articulation matrix.

**OMA355 ADVANCED NUMERICAL METHODS L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

**UNIT I ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM 9**

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

**UNIT II INTERPOLATION 9**

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

**UNIT III NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS 9**

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor - Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

**UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9**

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

**UNIT V FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 9**

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:

**CO1**: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;
**CO2**: understand the interpolation theory;
**CO3**: understand the concepts of numerical methods for ordinary differential equations;
**CO4**: demonstrate the understandings of common numerical methods for elliptic equations;

**CO5**: understand the concepts of numerical methods for time dependent partial differential equations

**TEXT BOOKS :**


1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.


**REFERENCES:**


1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., “Numerical Methods for Engineers”,4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., “Introductory Methods of Numerical Analysis”, 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.


**CO’s- PO’s & PSO’s MAPPING**

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |
| **Avg** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | - | - | - |

**OMA356** **RANDOM PROCESSES** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

**UNIT I RANDOM VARIABLES 9**

Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.

**UNIT II RANDOM PROCESSES 9**

Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.

**UNIT III SPECIAL RANDOM PROCESSES 9**

Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.

**UNIT IV CORRELATION AND SPECTRAL DENSITIES 9**

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

**UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS 9**

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1** Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.

**CO2** Apply the concept random processes in engineering disciplines.

**CO3** Understand and apply the concept of correlation and spectral densities.

**CO4** Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.

**CO5** Analyze the response of random inputs to linear time invariant systems.

**TEXT BOOKS**


1. Ibe, O.C.," Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4th Edition, New Delhi, 2002.


**REFERENCES**


1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes ", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3rd Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.

**CO's- PO's & PSO's MAPPING**

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **CO2** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **CO3** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **CO4** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **CO5** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |
| **Avg** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | - | - | - |

**OMA357 QUEUEING AND RELIABILITY MODELLING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

**UNIT I RANDOM PROCESSES 9**

Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.

**UNIT II MARKOVIAN QUEUEING MODELS 9**

Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms.

**UNIT III ADVANCED QUEUEING MODELS 9**

M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/$E_K$/1 as special cases – Series queues – Open Jackson networks.

**UNIT IV SYSTEM RELIABILITY 9**

Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.

**UNIT V MAINTAINABILITY AND AVAILABILITY 9**

Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1** Enable the students to apply the concept of random processes in engineering disciplines.

**CO2** Students acquire skills in analyzing various queueing models.

**CO3** Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner.
**CO4** Students can analyze reliability of the systems for various probability distributions.
**CO5** Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.

**TEXT BOOKS**


1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., “Fundamentals of Queueing Theory”, John Wiley and Sons, New York,2018.
2. Balagurusamy E., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.


**REFERENCES**


1. Medhi J, ”Stochastic models of Queueing Theory”, Academic Press, Elsevier, Amsterdam, 2003.
2. Taha, H.A., "Operations Research", 9th Edition, Pearson India Education Services, Delhi, 2016.
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
4. Govil A.K., “Reliability Engineering”, Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.


**CO’s- PO’s & PSO’s MAPPING**

| | PO 01 | PO 02 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO2** | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO3** | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO4** | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **CO5** | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |
| **Avg** | 3 | 3 | 1.4 | 0.8 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | - | - | - |

## OMG354 PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**:

- To know the basic concept and function of Production and Operation Management for entrepreneurship.
- To understand the Production process and planning.
- To understand the Production and Operations Management Control for business owners.

**UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9**

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research

**UNIT II PRODUCTION & OPERATION SYSTEMS 9**

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

**UNIT III PRODUCTION & OPERATIONS PLANNING 9**

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

**UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9**

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters –- Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

**UNIT V CONTROLING PRODUCTION & OPERATIONS MANAGEMENT 9**

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart ) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES**

Upon completion of this course the learners will be able :

**CO1** To understand the basics and functions of Production and Operation Management for business owners.

**CO2** To learn about the Production & Operation Systems.

**CO3** To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.

**CO4** To known about the Production & Operations Management Processes in organisations.

**CO5** To comprehend the techniques of controlling , Production and Operations in industries.

**REFERENCES**

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.

3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.
6. Chary S.N, Production and Operations Management, TMH Publications, 2010.
7. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.

**OMG355 MULTIVARIATE DATA ANALYSIS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVE:**

- To know various multivariate data analysis techniques for business research.

**UNIT I INTRODUCTION** **9**

Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation.

**UNIT II PREPARING FOR MULTIVARIATE ANALYSIS** **9**

Conceptualization of research model with variables, collection of data –-Approaches for dealing with missing data – Testing the assumptions of multivariate analysis.

**UNIT III MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS** **9**

Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. -Approaches to factor analysis – interpretation of results.

**UNIT IV LATENT VARIABLE TECHNIQUES** **9**

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

**UNIT V ADVANCED MULTIVARIATE TECHNIQUES** **9**

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES :**

**CO1** Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.

**CO2** Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.

**CO3** Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.

**CO4** Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.

**CO5** Make better business decisions by using advanced techniques in data analytics. ‘

**REFERENCES:**
1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.
2. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012.
3. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi, 2005.
4. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

**OME352 ADDITIVE MANUFACTURING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes.
- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

**UNIT I INTRODUCTION 9**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

**UNIT II VAT POLYMERIZATION AND MATERIAL EXTRUSION 9**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.

Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

**UNIT III POWDER BED FUSION AND BINDER JETTING 9**

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications.

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.

**UNIT IV MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION 9**

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.

Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery -Materials -Benefits -Applications.

**UNIT V SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY 9**

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation.

Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of this course students shall be able to:

**CO1**: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.

**CO2**: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.

**CO3**: Elaborate the process and applications of powder bed fusion and binder jetting.

**CO4**: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.

**CO5**: Acquire knowledge on sheet lamination and direct write technology.

**TEXT BOOKS:**


1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.


**REFERENCES:**


1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

**CME343 NEW PRODUCT DEVELOPMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To introduce the fundamental concepts of the new product development
- To develop material specifications, analysis and process.
- To Learn the Feasibility Studies & reporting of new product development.
- To study the New product qualification and Market Survey on similar products of new product development
- To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**UNIT I FUNDAMENTALS OF NPD 9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

**UNIT II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS 9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

**UNIT III ESSENTIALS OF NPD 9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

**UNIT IV CRITERIONS OF NPD 9**

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

**UNIT V REPORTING & FORWARD-THINKING OF NPD 9**

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students would be able to

**CO1** Discuss fundamental concepts and customer specific requirements of the New Product development

**CO2** Discuss the Material specification standards, analysis and fabrication, manufacturing process Develop Feasibility Studies & reporting of New Product development

**CO3** Analyzing the New product qualification and Market Survey on similar products of new product development

**CO4** Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

**TEXT BOOKS:**

Product Development – Sten Jonsson

Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

**REFERENCES:**

Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark

Change by Design

Toyota Product Development System – James Morgan & Jeffrey K. Liker

Winning at New Products – Robert Brands 3rd Edition

Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar

**CO's- PO's & PSO's MAPPING**

| CO | PO | | | | | | | | | | | | PSO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 1 | 1 | 3 | 1 | | | | 1 | 1 | | | 1 | 1 | 3 | 2 |
| 2 | 1 | 1 | 3 | 1 | | | | 1 | 1 | | | 1 | 1 | 3 | 2 |
| 3 | 1 | 1 | 3 | 1 | | | | 1 | 1 | | | 1 | 1 | 3 | 2 |
| 4 | 1 | 1 | 3 | 1 | | | | 1 | 1 | | | 1 | 1 | 3 | 2 |
| 5 | 1 | 1 | 3 | 1 | | | | 1 | 1 | | | 1 | 1 | 3 | 2 |
| Low (1) ; Medium (2) ; High (3) | | | | | | | | | | | | | | | |

**OME355 INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

**UNIT I UI/UX 9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology

and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives

**UNIT II APP DEVELOPMENT 9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

**UNIT III INDUSTRIAL DESIGN 9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

**UNIT IV MECHANICAL RAPID PROTOTYPING 9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

**UNIT V ELECTRONIC RAPID PROTOTYPING 9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**At the end of the course, learners will be able to:**

**CO1** Create quick UI/UX prototypes for customer needs
**CO2** Develop web application to test product traction / product feature
**CO3** Develop 3D models for prototyping various product ideas
**CO4** Built prototypes using Tools and Techniques in a quick iterative methodology

**TEXT BOOKS**


1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)


**REFERENCES**


1. https://www.adobe.com/products/xd/learn/get-star ted.html
2. https://developer.android.com/guide
3. https://help.autodesk.com/view/fusion360/ENU/courses/
4. https://help.prusa3d.com/en/categor y/prusaslicer_204

**MF3010 MICRO AND PRECISION ENGINEERING LT P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

At the end of this course the student should be able to

- Learn about the precision machine tools
- Learn about the macro and micro components.
- Understand handling and operating of the precision machine tools.
- Learn to work with miniature models of existing machine tools/robots and other instruments.
- Learn metrology for micro system

**UNIT I INTRODUCTION TO MICROSYSTEMS 9**

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

**UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS: 9**

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

**UNIT III INTRODUCTION TO PRECISION ENGINEERING 9**

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

**UNIT IV PRECISION MACHINING PROCESSES 9**

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

**UNIT V METROLOGY FOR MICRO SYSTEMS 9**

Metrology for micro systems - Surface integrity and its characterization.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon the completion of this course the students will be able to

**CO1** Select suitable precision machine tools and operate
**CO2** Apply the macro and micro components for fabrication of micro systems.
**CO3** Apply suitable machining process
**CO4** Able to work with miniature models of existing machine tools/robots and other instruments.
**CO5** Apply metrology for micro system

**TEXT BOOKS:**


1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017


**REFERENCES:**


1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing,

Philadelphia PA, 1994.
4. Murthy.R.L, —Precision Engineering in Manufacturing‖, New Age International, New Delhi, 2005

**OMF354 COST MANAGEMENT OF ENGINEERING PROJECTS L T PC**
**3 0 0 3**

**COURSE OBJECTIVES:**

Summarize the costing concepts and their role in decision making
Infer the project management concepts and their various aspects in selection
Interpret costing concepts with project execution
Develop knowledge of costing techniques in service sector and various budgetary control techniques
Illustrate with quantitative techniques in cost management

**UNIT I INTRODUCTION TO COSTING CONCEPTS 9**

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

**UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

**UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9**

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

**UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

**UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9**

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1**: Understand the costing concepts and their role in decision making.

**CO2**: Understand the project management concepts and their various aspects in selection.

**CO3**: Interpret costing concepts with project execution.

**CO4**: Gain knowledge of costing techniques in service sector and various budgetary control techniques.

**CO5**: Become familiar with quantitative techniques in cost management.

**TEXT BOOKS:**


1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.
2. Albert Lester ,Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.


**REFERENCES:**


1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.


**AU3002 BATTERIES AND MANAGEMENT SYSTEM L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

The objective of this course is to make the students

- To understand the working and characteristics of different types of batteries and their management .

**UNIT I ADVANCED BATTERIES 9**

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics-SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. *NCR18650B* specifications.

**UNIT II BATTERY PACK 9**

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging.

**UNITIII BATTERY MODELLING 9**

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models-Introduction. Battery Modelling software/simulation frameworks

**UNIT IV BATTERY STATE ESTIMATION 9**

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

**UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS 9**

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray- CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model-Based Design.

**TOTAL:45 PERIODS**

## COURSE OUTCOMES:

At the end of this course, students will be able to

**CO1** Acquire knowledge of different Li-ion Batteries performance.
**CO2** Design a Battery Pack and make related calculations.
**CO3** Demonstrate a BatteryModel or Simulation.
**CO4** Estimate State-of-Charges in a Battery Pack.
**CO5** Approach different BMS architectures during real world usage.

## TEXT BOOKS


1. Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles’’, Wiley, 2015.
2. Davide Andrea ,“Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010.


## REFERENCES


1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper
2. Panasonic *NCR18650B- DataSheet*
3. bq76PL536A-Q1- IC DataSheet
4. CC2662R-Q1- IC DataSheet

**AU3008 SENSORS AND ACTUATORS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

**UNIT I INTRODUCTION TO MEASUREMENTS AND SENSORS 9**

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards-Calibration methods- Classification of errors- Error analysis- Limiting error-Probable error-Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers-Dynamic characteristics of first and second order transducers for standard test inputs.

**UNIT II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9**

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers:- EI pick up and LVDT

**UNIT III VARIABLE AND OTHER SPECIAL SENSORS 9**

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

**UNIT IV AUTOMOTIVE ACTUATORS 9**

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines-Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

**UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9**

Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, the student will be able to

**CO1** List common types of sensor and actuators used in vehicles.

**CO2** Design measuring equipment's for the measurement of pressure force, temperature and flow.

**CO3** Generate new ideas in designing the sensors and actuators for automotive application

**CO4** Understand the operation of thesensors, actuators and electronic control.

**CO5** Design temperature control actuators for vehicles.

**TEXT BOOKS:**


1. Doebelin's Measurement Systems: 7th Edition (SIE),Ernest O. Doebelin DhaneshN.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001

3. William Kimberley," Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

**REFERENCES:**

1. James D Halderman, " Automotive Electrical and Electronics" , Prentice Hall, USA, 2013
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.
3. Patranabis.D, " Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd,2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

| OAS353 | SPACE VEHICLES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

**UNIT I FUNDAMENTAL ASPECTS 9**

Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity.

**UNIT II SELECTION OF ROCKET PROPULSION SYSTEMS 9**

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.

**UNIT III ENGINE SYSTEMS, CONTROLS, AND INTEGRATION 9**

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

**UNIT IV THRUST VECTOR CONTROL 9**

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

**UNIT V NOSE CONE CONFIGURATION 9**

Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1** Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.

**CO2** Apply knowledge in selecting the appropriate rocket propulsion systems.

**CO3** interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.

**CO4** Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.

**CO5** Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

| OIM352 | MANAGEMENT SCIENCE | L T P C<br>3 0 0 3 |
|---|---|---|

COURSE OBJECTIVES:

Of this course are

- To introduce fundamental concepts of management and organization to students.
- Toi mpart knowledge to students on various aspects of marketing, quality control and marketing strategies.
- To make students familiarize with the concepts of human resources management.
- To acquaint students with the concepts of project management and cost analysis.
- To make students familiarize with the concepts of planning process and business strategies.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION 9

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's TheoryX and TheoryY-HertzbergTwoFactorTheoryofMotivation-LeadershipStyles,Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation.

UNIT II OPERATIONS AND MARKETING MANAGEMENT 9

Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production),Work Study - Basic procedure involved in Method Study and Work Measurement – Business Process Reengineering (BPR)-Statistical Quality Control:control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ,ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System,Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on ProductLifeCycle.

UNIT III HUMAN RESOURCES MANAGEMENT 9

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager:Manpower planning, Recruitment, Selection, TrainingandDevelopment,WageandSalaryAdministration,Promotion,Transfer,PerformanceAppraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating -Capability Maturity Model (CMM)Levels.

UNIT IV PROJECT MANAGEMENT 9

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method(CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis,Project Crashing (simple problems).

UNITV STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy

Formulation and Implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Cardas Contemporary Business Strategies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, Students will be able to

**CO1**:`Plan an organizational structure for a given context in the organization to carryout production operations through Work-study.

**CO2**: Survey the markets, customers and competition better and price the given products appropriatey

**CO3**:Ensure quality for a given product or service.

**CO4**:Plan, schedule and control projects through PERTandCPM.

**CO5**:Evaluate strategyforabusiness orserviceorganisation.

**TEXTBOOKS:**


1. KanishkaBedi, Production and Operations Management,Oxford University Press,2007.
2. Stoner,Freeman, Gilbert, Management,6th Ed, PearsonEducation,NewDelhi,2004.
3. ThomasN.Duening & John M.Ivancevich Management Principles and Guidelines, Biztantra, 2007.
4. P.VijayKumar,N.Appa Rao and Ashnab, Chnalill, CengageLearning India,2012.


**REFERECES:**


1. KotlerPhilip and KellerKevinLane: Marketing Management, Pearson, 2012.
2. KoontzandWeihrich: Essentials of Management, McGrawHill, 2012.
3. Lawrence RJauch,R.Guptaand William F. Glueck: Business Policy and Strategic Management Science,McGrawHill,2012.
4. SamuelC.Certo:Modern Management,2012.


## CO's- PO's & PSO's MAPPING

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
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| AVg. | 3 | | | 2.6 | 2.8 | 2.6 | | 2.6 | 2.6 | 2.4 | | | 2 | 2 | 2.5 |

OIM353 PRODUCTION PLANNING AND CONTROL L T P C
3 0 0 3

**COURSE OBJECTIVES:**

- To understand the concept of production planning and control act work study,
- To apply the concept of product planning,
- To analyze the production scheduling,
- To apply the Inventory Control concepts.
- To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**UNIT I INTRODUCTION** **9**

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

**UNIT II WORK STUDY 9**

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

**UNIT III PRODUCT PLANNING AND PROCESS PLANNING 9**

Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.

**UNIT IV PRODUCTION SCHEDULING 9**

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling- Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9**

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course,

**CO1**:The students can able to prepare production planning and control act work study,
**CO2**:The students can able to prepare product planning,
**CO3**:The students can able to prepare production scheduling,
**CO4**:The students can able to prepare Inventory Control.
**CO5**:They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

**TEXT BOOKS:**

1. James. B. Dilworth, ”Operations management – Design, Planning and Control for manufacturing and services” Mcgraw Hill International edition 1992.
2. Martand Telsang, “Industrial Engineering and Production Management”, First edition, S. Chand and Company, 2000.

**REFERENCES**


1. Chary. S.N., “Theory and Problems in Production & Operations Management”, Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production / Operations Management”, 8th Edition John Wiley and Sons, 2000
3. Jain. K.C. & Aggarwal. L.N., “Production Planning Control and Industrial Management”, Khanna Publishers, 1990
4. Kanishka Bedi, “Production and Operations management”, 2nd Edition, Oxford university press, 2007.
5. Melynk, Denzler, “ Operations management – A value driven approach” Irwin Mcgraw hill.
6. Norman Gaither, G. Frazier, “Operations Management” 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, “Elements of Production Planning and Control”, Universal Book Corpn.1984
8. Upendra Kachru, “ Production and Operations Management – Text and cases” 1st Edition, Excel books 2007


**CO’s- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
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| AVg. | 3 | 2.6 | 2 | | 3 | | 1 | | | | 1 | | 3 | 1.8 | |

**OIE353 OPERATIONS MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

**UNIT I INTRODUCTION TO OPERATIONS MANAGEMENT 9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy – Strategic fit , framework; Supply Chain Management

**UNIT II FORECASTING, CAPACITY AND FACILITY DESIGN 9**

Demand Forecasting – Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

**UNIT III DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS 9**

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

**UNIT IV MATERIALS MANAGEMENT 9**

Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.

**UNIT V SCHEDULING AND PROJECT MANAGEMENT 9**

Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson"sAlgorithm – Gantt charts; personnel scheduling in services.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1:** The students will appreciate the role of Production and Operations management in enabling and enhancing a firm's competitive advantages in the dynamic business environment.

**CO2:** The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.

**CO3:** The students will able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.

**CO4:** The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.

**CO5:** The students will be able to apply scheduling and Lean Concepts for improving System Performance.

**TEXT BOOKS**

1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12th Edition, 2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.

**REFERENCES**


1. William J Stevenson, Operations Management, Tata McGraw Hill, 9th Edition, 2009.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.
7. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.


**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
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| 4 | | 3 | 3 | 3 | | | | | | | | | 2 | 3 | |
| 5 | | | 3 | 2 | | | | | | | | | | | |
| AVg. | 3 | 2.6 | 3 | 2.6 | | | | | | | | 2 | 2 | 3 | 3 |

**OSF352** **INDUSTRIAL HYGIENE** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety.
- Compare and contrast the roles of environmental and biological monitoring in work health and safety
- Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates
- Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures
- Provide high-level advice on managing and controlling noise and noise-related hazards

**UNIT I : INTRODUCTION AND SCOPE** **9**

Occupational Health and Environmental Safety Management - Principles practices. Comm on Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

**UNIT II : MONITORING FOR SAFETY, HEALTH & ENVIRONMENT** **9**

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

**UNIT III : OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION 9**

Element of training cycle, Assessment of needs.Techniques of training, design and development of training programs.Training methods and strategies types of training.Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit .

**UNIT IV : OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT 9**

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

**UNIT V : INDUSTRIAL HAZARDS** **9**

i. Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise , Different air pollutants in industries, Effect of different gases and particulate matter ,acid fumes ,smoke, fog on human health, Vibration: effects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Students able to

**CO1**: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems

**CO2**: Specify designs that avoid occupation related injuries

**CO3**: Define and apply the principles of work design, motion economy, and work environment design.

**CO4**: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.

**CO5**: Acknowledge the impact of workplace design and environment on productivity

**TEXT BOOKS:**

1. R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York .

**REFERENCES:**


1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2,
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth-Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).


**CO's- PO's & PSO's MAPPING**

| | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO's** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| 1 | 2 | | 2 | | 2 | - | - | - | - | - | 2 | - | - | - | - |
| 2 | - | | 2 | | - | - | 1 | - | - | - | 1 | - | - | - | - |
| 3 | - | | - | | 2 | - | - | - | - | - | 2 | - | - | - | - |
| 4 | - | | - | | - | - | - | - | 2 | - | 3 | - | - | - | - |
| 5 | - | | - | | - | - | - | 1 | - | - | - | - | - | - | - |
| AVg. | 2 | - | 2 | - | - | - | 1 | 1 | 2 | - | 2 | | - | - | - |

**OSF353 CHEMICAL PROCESS SAFETY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

**UNIT I SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES 9**

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

**UNIT II CHEMICAL REACTION HAZARDS 9**

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

**UNIT III SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS 9**

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

**UNIT IV SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS 9**

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

**UNIT V SAFETY AND ANALYSIS 9**

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Students able to**

**CO1** Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.

**CO2** Develop thorough knowledge about safety in the operation of chemical plants.

**CO3** Apply the principles of safety in the storage and handling of gases.

**CO4** Identify the conditions that lead to reaction hazards and adopt measures to prevent them.

**CO5** Develop thorough knowledge about

**TEXT BOOK**


1 David A Crowl& Joseph F Louvar,"Chemical Process safety", Pearson publication, 3rd Edition,2014

2 Maurice Jones .A,"Fire Protection Systems,2nd edition, Jones & Bartlett Publishers,2015


**REFERENCES:**


1. Ralph King and Ron Hirst,"King´s safety in the process industries", Arnold, London, 1998.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.

3. National Safety Council," Accident prevention manual for industrial operations". Chicago, 1982.
4. Lewis, Richard. J., Sr,"Sax´s dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.
5. Roy E Sanders, "Chemical Process Safety",3rd Edition, Gulf professional publishing, 2006

**CO's- PO's & PSO's MAPPING**

| | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO's** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| **1** | 2 | 3 | - | - | - | 1 | - | - | 1 | - | - | - | 2 | - | - |
| **2** | - | | | 2 | - | - | - | - | 1 | - | | - | - | 2 | - |
| **3** | - | 3 | | 1 | - | - | - | 2 | - | - | 1 | - | - | - | - |
| **4** | - | 2 | - | | - | 1 | - | - | 1 | - | | - | - | - | 2 |
| **5** | - | 2 | 3 | | - | - | - | 1 | - | - | 1 | - | - | - | - |
| **AVg.** | 2 | 2.5 | 3 | 1.5 | - | 1 | - | 1.5 | 1 | - | 1 | | 2 | 2 | 2 |

**OML352 ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the importance of various materials used in electrical, electronics and
- magnetic applications
- Acquiring knowledge on the properties of electrical, electronics and magnetic materials.
- Gaining knowledge on the selection of suitable materials for the given application
- Knowing the fundamental concepts in Semiconducting materials
- Getting equipped with the materials used in optical and optoelectronic applications.

**UNIT I DIELECTRIC MATERIALS 9**

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

**UNIT II MAGNETIC MATERIALS 9**

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

**UNIT III SEMICONDUCTOR MATERIALS 9**

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

**UNIT IV MATERIALS FOR ELECTRICAL APPLICATIONS 9**

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

**UNIT V OPTICAL AND OPTOELECTRONIC MATERIALS 9**

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

**CO1** Understand various types of dielectric materials, their properties in various conditions.
**CO2** Evaluate magnetic materials and their behavior.
**CO3** Evaluate semiconductor materials and technologies.
**CO4** Select suitable materials for electrical engineering applications.
**CO5** Identify right material for optical and optoelectronic applications

**TEXT BOOKS:**


1. Pradeep Fulay, “Electronic, Magnetic and Optical materials”, CRC Press, taylor and Francis, 2 nd illustrated edition, 2017.
2. “R K Rajput”, “A course in Electrical Engineering Materials”, Laxmi Publications, 2009.


**REFERENCES:**


1. T K Basak, “A course in Electrical Engineering Materials”, New Age Science Publications, 2009
2. TTTI Madras, “Electrical Engineering Materials”, McGraw Hill Education, 2004.
3. Adrianus J. Dekker, “Electrical Engineering Materials”, PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta “A course in Electrical Engineering Materials”, Dhanpat Rai & Sons, 2011.
5. C. Kittel, “Introduction to Solid State Physics”, 7th Edition, John Wiley & Sons,Singapore, (2006).


**CO’s- PO’s & PSO’s MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 3 | 2 | 2 | 3 | | | | | | | | 2 | 2 | 2 | 1 |
| C02 | 3 | 1 | 2 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| C03 | 3 | 2 | 1 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| CO4 | 3 | 2 | 1 | 2 | | | | | | | | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| Avg | 3 | 1.8 | 1.6 | 2.2 | | | | | | | | 2 | 2 | 2 | 1.2 |

**OML353 NANOMATERIALS AND APPLICATIONS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

**UNIT I NANOMATERIALS 9**

Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.

**UNIT II THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS 9**

Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.

**UNIT III PROCESSING 9**

Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.

**UNIT IV STRUCTURAL CHARACTERISTICS 9**

Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis

**UNIT V APPLICATIONS 9**

Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to

**CO1** Evaluate nanomaterials and understand the different types of nanomaterials
**CO2** Recognise the effects of dimensionality of materials on the properties
**CO3** Process different nanomaterials and use them in engineering applications
**CO4** Use appropriate techniques for characterising nanomaterials
**CO5** Identify and use different nanomaterials for applications in different engineering fields.

**TEXT BOOKS:**

1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd edition, 2007.

2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.

**REFERENCES:**


1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000
5. Gutkin Y., Ovid'ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004


**CO's- PO's & PSO's MAPPING**

| | PO 1 | PO2 | PO3 | PO4 | PO 5 | PO 6 | PO 7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 2 | 2 | 2 | 3 | | | | | | | | 2 | 1 | 2 | |
| C02 | 3 | 1 | 2 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| C03 | 3 | 2 | 1 | 2 | | | | | | | | 2 | 2 | 2 | |
| CO4 | 3 | 1 | | 2 | | | | | | | | 2 | 2 | 2 | 2 |
| CO5 | 3 | 2 | 2 | 2 | | | | | | | | 2 | 2 | 2 | 1 |
| Avg | 2.8 | 1.6 | 1.7 | 2.2 | | | | | | | | 2 | 1.8 | 2 | 1.3 |

**OMR352 HYDRAULICS AND PNEUMATICS L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- To knowledge on fluid power principles and working of hydraulic pumps
- To obtain the knowledge in hydraulic actuators and control components
- To understand the basics in hydraulic circuits and systems
- To obtain the knowledge in pneumatic and electro pneumatic systems
- To apply the concepts to solve the trouble shooting

**UNIT I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

**UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

**UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

**UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9**

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

**UNIT V TROUBLE SHOOTING AND APPLICATIONS 9**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1**: Analyze the methods in fluid power principles and working of hydraulic pumps
**CO2**: Recognize the concepts in hydraulic actuators and control components
**CO3**: Obtain the knowledge in basics of hydraulic circuits and systems
**CO4**: Know about the basics concept in pneumatic and electro pneumatic systems
**CO5**: Apply the concepts to solve the trouble shooting hydraulic and pneumatics

**TEXT BOOKS**


1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009.
2. James A. Sullivan, “Fluid Power Theory and Applications”, Fourth Edition, Prentice Hall, 1997.


**REFERENCES**


1. Shanmugasundaram.K, “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.
2. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance”, Tata McG Raw Hill, 2001.
3. Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGRaw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, “Basic Fluid Power”, Prentice Hall, 1987
5. Srinivasan. R, “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008
6. Joshi.P, Pneumatic Control”, Wiley India, 2008.
7. Jagadeesha T, “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.


**CO’s- PO’s & PSO’s MAPPING**

| COs/POs & PSOs | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO2 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO4 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO5 | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| CO/PO & PSO Average | 3 | 2 | 1 | | 2 | 2 | | | | | | 1 | 2 | 2 | 1 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**OMR353** **SENSORS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics.
- To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors.
- To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors.
- To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.
- To familiarize students with different signal conditioning circuits design and data acquisition system.

**UNIT I SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES 9**

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

**UNIT II DISPLACEMENT, PROXIMITY AND RANGING SENSORS 9**

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

**UNIT III FORCE, MAGNETIC AND HEADING SENSORS 9**

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers.

**UNIT IV OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS 9**

Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.

**UNIT V SIGNAL CONDITIONING 9**

Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1**: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the densor response.

**CO2**: Analyze and select suitable sensor for displacement, proximity and range measurement.

**CO3**: Analyze and select suitable sensor for force, magnetic field, speed, position and direction
measurement.

**CO4**: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.

**CO5**: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.

## TEXT BOOKS


1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.


## REFERENCES


1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.


## CO’s- PO’s & PSO’s MAPPING

| COs/POs & PSOs | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | 3 | 3 | 2 | | | | | | | | 1 | 2 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | 3 | 2 | 1 |
| CO5 | 3 | 3 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | 3 | 2 | 1 |
| CO/PO & PSO Average | 3 | 3 | 2 | 0.8 | 0.8 | 0.8 | | | | | 0.8 | 2 | 3 | 2 | 1 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**ORA352 CONCEPTS IN MOBILE ROBOTS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To introduce mobile robotic technology and its types in detail.
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors.
- To acquaint the localization strategies and mapping technique for mobile robot.
- To aware the collaborative mobile robotics in task planning, navigation and intelligence.

**UNIT I INTRODUCTION TO MOBILE ROBOTICS 9**

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

**UNIT II KINEMATICS 9**

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – **Manoeuvrability** – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

**UNIT III PERCEPTION 9**

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

**UNIT IV LOCALIZATION 9**

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

**UNIT V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9**

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to:
**CO1:** Evaluate the appropriate mobile robots for the desired application.
**CO2:** Create the kinematics for given wheeled and legged robot.
**CO3:**Analyse the sensors for the intelligence of mobile robotics.
**CO4:** Create the localization strategies and mapping technique for mobile robot.
**CO5:** Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.

**TEXTBOOK**

1. Roland Siegwart and IllahR.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.

**REFERENCES:**


1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015.
3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017.
4. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.


**MV3501 MARINE PROPULSION L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To impart knowledge on basics of propulsion system and ship dynamic movements
- To educate them on basic layout and propulsion equipment’s
- To impart basic knowledge on performance of the ship
- To impart basic knowledge on Ship propeller and its types
- To impart knowledge on ship rudder and its types

**UNIT I BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS 9**

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

**UNIT II SHIPS MOVEMENTS AND SHIP STABILIZATION 9**

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

**UNIT III SHIPS SPEED AND ITS PERFORMANCE 9**

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation’s, ship turning radius.

**UNIT IV BASICS OF PROPELLER 9**

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

**UNIT V BASICS OF RUDDER 9**

Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits

of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1**: Explain the basics of propulsion system and ship dynamic movements
**CO2**: Familiarize with various components assisting ship stabilization.
**CO3**: Demonstrate the performance of the ship.
**CO4**: Classify the Propeller and its types, Materials etc.
**CO5**: Categories the Rudder and its types, design criteria of rudder.

**TEXT BOOKS:**

1. GP. Ghose, "Basic Ship propulsion",2015
2. E.A. Stokoe "Reeds Ship construction for marine engineers", Vol. 5,2010
3. E.A. Stokoe, "Reeds Naval architecture for the marine engineers",4th Edition,2009

**REFERENCES:**

1. DJ Eyers and GJ Bruse, "Ship Construction", 7th Edition, 2006.
2. KJ Rawson and EC Tupper, "Basic Ship theory I" Vol. 1,5th Edition,2001.

## CO's- PO's & PSO's MAPPING

| CO | PO | | | | | | | | | | | | PSO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 | PS O4 |
| 1 | 1 | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | | 1 | | 1 |
| 2 | 1 | 1 | 1 | | | | | | | | | | | 1 | | 1 |
| 3 | 1 | | | 1 | 1 | | | | 1 | 1 | 1 | | 1 | 1 | | 1 |
| 4 | 1 | | 1 | 1 | | | | | | | | | | 1 | | 1 |
| 5 | 1 | | 1 | 1 | | | | | | | | | | 1 | | 1 |
| Avg | 5/5=1 | 2/2=1 | 4/4=1 | 4/4=1 | 2/2=1 | | | | 1/1=1 | 1/1=1 | 2/2=1 | 1/1=1 | 1/1=1 | 5/5=1 | | 5/5=1 |

**OMV351 MARINE MERCHANT VESSELS LT P C 3 0 0 3**

**COURSE OBJECTIVES:**

**At the end of the course, students are expected to acquire**

- Knowledge on basics of Hydrostatics
- Familiarization on types of merchant ships
- Knowledge on Shipbuilding Materials
- Knowledge on marine propeller and rudder
- Awareness on governing bodies in shipping industry

**UNIT I INTRODUCTION to HYDROSTATICS 9**

Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.

**UNIT II TYPES OF SHIP 10**

General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gascarriers - Chemical tankers - Passenger ships

**UNIT III SHIPBUILDING MATERIALS 9**

Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites

**UNIT IV MARINE PROPELLER AND RUDDER 8**

Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller

**UNIT V GOVERNING BODIES FOR SHIPPING INDUSTRY 9**

Role of **IMO** (International Maritime Organization), **SOLAS** (International Convention for the Safety of Life at Sea), **MARPOL** (International Convention for the Prevention of Pollution from Ships ) , **MLC** (Maritime Labour Convention), **STCW 2010** (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of this course, students would**

**CO1** Acquire Knowledge on floatation of ships

**CO2** Acquire Knowledge on features of various ships

**CO3** Acquire Knowledge of Shipbuilding Materials

**CO4** Acquire Knowledge to identify the different types of marine propeller and rudder

**CO5** Understand the Roles and responsibilities of governing bodies

**TEXT BOOKS:**


1. D.J.Eyres, “Ship Constructions”, Seventh Edition, Butter Worth Heinemann Publishing, USA,2015
2. Dr.DA Taylor, “Merchant Ship Naval Architecture” I. Mar EST publications, 2006
3. EA Stokoe, E.A, “Naval Architecture for Marine Engineers”, Vol.4, Reeds Publications,2000


**REFERENCES:**


1. Kemp & Young “Ship Construction Sketches & Notes”, Butter Worth Heinemann Publishing,USA, 2011
2. MARPOL Consolidated Edition , Bhandakar Publications, 2018
3. SOLAS Consolidated Edition , Bhandakar Publications, 2016

**OMV352 ELEMENTS OF MARINE ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**:

**At the end of the course, students are expected to**

- Understand the role of Marine machinery systems
- Be familiar with Marine propulsion machinery system
- Acquaint with Marine Auxiliary machinery system
- Have acquired basics of Marine Auxiliary boiler system
- Be aware of ship propellers and steering system

**UNIT I ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS 9**

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems

**UNIT II MARINE PROPULSION MACHINERY SYSTEM 9**

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

**UNIT III MARINE AUXILIARY MACHINERY SYSTEM 9**

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

**UNIT IV MARINE BOILER SYSTEM 9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

**UNIT V SHIP PROPELLERS AND STEERING MECHANISM 9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**At the end of the course, students should able to,**

**CO1** Distinguish the role of various marine machinery systems
**CO2** Relate the components of marine propulsion machinery system
**CO3** Explain the importance of marine auxiliary machinery system
**CO4** Acquire knowledge of marine boiler system
**CO5** Understand the importance of ship propellors and steering system

**TEXT BOOKS:**


1. Taylor, “Introduction to Marine engineering”, Revised Second Edition, Butterworth Heinemann, London, 2011
2. J.K.Dhar, “Basic Marine Engineering”, Tenth Edition, G-Maritime Publications, Mumbai, 2011
3. K.Ramaraj, “ Text book on Marine Engineering”, Eswar Press, Chennai, 2018


**REFERENCES:**


1. Alan L.Rowen, “Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006
2. A.S.Tambwekar, “Naval Architecture and Ship Construction”, The Institute of Marine Engineers (India), Mumbai, 2015


**CRA332 DRONE TECHNOLOGIES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basics of drone concepts
- To learn and understand the fundaments of design, fabrication and programming of drone
- To impart the knowledge of an flying and operation of drone
- To know about the various applications of drone
- To understand the safety risks and guidelines of fly safely

**UNIT I INTRODUCTION TO DRONE TECHNOLOGY 9**

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**UNIT II DRONE DESIGN, FABRICATION AND PROGRAMMING 9**

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program -Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

**UNIT III DRONE FLYING AND OPERATION 9**

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

**UNIT IV DRONE COMMERCIAL APPLICATIONS 9**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**UNIT V FUTURE DRONES AND SAFETY 9**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to:

**CO1**: Know about a various type of drone technology, drone fabrication and programming.
**CO2**: Execute the suitable operating procedures for functioning a drone
**CO3**: Select appropriate sensors and actuators for Drones
**CO4**: Develop a drone mechanism for specific applications
**CO5**: Createthe programs for various drones

**TEXT BOOKS**


1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016


**REFERENCES**


1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.


**CO’s- PO’s & PSO’s MAPPING**

| COs/Pos& PSOs | POs | | | | | | | | | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO2 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO3 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO4 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO5 | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| CO/PO & PSO Average | 1 | 2 | 3 | 1 | 3 | 2 | | | | | | 1 | 2 | 1 | 3 |
| 1 – Slight, 2 – Moderate, 3 – Substantial | | | | | | | | | | | | | | | |

**OGI352 GEOGRAPHICAL INFORMATION SYSTEM L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.

**UNIT I FUNDAMENTALS OF GIS 9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

**UNIT II SPATIAL DATA MODELS 9**

Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

**UNIT III DATA INPUT AND TOPOLOGY 9**

Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input –Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration

**UNIT IV DATA QUALITY AND STANDARDS 9**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards – Interoperability - OGC - Spatial Data Infrastructure

**UNIT V DATA MANAGEMENT AND OUTPUT 9**

Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.

**TOTAL:45 PERIODS**

**COURSE OUTCOMES:**

•On completion of the course, the student is expected to

**CO1** Have basic idea about the fundamentals of GIS.
**CO2** Understand the types of data models.
**CO3** Get knowledge about data input and topology
**CO4** Gain knowledge on data quality and standards
**CO5** Understand data management functions and data output

**TEXTBOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

**REFERENCE:**

1. Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

**CO's- PO's & PSO's MAPPING**

| PO | Graduate Attribute | Course Outcome | | | | | Average |
|---|---|---|---|---|---|---|---|
| | | CO 1 | CO 2 | CO 3 | CO 4 | CO 5 | |
| PO1 | Engineering Knowledge | 3 | 3 | 3 | 3 | 3 | 3 |
| PO2 | Problem Analysis | | | | 3 | 3 | 3 |
| PO3 | Design/Development of Solutions | | | 3 | 3 | 3 | 3 |
| PO4 | Conduct Investigations of Complex Problems | | | 3 | 3 | 3 | 3 |
| PO5 | Modern Tool Usage | | 3 | | 3 | 3 | 3 |
| PO6 | The Engineer and Society | | | | | | |
| PO 7 | Environment and Sustainability | | | | | | |
| PO 8 | Ethics | | | | | | |
| PO 9 | Individual and Team Work | | | | | | |
| PO10 | Communication | | | | | | |
| PO11 | Project Management and Finance | | | | | | |
| PO12 | Life-long Learning | | | | | | |
| PSO1 | Knowledge of Geoinformatics discipline | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO2 | Critical analysis of Geoinformatics Engineering problems and innovations | 3 | 3 | 3 | 3 | 3 | 3 |
| PSO3 | Conceptualization and evaluation of Design solutions | 3 | 3 | 3 | 3 | 3 | 3 |

**OAI352 AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT L T P C**

**3 0 0 3**

## COURSE OBJECTIVES

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

### UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT 9

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

### UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE 9

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE 9**

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing-Motivation-ordering-leading-supervision- communication and control-Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures-Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

**UNIT IV ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE 9**

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs- Economic system and its implication for decision making by individual entrepreneurs.

**UNIT V ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT 9**

Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis-Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private
partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES

**CO1** Judge about agricultural finance, banking and cooperation
**CO2** Evaluate basic concepts, principles and functions of financial management
**CO3** Improve the skills on basic banking and insurance schemes available to customers
**CO4** Analyze various financial data for efficient farm management
**CO5** Identify the financial institutions

## TEXT BOOKS


1. Joseph L. Massie, 1995, “Essentials of Management”, prentice Hall of India Pvt limited, New Delhi
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.


## REFERENCES


1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.

**CO's- PO's & PSO's MAPPING**

| PO/PSO | | CO 1 | CO 2 | CO 3 | CO 4 | CO 5 | Overall correlation of COs with POs |
|---|---|---|---|---|---|---|---|
| PO1 | Engineering Knowledge | 1 | 2 | 1 | 1 | 1 | 2 |
| PO2 | Problem Analysis | 2 | 1 | 1 | 1 | 2 | 1 |
| PO3 | Design/ Development of Solutions | 1 | 1 | 1 | 2 | 1 | 2 |
| PO4 | Conduct Investigations of Complex Problems | 1 | 1 | 2 | 1 | 1 | 1 |
| PO5 | Modern Tool Usage | 2 | 1 | 1 | 1 | 1 | 2 |
| PO6 | The Engineer and Society | 1 | 2 | 1 | 2 | 1 | 1 |
| PO7 | Environment and sustainability | 1 | 1 | 2 | 1 | 1 | 1 |
| PO8 | Ethics | 1 | 2 | 1 | 1 | 1 | 1 |
| PO9 | Individual and team work: | 1 | 1 | 1 | 2 | 1 | 1 |
| PO10 | Communication | 1 | 1 | 1 | 1 | 2 | 1 |
| PO11 | Project management and finance | 1 | 1 | 2 | 1 | 1 | 1 |
| PO12 | Life-long learning: | 1 | 2 | 1 | 1 | 1 | 2 |
| PSO1 | To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill | 1 | 2 | 1 | 1 | 1 | 1 |
| PSO2 | To enhance students ability to formulate solutions to real-world problems pertaining to sustained agricultural productivity using modern technologies. | 1 | 1 | 2 | 1 | 1 | 1 |
| PSO3 | To inculcate entrepreneurial skills through strong Industry-Institution linkage. | 1 | 2 | 1 | 1 | 2 | 1 |

**OEN352 BIODIVERSITY CONSERVATION L T P C**

**3 0 0 3**

**COURSE OBJECTIVE:**

- The identification of different aspects of biological diversity and conservation techniques.

**UNIT I INTRODUCTION 9**

Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

**UNIT II INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY 9**

Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.

**UNIT III MICROBIAL DIVERSITY 9**

Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis

**UNIT IV MEGA DIVERSITY 9**

Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.

**UNIT V CONSERVATIONS OF BIODIVERSITY 9**

In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species

**TOTAL: 45 PERIODS**

***TEXT BOOKS:***


1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001
2. Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L.Case, 13th Edition 2019


***REFERENCES:***


1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.


COURSE OUTCOMES

Upon successful completion of this course, students will:

**CO1**: An insight into the structure and function of diversity for ecosystem stability.
**CO2**: Understand the concept of animal diversity and taxonomy
**CO3**: Understand socio-economic issues pertaining to biodiversity
**CO4**: An understanding of biodiversity in community resource management.
**CO5**: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 2 | | | | | | 2 | | 2 | | | 2 | 2 | |
| 2 | | 2 | | 2 | 2 | 2 | | | | | | | 3 | 2 | |
| 3 | | | | 2 | | 2 | | | | | | | 3 | 2 | 3 |
| 4 | 3 | 2 | | | 2 | | | 2 | 2 | 2 | 2 | | 3 | 2 | 3 |
| 5 | | 2 | 3 | 2 | | | 1 | | | | | 1 | | 2 | |
| Avg. | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 |

**1.low, 2-medium, 3-high, '-"- no correlation**
**Note: The average value of this course to be used for program articulation matrix.**

**OEE353 INTRODUCTION TO CONTROL SYSTEMS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

**UNIT I MATHEMATICAL MODELS OF PHYSICALSYSTEMS 9**

Definition & classification of system – terminology & structure of feedback control theory –Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

**UNIT II TIME RESPONSE ANALYSIS & ROOTLOCUSTECHNIQUE 9**

Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus–Rules for sketching root loci.

**UNIT III FREQUENCY RESPONSE ANALYSIS 9**

Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

**UNIT IV STABILITY CONCEPTS & ANALYSIS 9**

Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion — Stability from Bode plot — Relative stability from Nyquist & Bode — Closed loop frequency response.

**UNITV STATE VARIABLE ANALYSIS 9**

Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Ability to

**CO1**: Design the basic mathematical model of physical System.
**CO2**: Analyze the time response analysis and techniques.
**CO3**: Analyze the transfer function from different plots.

**CO4**: Apply the stability concept in various criterion.
**CO5**: Assess the state models for linear and continuous Systems.

**TEXTBOOKS**

1. Farid Golnarghi **,** Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5th Edition2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

**REFERENCES**

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System AnalysisandDesign, 5th Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S.Janardhanan, Modern Control, Cengage Learning, First Impression2010.

**CO's- PO's & PSO's MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 2 | | | | | | | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 1 | | | | | | | | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 2 | | | | | | | | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 2 | | | | | | | 2 | 3 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 1 | 1 | | | | | | | 1 | 3 | 3 | 3 |
| | | | | | | | | | | | | | 3 | 3 | 3 |

**OEI354 INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS L T P C**
**3 0 03**

**COURSE OBJECTIVES:**

- To educate on design of signal conditioning circuits for various applications.
- To Introduce signal transmission techniques and their design.
- Study of components used in data acquisition systems interface techniques
- To educate on the components used in distributed control systems
- To introduce the communication buses used in automation industries.

**UNIT I INTRODUCTION 9**

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus

**UNIT II AUTOMATION COMPONENTS 9**

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.

**UNIT III COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS 9**

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.

**UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9**

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.

**UNIT V DISTRIBUTED CONTROL SYSTEM 9**

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.

**TOTAL:45 PERIODS**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**
**5**

1. Market survey of the recent PLCs and comparison of their features.
2. Summarize the PLC standards
3. Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)
4. Market survey of Industrial Data Networks.

**COURSE OUTCOMES:**
**Students able to**

**CO1** Design a signal conditioning circuits for various application (L3).
**CO2** Acquire a detail knowledge on data acquisition system interface and DCS system (L2).
**CO3** Understand the basics and Importance of communication buses in applied automation Engineering (L2).
**CO4** Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function BIock.(L3)
**CO5** Able to develop a PLC logic for a specific application on real world problem. (L5)

**TEXT BOOKS:**

1. S.K.Singh, “Industrial Instrumentation”, Tata Mcgraw Hill, 2nd edition companies, 2003.
2. C D Johnson, “Process Control Instrumentation Technology”, Prentice Hall India, 8th Edition, 2006.

3. E.A.Parr, Newnes ,NewDelhi,“Industrial Control Handbook”,3rd Edition, 2000.

**REFERENCES:**

1. John W. Webb and Ronald A. Reis, “Programmable Logic Controllers: Principles and Applications”, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, “Computer - Based Industrial Control”, 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,“Programmable Logic Controller”, CeneageLearning, 3 rd Edition,2005.

**List of Open Source Software/ Learning website:**

1. https://archive.nptel.ac.in/courses/108/105/108105062/
2. https://nptel.ac.in/courses/108105063
3. https://www.electrical4u.com/industrial-automation/
4. https://realpars.com/what-is-industrial-automation/
5. https://automationforum.co/what-is-industrial-automation-2/

**CO’s- PO’s & PSO’s MAPPING**

| | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO’s | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| CO1 | 3 | 2 | 2 | 2 | 1 | 1 | - | 1 | - | 1 | - | 1 | 1 | - | 1 |
| CO2 | 3 | `1 | 1 | - | 1 | - | - | 1 | - | 1 | - | - | 1 | - | 1 |
| CO3 | 3 | - | 1 | - | 1 | - | - | 1 | - | 1 | - | - | 1 | - | 1 |
| CO4 | 3 | 3 | 3 | 3 | 1 | | | 1 | | 1 | | | 1 | | 1 |
| CO5 | 3 | 3 | 3 | 3 | 1 | 1 | | 1 | | 1 | | | 1 | | 1 |
| AVg. | 3 | 2.25 | 2 | 2.6 | 1 | 1 | - | 1 | - | 1 | - | - | 1 | - | 1 |

**OCH353 ENERGY TECHNOLOGY L T P C**
**3 0 0 3**

**UNIT I INTRODUCTION 8**

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources

**UNIT II CONVENTIONAL ENERGY 8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY 10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind

electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY 10**

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

**UNIT V ENERGY CONSERVATION 9**

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

On completion of the course, the students will be able to

**CO1**: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.

**CO2**: Students will excel as professionals in the various fields of energy engineering

**CO3**: Compare different renewable energy technologies and choose the most appropriate based on local conditions.

**CO4**: Explain the technological basis for harnessing renewable energy sources.

**CO5**: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

**TEXT BOOKS**

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.

**REFERENCES**

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Enery - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

**CO's- PO's & PSO's MAPPING**

| Course Outcomes | Program Outcomes | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statements | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 |
| CO1 | Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels. | 2 | 3 | 2 | 3 | 3 | - | - | - | 1 | 1 | - | 3 | 1 | 1 | 3 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO2** | Students will excel as professionals in the various fields of energy engineering | **2** | **3** | **1** | **3** | **3** | **-** | **-** | **-** | **1** | **1** | **-** | **3** | **2** | **1** | **3** |
| **CO3** | Compare different renewable energy technologies and choose the most appropriate based on local conditions. | **2** | **2** | **2** | **3** | **3** | **1** | **1** | **-** | **1** | **1** | **-** | **3** | **2** | **1** | **3** |
| **CO4** | Explain the technological basis for harnessing renewable energy sources. | **2** | **2** | **1** | **3** | **3** | **1** | **1** | **1** | **1** | **-** | **1** | **3** | **1** | **1** | **3** |
| **CO5** | Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level | **2** | **2** | **1** | **3** | **3** | **1** | **1** | **1** | **1** | **-** | **1** | **3** | **2** | **1** | **3** |
| | OVERALL CO | **2** | **2** | **1** | **3** | **3** | **2** | **2** | **1** | **1** | **1** | **1** | **3** | **2** | **1** | **3** |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OCH354** **SURFACE SCIENCE** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to analyze properties of a surfaces and correlate them to structure, chemistry, and physics and surface modification technique.

**UNIT I SURFACE STRUCTURE AND EXPERIMENTAL PROBES 9**

Relevance of surface science to Chemical and Electrochemical Engineering, Heterogeneous Catalysis and Nanoscience; Surface structure and reconstructions, absorbate structure, Band and Vibrational structure, Importance of UHV techniques, Electronic probes and molecular beams, Scanning probes and diffraction, Qualitative introduction to electronic and vibrational spectroscopy

**UNIT II ADSORPTION, DYNAMICS, THERMODYNAMICS AND KINETICS AT SURFACES 9**

Interactions at the surface, Physisorption, Chemisorption, Diffusion, dynamics and reactions of atoms/molecules on surfaces, Generic reaction mechanism on surfaces, Adsorption isotherms, Kinetics of adsorption, Use of temperature desorption methods

**UNIT III LIQUID INTERFACES 9**

Structure and Thermodynamics of liquid-solid interface, Self-assembled monolayers, Electrified interfaces, Charge transfer at the liquid-solid interfaces, Photoelectrochemical processes, Gratzel cells

**UNIT IV HETEROGENEOUS CATALYSIS 9**

Characterization of heterogeneous catalytic processes, Microscopic kinetics to catalysis, Overview of important heterogeneous catalytic processes: Haber-Bosch, Fishcher-Tropsch and Automotive catalysis, Role of promoters and poisons, Bimetallic surfaces, surface functionalization and clusters in catalysis, Role of Sabatier principle in catalyst design, Rate oscillations and spatiotemporal pattern formation

**UNIT V EPITAXIAL GROWTH AND NANO SURFACE-STRUCTURES 9**

Origin of surface forces, Role of stress and strain in epitaxial growth, Energetic and growth modes, Nucleation theory, Nonequilibrium growth modes, MBE, CVD and ablation techniques, Catalytic growth of nanotubes, Etching of surfaces, Formation of nanopillars and nanorods and its application in photoelectrochemical processes, Polymer surfaces and biointerfaces.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- Upon completion of this course, the students can understand, predict and design surface properties based on surface structure. Students would understand the physics and chemistry behind surface phenomena

**TEXT BOOK:**

1. K. W. Kolasinski, “Surface Science: Foundations of catalysis and nanoscience” II Edition, John Wiley & Sons, New York, 2008.

**REFERENCE:**

1. Gabor A. Somorjai and Yimin Li “Introduction to Surface Chemistry and catalysis”, II Edition John Wiley & Sons, New York, 2010.

**OFD354 FUNDAMENTALS OF FOOD ENGINEERING L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

The course aims to

- acquaint and equip the students with different techniques of measurement of engineering properties.
- make the students understand the nature of food constituents in the design of processing equipment

**UNIT I 9**

Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

**UNIT II 9**

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave,

IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers

**UNIT III** **9**

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)

**UNIT IV** **9**

Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for lo.w- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.

**UNIT V** **9**

Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

At the end of the course the students will be able to

**CO1** understand the importance of food polymers

**CO2** understand the effect of various methods of processing on the structure and texture of food materials

**CO3** understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.

**TEXTBOOKS:**


1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Intitute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.

**OFD355 FOOD SAFETY AND QUALITY REGULATIONS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

**UNIT I** **10**

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation

**UNIT II** **8**

Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.

**UNIT III** **9**

Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication

**UNIT IV** **9**

Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)

**UNIT V** **9**

Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** Thorough Knowledge of food hazards, physical, chemical and biological in the industry and food service establishments

**CO2** Awareness on regulatory and statutory bodies in India and the world

**REFERENCES:**


1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973
5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003

**OPY353** **NUTRACEUTICALS** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

**UNIT I INTRODUCTION AND SIGNIFICANCE 6**

Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.

**UNIT II PHYTOCHEMICALS AS NUTRACEUTICALS 11**

Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.

**UNIT III ASSESSMENT OF ANTIOXIDANT ACTIVITY 11**

In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different *in vitro* methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.

**UNIT IV ROLE IN HEALTH AND DISEASE 11**

The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.

**UNIT V SAFETY ISSUES 6**

Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**


1. Bisset, Normal Grainger and Max Wich H “Herbal Drugs and Phytopharmaceuticals”, 2nd Edition, CRC, 2001.
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006
4. Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press /Elsevier, 2005.


**REFERENCES:**


1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000

5. Hanson, James R. “Natural Products: The Secondary Metabolites”, Royal Society of Chemistry, 2003.

**COURSE OUTCOMES**

**CO1** acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.
**CO2** acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes
**CO3** attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.
**CO4** distinguish the various *In vitro* and *In vivo* assessment of Antioxidant activity of compounds from plant sources.
**CO5** gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases.
**CO6** Attain the knowledge of the regulatory and safety issues of nutraceuticals at national and international level.

**CO’s- PO’s & PSO’s MAPPING**

| **Course outcome** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | | | | | | | | | | 1 |
| **CO 2** | 3 | | | | | | | | | | | 1 |
| **CO 3** | 3 | | | | | 2 | | | | | | |
| **CO 4** | 3 | | | | | | | | | | | |
| **CO 5** | 3 | | | | | 2 | | | | | | 1 |
| **CO 6** | 3 | | | | | | | 2 | | | | 1 |

**OTT354 BASICS OF DYEING AND PRINTING L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

**UNIT I INTRODUCTION 9**

Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,

**UNIT II PRE TREATMENT 9**

Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring– Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.

**UNIT III DYEING 9**

Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand.

**UNIT IV PRINTING 9**

Definition of printing – Difference between printing and dying- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing.

**UNIT V MACHINERIES 9**

Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand the

**CO1**: Basics of grey fabric
**CO2**: Basics of pre treatment
**CO3**: Concept of Dyeing
**CO4**: Concept of Printing
**CO5**: Machinery in processing industry

**TEXT BOOKS:**


1. Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.
2. Shenai V.A. “Technology of Textile Processing Vol. IV” 1998, Sevak Publications, Mumbai.


**REFERENCES:**


1. Trotman E. R., “Dyeing and Chemical Technology of Textile Fibres”, Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.
2. Dr. N N Mahapatra., “Textile dyeing”, Wood head publishing India, 2018
3. Mathews Kolanjikombil., ”Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics”, Wood head publishing India , 2021
4. Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series
5. Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-3.


## CO’s- PO’s & PSO’s MAPPING

| Course Outcomes | Program Outcome | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Statement | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PS |
| **CO1** | Classification of fibres and production of natural fibres | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| **CO2** | Regenerated and synthetic fibres | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| **CO3** | Yarn spinning | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| **CO4** | Weaving | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| **CO5** | Knitting and nonwoven | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |
| **Overall CO** | | - | - | - | - | - | - | - | 2 | 1 | - | 1 | 1 | - | 1 | - |

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**FT3201 FIBRE SCIENCE L T P C**
**3 0 0 3**

**COURSE OBJECTIVE**

- To enable the students to learn about the types of fibre and its properties

**UNIT I INTRODUCTION TO TEXTILE FIBRES 9**

Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.

**UNIT II REGENERATED FIBRES 9**

Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel

**UNIT III SYNTHEITC FIBRES 9**

Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization

**UNIT IV SPECIALITY FIBRES 9**

Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres

**UNIT V FUNCTIONAL SPECIALITY FIBRES 9**

**Properties and end uses :** Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of this course, the student would be able to
**CO1** Understand the process sequence of various fibres
**CO2** Understand the properties of various fibres

**TEXT BOOKS:**


1. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95
2. Meredith R., and Hearle J. W. S., “Physical Methods of Investigation of Textiles”, Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:
3. Mukhopadhyay S. K., “Advances in Fibre Science”, The Textile Institute,1992, ISBN: 1870812379

**REFERENCES:**


1. Meredith R., “Mechanical Properties of Textile Fibres”, North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698
2. Hearle J. W. S., Lomas B., and Cooke W. D., “Atlas of Fibre Fracture and Damage to Textiles”, The Textile Institute, 2nd Edition, 1998, ISBN: 1855733196.
3. Raheel M. (ed.)., “Modern Textile Characterization Methods”, Marcel Dekker, 1995, ISBN:0824794737
4. Mukhopadhyay. S. K., “The Structure and Properties of Typical Melt Spun Fibres”, Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115
5. Hearle J.W.S., “Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1”, Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36


**OTT355 GARMENT MANUFACTURING TECHNOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

**UNIT I PATTERN MAKING, MARKER PLANNING, CUTTING 9**

Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

**UNIT II TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES 9**

Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

**UNIT III COMPONENTS AND TRIMS USED IN GARMENT 9**

Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

**UNIT IV GARMENT INSPECTION AND DIMENSIONAL CHANGES 9**

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

**UNIT V GARMENT PRESSING, PACKING AND CARE LABELING 9**

Garment pressing – categories and equipment, packing; care 336abelling of apparels

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to Understand

**CO1**: Pattern making, marker planning, cutting
**CO2**: Types of seams, stitches and functions of needles
**CO3**: Components and trims used in garment
**CO4**: Garment inspection and dimensional changes

**CO5**: Garment pressing, packing and careabelling

**TEXT BOOKS:**


1. Carr H., and Latham B., “The Technology of Clothing Manufacture”, Blackwell Science Ltd., Oxford, 1994.
2. Gerry Cooklin, “Introduction to Clothing Manufacture” Blackwell Science Ltd., 1995. 64
3. Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.


**REFERENCES:**


1. Winifred Aldrich., “Metric Pattern Cutting”, Blackwell Science Ltd., Oxford, 1994
2. Peggal H., “The Complete Dress Maker”, Marshall Caverdish, London, 1985
3. Jai Prakash and Gaur R.K., “Sewing Thread”, NITRA, 1994
4. Ruth Glock, Grace I. Kunz, “Apparel Manufacturing”, Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, “An Introduction to Quality Control for the Apparel Industry”, J.S.N. Internationals, 1992.


**CO’s- PO’s & PSO’s MAPPING**

| | PO’s | | | | | | | | | | | | PSO’s | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO’s** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** | **4** |
| **1** | 1 | 1 | 1 | - | 2 | - | 1 | 1 | - | 2 | 3 | 1 | 2 | 3 | 1 | 3 |
| **2** | 2 | 2 | 1 | 1 | 1 | - | 1 | 1 | - | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **3** | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | 1 | 2 | 1 | 1 | 3 | 1 | 3 |
| **4** | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 3 |
| **5** | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | - | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| **Avg** | 1.6 | 1.2 | 1 | 0.8 | 1.4 | 0.8 | 1.4 | 1 | 0.2 | 1.8 | 2.4 | 1 | 1.8 | 2.6 | 1 | 2.6 |

**OPE353** **INDUSTRIAL SAFETY** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To educate about the health hazards and the safety measures to be followed in the industrial environment.
- Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings
- Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards

**UNIT I INTRODUCTION** **9**

Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.

**UNIT II OCCUPATIONAL HEALTH AND HYGIENE 9**

Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.

**UNIT III WORKPLACE SAFETY AND SAFETY SYSTEMS 9**

Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.

**UNIT IV HAZARDS AND RISK MANAGEMENT 9**

Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.

**UNIT V ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT 9**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the student is expected to be able to:

**CO1** Describe, with example, the common work-related diseases and accidents in occupational setting

**CO2** Name essential members of the Occupational Health team

**CO3** What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

**OPE354 UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.

**UNIT I FLUID MECHANICS CONCEPTS 9**

Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton’s Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler’s equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

**UNIT II FLOW MEASUREMENTS & MECHANICAL OPERATIONS 9**

Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

**UNIT III CONDUCTIVE & CONVECTIVE HEAT TRANSFER 9**

Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).

**UNIT IV BASICS OF MASS TRANSFER 9**

Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

**UNIT V MASS TRANSFER OPERATIONS 9**

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction).Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method.Drying- drying operations, batch and continuous drying. Conceptual numerical.

**TOTAL: 45 PERIODS**

## COURSE OUTCOMES:

At the end of the course the student will be able to:

**CO1** State and describe the nature and properties of the fluids.

**CO2** Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.

**CO3** Comprehend the laws governing the heat and mass transfer operations to solve the problems.

**CO4** Design the heat transfer equipment suitable for specific requirement.

## TEXTBOOKS


1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014
2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008
3. Introduction to Chemical Engineering Badger W.I. and Banchero, J.T., Tata McGraw Hill New York 1997


## REFERENCES


1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008
2. Unit Operations of Chemical Engineering, Vol I &II Chattopadhyaya Khanna Publishers, Delhi-6 1996
3. Heat Transfer J P Holman McGraw Hill International Ed

**OPT352 PLASTIC MATERIALS FOR ENGINEERS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable specialty plastics for different end applications

**UNIT I INTRODUCTION TO PLASTIC MATERIALS 9**

Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/ Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)

**UNIT II ENGINEERING THERMOPLASTICS AND APPLICATIONS 9**

Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)

**UNIT III THERMOSETTING PLASTICS 9**

Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.

**UNIT IV MISCELLANEOUS PLASTICS FOR END APPLICATIONS 9**

Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications

**UNIT V PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS 9**

Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanoates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1** To study the importance, advantages and classification of plastic materials
**CO2** Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics
**CO3** To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins
**CO4** Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU
**CO5** To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

## REFERENCES


1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8th Edn., Elsevier (2017).
2. J.A.Brydson, Plastics Materials, 7th Edn., Butterworth Heinemann (1999).
3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4th Edn., CRC press (2006).
4. A. Brent Strong, Plastics: Materials and Processing, 3rd Edn., Pearson Prentice Hall (2006).
5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2nd Edn., CRC press(2016).
6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.
7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.


## OPT353 PROPERTIES AND TESTING OF PLASTICS L T P C 3 0 0 3

## COURSE OBJECTIVES

- To understand the relevance of standards and specifications as well as the specimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

### UNIT I INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS 9

Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and specifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.

### UNIT II MECHANICAL PROPERTIES 9

Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers

### UNIT III THERMAL RHEOLOGICAL PROPERTIES 9

Thermal properties: Transition temperatures, specific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.

### UNIT IV ELECTRICAL AND OPTICAL PROPERTIES 9

Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.

**UNIT V ENVIRONMENTAL AND CHEMICAL RESISTANCE 9**

Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1** Understand the relevance of standards and specifications.
**CO2** Summarize the various test methods for evaluating the mechanical properties of the polymers.
**CO3** To know the thermal, electrical & optical properties of polymers.
**CO4** Identify various techniques used for characterizing polymers.
**CO5** Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

**REFERENCES**


1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.
2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.
3. R.P.Brown, Plastic test methods, 2nd Edn., Harlond, Longman Scientific, 1981.
4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastcis, Allied Publishers Pvt. Ltd., New Delhi, 2003.
5. Vishu Shah, Handbook of Plastic Testing Technology, 3rd Edn., John Wiley & Sons 2007.
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.


**OEC353 VLSI DESIGN L T P C**

**3 0 0 3**

**COURSE OBJECTIVES:**

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

**UNIT I MOS TRANSISTOR PRINCIPLES 9**

MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET.

**UNIT II COMBINATIONAL LOGIC CIRCUITS 9**

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

**UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES 9**

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .

**UNIT IV INTERCONNECT, MEMORY ARCHITECTURE** **9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

**UNIT V DESIGN OF ARITHMETIC BUILDING BLOCKS** **9**

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**Upon successful completion of the course the student will be able to**

**CO1**: Understand the working principle and characteristics of MOSFET
**CO2**: Design Combinational Logic Circuits
**CO3**: Design Sequential Logic Circuits and Clocking systems
**CO4**: Understand Memory architecture and interconnects
**CO5**: Design of arithmetic building blocks.

**TEXTBOOKS**


1. Jan D Rabaey, Anantha Chandrakasan, “Digital Integrated Circuits: A Design Perspective”, PHI, 2016.(Units II, III IV and V).
2. Neil H E Weste, Kamran Eshranghian, “Principles of CMOS VLSI Design: A System Perspective,” Addison Wesley, 2009.( Units - I).


**REFERENCES**


1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and Yervant Zorian, “Principles of Testing Electronic Systems”, Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000


**CO’s- PO’s & PSO’s MAPPING**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 3 | 3 | 2 | 2 | 1 | 3 | - | - | - | - | 2 | 3 | 3 | 3 | 3 |
| **2** | 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 3 | 3 | 3 |
| **3** | 3 | - | 3 | 2 | 1 | 2 | - | - | - | - | 3 | 2 | 3 | 2 | 3 |
| **4** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 3 | 2 |
| **5** | 2 | - | 3 | 2 | 2 | 1 | - | - | - | - | 1 | 1 | 3 | 2 | 2 |
| **AvgO** | **3** | **3** | **2** | **2** | **1** | **2** | **-** | **-** | **-** | **-** | **2** | **2** | **3** | **3** | **3** |

**CBM370 WEARABLE DEVICES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

**The student should be made to:**

- To know the hardware requirement of wearable systems
- To understand the communication and security aspects in the wearable devices
- To know the applications of wearable devices in the field of medicine

**UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9**

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor.

**UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

**UNIT III WIRELESS HEALTH SYSTEMS 9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

**UNIT IV SMART TEXTILE 9**

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks.Case study- smart fabric for monitoring biological parameters - ECG, respiration.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**TOTAL :45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to

**CO1**: Describe the concepts of wearable system.
**CO2**: Explain the energy harvestings in wearable device.
**CO3**: Use the concepts of BAN in health care.
**CO4**: Illustrate the concept of smart textile
**CO5**: Compare the various wearable devices in healthcare system

**TEXT BOOKS**


1. Annalisa Bonfiglo and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems,Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014

4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications,Pan Stanford Publishing Pte.Ltd, Singapore, 2012

**REFERENCES**

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| 2 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| 3 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| 4 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| 5 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | | 1 |
| AVg. | | | | | | | | | | | | | | | |

**CBM356 MEDICAL INFORMATICS L T P C**
**3 0 0 3**

**Preamble:**

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

**UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9**

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

**UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9**

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

**UNIT III COMPUTERISED PATIENT RECORD 9**

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

**UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9**

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer–assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis inclinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9**

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

**Upon completion of the course, students will be able to:**

**CO1** Explain the structure and functional capabilities of Hospital Information System.
**CO2** Describe the need of computers in medical imaging and automated clinical laboratory.
**CO3** Articulate the functioning of information storage and retrieval in computerized patient record system.
**CO4** Apply the suitable decision support system for automated clinical diagnosis.
**CO5** Discuss the application of virtual reality and telehealth technology in medical industry.

**TEXT BOOKS:**

1. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, “Computers in medicine progress in medical informatics”, Tata Mcgraw Hill, 2005

**REFERENCE:**

1. Kathryn J. Hannah, Marion J Ball, “Health Informatics”, 3rd Edition, Springer, 2006.

**CO’s- PO’s & PSO’s MAPPING**

| CO’s | PO’s | | | | | | | | | | | | PSO’s | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| 2 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| 3 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| 4 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| 5 | 3 | 2 | 1 | 1 | 2 | | | 1 | | | | | 1 | 1 | 1 |
| AVg. | | | | | | | | | | | | | | | |

**OBT355 BIOTECHNOLOGY FOR WASTE MANAGEMENT L T P C**
**3 0 0 3**

**UNIT I BIOLOGICAL TREATMENT PROCESS 9**

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continous fermentation

**UNIT II WASTE BIOMASS AND ITS VALUE ADDITION 9**

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes – Direct extraction of biochemicals from biomass – Plant biomass for industrial application

**UNIT III BIOCONVERSION OF WASTES TO ENERGY 9**

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photofermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production - Enzymatic hydrolysis technologies

**UNIT IV CHEMICALS AND ENZYME PRODUCTION FROM WASTES 9**

Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases

**UNIT V BIOCOMPOSTING OF ORGANIC WASTES 9**

Overview of composting process - Benefitis of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Nonreactor Composting, Reactor composting - Compost Quality

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

After completion of this course, the students should be able

**CO1** To learn the various methods biological treatment
**CO2** To know the details of waste biomass and its value addition
**CO3** To develop the bioconversion processes to convert wastes to energy
**CO4** To synthesize the chemicals and enzyme from wastes
**CO5** To produce the biocompost from wastes
**CO6** To apply the theoretical knowledge for the development of value added products

**TEXT BOOKS**

1. Antoine P. T., (2017) “Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation”, CRC press
2. Joseph C A., (2019)“Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook”, CRC Press,

**REFERENCES**
1. Palmiro P. and Oscar F.D'Urso, (2016) 'Biotransformation of Agricultural Waste and By-Products',The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014)'Biotransformation of Waste Biomass into High Value Biochemicals', Springer.
3. Keikhosro K, Editor, (2015) 'Lignocellulose-Based Bioproducts', Springer.
4. John P, (2014) 'Waste Management Practices-Municipal, Hazardous, and Industrial', Second Edition, CRC Press, 2014

**OBT356 LIFESTYLE DISEASES L T P C**
**3 0 0 3**

**UNIT I INTRODUCTION 9**

Lifestyle diseases – Definition ; Risk factors – Eating, smoking, drinking, stress, physical activity, illicit drug use ; Obesity, diabetes, cardiovascular diseases, respiratory diseases, cancer; Prevention – Diet and exercise.

**UNIT II CANCER 9**

Types - Lung cancer, Mouth cancer, Skin cancer, Cervical cancer, Carcinoma oesophagus; Causes Tobacco usage, Diagnosis – Biomarkers, Treatment

**UNIT III CARDIOVASCULAR DISEASES 9**

Coronoary atherosclerosis – Coronary artery disease; Causes -Fat and lipids, Alcohol abuse -– Diagnosis - Electrocardiograph, echocardiograph, Treatment, Exercise and Cardiac rehabilitation

**UNIT IV DIABETES AND OBESITY 9**

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes – Paediatric and adolescent obesity – Weight control and BMI

**UNIT V RESPIRATORY DISEASES 9**

Chronic lung disease, Asthma, COPD; Causes - Breathing pattern (Nasal vs mouth), Smoking – Diagnosis - Pulmonary function testing

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. R.Kumar&Meenal Kumar, "Guide to Prevention of Lifestyle Diseases", Deep & Deep Publications, 2003
2. Gary Eggar et al, "Lifestyle Medicine", 3rd Edition, Academic Press, 2017

**REFERENCES:**

1. James M.R, "Lifestyle Medicine", 2nd Edition, CRC Press, 2013
2. Akira Miyazaki et al, "New Frontiers in Lifestyle-Related Disease", Springer, 2008

**OBT357 BIOTECHNOLOGY IN HEALTH CARE L T P C**
**3 0 0 3**

## COURSE OBJECTIVES

The aim of this course is to

- Create higher standard of knowledge on healthcare system and services
- Prioritize advanced technologies for the diagnosis and treatment of various diseases

## UNIT I PUBLIC HEALTH 9

Definition and Concept of Public Health, Historical aspects of Public Health, Changing Concepts of Public Health, Public Health versus Medical Care, Unique Features of Public Health, Determinants of Health (Social, Economic, Cultural, Environmental, Education, Genetics, Food and Nutrition). Indicators of health, Burden of disease, Role of different disciplines in Public Health.

## UNIT II CLINICAL DISEASES 9

Communicable diseases: Chickenpox / Shingles, COVID-19, Tuberculosis, Hepatitis B, Hepatitis C, HIV / AIDS, Influenza, Swine flu. Non Communicable diseases: Diabetes mellitus, atherosclerosis, fatty liver, Obesity, Cancer

## UNIT III VACCINOLOGY 9

History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems. Instruments related to monitoring of temperature, sterilization, environment.

## UNIT IV OUTPATIENT & IN PATIENT SERVICES 9

Radiotherapy, Nuclear medicine, surgical units, OT Medical units, G & Obs. units Pediatric, neonatal units, Critical care units, Physical medicine & Rehabilitation, Neurology, Gastroenterology, Endoscopy, Pulmonology, Cardiology.

## UNIT V BASICS OF IMAGING MODALITIES 9

Diagnostic X-rays - Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems.

**TOTAL: 45 PERIODS**

## TEXT BOOKS


1. Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
2. Thomas M. Devlin.Textbook of Biochemistry with clinical correlations. Wiley Liss Publishers
3. The Vaccine Book (2nd Ed.), Rafi Ahmed, Roy M. Anderson et. al.Editor(s): Barry R. Bloom, PaulHenri Lambert, Academic Press, 2016, Pages xxi-xxiv.


## REFERENCES


1. Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical chemistry. Saunders Company
3. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker

## VERTICAL 1: FINTECH AND BLOCK CHAIN

**CMG331 FINANCIAL MANAGEMENT LT P C**
**3 0 0 3**

### COURSE OBJECTIVES

- To acquire the knowledge of the decision areas in finance.
- To learn the various sources of Finance
- To describe about capital budgeting and cost of capital.
- To discuss on how to construct a robust capital structure and dividend policy
- To develop an understanding of tools on Working Capital Management.

**UNIT I INTRODUCTION TO FINANCIAL MANGEMENT 9**

Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.

**UNIT II . SOURCES OF FINANCE 9**

Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc

**UNIT III INVESTMENT DECISIONS: 9**

Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting -– Payback -ARR – NPV – IRR –Profitability Index.

Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.

**UNIT IV FINANCING AND DIVIDEND DECISION 9**

Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure .

Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy

**UNIT V WORKING CAPITAL DECISION 9**

Working Capital Management: Working Capital Management - concepts - importance - Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.

**TOTAL : 45 PERIODS**

### TEXT BOOKS

1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd

### REFERENCES .

1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.
2. Prasanna Chandra, Financial Management,
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011

**CMG332 FUNDAMENTALS OF INVESTMENT LT P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- Describe the investment environment in which investment decisions are taken.
- Explain how to Value bonds and equities
- Explain the various approaches to value securities
- Describe how to create efficient portfolios through diversification
- Discuss the mechanism of investor protection in India.

**UNIT I THE INVESTMENT ENVIRONMENT 9**

The investment decision process, Types of Investments – Commodities, Real Estate and FinancialAssets, the Indian securities market, the market participants and trading of securities, securitymarket indices, sources of financial information, Concept of return and risk, Impact of Taxes andInflationonreturn.

**UNIT II FIXED INCOME SECURITIES 9**

Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, defaultrisk andcreditrating.

**UNIT III APPROACHES TOEQUITYANALYSIS 9**

Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.

**UNIT IV PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES 9**

Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India

**UNIT V INVESTOR PROTECTION 9**

Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness andactivism

**TOTAL : 45 PERIODS**

**REFERENCES**


1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14TH Edition, 2019.
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5th, Edition, 2017.
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.
4. ZviBodie, Alex Kane, Alan J Marcus, PitabusMohanty, Investments, McGraw Hill Education (India), 11 Edition(SIE), 2019


**CMG333 BANKING, FINANCIAL SERVICES AND INSURANCE LT P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- Understand the Banking system in India
- Grasp how banks raise their sources and how they deploy it
- Understand the development in banking technology
- Understand the financial services in India
- Understand the insurance Industry in India

**UNIT I INTRODUCTION TO INDIAN BANKING SYSTEM 9**

Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations in Indian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.

**UNIT II MANAGING BANK FUNDS/ PRODUCTS 9**

Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA's – Current issues on NPA's – M&A's of banks into securities market

**UNIT III DEVELOPMENT IN BANKING TECHNOLOGY 9**

Payment system in India – paper based – e payment –electronic banking –plastic money – e-money –forecasting of cash demand at ATM's –The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

**UNIT IV FINANCIAL SERVICES 9**

Introduction – Need for Financial Services – Financial Services Market in India – NBFC –– Leasing and Hire Purchase –– mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking

**UNIT V INSURANCE 9**

Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 – IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

**TOTAL : 45 PERIODS**

**REFERENCES :**


1. Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and Risk Management", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", Tata McGraw Hill, New Delhi, 2017


**CMG334 INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS LT P C**
**3 0 0 3**

**UNIT I INTRODUCTION TO BLOCKCHAIN**
**9**

Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.

**UNIT II INTRODUCTION TO CRYPTOCURRENCY 9**

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations –

Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain

**UNIT III ETHEREUM 9**

Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

**UNIT IV WEB3 AND HYPERLEDGE `**
**9**

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

**UNIT V EMERGING TRENDS 9**

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

**TOTAL : 45 PERIODS**

**REFERENCE**


1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2nd Edition, 2018
2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018
3. ArshdeepBahga, Vijay Madisetti, “Blockchain Applications: A Hands On Approach”, VPT, 2017.


**CMG335 FINTECH PERSONAL FINANCE AND PAYMENTS LT P C**
**3 0 0 3**

**UNIT I CURRENCY EXCHANGE AND PAYMENT 9**

Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets -Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues

**UNIT II DIGITAL FINANCE AND ALTERNATIVE FINANCE 9**

A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering

**UNIT III INSURETECH 9**

InsurTech Introduction , Business model disruption AI/ML in InsurTech ● IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services

**UNIT IV PEER TO PEER LENDING 9**

P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies , Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations

**UNIT V REGULATORY ISSUES 9**

FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection

**TOTAL : 45 PERIODS**

**REFERENCES:**


1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business, Springer, 2019
3. Henning Diedrich, Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations, Wildfire Publishing, 2016
4. Jacob William, FinTech:TheBeginner's Guide to Financial Technology, Createspace Independent Publishing Platform, 2016
5. IIBF, Digital Banking, Taxmann Publication, 2016
6. Jacob William, Financial Technology, Create space Independent Pub, 2016
7. Luke Sutton, Financial Technology: Bitcoin & Blockchain, Createspace Independent Pub, 2016


**CMG336 INTRODUCTION TO FINTECH LT P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To learn about history, importance and evolution of Fintech
- To acquire the knowledge of Fintech in payment industry
- To acquire the knowledge of Fintech in insurance industry
- To learn the Fintech developments around the world
- To know about the future of Fintech

**UNIT I INTRODUCTION 9**

Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.

**UNIT II PAYMENT INDUSTRY 9**

FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal

lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.

**UNIT III INSURANCE INDUSTRY 9**

FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry-P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.

**UNIT IV FINTECH AROUND THE GLOBE 9**

FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.

**UNIT V FUTURE OF FINTECH 9**

How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.

**TOTAL : 45 PERIODS**

**REFERENCES**


1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018


## VERTICAL 2: ENTREPRENEURSHIP

**CMG337 FOUNDATIONS OF ENTREPRENERUSHIP L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businessess.
- To empower the learners to run a Technology driven business efficiently and effectively

**UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9**

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entreprenrship to Economic Development.

**UNIT II BUSINESS OWNERSHIP & ENVRIONMENT 9**

Types of Business Ownership – Buiness Envrionemental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Reosurces Mobilisation-Basics of Managing Finance- Esentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

**UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP 9**

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts-Principles - Characterisitcis of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportuinites in Technopreneurship - Recent trends

**UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP 9**

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship -– Success Stories of Technopreneurs - Case Studies

**UNIT V EMERGING TRENDS IN ENTREPRENERUSHIP 9**

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing-Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneruship - NGO Entrepreneurship – Recent Entrperneruial Develoments - Local – National – Global perspectives.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the student should be able to:

**CO1** Learn the basics of Entrepreneurship
**CO2** Understand the business ownership patterns and evnironment
**CO3** Understand the Job opportunites in Industries relating to Technopreneurship
**CO4** Learn about applications of tehnopreneurship and successful technopreneurs
**CO5** Acquaint with the recent and emerging trends in entreprenerushiip

**TEXT BOOKS:**

1) S.S.Khanka, “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning,

**REFERENCES :**

1) Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
2) Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
3) Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,

5) HarperBusiness,https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED EDUCATION-REVOLUTION.pdf
6) JumpStart: A Technoprenuership Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
7) Basics of Technoprenuership: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
8) Journal articles pertaining to Entrepreneurship

## CMG338 TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

### COURSE OBJECTIVES

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businessess.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

### UNIT I INTRODUCTION TO MANAGING TEAMS 9

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Devlopment - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

### UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9

Team-based Organisations- Leadershp roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

### UNIT III INTRODUCTION TO LEADERSHIP 9

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

### UNIT IV LEADERSHIP IN ORGANISATIONS 9

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

### UNIT V LEADERSHIP EFFECTIVENESS 9

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the student should be able to:

**CO1** Learn the basics of managing teams for business.
**CO2** Understand developing effective teams for business management.
**CO3** Understand the fundamentals of leadership for running a business.
**CO4** Learn about the importance of leadership for business development.
**CO5** Acquaint with emerging trends in leadership effectiveness for entreprenerus."

**REFERENCES :**


1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience ,9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).


**CMG339 CREATIVITY & INNOVATION IN ENTREPRENEURSHIP L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entprerenship.
- To develeop innovative business models for business.

**UNIT I CREATIVITY 9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities-Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.

**UNIT II CREATIVE INTELLIGENCE 9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities-Strategies for Unblocking- Designing Creativity Enabling Environment.

**UNIT III INNOVATION 9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators-Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity-Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

**UNIT IV INNOVATION AND ENTREPRENEURSHIP 9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours-Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial

Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

**UNIT V INNOVATIVE BUSINESS MODELS 9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models-Responsible Innovation and Creativity.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the student should be able to:

**CO1** Learn the basics of creativity for developing Entrepreneurship
**CO2** Understand the importance of creative inteligence for business growth
**CO3** Understand the advances through Innovation in Industries
**CO4** Learn about applications of innovation in building successful ventures
**CO5** Acquaint with developing innovative business models to run the business effecientlty and effectively

**Suggested Readings:**

Creativity and Inovation in Entrepreneurship, Kankha, Sultan Chand
Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.
Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.
Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.
Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.
A. Dale Timpe, Creativity, Jaico Publishing House, 2003.
Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.
Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

**CMG340 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

**UNIT I INTRODUCTION TO MARKETING MANAGEMENT 9**

Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

**UNIT II MARKETING ENVIRONMENT 9**

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

**UNIT III PRODUCT AND PRICING MANAGEMENT 9**

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

**UNIT IV PROMOTION AND DISTRIBTUION MANAGEMENT 9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)-Logistics Management- Introduction to Retailing and Wholesaling.

**UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT 9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

**TOTAL 45 : PERIODS**

**COURSE OUTCOMES:**

After completion of this course, the students will be able to :

**CO1** Have the awareness of marketing management process

**CO2** Understand the marketing environment

**CO3** Acquaint about product and pricing strategies

**CO4** Knowledge of promotion and distribution in marketing management.

**CO5** Comprehend the contemporary marketing scenairos and offer solutions to marketing issues.

**REFERENCES:**

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management , Philip Kortler and Kevin Lane Keller, PHI 15th Ed, 2015.
3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

**CMG341 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**:

- To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- To create an awareness of the roles, functions and functioning of human resource department.
- To understand the methods and techniques followed by Human Resource Management practitioners.

**UNIT I INTRODUCTION TO HRM 9**

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

**UNIT II HUMAN RESOURCE PLANNING 9**

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

**UNIT III RECRUITMENT AND SELECTION 9**

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

**UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT 9**

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

**UNIT V CONTROLLING HUMAN RESOURCES 9**

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course the learners will be able:

**CO1** To understand the Evolution of HRM and Challenges faced by HR Managers
**CO2** To learn about the HR Planning Methods and practices.
**CO3** To acquaint about the Recruitment and Selection Techniques followed in Industries.
**CO4** To known about the methods of Training and Employee Development.
**CO5** To comprehend the techniques of controlling human resources in organisations.

**REFERENCES**


1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.

7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases ,9th Edition, McGraw Hill, 2021.
8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

**CMG342 FINANCING NEW BUSINESS VENTURES L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and quity financing.
- To empower the learners towards fund rasiing for new ventures effectively.

**UNIT I ESSENTIALS OF NEW BUSINES VENTURE 9**

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

**UNIT II INTRODUCTION TO VENTURE FINANCING 9**

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Dent and Equity - Challenges and Opportunities.

**UNIT III SOURCES OF DEBT FINANCING 9**

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

**UNIT IV SOURCES OF EQUITY FINANCING 9**

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

**UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9**

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

**TOTAL : 45PERIODS**

**COURSE OUTCOMES**:

Upon completion of this course, the students should be able to:

**CO1** Learn the basics of starting a new business venture.
**CO2** Understand the basics of venture financing.
**CO3** Understand the sources of debt financing.
**CO4** Understanf the sources of equity financing.
**CO5** Acquaint with the methods of fund raising for new business ventures.

**REFERENCES :**

1) Principles of Corporate Finance by Brealey and Myers et al.,12TH ed, McGraw Hill Education (India) Private Limited, 2018
2) Prasanna Chandra, Projects : Planning ,Analysis,Selection ,Financing,Implementation and Review, McGraw Hilld Education India Pvt Ltd ,New Delhi , 2019.
3) Introduction to Project Finance. Andrew Fight,Butterworth-Heinemann, 2006.

4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. Mcgraw-Hill Higher Education, 2014.
10) Lerner, Josh; Leamon, Ann; Hardymon, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

## VERTICAL 3: PUBLIC ADMINISTRATION

**CMG343 PRINCIPLES OF PUBLIC ADMINISTRATION L T P C**
**3 0 0 3**

**UNIT I** **(9)**
1. Meaning, Nature and Scope of Public Administration
2. Importance of Public Administration
3. Evolution of Public Administration

**UNIT II** **(9)**
1. New Public Administration
2. New Public Management
3. Public and Private Administration

**UNIT III** **(9)**
1. Relationships with Political Science, History and Sociology
2. Classical Approach
3. Scientific Management Approach

**UNIT IV** **(9)**
1. Bureaucratic Approach: Max Weber
2. Human Relations Approach : Elton Mayo
3. Ecological Approach : Riggs

**UNIT V** **(9)**
1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

**TOTAL: 45 PERIODS**

**REFERENCEs**:
1. Avasthi and Maheswari: Public Administration in India, Agra:Lakshmi Narain Agarwal,2013.
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.

4. Rumki Basu: Public Administration:Concept and Theories, New Delhi:Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

| CMG344 | CONSTITUTION OF INDIA | L T P C<br>3 0 0 3 |
|---|---|---|

**UNIT I** **(9)**

1. Constitutional Development Since 1909 to 1947
2. Making of the Constitution.
3. Constituent Assembly

**UNIT II** **(9)**

1. Fundamental Rights
2. Fundamental Duties
3. Directive Principles of State Policy

**UNIT III** **(9)**

1. President
2. Parliament
3. Supreme Court

**UNIT IV** **(9)**

1. Governor
2. State Legislature
3. High Court

**UNIT V** **(9)**

1. Secularism
2. Social Justice
3. Minority Safeguards

**TOTAL: 45 PERIODS**

**REFERENCES**:

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

| CMG345 | PUBLIC PERSONNEL ADMINISTRATION | L T P C<br>3 0 0 3 |
|---|---|---|

**UNIT I** **(9)**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

**UNIT II** **(9)**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

**UNIT III** **(9)**

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

**UNIT IV** **(9)**

1. All India Services
2. Service Conditions
3. State Public Service Commission

**UNIT V** **(9)**

1. Employer Employee Relations
2. Wage and Salary Administration
3. Allowances and Benefits

**TOTAL: 45 PERIODS**

**REFERENCES**:


1. Stahl Glean O: Public Personnel Administration
2. Parnandikar Pai V.A: Personnel System for Development Administration.
3. Bhambhiru . P: Bureaucracy and Policy in India.
4. Dwivedi O.P and Jain R.B: India's Administrative state.
5. Muttalis M.A: Union Public Service Commission.
6. Bhakara Rao .V: Employer Employee Relations in India.
7. Davar R.S. Personnel Management & Industrial Relations


**CMG346** **ADMINISTRATIVE THEORIES** **L T P C**
**3 0 0 3**

**UNIT I** **(9)**

Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration

**UNIT II** **(9)**

Theories of Organization: Scientific Management Theory, Classical Model,
Human Relations Theory

**UNIT III** **(9)**

Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.

**UNIT IV** **(9)**

Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making

**UNIT V** **(9)**

Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker

**TOTAL: 45 PERIODS**

**REFERENCES**:


1. Crozior M : The Bureaucratic phenomenon (Chand)
2. Blau. P.M and Scott. W : Formal Organizations (RKP)
3. Presthus. R : The Organizational Society (MAC)
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.
5. Keith Davis : Organization Theory (MAC)

**CMG347 INDIAN ADMINISTRATIVE SYSTEM L T P C**
**3 0 0 3**

**UNIT I (9)**
Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India

**UNIT II (9)**
Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government

**UNIT III (9)**
Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992

**UNIT IV (9)**
Coalition politics in India, Integrity and Vigilance in Indian Administration

**UNIT V (9)**
Corruption – Ombudsman, Lok Pal & Lok Ayuktha

**TOTAL: 45 PERIODS**

**REFERENCES**:
1. S.R. Maheswari : Indian Administration
2. Khera. S.S : Administration in India
3. Ramesh K. Arora : Indian Public Administration
4. T.N. Chaturvedi : State administration in India
5. Basu, D.D : Introduction to the Constitution of India

**CMG348 PUBLIC POLICY ADMINISTRATION L T P C**
**3 0 0 3**

**UNIT I (9)**
Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

**UNIT II (9)**
Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Model

**UNIT III (9)**
Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

**UNIT IV (9)**
Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

**UNIT V** **(9)**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

**TOTAL: 45 PERIODS**

**REFERENCES**:

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.
2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.
3. Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.
4. Pradeep Saxena : Public Policy Administration and Development
5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.

**CMG349 STATISTICS FOR MANAGEMENT** **L T P C**
**3 0 0 3**

**COURSE OBJECTIVE**:

- To learn the applications of statistics in business decision making.

**UNIT I INTRODUCTION** **9**

Basic definitions and rules for probability, Baye‘s theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

**UNIT II SAMPLING DISTRIBUTION AND ESTIMATION** **9**

Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and Interval estimates of population parameters.

**UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS** **9**

Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.

**UNIT IV NON-PARAMETRIC TESTS** **9**

Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.

**UNIT V CORRELATION AND REGRESSION** **9**

Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**:

**CO**1 To facilitate objective solutions in business decision making.
**CO2** understand and solve business problems
**CO3** To apply statistical techniques to data sets, and correctly interpret the results.
**CO4** To develop skill-set that is in demand in both the research and business environments
**CO5** To enable the students to apply the statistical techniques in a work setting.

**REFERENCES**:

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.

5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.
6. N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.

**CMG350 DATAMINING FOR BUSINESS INTELLIGENCE L T P C**
**3 0 0 3**

**COURSE OBJECTIVES :**

- To know how to derive meaning form huge volume of data and information.
- To understand how knowledge discovering process is used in business decision making.

**UNIT I INTRODUCTION 9**
Data mining, Text mining, Web mining, Data ware house.

**UNIT II DATA MINING PROCESS 9**
Datamining process – KDD, CRISP-DM, SEMMA
Prediction performance measures

**UNIT III PREDICTION TECHNIQUES 9**
Data visualization, Time series – ARIMA, Winter Holts,

**UNIT IV CLASSIFICATION AND CLUSTERING TECHNIQUES 9**
Classification, Association, Clustering.

**UNIT V MACHINE LEARNING AND AI 9**
Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
**CO1** Learn to apply various data mining techniques into various areas of different domains.
**CO2** Be able to interact competently on the topic of data mining for business intelligence.
**CO3** Apply various prediction techniques.
**CO4** Learn about supervised and unsupervised learning technique.
**CO5** Develop and implement machine learning algorithms

**REFERENCES :**
1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition,2013.
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011
7. G. K. Gupta, İntroduction to Data mining with Case Studies, Prentice hall of India, 2011
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011

10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriac C, Adaptive Business Intelligence, Springer – Verlag, 2007
11. GalitShmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.

**CMG351 HUMAN RESOURCE ANALYTICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.

**UNIT I INTRODUCTION TO HR ANALYTICS 9**

People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.

**UNIT II HR ANLYTICS I: RECRUITMENT 9**

Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.

**UNIT III HR ANALYTICS - TRAINING AND DEVELOPMENT 9**

Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

**UNIT IV HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION 9**

Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover- grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

**UNIT V HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT 9**

Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1** The learners will be conversant about HR metrics and ready to apply at work settings.
**CO2** The learners will be able to resolve HR issues using people analytics.

**REFERENCES:**

1. JacFitzenz , The New HR Analytics, AMACOM , 2010.

2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.
3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003
4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.
5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.
6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.
7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.
8. HR Scorecard and Metrices, HBR, 2001.

**CMG352 MARKETING AND SOCIAL MEDIA WEB ANALYTICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To showcase the opportunities that exist today to leverage the power of the web and social media

**UNIT I MARKETING ANALYTICS 9**

Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis

**UNIT II COMMUNITY BUILDING AND MANAGEMENT 9**

History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages- Linking Social Media Accounts-The Viral Impact of Social Media.

**UNIT III SOCIAL MEDIA POLICIES AND MEASUREMENTS 9**

Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.

**UNIT IV WEB ANALYTICS 9**

Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

**UNIT V SEARCH ANALYTICS 9**

Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

- The Learners will understand social media, web and social media analytics and their potential impact.

**REFERENCES:**

1. K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013
2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014
3. Bittu Kumar, Social Networking, V & S Publishers, 2013
4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007
5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004
6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

**CMG353 OPERATION AND SUPPLY CHAIN ANALYTICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To treat the subject in depth by emphasizing on the advanced quantitative models and methods in operations and supply chain management and its practical aspects and the latest developments in the field.

**UNIT I INTRODUCTION 9**

Descriptive, predictive and prescriptive analytics, Data Driven Supply Chains – Basics, transforming supply chains.

**UNIT II WAREHOUSING DECISIONS 9**

P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.

**UNIT III INVENTORY MANAGEMENT 9**

Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.

**UNIT IV TRANSPORTATION NETWORK MODELS 9**

Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.

**UNIT V MCDM MODELS 9**

Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

**CO1** To enable quantitative solutions in business decision making under conditions of certainty, risk and uncertainty.

**REFERENCES:**

1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.

2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design: Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.
3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time: Supply Chain Analytics for Perishable Products, Springer, 2013.
4. Muthu Mathirajan, Chandrasekharan Rajendran, Sowmyanarayanan Sadagopan, Arunachalam Ravindran, Parasuram Balasubramanian, Analytics in Operations/Supply Chain Management , I.K. International Publishing House Pvt. Ltd., 2016.
5. Gerhard J. Plenert, Supply Chain Optimization through Segmentation and Analytics, CRC Press, Taylor & Francis Group, 2014.

**CMG354 FINANCIAL ANALYTICS L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- This course introduces a core set of modern analytical tools that specifically target finance applications.

**UNIT I CORPORATE FINANCE ANALYSIS 9**

Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.

**UNIT II FINANCIAL MARKET ANALYSIS 9**

Estimation and prediction of risk and return ( bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.

**UNIT III PORTFOLIO ANALYSIS 9**

Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models-binomial model for options, Black Scholes model and Option implied volatility.

**UNIT IV TECHNICAL ANALYSIS 9**

Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.

**UNIT V CREDIT RISK ANALYSIS 9**

Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.

**TOTAL: 45 PERIODS**

**COURSE OUTCOME**

**CO1** The learners should be able to perform financial analysis for decision making using excel, Python and R.

**REFERENCES:**

1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.

3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.
4. Python for Finance - Paperback – Import, 30 Jun 2017 by Yuxing Yan (Author).
5. Mastering Python for Finance Paperback – Import, 29 Apr 2015 by James Ma Weiming.

## VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

**CES331 SUSTAINABLE INFRASTRUCTURE DEVELOPMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

**UNIT I SUSTAINABLE DEVELOPMENT GOALS 9**

Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

**UNIT II SUSTAINABLE INFRASTRUCTURE PLANNING 9**

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement &Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

**UNIT III SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9**

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings.

**UNIT IV SUSTAINABLE CONSTRUCTION MATERIALS 9**

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies,

Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies

**UNIT V SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS 9**

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

**TOTAL: 45 PERIODS**

**COURSE OUTCOME:**

On completion of the course, the student is expected to be able to

**CO1** Understand the environment sustainability goals at global and Indian scenario.
**CO2** Understand risks in development of projects and suggest mitigation measures.
**CO3** Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.
**CO4** Explain Life Cycle Analysis and life cycle cost of construction materials.
**CO5** Explain the new technologies for maintenance of infrastructure projects.

**REFERENCES:**


1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
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**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | 2 | | 1 | 1 | | 2 | 3 | 1 | 1 | | 2 | 1 | 1 | 2 | 1 |
| 2 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| 3 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 3 | 1 |
| 4 | 3 | 1 | 3 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| 5 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 1 | | 1 | 1 | 2 | 2 | 3 | 2 |
| Avg. | 3 | 1 | 3 | 2 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 |

**CES332 SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

**UNIT I AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS 9**

Ecosystem definition - Biotic *Vs*. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

**UNIT II SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT 9**

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

**UNIT III WATER MANAGEMENT 9**

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

**UNIT IV ENERGY AND WASTE MANAGEMENT 9**

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

**UNIT V EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS 9**

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

**TOTAL: 45 PERIODS**

**COURSE OUTCOME**

- On completion of the course, the student is expected to be able to

CO1 Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture

CO2 Discuss the sustainable ways in managing soil health, nutrients, pests and diseases

CO3 Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources

CO4 Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas

CO5 Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem

**REFERENCES:**


1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014


**CO's- PO's & PSO's MAPPING**

| CO's | PO's | | | | | | | | | | | | PSO's | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| 1 | | 2 | | | | | | 2 | | 2 | | | 2 | 2 | |
| 2 | | 2 | | 2 | 2 | 2 | | | | | | | 3 | 2 | |
| 3 | | | | 2 | | 2 | | | | | | | 3 | 2 | 3 |
| 4 | 3 | 2 | | | 2 | | | 2 | 2 | 2 | 2 | | 3 | 2 | 3 |
| 5 | | 2 | 3 | 2 | | | 1 | | | | | 1 | | 2 | |
| Avg. | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 |

**1 – Low; 2 – Medium; 3 – High; '- "– No correlation**

**CES333 SUSTAINABLE BIOMATERIALS L T P C**
**3 0 0 3**

## COURSE OBJECTIVES

- To Impart knowledge of biomaterials and their properties
- To learn about Fundamentals aspects of Biopolymers and their applications
- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

**UNIT I INTRODUCTION TO BIOMATERIALS 9**

Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials

**UNIT II BIO POLYMERS 9**

Molecular structure of polymers -Molecular weight - Types of polymerization techniques– Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials -Polyethylene -Polymethylmethacrylate (PMMA-Polylactic acid (PLA) and polyglycolic acid (PGA) -Polycaprolactone (PCL) - Other biodegradable polymers – Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives-Synthetic polymeric membranes and their biological applications

**UNIT III BIO CERAMICS AND BIOCOMPOSITES 9**

General properties- Bio ceramics -Silicate glass - Alumina (Al2O3) -Zirconia (ZrO2)-Carbon-Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Compsite(PMC)-Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds

**UNIT IV METALS AS BIOMATERIALS 9**

Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals

**UNIT V NANOBIOMATERIALS 9**

Meatllicnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics- BioNEMs -Biosensor**-**Bioimaging/Molecular Imaging**-** challenges and future perspective.

**TOTAL : 45 PERIODS**

## COURSE OUTCOMES

**CO1** Students will gain familiarity with Biomaterials and they will understand their importance.

**CO2** Students will get an overview of different biopolymers and their properties

**CO3** Students gain knowledge on some of the important Bioceramics and Biocomposite materials

**CO4** Students gain knowledge on metals as biomaterials
**CO5** Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

**REFERENCES**


1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani "Introduction to Biomaterials Basic Theory with Engineering Applications" Cambridge University Press, 2014.
2. Donglu shi "Introduction to Biomaterials" Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes "Biomaterials An Introduction" third edition, Springer 2007.
4. M.Jaffe,W.Hammond, P.Tolias and T.Arinzeh "Characterization of Biomaterials" Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science "An Introduction to Material in Medicine" Third Edition, 2013.
6. VasifHasirci, NesrinHasirci "Fundamentals of Biomaterials" Springer, 2018
7. Leopoido Javier Rios Gonzalez. "Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process" Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad "Functional Bionanomaterials" springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.


**CES334 MATERIALS FOR ENERGY SUSTAINABILITY L T P C**
**3 0 0 3**

**COURSE OBJECTIVES**

- To familiarize the students about the challenges and demands of energy sustainability
- To provide fundamental knowledge about electrochemical devices and the materials used.
- To introduce the students to various types of fuel cell
- To enable students to appreciate novel materials and their usage in photovoltaic application
- To introduce students to the basic principles of various types Supercapacitors and the materials used.

**UNIT I SUSTAINABLE ENERGY SOURCES 9**

Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy

**UNIT II ELECTROCHEMICAL DEVICES 9**

Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-$O_2$ battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, $LiCoO_2$, $LiFePO_4$, $LiMn_2O_4$) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)

**UNIT III FUEL CELLS 9**

Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel

utilization – electrolyte membrane ( proton conducting and anion conducting) – Catalysts ( Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).

**UNIT IV PHOTOVOLTAICS 9**

Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators – $Cu(InGa)Se_2$ solar cells – Cadium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials used in solar cells ( metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-phthalocyanine and perylenetetracarboxylicbis - benzine – fullerenes - boron subphthalocyanine- tin (II) phthalocyanine)

**UNIT V SUPERCAPACITORS 9**

Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite- conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon–carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES**

**CO1** Students will acquire knowledge about energy sustainability.
**CO2** Students understand the principles of different electrochemical devices.
**CO3** Students learn about the working of fuel cells and their application.
**CO4** Students will learn about various Photovoltaic applications and the materials used.
**CO5** The students gain knowledge on different types of supercapacitors and the performance of various materials

**REFERENCES**


1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.

8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.

**CES335 GREEN TECHNOLOGY L T P C**
**3 0 0 3**

**COURSE OBJECTIVE:**

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

**UNIT I PRINCIPLES OF GREEN CHEMISTRY 9**

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

**UNIT II POLLUTION TYPES 9**

Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

**UNIT III GREEN REAGENTS AND GREEN SYNTHESIS 9**

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

**UNIT IV DESIGNING GREEN PROCESSES 9**

Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

**UNIT V GREEN NANOTECHNOLOGY 9**

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

**CO1**: To understand the principles of green engineering and technology
**CO2**: To learn about pollution using hazardous chemicals and solvents
**CO3**: To modify processes and products to make them green and safe.
**CO4**: To design processes and products using green technology
**CO5**: To understand advanced technology in green synthesis

**TEXT BOOKS**

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997
2. Green Chemistry – An introductory text - M. Lancaster, RSC, 2016.

3. Green chemistry metrics - Alexi Lapkin and david Constable (Eds) ,Wiley publications,2008

**REFERENCE**

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

**CES336 ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

**UNIT I: ENVIRONMENTAL MONITORING AND STANDARDS 9**

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

**UNIT II: MONITORING OF ENVIRONMENTAL PARAMETERS 9**

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

**UNIT III: ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING 9**

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis

**UNIT IV : ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT 9**

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.

**UNIT V: AUTOMATED DATA ACQUISITION AND PROCESSING 9**

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

After completion of this course, the students will know

**CO1** Basic concepts of environmental standards and monitoring.

**CO2** the ambient air quality and water quality standards;
**CO3** the various instrumental methods and their principles for environmental monitoring
**CO4** The significance of environmental standards in monitoring quality and sustainability of the environment.
**CO5** the various ways of raising environmental awareness among the people.
**CO6** Know the standard research methods that are used worldwide for monitoring the environment.

**TEXTBOOKS**

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soild wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

**REFERENCES**

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

**CO's- PO's & PSO's MAPPING**

| Course Outcomes | Program Outcomes | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| CO1 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | 3 | - | - |
| CO2 | 1 | 1 | 1 | 1 | 1 | - | - | - | 1 | - | 2 | 2 | 2 | 1 | 1 |
| CO3 | 1 | 1 | 2 | 1 | 1 | - | - | - | 2 | - | 1 | 1 | 1 | - | - |
| CO4 | 1 | 2 | 3 | 3 | 1 | - | - | - | 2 | - | 3 | 3 | 1 | - | - |
| CO5 | 1 | 1 | 3 | 2 | 1 | - | - | - | 3 | - | 3 | 1 | 2 | - | - |
| CO6 | 3 | 2 | 3 | 3 | 2 | - | - | - | 3 | - | 3 | 3 | 3 | 1 | 1 |
| Over all | 3 | 2 | 3 | 3 | 2 | - | - | - | 3 | - | 3 | 3 | 3 | 1 | 1 |

**CES337 INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT**

**L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To create awareness on the energy scenario of India with respect to world
- To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation
- Familiarisation on the concept of sustainable development and its benefits
- Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development
- Acquainting with energy policies and energy planning for sustainable development

**UNIT I ENERGY SCENARIO 9**

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security

**UNIT II ENERGY AND ENVIRONMENT 9**

Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls

**UNIT III SUSTAINABLE DEVELOPMENT 9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.

**UNIT IV RENEWABLE ENERGY TECHNOLOGY 9**

Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits

**UNIT V ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT 9**

National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1** Understand the world and Indian energy scenario

**CO2** Analyse energy projects, its impact on environment and suggest control strategies

**CO3** Recognise the need of Sustainable development and its impact on human resource development

**CO4** Apply renewable energy technologies for sustainable development

**CO5** Fathom Energy policies and planning for sustainable development.

**REFERENCES:**


1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Robert Ristirer and Jack P. Kraushaar, “Energy and the environment”, Willey, 2005.
3. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012
4. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.
5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.
6. M.H. Fulekar,Bhawana Pathak, R K Kale,“Environment and Sustainable Development” Springer,2016
7. https://www.niti.gov.in/verticals/energy

**CES338 ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT L T P C**
**3 0 0 3**

**COURSE OBJECTIVES:**

- To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation
- To create awareness on energy audit and its impacts
- To acquaint the techniques adopted for performance evaluation of thermal utilities
- To familiarise on the procedures adopted for performance evaluation of electrical utilities
- To learn the concept of sustainable development and the implication of energy usage

**UNIT I ENERGY AND ENVIRONMENT 9**

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

**UNIT II ENERGY AUDITING 9**

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

**UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9**

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

**UNIT IV ENERGY CONSERVTION IN ELECTRICAL UTILITIES 9**

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

**UNIT V SUSTAINABLE DEVELOPMENT 9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,

**TOTAL : 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, the students will be able to

**CO1** Understand the prevailing energy scenario
**CO2** Familiarise on energy audits and its relevance
**CO3** Apply the concept of energy audit on thermal utilities
**CO4** Employ relevant techniques for energy improvement in electrical utilities
**CO5** Understand Sustainable development and its impact on human resource development

**REFERENCES:**


1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific & Technical, ISBN-0-582-03184, 1990

3. W.R. Murphy and G. McKay “Energy Management” Butterworths, London 1987
4. Pratap Bhattacharyya, “Climate Change and Greenhouse Gas Emission”, New India Publishing Agency- Nipa,2020
5. Matthew John Franchetti , Defne Apul “Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies” CRC Press,2012
6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, “Energy and the Environment”, 4th Edition,Wiley,2022
7. M.H. Fulekar,Bhawana Pathak, R K Kale,“Environment and Sustainable Development” Springer,2016
8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.