ANNAUNIVERSITY,CHENNAI
NON-AUTONOMOUSAFFILIATEDCOLLEGES REGULATIONS
2021
CHOICEBASEDCREDITSYSTEM

B.E. ELECTRONICS ENGINEERING
(VLSI DESIGN AND TECHNOLOGY)

I. PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

1. To provide the students with a strong foundation in the required sciences in order to pursue studies in Electronics Engineering.
2. To gain adequate knowledge to become good professional in electronics engineering associated industries, higher education and research.
3. To develop attitude in lifelong learning, applying and adapting new ideas and technologies as their field evolves.
4. To prepare students to critically analyze existing literature in an area of specialization and ethically develop innovative and research oriented methodologies to solve the problems identified.
5. To inculcate in the students a professional and ethical attitude and an ability to visualize the engineering issues in a broader social context.

II. PROGRAM OUTCOMES(POs)

1 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2 **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5 **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6 **Theengineerandsociety**:Applyreasoninginformedbythecontextualknowledge toassesssocietal,health,safety,legalandculturalissuesandtheconsequentresponsibilitiesrelevanttothe professional engineering practice.

7 **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and needfor sustainable development.

8 **Ethics**:Applyethicalprinciplesandcommittoprofessionalethicsandresponsibilities andnormsof the engineering practice.

9 **Individualandteamwork**:Functioneffectivelyasanindividual,andasamember orleaderin diverse teams, and in multidisciplinary settings.

10 **Communication:**Communicate effectively on complex engineeringactivitieswith the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-longlearning**:Recognizetheneedfor,andhavethepreparationandability toengagein independentandlife-longlearninginthebroadestcontextoftechnological change.

III. PROGRAMSPECIFICOUTCOMES(PSOs)

PSO1: Design, develop and analyze electronic systems through application of relevant electronics, mathematics and engineering principles

PSO2: Design, develop and analyze electronic systems through application of fundamentals from electronic principles, VLSI technology, signal processing, and RF System Design.

PSO3:Adapt to emerging electronics and VLSI technologies and develop innovative solutions for existing and newer problems

PEOs(1to5)mappedwithPosandPSOs

PEO	PO												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
I.	3	3	2	2	2	2	-	-	-	-	-	3	3	2	3
II.	3	3	3	3	2	-	-	-	2	1	2	3	3	3	3
III.	3	2	3	3	3	-	-	-	2	2	-	3	3	3	3
IV.	3	3	3	3	2	-	-	3	-	-	-	2	2	2	2
V.	-	-	-	-	2	2	2	2	-	-	-	-	1	1	1

1-low,2-medium,3-high,'-'-nocorrelation

MappingofCourseOutcomeandProgrammeOutcome																	
Year	Sem	Coursename	PO												PSO		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I	I	Induction Programme															
		Professional English- I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	
		Matrices and Calculus	3	3	1	1	0	0	0	0	2	0	2	3	-	-	
		Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	
		Engineering Graphics	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
		Programming in C	3	3	3	3	2	1	-	-	3	2	3	3	3	3	-
		தமிழர்மரபு/ Heritage of Tamils															
		Engineering Practices Laboratory	3	2			1	1	1					2	2	1	1
		Physics Laboratory	3	2.4	2.6	1	1										
		English Laboratory$	3	3	3	3	1	3	3	3	3	3	3	3	-	-	
	II	Professional English-II	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-
		Statistics and Numerical Methods	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
		Electrical and Instrumentation Engineering	2	1	1					1					-	-	-
		C++ and Data Structures	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2
		Semiconductor and Devices	3	2	1.4	1.5	2.5	2	3					1			
		Circuits and Network Analysis	3	3	3	2	-	-	-	1	-	1	-	-	-	-	-
		தமிழரும் தொழில்நுட்பமும் / Tamils andTechnology															
		Communication Laboratory	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-
II	III	Probability. Random Processes and Linear Algebra	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
		Electromagnetic Fields and Transmission lines	3	3	2.6	1.8	2.2	-	-	-	-		-	-	2.6	2.8	1.4
		Signals and Systems	3	3	2.4	2	2	-	-	-	1	1	-	-	2.6	2.6	0.2
		Analog Circuits	3	3	3	3	2	2	-	-	-	-	-	1	2	1	1
		Digital System Design	2	2	2.6	3	2	1	-	-	-	-	-	1	2	1	1
		Object Oriented Programming using Python	2	3	3	3	2	-	-	-	-	-	2	2	3	3	2
		Analog Circuits Laboratory	3	3	2.3	2	2.3	-	-	-	1	1	-	-	2.7	2.3	1
		Professional Development$															
II	IV	LinearIntegrated Circuits	1.4	2.5	3	2.2	-	-	-	-	1	-	1	3	2	1	1
		Principles of Communication Systems	3	3	3	3	2	1	1	-	-	-	1	1	3	2	2
		Control Systems	3	3	3	3	2	2	-	-	-	-	2	3	3	3	3
		Digital VLSI Design	2	2	2	2	1	1.5	-	-	-	-	1	2	3	3	3
		Digital Signal Processing	3	3	2	2	2	2	-	-	-	-	1	1	2	2	2

		Environmental SciencesandSustainability	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-
		HDL Programming Laboratory	3	2.4	2.6	2.22	2.8	-	-	-	1	2	1	-	3	3	2
		Linear Integrated Circuits Laboratory	2	3	3	3	2	-	-	-	-	-	1	1			
III	V	Computer Architecture And Organization	3	2.6	1.75	1	2.6	-	-	-	1	-	--	1.2	2.6	2.6	1.8
		Analog CMOS ICDesign	3	3	2.6	2.2	1.8	1.8	-	-	-	-	-	2.2	2.4	2	2
		VLSI Testing And Design For Testability	3	2.6	2	2.2	3	-	1	-	1	-	--	1.2	2.8	3	2.4
		Microprocessors, Microcontrollers And Interfacing	3	2.6	2.75	1.5	2.8	-	1	-	1	1	-	1.2	3	2.8	2
		Analog And Digital CMOS IC Design Laboratory	3	2.8	2.8	2.4	3	-	1	1	1	1	1	2.2	3	3	2.8
	VI	Wireless Communication	3	3	2	2	2	2	-	-	-	-	-	1	3	1	2
		Machine Learning For IC Design	3	2.6	2.75	1.8	2.8	-	1	-	1	1	-	2	2.8	2.4	3
		VLSI Signal Processing	2.6	2.6	2	1.75	2.6		1				2	1.7	2.4	2.4	1.6
		Mini Project															
IV	VII	Human Values And Ethics	2	2.2	-	2	-	2.8	1.8	2.4	2.2	2	-	2.4	-	-	1
		IC Packaging Technologies	3	2.8	2.2	2. 7	2.25					2		2	3	2.6	2.4
		Summer Internship															
	VIII	Project Work/ Internship															

1-low,2-medium,3-high,'-' –nocorrelation

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B.E.ELECTRONICS ENGINEERING (VLSI DESIGN AND TECHNOLOGY)
CHOICE BASED CREDIT SYSTEM
CURRICULUMANDSYLLABIFORSEMESTERSITO VIII

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.	GE3251	Engineering Graphics	BSC	2	0	4	6	4
6.	VL3101	Programming in C	ESC	2	0	2	4	3
7.	GE3152	தமிழர்மரபு/ Heritage of Tamils	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	VL3111	Physics Laboratory	BSC	0	0	2	2	1
10.	GE3172	English Laboratory	EEC	0	0	2	2	1
			TOTAL	**14**	**1**	**14**	**29**	**22**

SEMESTER II

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			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.	BE3254	Electrical and Instrumentation Engineering	ESC	3	0	0	3	3
4.	VL3201	C++ and Data Structures	ESC	2	0	4	6	4
5.	VL3202	Semiconductor and Devices	PCC	3	0	2	5	4
6.	VL3203	Circuits and Network Analysis	PCC	3	1	2	6	5
7.	GE3252	Tamils and Technology	HSMC	1	0	0	1	1
8.		NCC Credit Course Level1#	-	2	0	0	2	2*
PRACTICALS								
9.	GE3272	Communication Laboratory	EEC	0	0	4	4	2
			TOTAL	**17**	**2**	**12**	**31**	**25**

#NCC Credit Course level1 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.

SEMESTERIII

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3305	Probability, Random Processes and Linear Algebra	BSC	3	1	0	4	4
2.	VL3301	Electromagnetic Fields and Transmission Lines	PCC	3	0	0	3	3
3.	EC3354	Signals and Systems	PCC	3	1	0	4	4
4.	VL3302	Analog Circuits	PCC	3	0	0	3	3
5.	EC3352	Digital System Design	PCC	3	0	2	5	4
6.	VL3303	Object Oriented Programming using Python	ESC	3	0	2	5	4
PRACTICALS								
7.	VL3311	Analog Circuits Laboratory	PCC	0	0	4	4	2
8.	GE3361	Professional Development	EEC	0	0	2	2	1
			TOTAL	**18**	**2**	**10**	**31**	**25**

SEMESTERIV

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EC3451	Linear Integrated Circuits	PCC	3	0	0	3	3
2.	VL3401	Principles of Communication Systems	PCC	3	0	2	5	4
3.	EC3351	Control Systems	PCC	3	0	0	3	3
4.	VL3402	Digital VLSI Design	PCC	3	0	0	3	3
5.	EC3492	Digital Signal Processing	PCC	3	0	2	5	4
6.	GE3451	Environmental Sciences and Sustainability	BSC	2	0	0	2	2
		NCC Credit Course Level 2[#]		3	0	0	3	3[#]
PRACTICALS								
7.	VL3411	HDL Programming Laboratory	PCC	0	0	4	4	2
8.	VL3412	Linear Integrated Circuits Laboratory	PCC	0	0	4	4	2
			TOTAL	**17**	**0**	**12**	**29**	**23**

[#]NCC Credit Course level 2 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 V

S. NO.	COURSE CODE	COURSETITLE	CATE-GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	VL3501	Computer Architecture and Organization	PCC	3	0	0	3	3
2.	VL3502	Analog CMOS IC Design	PCC	3	0	0	3	3
3.	CEC362	VLSI Testing and Design For Testability	PCC	3	0	0	3	3
4.	VL3503	Microprocessors, Microcontrollers and Interfacing	PCC	3	0	2	5	4
5.		Professional Elective I	PEC	-	-	-	-	3
6.		Professional Elective II	PEC	-	-	-	-	3
		Mandatory Course-I[&]	MC	3	0	0	3	Non-credit course
PRACTICALS								
7.	VL3511	Analog and Digital CMOS IC Design Laboratory	PCC	0	0	4	4	2
			TOTAL	**15**	**0**	**6**	**21**	**21**

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

SEMESTER VI

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EC3501	Wireless Communication	PCC	3	0	2	5	4
2.	VL3601	Machine Learningfor IC Design	PCC	3	0	2	5	4
3.	VL3602	VLSI Signal Processing	PCC	3	0	0	3	3
4.		Open Elective–I*	OEC	3	0	0	3	3
5.		Professional Elective III	PEC	-	-	-	-	3
6.		Professional Elective IV	PEC	-	-	-	-	3
7.		Mandatory Course-II&	MC	3	0	0	3	Non-credit course
8.		NCC Credit Course Level 3#		3	0	0	3	3[#]
PRACTICALS								
9.	VL3611	Mini Project	EEC	0	0	2	2	1
			TOTAL	**18**	**0**	**6**	**24**	**21**

*Open Elective–I Shall be chosen from the list of open electives offered by other Programmes

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

SEMESTERVII/VIII*

S. NO	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
2.		Elective-Management#	HSMC	3	0	0	3	3
3.	VL3701	IC Packaging Technologies	PCC	3	0	0	3	3
4.		Professional Elective V	PEC	-	-	-	-	3
5.		Open Elective– II**	OEC	3	0	0	3	3
PRACTICALS								
8.	VL3711	Summer internship	EEC	0	0	0	0	2
			TOTAL	**14**	**0**	**0**	**11**	**16**

*If students undergo internship in Semester VII, then the courses offered during semester VII will be offeredduring semester VIII.
**Open ElectiveII (Shall be chosen from the list of open electives offered by other Programmes).
#Elective-Management shall be chosen from the Elective Management courses.

SEMESTER VIII/VII*

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	VL3811	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.

TOTALCREDITS: 162

ELECTIVE–MANAGEMENTCOURSES

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	GE3751	Principles of Management	HSMC	3	0	0	3	3
2.	GE3752	Total Quality Management	HSMC	3	0	0	3	3
3.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
4.	GE3754	HumanResource Management	HSMC	3	0	0	3	3
5.	GE3755	Knowledge Management	HSMC	3	0	0	3	3
6.	GE3792	Industrial Management	HSMC	3	0	0	3	3

MANDATORYCOURSES I*

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

*Mandatory Courses are offered as Non-Credit Courses

MANDATORYCOURSES II*

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

*Mandatory Courses are offered as Non-Credit Courses

PROFESSIONAL ELECTIVE COURSES:VERTICALS

Vertical I Semiconductor Devices and Technology	Vertical II Chip Design and Testing	Vertical III VLSI Circuits and System Design	Vertical IV Signal Processing	Vertical V RF Technologies	Vertical VI IoT and Applications	Vertical VII VLSI Applications	Vertical VIII Fabrication and Advanced Design Techniques
Semiconductor Device Modeling	ASIC Design	Data Converters	Advanced Digital Signal Processing	RFTransceivers	Embedded Systems and IoT	VLSI Architectures for Image Processing	Microchip Fabrication
Fundamentals of Nano Electronics	Validation and Testing Technology	Reconfigurable Architectures	Digital Image and Video Processing	Signal Integrity for High Speed Design	WirelessSensor Network Design	VLSI Circuits for Biomedical applications	Evolvable hardware
Advanced Semiconductor Devices	Network On Chip	Hardware Software Co Design For FPGA	Speech processing	VLSI Interconnects	IoT Processors	VLSI structures for DSP	Reliability in VLSI Circuits
Wide bandgapdevices	Mixed Signal IC Design	Power Management and Clock Distribution	Computer Vision	MICs And RF System Design	IoT Protocols	VLSIDesign Of Neural Networks	Cryptography and Hardware Security
FinFETDevices for VLSI Circuits and Systems	Low Power IC Design	Semiconductor Memories	DSP Architecture and Programming	EMI/EMC Pre Compliance Testing	IoT Security	VLSI for Wireless Communications	IP Core Design and Protection
Nano Sensors and Devices	Algorithms For VLSI Physical Design Automation	Multicore Architecture and Programming	Adaptive Signal Processing	RFID System Design &Testing	Industrial IoT and Industry 4.0	Integrated Circuits for Optical Communication	Artificial Intelligence in VLSI design
Nanophotonic Devices	System on chip	Synthesis and Optimization of VLSI circuits	Bio-Inspired Computing	Introduction To MEMS and NEMS	Data Analytics For IoT	Hardware architectures for deep learning	Quantum computing
	System Verilog for Verification						

RegistrationofProfessionalElectiveCoursesfromVerticals:

RefertotheRegulations2021,Clause6.3.(Amendedon27.07.2023)

PROFESSIONALELECTIVECOURSES:VERTICALS

VERTICAL1:SEMICONDUCTOR DEVICES AND TECHNOLOGY

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL3001	Semiconductor device modeling	PEC	3	0	0	3	3
2.	CEC339	Fundamentals of Nanoelectronics	PEC	3	0	0	3	3
3.	VL3002	Advanced Semiconductor Devices	PEC	3	0	0	3	3
4.	CEC363	Wide Bandgap Devices	PEC	2	0	2	4	3
5.	VL3003	FinFET Devices for VLSI Circuits and Systems	PEC	2	0	2	4	3
6.	VL3004	Nano Sensors and Devices	PEC	3	0	0	3	3
7.	VL3005	Nanophotonic Devices	PEC	3	0	0	3	3

VERTICAL 2: CHIP DESIGN AND TESTING

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL3006	ASIC Design	PEC	3	0	0	3	3
2.	CEC361	Validation and Testing Technology	PEC	3	0	0	3	3
3.	VL3007	Network On Chip	PEC	3	0	0	3	3
4.	VL3008	Mixed Signal IC Design	PEC	2	0	2	4	3
5.	CEC370	Low Power IC Design	PEC	2	0	2	4	3
6.	VL3009	Algorithms for VLSI Physical Design Automation	PEC	3	0	0	3	3
7.	VL3010	System on chip	PEC	3	0	0	3	3
8.	VL3011	System Verilog for Verification	PEC	2	0	2	4	3

VERTICAL 3: VLSI CIRCUITS AND SYSTEM DESIGN

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL3012	Data Converters	PEC	3	0	0	3	3
2.	VL3013	Reconfigurable Architectures	PEC	3	0	0	3	3
3.	VL3014	Hardware Software Co Design For FPGA	PEC	3	0	0	3	3
4.	VL3015	Power Management and Clock Distribution	PEC	3	0	0	3	3
5.	VL3016	Semiconductor Memories	PEC	3	0	0	3	3
6.	VL3017	Multicore Architecture and Programming	PEC	3	0	0	3	3
7.	VL3018	Synthesis and Optimization of VLSI Circuits	PEC	3	0	0	3	3

VERTICAL 4: SIGNAL PROCESSING

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC332	Advanced Digital Signal Processing	PEC	2	0	2	4	3
2.	VL3019	Digital Image and Video Processing	PEC	3	0	0	3	3
3.	CEC356	Speech Processing	PEC	3	0	0	3	3
4.	CCS338	Computer Vision	PEC	2	0	2	4	3
5.	CEC337	DSP Architecture and Programming	PEC	2	0	2	4	3
6.	VL3020	Adaptive Signal Processing	PEC	3	0	0	3	3
7.	VL3021	Bio-Inspired Computing	PEC	3	0	0	3	3

VERTICAL 5:RF TECHNOLOGIES

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CEC350	RFTransceivers	PEC	2	0	2	4	3
2.	VL3022	Signal Integrity for High Speed Design	PEC	3	0	0	3	3
3.	VL3023	VLSI Interconnects	PEC	3	0	0	3	3
4.	CEC341	MICs And RF System Design	PEC	2	0	2	4	3
5.	CEC338	EMI / EMC Pre Compliance Testing	PEC	2	0	2	4	3
6.	CEC349	RFID System Design &Testing	PEC	2	0	2	4	3
7.	VL3024	Introduction To MEMS and NEMS	PEC	3	0	0	3	3

VERTICAL 6: IoT AND APPLICATIONS

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL3042	Embedded Systems and IoT	PEC	2	0	2	4	3
2.	CEC365	Wireless Sensor Network Design	PEC	3	0	0	3	3
3.	CEC369	IoTProcessors	PEC	2	0	2	4	3
4.	VL3025	IoT Protocols	PEC	3	0	0	3	3
5.	VL3026	IoT Security	PEC	3	0	0	3	3
6.	CEC367	Industrial IoT and Industry 4.0	PEC	3	0	0	3	3
7.	VL3027	Data Analytics for IoT	PEC	3	0	0	3	3

VERTICAL7: VLSI APPLICATIONS

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL3028	VLSI Architectures for Image Processing	PEC	3	0	0	3	3
2.	VL3029	VLSI Circuits for Biomedical applications	PEC	3	0	0	3	3
3.	VL3030	VLSI Structures for DSP	PEC	3	0	0	3	3
4.	VL3031	VLSI Design of Neural networks	PEC	3	0	0	3	3
5.	VL3032	VLSI for Wireless Communications	PEC	3	0	0	3	3
6.	VL3033	Integrated Circuits for Optical Communication	PEC	3	0	0	3	3
7.	VL3034	Hardware architectures for deep learning	PEC	3	0	0	3	3

VERTICAL 8: FABRICATION AND ADVANCED DESIGN TECHNIQUES

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIOD PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	VL3035	Microchip Fabrication	PEC	3	0	0	3	3
2.	VL3036	Evolvable hardware	PEC	3	0	0	3	3
3.	VL3037	Reliability in VLSI Circuits	PEC	3	0	0	3	3
4.	VL3038	Cryptography and Hardware Security	PEC	3	0	0	3	3
5.	VL3039	IP Core Design and Protection	PEC	3	0	0	3	3
6.	VL3040	Artificial Intelligence in VLSI design	PEC	3	0	0	3	3
7.	VL3041	Quantum computing	PEC	2	0	2	4	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).

OPENELECTIVES–I

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OAS351	Space Science	OEC	3	0	0	3	3
2.	OIE351	Introduction to Industrial Engineering	OEC	3	0	0	3	3
3.	OCH353	Energy Technology	OEC	3	0	0	3	3
4.	OCE351	Environmental and Social Impact Assessment	OEC	3	0	0	3	3
5.	OEE351	Renewable Energy System	OEC	3	0	0	3	3
6.	OEI351	Introduction to Industrial Instrumentation and Control	OEC	3	0	0	3	3
7.	OMA351	Graph Theory	OEC	3	0	0	3	3
8.	CCW332	Digital Marketing	OEC	2	0	2	4	3
9.	OIE352	Resource Management Techniques	OEC	3	0	0	3	3
10.	OMG351	Fintech Regulation	OEC	3	0	0	3	3
11.	OFD351	Holistic Nutrition	OEC	3	0	0	3	3
12.	AI3021	IT in Agricultural System	OEC	3	0	0	3	3
13.	OEI352	Introduction to Control Engineering	OEC	3	0	0	3	3
14.	CME365	Renewable Energy Technologies	OEC	3	0	0	3	3
15.	OAE351	Aviation Management	OEC	3	0	0	3	3
16.	CCS342	DevOps	OEC	2	0	2	4	3
17.	CCS361	Robotic Process Automation	OEC	2	0	2	4	3
18.	OMR351	Mechatronics	OEC	3	0	0	3	3
19.	OMR353	Sensors	OEC	3	0	0	3	3
20.	AU3791	Electric and Hybrid Vehicles	OEC	3	0	0	3	3
21.	OAS352	Space Engineering	OEC	3	0	0	3	3
22.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
23.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
24.	AU3008	Sensors and Actuators	OEC	3	0	0	3	3
25.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
26.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
27.	CCS355	Neural Networks and Deep Learning	OEC	2	0	2	4	3

OPENELECTIVES–II

S. NO.	COURSE CODE	COURSETITLE	CATEGORY	PERIODS PERWEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	EnglishforCompetitive Examinations	OEC	3	0	0	3	3
2.	OBT351	Food, Nutrition and Health	OEC	3	0	0	3	3
3.	OMG353	DemocracyandGood Governance	OEC	3	0	0	3	3
4.	OME354	Applied Design Thinking	OEC	3	0	0	3	3
5.	MF3003	Reverse Engineering	OEC	3	0	0	3	3
6.	OIM351	Industrial Management	OEC	3	0	0	3	3
7.	OIE354	Quality Engineering	OEC	3	0	0	3	3
8.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
9.	OML351	Introduction to Non-Destructive Testing	OEC	3	0	0	3	3
10.	OAE352	Fundamentals of Aeronautical Engineering	OEC	3	0	0	3	3
11.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
12.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
13.	OEN351	Drinking Water Supply and Treatment	OEC	3	0	0	3	3
14.	OEE352	Electric Vehicle Technology	OEC	3	0	0	3	3
15.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
16.	OCH351	Nano Technology	OEC	3	0	0	3	3
17.	OCH352	Functional Materials	OEC	3	0	0	3	3
18.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
19.	OFD353	Introduction to Food Processing	OEC	3	0	0	3	3
20.	OPY351	Pharmaceutical Nanotechnology	OEC	3	0	0	3	3
21.	CPE334	EnergyConservationand Management	OEC	3	0	0	3	3
22.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
23.	CBM348	Foundation Skills in Integrated Product Development	OEC	3	0	0	3	3
24.	CBM333	Assistive Technology	OEC	3	0	0	3	3
25.	OMA352	Operations Research	OEC	3	0	0	3	3
26.	OCE353	Lean Concepts, Tools and Practices	OEC	3	0	0	3	3
27.	OHS352	Project Report Writing	OEC	3	0	0	3	3
28.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
29.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
30.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
31.	CME343	New Product Development	OEC	3	0	0	3	3
32.	OME355	Industrial Design&Rapid Prototyping Techniques	OEC	3	0	0	3	3
33.	MF3010	MicroandPrecisionEngineering	OEC	3	0	0	3	3
34.	OMF354	CostManagementof EngineeringProjects	OEC	3	0	0	3	3
35.	AU3002	BatteriesandManagement system	OEC	3	0	0	3	3
36.	OIE353	OperationsManagement	OEC	3	0	0	3	3
37.	OSF352	IndustrialHygiene	OEC	3	0	0	3	3
38.	OSF353	ChemicalProcessSafety	OEC	3	0	0	3	3
39.	ORA352	ConceptsinMobileRobots	OEC	3	0	0	3	3
40.	CRA332	DroneTechnologies	OEC	3	0	0	3	3

41.	OGI352	GeographicalInformation System	OEC	3	0	0	3	3
42.	OAI352	AgricultureEntrepreneurship Development	OEC	3	0	0	3	3
43.	OEN352	BiodiversityConservation	OEC	3	0	0	3	3
44.	OCH354	SurfaceScience	OEC	3	0	0	3	3
45.	OFD354	FundamentalsofFood Engineering	OEC	3	0	0	3	3
46.	OFD355	FoodSafetyandQuality Regulations	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.	OBT356	Lifestyle Diseases	OEC	3	0	0	3	3
50.	OBT357	Biotechnology in Health Care	OEC	3	0	0	3	3

SUMMARY

Name of the Programme: B.E. Electronics Engineering (VLSI Design and Technology)										
S.No	**SubjectArea**	**Creditsper Semester**								**Total Credits**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII/VIII**	**VIII/VII**	
1	**HSMC**	**4**	**3**					**5**		**12**
2	**BSC**	**12**	**4**	**4**	**2**					**22**
3	**ESC**	**5**	**7**	**4**						**16**
4	**PCC**		**9**	**16**	**21**	**15**	**10**	**3**		**74**
5	**PEC**					**6**	**6**	**3**		**15**
6	**OEC**						**3**	**3**		**6**
7	**EEC**	**1**	**2**	**1**			**1**	**2**	**10**	**17**
8	**Non-Credit /(Mandatory)**					√	√			
Total		**22**	**25**	**25**	**23**	**21**	**20**	**16**	**10**	**162**

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 (Amendments) of Regulations 2021.

VERTICALS FOR MINOR DEGREE

(In addition to all the verticals of other programmes)

Vertical I **Fintechand BlockChain**	Vertical II **Entrepreneurship**	Vertical III **PublicAdministration**	Vertical IV **BusinessData Analytics**	Vertical V **EnvironmentandSustainability**
Financial Management	Foundationsof Entrepreneurship	PrinciplesofPublic Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentalsof Investment	TeamBuilding&Leadership Managementfor Business	ConstitutionofIndia	Dataminingfor Business Intelligence	Sustainable Agricultureand Environmental Management
Banking,Financial Services and Insurance	Creativity&Innovation in Entrepreneurship	PublicPersonnel Administration	Human Resource Analytics	SustainableBio Materials
Introduction to Blockchainandits Applications	PrinciplesofMarketing Management ForBusiness	Administrative Theories	Marketingand Social Media WebAnalytics	MaterialsforEnergySustainability
FintechPersonal Finance and Payments	HumanResource Management for Entrepreneurs	IndianAdministrative System	Operationand Supply Chain Analytics	GreenTechnology
Introductionto Fintech	FinancingNew BusinessVentures	Public Policy Administration	Financial Analytics	EnvironmentalQuality Monitoring and Analysis
-	-	-	-	IntegratedEnergy Planning for Sustainable Development
-	-	-	-	EnergyEfficiencyfor Sustainable Development

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL1:FINTECHANDBLOCKCHAIN

S. NO.	COURSE CODE	COURSETITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction toBlockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

VERTICAL 2: ENTREPRENEURSHIP

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building & Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity & Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management For Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurs	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL 3: PUBLIC ADMINISTRATION

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL 4: BUSINESS DATA ANALYTICS

S. NO.	COURSE CODE	COURSETITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics for Management	PEC	3	0	0	3	3
2.	CMG350	Data mining for Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing and Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation and Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

S. NO.	COURSE CODE	COURSETITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable BioMaterials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning For Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

IP3151 INDUCTION PROGRAMME

This is a mandatory 2 weekprogramme 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, standup 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 basedprogramme and therefore there shall be no tests / assessments during this programme.

References:

Guide to Induction program from AICTE

HS3152 PROFESSIONAL ENGLISH I L T PC

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?

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 grammatic structures and use them in right context. CO3: To read and infer the denotative and connotative meanings of technical texts

CO4: 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) English for Science & Technology Cambridge University Press, 2021.
2. 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, McgrawHill 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 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
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

MA3151 MATRICES AND CALCULUSL T P C

3 1 0 4

COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that are 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 MATRICES9+3

Eigen values and Eigen vectors of a real matrix –Characteristic equation –Properties of Eigen values 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 CALCULUS9+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.

TEXTBOOKS:

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal.B.S.,"HigherEngineering Mathematics", KhannaPublishers,NewDelhi, 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. andIyengar.S.R.K., "Advanced EngineeringMathematics",NarosaPublications, New Delhi,5th Edition, 2016.
4. Narayanan.S.andManicavachagomPillai.T.K.,"Calculus" Volume IandII, 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	-	-	-

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

PH3151 ENGINEERING PHYSICS L T P C

3 0 0 3

COURSE OBJECTIVES:

- To make the students effectively 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 successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

UNIT I MECHANICS 9

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the 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 energybands.

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. PaulA.Tipler,Physic–Volume1&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.Damask27eri.Schwarz. Physics for Computer Science Students. Springer- Verlag, 2012.

CO's – PO's & PSO's MAPPING

CO	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	-	-	-	-	-	-	-	-	-
AV	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-

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

GE3251 ENGINEERING GRAPHICS L T PC
2 0 44

COURSE OBJECTIVES:

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

- Drawing engineering curves.
- Drawing free hand 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 CURVES6+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 SURFACE6+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 FREE HAND SKETCHING6+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 SURFACES6+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 PROJECTIONS6+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) 90PERIODS

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. BhattN.D.andPanchalV.M.,"EngineeringDrawing",CharotarPublishingHouse,53rd Edition, 2019.
2. Natrajan K.V., "AText Book of EngineeringGraphics", Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy,N.S.and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

REFERENCES:

1. Basant Agarwaland 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. ShahM.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. IS10711—2001: Technical products Documentation— Size and layout of drawing sheets.
2. IS9609 (Parts 0 & 1)—2001: Technical products Documentation—Lettering.
3. IS10714 (Part 20)—2001 & SP46—2003: Lines for technical drawings.
4. IS11669—1986 & SP46—2003: Dimensioning of Technical Drawings.
5. IS15021(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

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	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	-
CO	**3**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**2**	**2**	**2**	**-**

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

VL3101 PROGRAMMING IN C L T P C

2 0 2 3

UNIT I BASICS OF C PROGRAMMING 6

Introduction to programming paradigms –- Structure of C program – C programming: Data Types – Constants – Keywords – Operators: Precedence and Associativity – Expressions – Input / Output statements, Assignment statements – Decision making statements – Switch statement.

UNIT II LOOP CONTROL STATEMENTS AND ARRAYS 6

Iteration statements: For, while, Do-while statements, nested loops, break & continue statements – Introduction to Arrays: Declaration, Initialization –One dimensional array –Two dimensional arrays – Searching and sorting in Arrays – Strings – string handling functions – array of strings.

UNIT III FUNCTIONS AND POINTERS 6

Modular programming – Function prototype, function definition, function call, Built-in functions – Recursion – Recursive functions – Pointers – Pointer increment, Pointer arithmetic – Parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation with *malloc/calloc*

UNIT IV STRUCTURES AND UNION 6

Storage class, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, structure and functions, typedef, bit fields, enumerated data types, Union.

UNIT V MACROS AND FILE PROCESSING 6

Preprocessor directives – Simple and Conditional macros with and without parameters – Files – Types of file processing: Sequential and Random access – File operations – read, write & seek.

30 PERIODS

PRACTICALS:

1. Programs for i/o operations with different data types and operators
2. Programs using branching and looping statements
3. Programs implementing searching and sorting using arrays
4. Programs using recursive functions
5. Programs using pointers
6. Programs using Structures and Unions
7. Programs using macros
8. Programs to handle file operations

30 PERIODS

COURSE OUTCOMES:

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

CO1: Write simple C programs using basic constructs.

CO2: Design searching and sorting algorithms using arrays and strings.

CO3: Implement modular applications using Functions and pointers.

CO4: Develop and execute applications using structures and Unions.

CO5: Solve real world problem using files.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCE BOOKS:

1. Pradip Dey, Manas Ghosh, “Computer Fundamentals and Programming in C”, Second Edition, Oxford University Press, 2013.
2. Ashok N Kamthane, Programming in C, Pearson, Third Edition, 2020
3. Reema Thareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
4. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education, 2018.
5. Byron S. Gottfried, “Schaum’s Outline of Theory and Problems of Programming with C”’ McGraw-Hill Education, 1996.
6. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, 1st Edition, Pearson Education, 2013.

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	1	2	2	1	-	-	-	2	-	3	3	3	-
2	3	-	3	3	1	1	-	-	-	-	-	-	3	-	-
3	3	3	3	3	2	-	-	-	3	-	-	-	3	-	-
4	3	3	3	3	2	-	-	-	3	-	3	3	3	-	-
5	3	3	3	3	3	2	-	-	-	-	3	3	3	-	-
Avg	**3**	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**3**	**2**	**3**	**3**	**3**	**3**	**-**

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

GE3152 HERITAGE OF TAMILS L TP C
1 00 1

UNIT I LANGUAGE AND LITERATURE3

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 andImpact 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 – ROCKART 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 ARTS3

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

UNIT IV THINAI CONCEPT OF TAMILS3

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 CONTRIBUTIONOFTAMILSTOINDIANNATIONALMOVEMENTANDINDIAN CULTURE3

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. தமிழகவரலொறு–மக்களும்பண்பொடும்–கக·கக·பிள்ளள(தவளியீடு: தமிழ்நொடுபொடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2. கணினித்தமிழ்–முளனவர்இல·சுந்தரம்·(விகடன்பிரசுரம்)·
3. கீழடி–
   ளவளகநதிக்களரயில்சங்ககொலநகரநொகரிகம்(ததொல்லியல்Fளறதவளியீடு)
4. தபொருளந–ஆற்றங்களரநொகரிகம்·(ததொல்லியல்Fளறதவளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL–(inprint)
6. Social Life of the Tamils-The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. HistoricalHeritageoftheTamils(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 Civilization 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 TamilNadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology &TamilNadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3152 **தமிழர்மரபு** **L T P C**

1 0 0 1

அலகு I **மொழிமற்றும்இலக்கியம்**: **3**

இந்தியமொழிக்குடும்பங்கள் – திராவிடமொழிகள் – தமிழ்ஒருசெம்மொழி – தமிழ்செவ்விலக்கியங்கள்–சங்கஇலக்கியத்தின்சமயச்சார்பற்றதன்மை – சங்கஇலக்கியத்தில்பகிர்தல்அறம் – திருக்குறளில்மேலாண்மைக்கருத்துக்கள் – தமிழ்க்காப்பியங்கள், தமிழகத்தில்சமணபௌத்தசமயங்களின்தாக்கம்– பக்திஇலக்கியம், ஆழ்வார்கள்மற்றும்நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில்நவீனஇலக்கியத்தின்வளர்ச்சி – தமிழ்இலக்கியவளர்ச்சியில்பாரதியார்மற்றும்பாரதிதாசன்ஆகியோரின்பங்களிப்பு.

அலகு II மரபு – பாறைஓவியங்கள்முதல்நவீனஓவியங்கள்வரை – சிற்பக்கலை: **3**

நடுகல்முதல்நவீனசிற்பங்கள்வரை – ஐம்பொன்சிலைகள்– பழங்குடியினர்மற்றும்அவர்கள்தயாரிக்கும்கைவினைப்பொருட்கள், பொம்மைகள் – தேர்செய்யும்கலை – சுடுமண்சிற்பங்கள் – நாட்டுப்புறத்தெய்வங்கள் – குமரிமுனையில்திருவள்ளுவர்சிலை – இசைக்கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின்சமூகபொருளாதாரவாழ்வில்கோவில்களின்பங்கு.

அலகு III **நாட்டுப்புறக்கலைகள்மற்றும்வீரவிளையாட்டுகள்**: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான்கூத்து, ஒயிலாட்டம், தோல்பாவைக்கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின்விளையாட்டுகள்.

அலகு IV **தமிழர்களின்திணைக்கோட்பாடுகள்**: **3**

தமிழகத்தின்தாவரங்களும், விலங்குகளும் – தொல்காப்பியம்மற்றும்சங்கஇலக்கியத்தில்அகம்மற்றும்புறக்கோட்பாடுகள் – தமிழர்கள்போற்றியஅறக்கோட்பாடு – சங்ககாலத்தில்தமிழகத்தில்எழுத்தறிவும், கல்வியும் – சங்ககாலநகரங்களும்துறைமுகங்களும் – சங்ககாலத்தில்ஏற்றுமதிமற்றும்இறக்குமதி – கடல்கடந்தநாடுகளில்சோழர்களின்வெற்றி.

அலகு V **இந்தியதேசியஇயக்கம்மற்றும்இந்தியபண்பாட்டிற்குத் தமிழர்களின்பங்களிப்பு**: **3**

இந்தியவிடுதலைப்போரில்தமிழர்களின்பங்கு – இந்தியாவின்பிறப்பகுதிகளில்தமிழ்ப்பண்பாட்டின்தாக்கம் – சுயமரியாதைஇயக்கம் – இந்தியமருத்துவத்தில், சித்தமருத்துவத்தின்பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள்–தமிழ்ப்புத்தகங்களின்அச்சுவரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழகவரலாறு – மக்களும்பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடுபாடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2. கணினித்தமிழ் – முனைவர்இல. சுந்தரம். (விகடன்பிரசுரம்).

3. கீழடி – வைகைநதிக்கரையில்சங்ககாலநகரநாகரிகம் (தொல்லியல்துறைவெளியீடு)
4. பொருநை – ஆற்றங்கரைநாகரிகம். (தொல்லியல்துறைவெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB& ESC and RMRL – (in print)
6. SocialLifeoftheTamils– TheClassicalPeriod(Dr.S.Singaravelu)(Publishedby:InternationalInstituteofTamilStudies.
7. HistoricalHeritageoftheTamils(Dr.S.V.Subatamanian,Dr.K.D. Thirunavukkarasu)(Published by:InternationalInstitute ofTamilStudies).
8. TheContributionsoftheTamilstoIndianCulture(Dr.M.Valarmathi)(Publishedby:International InstituteofTamilStudies.)
9. Keeladi– 'Sangam City C ivilizationonthebanksofriverVaigai'(JointlyPublishedby: DepartmentofArchaeology&Tamil NaduText BookandEducational ServicesCorporation,Tamil Nadu)
10. StudiesintheHistoryofIndiawithSpecialReferencetoTamilNadu(Dr.K.K.Pillay)(Publishedby: The Author)
11. PorunaiCivilization(JointlyPublishedby:DepartmentofArchaeology&TamilNaduTextBookandEducationalServices Corporation,TamilNadu)
12. JourneyofCivilizationIndustoVaigai(R.Balakrishnan)(Publishedby: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; 37erifica; making joints in wood materials used in common household wood work.
- Wiring various electrical joints in common household electrical wirework.
- 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) Planingand
c) Making joints likeT-Joint, Mortise joint and Tenon joint and Dovetail joint.
Wood Work Study:
a) Studying joints indoor panels and wooden furniture
b) Studying common industrial trusses using models.

PART II ELECTRICAL ENGINEERING PRACTICES15

a) Introduction to switches, fuses, indicators and lamps –Basics witch 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 IronBox wiring and assembly
f) Study of FanRegulator (Resistor type and Electronic type using Diac / Triac / 37erific)
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 air conditioner.

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 smartphone.
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 pipeline 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.

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	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
CO	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1

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

VL3111 **PHYSICS LABORATORY** **L T P C**

0 0 2 1

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 an active participant in each part of all lab exercises.

Any Seven Experiments

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 wavelength 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 Bandgap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamic skit

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

GE3172 ENGLISH LABORATORY L T P C

0 02 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.
- Touselanguageefficientlyinexpressingtheiropinionsviavariousmedia.

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.

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	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 PC

2 00 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 RELATIONSIN 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 –Error correction; 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.

REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta(2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and LaxmiChandra, Oxford Univ.Press,2001, New Delhi.
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.

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	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.
- Tointroducethebasicconceptsofsolvingalgebraicandtranscendentalequations.
- 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 HYPOTHESIS9+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 PROBLEMS9+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 EQUATIONS9+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, Iand Freund J.," Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES:

1. Burden, R. Land Faires, J.D,"Numerical Analysis", 9th Edition, Cengage Learning,2016.
2. Devore.J.L.,"ProbabilityandStatisticsforEngineeringandtheSciences", 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. andYe.K. ," Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	-	-	-

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

BE3254 ELECTRICAL AND INSTRUMENTATION ENGINEERING L TP C

3 0 03

COURSE OBJECTIVES:

- To impart knowledge in types, construction and working of transformers
- To impart knowledge in types, construction and working of DC machines
- To impart knowledge in types, construction and working of AC rotating machines
- To introduce the functional elements and working of measuring instruments.
- To introduce the basics of power system and protection schemes

UNIT I TRANSFORMER 9

Introduction – Ideal and Practical Transformer – Phasor diagram–Per Unit System – Equivalent circuit- Testing- Efficiency and Voltage Regulation– Three Phase Transformers –Applications- Auto Transformers, Advantages- Harmonics.

UNIT II DC MACHINES 9

Introduction – Constructional Features– Motor and Generator mode- EMF and Torque equation – Circuit Model – Methods of Excitation- Characteristics – Starting and Speed Control – Universal Motor- Stepper Motors – Brushless DC Motors- Applications

UNIT III AC ROTATING MACHINES 9

Principle of operation of three-phase induction motors – Construction –Types – Equivalent circuit, Speed Control – Single phase Induction motors –Construction– Types–starting methods. Alternator: Working principle–Equation of induced EMF – Voltage regulation, Synchronous motors- working principle-starting methods – Torque equation.

UNIT IV MEASUREMENTSANDINSTRUMENTATION 9

Functional elements of an instrument, Standards and calibration, Operating Principle, types – Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT, DSO- Block diagram- Data acquisition.

UNIT V BASICS OF POWER SYSTEMS 9

Power system structure –Generation, Transmission and distribution , Various voltage levels, Earthing – methods of earthing, protective devices- switch fuse unit- Miniature circuit breaker- moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid

TOTAL:45 PERIODS

COURSE OUTCOMES:

After completing this course, the students will be able to

CO1: Explain the working principle of electrical machines

CO2: Analyze the output characteristics of electrical machines

CO3: Choose the appropriate electrical machines for various applications

CO4: Explain the types and operating principles of measuring instruments

CO5: Explain the basic power system structure and protection schemes

TEXT BOOKS:

1. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, Second Edition, McGraw Hill Education, 2020
2. S. K, Bhattacharya, “Basic Electrical and Electronics Engineering”, Second Edition, Pearson Education, 2017.

3. A.K.Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements &Instrumentation', Dhanpat Rai andCo,NewDelhi,2015.
4. C.L.Wadhwa,"Generation, Distribution and Utilization of Electrical Energy",New Age International pvt.ltd.,2003

REFERENCES:

1. Kothari D PandI.JNagrath,"Basic Electrical Engineering",FourthEdition,McGrawHill Education, 2019
2. Mahmood Nahvi and Joseph A.Edminister,"Electric Circuits",Schaum'Outline Series, McGraw Hill, 2002.
3. H.S.Kalsi,'ElectronicInstrumentation',Tata McGraw-Hill,New Delhi,2010

CO's-PO's&PSO'sMAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	-	-	-	-	-	-	-
CO	**2**	**1**	**1**	-	-	-	-	**1**	-	-	-	-	-	-	-

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

VL3201 C++ AND DATA STRUCTURES L T P C

2 0 4 4

UNIT I DATA ABSTRACTION & OVERLOADING 6

Overview of C++ – Structures – Class Scope and Accessing Class Members – Reference Variables – Initialization – Constructors – Destructors – Member Functions and Classes – Friend Function – Dynamic Memory Allocation – Static Class Members – Container Classes and Integrators – Proxy Classes – Overloading: Function overloading and Operator Overloading.

UNIT II INHERITANCE & POLYMORPHISM 6

Base Classes and Derived Classes – Protected Members – Casting Class pointers and Member Functions – Overriding – Public, Protected and Private Inheritance – Constructors and Destructors in derived Classes – Implicit Derived – Class Object To Base – Class Object Conversion – Composition Vs. Inheritance – Virtual functions – This Pointer – Abstract Base Classes and Concrete Classes – Virtual Destructors – Dynamic Binding.

UNIT III LINEAR DATA STRUCTURES 6

Asymptotic Notations: Big-Oh, Omega and Theta – Best, Worst and Average case Analysis: Definition and an example – Arrays and its representations – Stacks and Queues – Linked lists – Linked list based implementation of Stacks and Queues – Evaluation of Expressions – Linked list based polynomial addition.

UNIT IV NON-LINEAR DATA STRUCTURES 6

Trees – Binary Trees – Binary tree representation and traversals – Threaded binary trees – Binary tree representation of trees – Application of trees: Set representation and Union-Find operations – Graph and its representations – Graph Traversals – Connected components.

UNIT V SORTING & SEARCHING 6

Insertion sort – Merge sort – Quick sort – Heap sort – Linear Search – Binary Search.

TOTAL : 30 PERIODS

List of Experiments:

1. C++ Program to Implement Constructors and Destructors.
2. C++ Program to implement Member Functions, Classes and Friend Functions.
3. C++ Program to Implement Dynamic Memory Allocation and Overloading.
4. C++ Program to Implement Various Inheritances.
5. C++ Program to Implement Virtual Functions and Dynamic Binding.
6. C++ Program to Implement Various Operations on Arrays and Linked Lists.
7. C++ Program to Implement Various Operations on Stacks and Queues using Array and Linked List.
8. C++ Program to Evaluate the Infix Expressions by converting into Prefix and Postfix Expressions.
9. C++ Program to Implement Binary Tree Traversal and Graph Traversal Algorithm.
10. C++ Program to Implement the Single Source Shortest Path Algorithm and All Pair Shortest Path Algorithm.
11. C++ Program to find the Minimal Spanning Tree for a Graph.
12. C++ Program to Implement Linear Search and Binary Search Algorithms.
13. C++ Program to Implement Insertion Sort, Merge Sort, Quick Sort and Heap Sort Algorithms.

30 PERIODS

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Comprehend and appreciate the significance and role of this course in the present contemporary world

CO2: Select and realize suitable data structure for specific Application.

CO3: Compare and realize Linear and nonlinear data structures for different application.

CO4: Implement different searching and sorting techniques.

CO5: Identify and realize connected components in trees.

CO6: Analyze and realize asymptotic notations.

TEXT BOOKS:

1. Deitel and Deitel, " C++, How To Program", Fifth Edition, Pearson Education, 2005
2. Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, Fundamentals of Data Structures in C++, 2nd edition, Universities Press Pvt Ltd., Hyderabad, 2007.

REFERENCE BOOKS:

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Third Edition, Addison-Wesley, 2007**.**
2. Bhushan Trivedi, "Programming with ANSI C++, A Step-By-Step approach", Oxford University Press, 2010.
3. Goodrich, Michael T., Roberto Tamassia, "David Mount. " Data Structures and Algorithms in C++", 7th edition, Wiley. 2004

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	2	1		3	1		1	1	1			2	1	1
2	3	2	1		3	1		1	1	1			2	1	1
3	3	2	1		3	1		1	1	1			2	1	1
4	3	2	1		3	1		1	1	1			2	1	1
5	3	2	1		3	1		1	1	1			2	1	1
6	3	2	1		3	1		1	1	1					
AVG	3	2	1		3	1		1	1	1			2	1	1

VL3202 SEMICONDUCTORS AND DEVICES L T P C

3 0 2 4

UNIT I ELECTRONIC STATES 9

Quantum free electron theory – Fermi distribution and energy – Density of states Dynamics of electrons in periodic potential – Electron in a periodic potential – Energy bands in solids–Conductors – Semiconductors – Insulators – tight binding approximation – Electron effective mass– the concept of hole – properties of conduction and valence bands.

UNIT II CARRIERS AND DOPING 9

Intrinsic concentration – intrinsic Fermi level – n and p type doping – density of carriers in extrinsic semiconductors and their temperature dependence – extrinsic semiconductor Fermi energy level – degenerate and non-degenerate semiconductors – Direct and Indirect band gap semiconductors – band- gap engineering – electrons and holes in quantum wells and super lattices.

UNIT III PN DIODE AND BIPOLAR JUNCTION TRANSISTOR 9

PN junction diode, current equations, V-I characteristics, Bipolar Junction Transistor- bipolar transistor action, minority carrier, distribution, low frequency common base, current gain, non-ideal effects, equivalent circuits, Ebers Moll Model, Hybrid-pi model, frequency limitations, large signal switching characteristics, SiGe and hetro-junction.

UNIT IV FIELD EFFECT TRANSISTORS 10

Two terminal MOS structures, threshold voltage and charge distribution, capacitance-voltage characteristics, MOSFET structures, I-V relationships, transconductance and substrate effects, frequency limitations, non-ideal effects, MOSFET scaling, threshold voltage modification due to short and narrow channel effects, avalanche breakdown, drain induced barrier effects, Basic features of FinFET devices and operation.

UNIT V SPECIAL SEMICONDUCTOR DEVICES 8

IGBT, LED, LCD, Photo transistor, Opto Coupler, Solar cell, MESFET, Schottky barrier diode-Zener diode-Varactor diode –Tunnel diode-Gallium Arsenide device, UJT

45 PERIODS

PRACTICALS:

LIST OF EXPERIMENTS

1. Characteristics of PN Junction Diode and Zener diode.
2. Characteristics of LED
3. Characteristics of phototransistor
4. Characteristics of BJT
5. Characteristics of UJT
6. MOSFET Drain current and Transfer Characteristics.

30 PERIODS

TOTAL : 75 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basics of electronic states and energy band structure formation

CO2: Recognize the importance of carrier concentration and doping in semiconductors

CO3: Understand the operation and characteristics of PN junction and BJTs.

CO4: Comprehend the characteristics of the field effect transistors.

CO5: Realize the physics of special semiconductor devices.

TEXT BOOKS:

1. R.F.Pierret. Semiconductor Device Fundamentals. Pearson, 2006
2. D.Neamen and D.Biswas. Semiconductor physics and devices. McGraw Hill Education, 2017
3. Samar K. Saha. FinFET Devices for VLSI Circuits and Systems. CRC Press, 2021

REFERENCE BOOKS:

1. N.Garcia, A. Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.
2. Umesh Mishra and Jasprit Singh. Semiconductor Device Physics and Design. Springer, 2008.
3. Nandita Dasgupta and Amitava Dasgupta. Semiconductor Devices: Modelling and Technology.PHI Learning Pvt. Ltd. 2004
4. F.H. Mitchell, ‘ Introduction to Electronics Design” Prentice Hall of India Pvt. Lt, 1995.
5. Robert L. Boylestad, Louis Nashelsky “ Electronic devices and circuit theory” , Pearson, 2009.

CO’s-PO’s&PSO’sMAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	1	-	-	-	-	-	1	-	1	-	-	2	1	1
2	3	1	-	-	-	-	-	1	-	1	-	-	2	1	1
3	2	2	1	1	-	-	-	1	-	1	-	-	2	1	1
4	2	2	1	1	-	-	-	1	-	1	-	-	2	1	1
5	1	2	1	1	-	-	-	1	-	1	-	-	2	1	1
AVG	2.2	1.6	1	1	-	-	-	1	-	1	-	-	2	1	1

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

VL3203 CIRCUIT AND NETWORK ANALYSIS L T P C

3 1 2 5

COURSE OBJECTIVES:

- To learn the basic concepts and behavior of DC and AC circuits.
- To understand various methods of circuit/ network analysis using network theorems.
- To understand the transient and steady state response of the circuits subjected to DC excitations and AC with sinusoidal excitations.
- To learn the concept of coupling in circuits and topologies.

UNIT I DC CIRCUIT ANALYSIS 12

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Current Law, Kirchoff's voltage law, The single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.

UNIT II NETWORK THEOREM AND DUALITY 12

Useful Circuit Analysis techniques – Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion. Duals, Dual circuits. Analysis using dependent current sources and voltage sources

UNIT III SINUSOIDAL STEADY STATE ANALYSIS 12

Sinusoidal Steady – State analysis, Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.

UNIT IV TRANSIENTS AND RESONANCE IN RLC CIRCUITS 12

Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.

UNIT V NETWORK ANALYSIS AND SYNTHESIS 12

An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis, Two port Network Analysis- Z and H parameters, T and Π Representation, Lattice Networks, Synthesis of RL and RC networks.

60 PERIODS

SUGGESTED ACTIVITIES:

- Practice solving variety of problems

List of Experiments:

1. Verification of KVL&KCL.
2. Verification of Thevenin &Norton theorem.
3. Verification of Superposition Theorem.
4. Verification of maximum power transfer Theorem
5. Determination of Resonance Frequency of Series & Parallel RLC Circuits.
6. Transient analysis of RL and RC circuits.

30 PERIODS

COURSE OUTCOMES

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

CO1: Apply the basic concepts of circuit analysis such as Kirchoff's laws, mesh current and node voltage method for analysis of DC and AC circuits.

CO2: Apply suitable network theorems and analyze AC and DC circuits

CO3: Analyze steady state response of any R, L and C circuits

CO4: Analyze the transient response for any RC, RL and RLC circuits and frequency response of parallel and series resonance circuits.

CO5: Analyze the network topologies

TOTAL: 90 PERIODS

TEXT BOOKS:

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", Mc Graw Hill education, 9th Edition, 2018.
2. Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Circuits", Mc Graw-Hill, 2nd Edition, 2003.
3. Joseph Edminister and Mahmood Nahvi, —Electric Circuits, Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.

REFERENCES:

1. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014. David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7thEdition, 2009.
2. John O Mallay, Schaum's Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2nd Edition, 2011
3. Allan H.Robbins, Wilhelm C.Miller, "Circuit Analysis Theory and Practice", Cengage Learning, Fifth Edition, 1st Indian Reprint 2013

CO's-PO's&PSO'sMAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	-	-	-	1		1	-	-	-	-	-
2	3	3	2	2	-	-	-	1		1	-	-	-	-	-
3	3	3	3	3	-	-	-	1		1	-	-	-	-	-
4	3	3	3	3	-	-	-	1		1	-	-	-	-	-
5	3	3	3	2	-	-	-	1		1	-	-	-	-	-
CO	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**1**		**1**	**-**	**-**	**-**	**-**	**-**

1-low,2-medium,3-high,'-'-nocorrelation

GE3252 TAMILS AND TECHNOLOGY L T P C

1 00 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during SangamAge– 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 MeenakshiTemple)-Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo – Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting,steel–Copper and gold-Coinsassourceof history- Minting of Coins–Beadsmaking-industriesStone beads-Glassbeads - Terracotta beads –Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu of 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.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

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.

TOTAL:15 PERIODS

TEXT-CUM- REFERENCE BOOKS

1. தமிழகவரலொறு–மக்களும்பண்பொடும்–கக·கக·பிள்ளள(தவளியீடு: தமிழ்நொடுபொடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2. கணினித்தமிழ்–முளனவர்இல.சுந்தரம்.(விகடன்பிரசுரம்).
3. கீழடி– ளவளகநதிக்களரயில்சங்ககொலநகரநொகரிகம்(ததொல்லியல்Fளறதவளியீடு)
4. தபொருளந–ஆற்றங்களரநொகரிகம்.(ததொல்லியல்Fளறதவளியீடு)
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) (Publishedby: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D.Thirunavukkarasu) (Publishedby: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi)(Publishedby: International Institute of Tamil Studies.)
9. Keeladi– 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, TamilNadu)

10. Studies in the History of India with Special Reference to TamilNadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology &TamilNadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

GE3252 **தமிழரும்தொழில்நுட்பமும்L T P C**

1 0 0 1

அலகு I **நெசவுமற்றும்பானைத்தொழில்நுட்பம்**: **3**

சங்ககாலத்தில்நெசவுத்தொழில் – பானைத்தொழில்நுட்பம்– கருப்புசிவப்புபாண்டங்கள் – பாண்டங்களில்கீறல்குறியீடுகள்.

அலகு II **வடிவமைப்புமற்றும்கட்டிடத்தொழில்நுட்பம்**: **3**

சங்ககாலத்தில்வடிவமைப்புமற்றும்கட்டுமானங்கள்&சங்ககாலத்தில்வீட்டுப்பொருட்களில்வடிவமைப்பு- சங்ககாலத்தில்கட்டுமானபொருட்களும்நடுகல்லும் – சிலப்பதிகாரத்தில்மேடைஅமைப்புபற்றியவிவரங்கள்–மாமல்லபுரச்சிற்பங்களும், கோவில்களும் – சோழர்காலத்துப்பெருங்கோயில்கள்மற்றும்பிறவழிபாட்டுத்தலங்கள் – நாயக்கர்காலக்கோயில்கள் - மாதிரிகட்டமைப்புகள்பற்றிஅறிதல், மதுரைமீனாட்சிஅம்மன்ஆலயம்மற்றும்திருமலைநாயக்கர்மஹால் – செட்டிநாட்டுவீடுகள் – பிரிட்டிஷ்காலத்தில்சென்னையில்இந்தோ-சாரோசெனிக்கட்டிடக்கலை.

அலகு III **உற்பத்தித்தொழில்நுட்பம்**: **3**

கப்பல்கட்டும்கலை – உலோகவியல் – இரும்புத்தொழிற்சாலை – இரும்பைஉருக்குதல், எஃகு – வரலாற்றுச்சான்றுகளாகசெம்புமற்றும்தங்கநாணயங்கள் – நாணயங்கள்அச்சடித்தல் – மணிஉருவாக்கும்தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடிமணிகள் – சுடுமண்மணிகள் – சங்குமணிகள் – எலும்புத்துண்டுகள் – தொல்லியல்சான்றுகள் – சிலப்பதிகாரத்தில்மணிகளின்வகைகள்.

அலகு IV **வேளாண்மைமற்றும்நீர்ப்பாசனத்தொழில்நுட்பம்**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக்குமுழித்தூம்பின்முக்கியத்துவம் – கால்நடைபராமரிப்பு – கால்நடைகளுக்காகவடிவமைக்கப்பட்டகிணறுகள் – வேளாண்மைமற்றும்வேளாண்மைச்சார்ந்தசெயல்பாடுகள் – கடல்சார்அறிவு – மீன்வளம் – முத்துமற்றும்முத்துக்குளித்தல் – பெருங்கடல்குறித்தபண்டையஅறிவு – அறிவுசார்சமூகம்.

அலகு V **அறிவியல்தமிழ்மற்றும்கணித்தமிழ்**: **3**

அறிவியல்தமிழின்வளர்ச்சி –கணித்தமிழ்வளர்ச்சி- தமிழ்நூல்களைமின்பதிப்புசெய்தல் – தமிழ்மென்பொருட்கள்உருவாக்கம் – தமிழ்இணையக்கல்விக்கழகம் – தமிழ்மின்நூலகம் – இணையத்தில்தமிழ்அகராதிகள் – சொற்குவைத்திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCEBOOKS

1. தமிழகவரலாறு – மக்களும்பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடுபாடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2. கணினித்தமிழ் – முனைவர்இல. சுந்தரம். (விகடன்பிரசுரம்).
3. கீழடி – வைகைநதிக்கரையில்சங்ககாலநகரநாகரிகம் (தொல்லியல்துறைவெளியீடு)
4. பொருநை – ஆற்றங்கரைநாகரிகம். (தொல்லியல்துறைவெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB& ESC and RMRL – (in print)
6. SocialLifeoftheTamils– TheClassicalPeriod(Dr.S.Singaravelu)(Publishedby:InternationalInstituteofTamilStudies.
7. HistoricalHeritageoftheTamils(Dr.S.V.Subatamanian,Dr.K.D. Thirunavukkarasu)(Published by:InternationalInstitute ofTamilStudies).
8. TheContributionsoftheTamilstoIndianCulture(Dr.M.Valarmathi)(Publishedby:International InstituteofTamilStudies.)
9. Keeladi– 'Sangam City C ivilizationonthebanksofriverVaigai'(JointlyPublishedby: DepartmentofArchaeology&Tamil NaduText BookandEducational ServicesCorporation,Tamil Nadu)
10. StudiesintheHistoryofIndiawithSpecialReferencetoTamilNadu(Dr.K.K.Pillay)(Publishedby: The Author)
11. PorunaiCivilization(JointlyPublishedby:DepartmentofArchaeology&TamilNaduTextBookandEducationalServices Corporation,TamilNadu)
12. JourneyofCivilizationIndustoVaigai(R.Balakrishnan)(Publishedby:RMRL) – Reference Book.

NX3251 NCC Credit Course Level1*

(ARMY WING)

NCC Credit Course Level1	**L**	**T**	**P**	**C**
	2		**0**	**2**

NCC GENERAL		**6**
NCC1	Aims ,Objectives& Organization of NCC	1
NCC2	Incentives	2
NCC3	Duties of NCC Cadet	1
NCC4	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**
PD1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD2	Communication Skills	3

PD3	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**
SS1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	**3**
SS4	Protection of Children and Women Safety	1
SS5	Road/Rail Travel Safety	1
SS6	New Initiatives	2
SS7	Cyber and Mobile Security Awareness	1

TOTAL:30 PERIODS

NX3252 **NCCCreditCourseLevel1***

(NAVAL WING)

NCC Credit Course Level-I

L	**T**	**P**	**C**
2	**0**	**0**	**2**

NCC GENERAL		**6**
NCC1	Aims, Objectives & Organization of NCC	1
NCC2	Incentives	2
NCC3	Duties of NCC Cadet	1
NCC4	NCC Camps: Types& Conduct	2
NATIONALINTEGRATIONANDAWARENESS		**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
PERSONALITYDEVELOPMENT		**7**
PD1	Self-Awareness, Empathy ,Critical& Creative Thinking, Decision Making and Problem Solving	2
PD2	Communication Skills	3
PD3	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**
SS1	Basics, Rural Development Programmes, NGOs, ContributionofYouth	3
SS4	Protection of Children and Women Safety	1
SS5	Road/Rail Travel Safety	1
SS6	New Initiatives	2
SS7	Cyber and Mobile Security Awareness	1

TOTAL:30 PERIODS

NX3253 **NCCCreditCourseLevel1***

(AIR FORCE WING)

NCC Credit Course Level-I

LT	**P**	**C**
2	**0 0**	**2**

NCCGENERAL		**6**
NCC1	Aims, Objectives & Organization of NCC	1
NCC2	Incentives	2
NCC3	Duties of NCC Cadet	1
NCC4	NCC Camps: Types& Conduct	2
NATIONALINTEGRATIONANDAWARENESS		**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
PERSONALITYDEVELOPMENT		**7**
PD1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD2	Communication Skills	3
PD3	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**

SS1	Basics, Rural Development Programmes, NGOs, ContributionofYouth	3
SS4	Protection of Children and Women Safety	1
SS5	Road/Rail Travel Safety	1
SS6	New Initiatives	2
SS7	Cyber and Mobile Security Awareness	1

TOTAL:30 PERIODS

GE3272 COMMUNICATION LABORATORY L T P C

0 04 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

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.

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

CO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
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.

MA3305 PROBABILITY RANDOMPROCESSESANDLINEARALGEBRA LTPC

3104

COURSEOBJECTIVES:

- To introduce the basic notions of vector spaces which will then be used to solve related problems
- To understand the basic concepts of probability, one and two dimensional random variables and to introduce some standard distributions applicable to engineering which can describe real life phenomenon.

UNIT–IPROBABILITYANDRANDOMVARIABLES 9 +3

Axioms of probability – Conditional probability – Baye's theorem – Discrete and continuous randomvariables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions – Functions of a random variable.

UNIT–IITWO–DIMENSIONALRANDOMVARIABLES 9 + 3

Jointdistributions – Marginal andconditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT–IIIRANDOMPROCESSES 9 + 3

Classification – Stationary process – Markov process – Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations (Statement only) – Limiting distributions.

UNIT– IVVECTOR SPACES 9 +3

Vector spaces – Subspaces – Linear combinations and linear systemof equations – Linear independence and linear dependence – Bases and dimensions.

UNIT–VLINEARTRANSFORMATIONAND INNERPRODUCTSPACES 9 + 3

Linear transformation –Null spaces and ranges –Dimension theorem –Matrix representation of a linear transformation –Inner product –Norms –Gram Schmidt orthogonalization process –Adjoint of linear operations – Least square approximation.

TOTAL: 60PERIODS

COURSEOUTCOMES:

Uponsuccessfulcompletionofthecourse,studentswillbeableto:

CO1:Explainthefundamentalconceptsofadvancedalgebraandtheirrolein modern mathematicsandapplied contexts.

CO2:Demonstrateaccurateandefficientuseofadvancedalgebraictechniques.

CO3:Apply the concept of random processes in engineering disciplines.

CO4:Understand the fundamental concepts ofprobability with a thorough knowledge ofstandard distributions that can describe certain real-life phenomenon.

CO5: Understand the basic concepts of one and two dimensional random variables and apply them to model engineering problems.

TEXTBOOKS:

1. Gross,D.,Shortle,J.F,Thompson,J.MandHarris.C.M.,"FundamentalsofQueueing Theory", Wiley Student 4th Edition, 2014.
2. Ibe,O.C.,"FundamentalsofAppliedProbabilityandRandomProcesses", Elsevier,1st Indian Reprint, 2007.
3. Friedberg. A.H., Insel. A.J. and Spence.L.,"Linear Algebra", Prentice Hall of India, New Delhi, 4th Edition, 2004.

REFERENCES:

1. Hsu, "Schaum's Outline ofTheoryand Problems of Probability,RandomVariables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
2. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.
3. Yates,R.D.andGoodman.D.J.,"ProbabilityandStochasticProcesses",2nd Edition, Wiley India Pvt. Ltd., Bangalore, 2012.
4. Kolman.B.Hill.D.R.,"IntroductoryLinearAlgebra",PearsonEducation,New Delhi, First Reprint, 2009.
5. Kumaresan.S.,"LinearAlgebra –AGeometricApproach",Prentice –Hall ofIndia, New Delhi, Reprint, 2010.
6. Strang.G.,"LinearAlgebraanditsapplications",Thomson(Brooks/Cole),New Delhi, 2005.

CO's- PO's&PSO'sMAPPING

CO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
AV	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

1-low,2-medium,3-high,'-'-nocorrelation

VL3301	ELECTROMAGNETIC FIELDS AND TRANSMISSION LINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply vector calculus in analyzing static electric and magnetic fields.
- To understand Maxwell's equations and their role in time-varying electromagnetic fields and wave propagation.
- To study transmission line 62erificat, including distortion, reflections, and impedance.
- To analyze high-frequency transmission lines using standing wave concepts and impedance measurements.
- To perform impedance matching using stubs, wave transformers, and the Smith chart.

UNIT I STATIC ELECTRIC AND MAGNETIC FIELDS 9

Vectors and co-ordinate systems: Cartesian, cylindrical and spherical co-ordinate system,Line, surface and volume integrals, Gradient of a scalar field, Divergence theorem, Stoke's theorem, Conductors in static electric field- Dielectrics in static electric field- Electric flux density a dielectric constant- Boundary conditions, Static Magnetic Field-Lorentz force equation, Amper law, Biot-Savart law, Magnetic flux density, Magnetic Energy.

UNIT II TIME VARYING FIELDS AND MAXWELL's EQUATIONS 9

Faraday's law, Displacement current and Maxwell-Ampere law, Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and solutions, Time-harmonic fields, Observing the Phenomenon of wave propagation with the aid of Maxwell's equations

UNIT III TRANSMISSION LINE THEORY 9

General theory of Transmission lines – the transmission line – general solution – The infinite line – Wavelength, velocity of propagation – Waveform distortion – the distortion less line – Loading and different methods of loading – Line not terminated in Z 0 – Reflection coefficient – calculation of current, voltage, power delivered and efficiency of transmission – Input and transfer impedance – Open and short circuited lines – reflection factor and reflection loss.

UNIT IV HIGH FREQUENCY TRANSMISSION LINES 9

Transmission line equations at radio frequencies – Line of Zero dissipation – Voltage and current on the dissipation less line, Standing Waves, Nodes, Standing Wave Ratio – Input impedance of the dissipation less line – Open and short circuited lines – Power and impedance measurement on lines – Reflection losses – Measurement of VSWR and wavelength.

UNIT V IMPEDANCE MATCHING IN HIGH FREQUENCY LINE 9

Impedance matching: Quarter wave transformer ,One Eighth wave line, Half wave line-Impedance matching by stubs- Single stub and double stub matching – Smith chart – Application of Smith chart, Solutions of problems using Smith chart – Single and double stub matching using Smith chart.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1: Apply vector calculus to analyze static electric and magnetic fields.

CO2: Use Maxwell's equations to study time-varying electromagnetic fields and wave propagation.

CO3: Analyze transmission line parameters and signal 63erificat under various loading conditions.
CO4: Evaluate high-frequency transmission line characteristics and standing wave phenomena.
CO5: Design impedance matching networks using analytical methods and the Smith chart.

TEXTBOOKS :

1. D.K. Cheng, Field and wave 63erification63ic, 2nd ed., Pearson (India), 2002
2. M.N.O.Sadiku and S.V. Kulkarni, Principles of 63erification63ic, 6th ed., Oxford(Asian Edition), 2015
3. John D Ryder, “Networks lines and fields”,Prentice Hall of India,New Delhi,2005.

REFERENCES :

1. Edward C. Jordan & Keith G. Balmain, Electromagnetic waves and Radiating Systems, Second Edition, Prentice-Hall Electrical Engineering Series, 2012.
2. W.H. Hayt and J.A. Buck, Engineering 63erification63ic, 7th ed., McGraw-Hill (India), 2006
3. B.M. Notaros, Electromagnetics, Pearson: New Jersey, 2011

CO’s- PO’s & PSO’s MAPPING

CO	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
1	3	3	2	2	1	-	-	-	-		-	-	2	2	0
2	3	3	2	2	2	-	-	-	-		-	-	2	3	0
3	3	3	3	2	2	-	-	-	-		-	-	3	3	0
4	3	3	3	2	3	-	-	-	-		-	-	3	3	0
5	3	3	3	1	3	-	-	-	-		-	-	3	3	2
CO	3	3	2.6	1.8	2.2	-	-	-	-		-	-	2.6	2.8	1.4

1-low,2-medium,3-high,‘-‘-nocorrelation

EC3354 SIGNALS AND SYSTEMS

L	T	P	C
3	1	0	4

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 6+6

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 –Classificationof

systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal& Non-causal, Stable & Unstable.

UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 6+6

Fourier series for periodic signals – Fourier Transform – properties- Laplace Transforms and Properties

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 6+6

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 6+6

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT – Z Transform & Properties

UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 6+6

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: 30+30 PERIODS

COURSE OUTCOMES :

At the end of the course, students 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

TEXTBOOKS :

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(Units I – V)
   Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002.

CO’s-PO’s & PSO’s MAPPING

CO	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
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
CO	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**3**	**1**

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

VL3302	ANALOG CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the methods of biasing transistors
- To design and analyze BJT and MOSFET amplifier circuits
- To analyze the frequency response of small signal amplifiers
- To study about feedback amplifiers and oscillators principles
- To understand the analysis and design of power amplifiers and converters

UNIT I BIASING OF DISCRETE BJT AND MOSFET 8

BJT– Need for biasing – DC Load Line and Bias Point – DC analysis of Transistor circuits – Various biasing methods of BJT – Bias Circuit Design – Thermal stability – Stability factors – MOSFET Biasing – DC Load Line and Bias Point – DC analysis of MOSFET circuits, Biasing MOSFET Switching Circuits.

UNIT II SINGLE STAGE BJT AND MOSFET AMPLIFIERS 10

CE, CC and CB Configurations, Analysis of CE, CC and CB amplifiers using Hybrid π equivalent circuits – AC Load Line Analysis- Darlington Amplifier –Bootstrap technique – Cascade, Cascode configurations – Differential amplifier, Basic BJT differential pair – Small signal analysis and CMRR. Small Signal Hybrid π equivalent circuit of MOSFET – CS, CD and CG Configurations, Analysis of CS, CD and CG amplifiers using Hybrid π equivalent circuits.

UNIT III FREQUENCY RESPONSE OF AMPLIFIERS 9

Amplifier frequency response – Frequency response of transistor amplifiers with circuit capacitors – BJT frequency response – short circuit current gain – cut off frequency – fα, fβ and unity gain bandwidth – Miller effect – frequency response of FET – High frequency analysis of CE and MOSFET CS amplifier – Transistor Switching Times

UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9

Advantages of negative feedback –Voltage / Current, Series, Shunt feedback Amplifiers– positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

UNIT VPOWER AMPLIFIERS AND DC/DC CONVERTERS 9

Power amplifiers-class A-Class B-Class AB-Class C-Power MOSFET-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, students will be able to

CO1: Acquire knowledge of working principles, characteristics and biasing of BJT and FET
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 converters

TEXTBOOKS :

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, 7th Edition, 2014.

REFERENCES :

1. Donald. A. Neamen, “Electronic Circuit Analysis and Design”,Tata McGraw Hill, 3rd Edition,2010.
2. D.Schilling and C.Belove, “Electronic Circuits”, McGraw Hill, 3rd Edition,1989
3. Muhammad H.Rashid, “Power Electronics”, Pearson Education/PHI, 2004.

CO’s-PO’s & PSO’s MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
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
CO	**3**	**3**	**3**	**3**	**2**	**2**	-	-	-	-	-	**1**	**2**	**1**	**1**

1-low,2-medium,3-high,‘-‘-nocorrelation

EC3352 DIGITAL SYSTEM DESIGN L T P C
3 0 2 4

COURSE OBJECTIVES:

- To present the fundamentals of digital circuits and simplification methods
- To practice the design of various combinational digital circuits using logic gates
- To bring out the analysis and design procedures for synchronous and asynchronous Sequential circuits
- To learn integrated circuit families.
- To introduce semiconductor memories and related technology

UNIT I BASIC CONCEPTS 9

Review of number systems-representation-conversions, Review of Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms min term and max term, Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Implementation of Boolean expressions using universal gates ,Tabulation methods.

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Problem formulation and design of combinational circuits – Code-Converters, Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Mux/Demux, Case study: Digital trans-receiver / 8 bit Arithmetic and logic unit, Parity Generator/Checker, Seven Segment display decoder

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Latches, Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – Design – Moore/Mealy models, state minimization, state assignment,lock– out condition circuit implementation – Counters, Ripple Counters, Ring Counters, Shift registers, Universal Shift Register. Model Development: Designing of rolling display/real time clock

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS 9

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Fundamental and Pulse mode sequential circuits, Design of Hazard free circuits.

UNIT V LOGIC FAMILIES AND PROGRAMMABLE LOGIC DEVICES 9

Logic families- Propagation Delay, Fan – In and Fan – Out – Noise Margin –RTL ,TTL,ECL, CMOS– Comparison of Logic families – Implementation of combinational logic/sequential logic design using standard Ics, PROM, PLA and PAL, basic memory, static ROM,PROM,EPROM,EEPROM EAPROM.

TOTAL: 45 PERIODS

PRACTICAL EXERCISES : 30 PERIODS

1. Design of adders and subtractors & code converters.
2. Design of Multiplexers & Demultiplexers.
3. Design of Encoders and Decoders.
4. Design of Magnitude Comparators
5. Design and implementation of counters using flip-flops
6. Design and implementation of shift registers.

COURSE OUTCOMES :

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

CO1: Use Boolean algebra and simplification procedures relevant to digital logic.
CO2: Design various combinational digital circuits using logic gates.
CO3:Analyse and design synchronous sequential circuits.
CO4: Analyse and design asynchronous sequential circuits..
CO5: Build logic gates and use programmable devices

TOTAL:75 PERIODS

TEXTBOOKS :

1. M. Morris Mano and Michael D. Ciletti, 'Digital Design', Pearson, 5th Edition, 2013.(Unit – I –V)

REFERENCES :

1. Charles H. Roth, Jr, 'Fundamentals of Logic Design', Jaico Books, 4th Edition, 2002.
2. William I. Fletcher, "An Engineering Approach to Digital Design", Prentice- Hall of India, 1980.
3. Floyd T.L., "Digital Fundamentals", Charles E. Merril publishing company,1982.
4. John. F. Wakerly, "Digital Design Principles and Practices", Pearson Education, 4 th Edition,2007.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9		PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	2	2	2	-	2	-	-	-		-	3	3	3	3	2
2	-	-	-	-	-	-	-	-	-		-	2	1	2	3	2
3	-	3	3	2	-	2	-	-	-		-	2	2	3	3	2
4	-	-	-	-	-	-	-	-	-		-	3	2	2	3	1
5	-	3	3	3	-	-	-	-	-		-	2	2	3	3	2
CO	**3**	**2.6**	**2.6**	**2.3**	**-**	**2**	**-**	**-**	**-**		**-**	**2**	**2**	**3**	**3**	**2**

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

VL3303 OBJECT ORIENTED PROGRAMMING USING PYTHON L T P C

3 0 2 4

COURSE OBJECTIVES:

- To learn the basic programming constructs in Python.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To do input/output with files in Python.
- To understand OOP concepts with Python

UNIT I PYTHON BASICS, CONTROL STATEMENTS AND FUNCTIONS 9

Introduction to Python Specification – Data Representation: Simple statements: Variables and Identifiers – Object Types – Operators – Expressions and its evaluation, Conditional statements: if- if else – if elif – Nested conditional statements. Repetitive statements: while – for – Nested repetitive statements. Branching statement: break – continue – pass. Functions – Defining functions – Argument types – Scope and namespaces – Recursive functions – Lambda functions – Functions as arguments

UNIT II STRING, LIST, TUPLES, SETS & DICTIONARIES 9

String literals – String methods – String formatting expressions. Lists – Lists iteration and operations – Lists as stacks and queues – List comprehensions – Nested List comprehensions – Matrix operations using Lists – Tuples and sequences – Tuple iteration and operations Sets – Set iteration and operations – Dictionaries – Dictionary iteration and operations – Dictionary comprehensions – Nested Dictionary comprehensions.

UNIT III FUNCTIONAL PROGRAMMING, EXCEPTIONS AND FILE HANDLING 9

Functional programming tools (map, filter, reduce) – Modules – import and from statements- Executing modules as scripts – Standard modules & Packages, creation of module/package. Errors: Syntax and logical errors – Exceptions: Exception types – Handling exceptions – Multiple exceptions and handlers – Raising exceptions. Files: File Path – Type of files – opening modes – Reading and Writing files. Handling Data files.

UNIT IV CLASSES AND OBJECTS 9

Introduction to OOP: Classes, Objects, self, methods-Constructors, destructors, encapsulation. Objects in Python, Creating Python classes, modules and packages, Case studies.

UNIT V INHERITANCE, POLYMORPHISM AND OVERLOADING 9

Inheritance: types and implementation in Python-Polymorphism and method overriding-Operator Overloading-Abstract classes and interfaces.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to

CO1: Write Python programs using conditionals and loops for solving problems.
CO2: Decompose a Python program into functions.
CO3: Represent compound data using Python lists, tuples, dictionaries etc.
CO4: Read and write data from/to files in Python programs.
CO5: Implement OOP concepts in Python.

PRACTICALS:

LIST OF EXPERIMENTS:

1. Python programming using simple statements and expressions (dynamic power dissipation in Digital Circuits, distance between two points).
2. Write Python programs using simple and nested control statements (Sin series, Number Patterns)
3. Develop Python programs using simple functions and recursion (Solving Quadratic equation, Factorial)
4. Write Python programs using lambda functions.
5. Write Python programs for operating on Strings (reverse, palindrome, character count, replacing characters)
6. Design Python programs using Lists (Creation, Appending, Insertion, Sorting, Reverse, Indexing)
7. Develop Python programs using Tuples (Creation, Indexing, Concatenation, Repetition, Membership, Slicing)
8. Write Python programs for performing set operations(Creation, Addition, Remove, Union, Intersection, Difference, Symmetric difference)
9. Develop Python programs using Dictionary (Creation, Copy, Update, Pop, Values, Clear)
10. Create, import, and use user-defined modules (Find Square Root).
11. Organize python code using Packages (Matplotlib, Pandas, Numpy)
12. Design Python programs to handle errors and exceptions using try, except, and finally blocks
13. Write Python programs to perform various operations on text and data files (copy from one file to another, word count, longest word)
14. Implementation of basic class structures in Python.
15. Implementation of various types of constructors and destructors.
16. Implementation of different types of inheritance.
17. Implementation of method overriding and operator overloading.

30 PERIODS

TOTAL: 60 PERIODS

TEXTBOOKS:

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.
3. Steven F. Lott, Dusty Phillips, "Python Object-Oriented Programming, Build Robust and Maintainable Object-oriented Python Applications and Libraries, Packt Publishing, 2021

REFERENCES:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1stEdition, 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. EricMatthes,"PythonCrashCourse,Ahands-onProjectBasedIntroductiontoProgramming", 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. MartinC.Brown,"Python:TheCompleteReference",4thEdition,Mc-GrawHill,2018.

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

CO'	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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	-
Avg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3

1-low,2-medium,3-high,'-'-nocorrelation

VL3311 ANALOG CIRCUITS LABORATORY LT P C

0 0 4 2

COURSE OBJECTIVES:

- To analyze frequency response and bandwidth of various transistor amplifiers and oscillator circuits.
- To understand the characteristics of differential amplifiers, feedback amplifiers, and power amplifiers..
- To simulate and verify transistor biasing circuits and oscillator/amplifier designs.

LIST OF EXPERIMENTS

1. Frequency response and determination of bandwidth for
    - CE, CB and CC amplifiers.
    - CS and CD amplifiers.
    - Darlington Amplifier
    - Cascode and Cascade amplifier
2. Differential Amplifiers – Transfer characteristics, CMRR Measurement
3. Series and Shunt feedback amplifiers (Frequency response, Input and output impedance)
4. RC Phase shift oscillator and Wien Bridge Oscillator
5. Class A Transformer Coupled Power Amplifier.

SIMULATION USING SPICE:

1. Analysis of BJT with Fixed bias and Voltage divider bias
2. Analysis of MOSFET with fixed bias, self-bias and voltage divider bias
3. Hartley Oscillator and Colpitts Oscillator
4. Analysis of power amplifier (Class A, Class B, Class AB and Class C)

TOTAL: 60 PERIODS

COURSE OUTCOMES

After completing the course, the student will be able to:

1. Evaluate the frequency response and bandwidth of different transistor amplifier configurations and oscillator circuits.
2. Measure and interpret transfer characteristics, CMRR of differential amplifiers, and analyze feedback amplifier parameters.
3. Perform circuit simulations using SPICE to analyze transistor biasing and amplifier/oscillator performance, and validate experimental results.

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

CO's- PO's & PSO's Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	2	2	2	-	-	-	1	1	-	-	2	2	1
2	3	3	3	2	2	-	-	-	1	1	-	-	3	2	1
3	3	3	2	2	3	-	-	-	1	1	-	-	3	3	1
Avg.	3	3	2.3	2	2.3	-	-	-	1	1	-	-	2.7	2.3	1

1-low,2-medium,3-high,'-'-nocorrelation

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.

EC3451	LINEAR INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic building blocks of linear integrated circuits
- To learn the linear and non-linear applications of operational amplifiers
- To introduce the theory and applications of analog multipliers and PLL
- To learn the theory of ADC and DAC
- To introduce the concepts of waveform generation and introduce some special function Ics

UNIT I BASICS OF OPERATIONAL AMPLIFIERS 9

Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, BJT Differential amplifier with active loads, Basic information about op-amps – Ideal Operational Amplifier – General operational amplifier stages –and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate, Open and closed loop configurations – MOSFET Operational Amplifiers – LF155 and TL082.

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and

clamper, Low-pass, high-pass and band-pass Butterworth filters.

UNIT III ANALOG MULTIPLIER AND PLL 9

Analog Multiplier using Emitter Coupled Transistor Pair – Gilbert Multiplier cell – Variable transconductance technique, analog multiplier Ics and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronization

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 9

Analog and Digital Data Conversions, D/A converter – specifications – weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode *R –2R* Ladder types – switches for D/A converters, high speed sample-and-hold circuits, A/D Converters – specifications – Flash type – Successive Approximation type – Single Slope type – Dual Slope type – A/D Converter using Voltage-to-Time Conversion – Over-sampling A/D Converters, Sigma – Delta converters.

UNIT V WAVEFORM GENERATORS AND SPECIAL FUNCTION ICS 9

Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators – IC 723 general purpose regulator – Monolithic switching regulator, Low Drop – Out(LDO) Regulators – Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1 : Design linear and nonlinear applications of OP – AMPS
CO2 : Design applications using analog multiplier and PLL
CO3 : Design ADC and DAC using OP – AMPS
CO4 : Generate waveforms using OP – AMP Circuits
CO5 : Analyze special function Ics

TEXT BOOK

1. 1.D.Roy Choudhry, Shail Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd., 2018, Fifth Edition. (Unit I – V)
2. 2.Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 4th Edition, Tata Mc Graw-Hill, 2016 (Unit I – V)

REFERENCES

1. Ramakant A. Gayakwad, “OP-AMP and Linear Ics”, 4th Edition, Prentice Hall / Pearson Education, 2015
2. Robert F.Coughlin, Frederick F.Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, Sixth Edition, PHI, 2001.
3. S.Salivahanan& V.S. Kanchana Bhaskaran, “Linear Integrated Circuits”, TMH,2nd Edition, 4th Reprint, 2016.

CO’s-PO’s & PSO’s MAPPING

CO	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
1	2	-	-	-	-	-	-	-	-	-	1	-	2	1	1
2	2	3	3	2	-	-	-	-	-	-	-	-	2	1	1
3	1	-	-	2	-		-	-	-	-	-	-	2	1	1
4	1	-	-	2	-	-	-	-	-	-	-	-	2	1	1
5	1	2	3	3	-	-	-	-	-	-	-	3	2	1	1
CO	**1.4**	**2.5**	**3**	**2.2**	-	-	-	-	-	-	**1**	**3**	**2**	**1**	**1**

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

VL3401 PRINCIPLES OF COMMUNICATION SYSTEMS L T P C
3 0 2 4

COURSE OBJECTIVES:

- To understand various analog modulation techniques
- To understand the principles of pulse and digital modulation techniques
- To explore the principles of digital data transmission
- To introduce the fundamentals of RF and microwave
- To explore basics of communication networks

UNIT I ANALOG MODULATION 9

Introduction to communication systems – Analog and digital messages – SNR, Channel bandwidth and Rate of communication – Modulation – Randomness, redundancy and coding – Baseband and carrier communication – Amplitude modulation – Double side band AM – single side band AM – Vestigial sideband AM – Superheterodyne AM receiver – Concept of instantaneous frequency – Generation and demodulation of FM –FM receiver – Bandwidth of angle modulated waves

UNIT II PULSE AND DIGITAL MODULATION 9

Pulse amplitude modulation – Pulse position modulation – Pulse width modulation – Sampling theorem – pulse code modulation – Differential pulse code modulation – Delta modulation – Error Control Coding

UNIT III PRINCIPLES OF DIGITAL DATA TRANSMISSION 9

Digital communication system – Line coding – Pulse shaping – Scrambling – Regenerative repeater – Detection error probability – M-ary communication – Digital carrier systems – Digital multiplexing

UNIT IV RF AND MICROWAVE FUNDAMENTALS 12

Frequency Bands – Physical Phenomena in the High Frequency Domain – Multi-Port Network Representations – Normalized Power Waves – Scattering Parameters and Power – S-Parameter Representation of Network Properties – Calculation of S-Parameters – RF Components and Circuits: Resonator- Impedance Matching- Filter Circulator- Directional Coupler – Balanced-to-Unbalanced Circuits – Electronic Circuits – Standard Types of Antennas – Radio frequency and Microwave Applications

UNIT V COMMUNICATION NETWORKS 6

Networks: Distributed Processing – Network Criteria – Types of connections – Physical topologies – Categories of Networks – Interconnection of Networks –Network Models – The OSI Model - Layers InThe OSI Model – TCP/IP Protocol Suite – Addressing: Physical Addresses – Logical Addresses – Port Addresses – Specific Addresses

45 PERIODS

PRACTICAL EXPERIMENTS

1. Analog Modulation- AM, FM
2. Pulse Modulation (PAM, PPM, PWM and PCM).
3. Digital Modulation–ASK, FSK.
4. Delta Modulation and Demodulation.
5. Study of Network Topology using hardware- Star, Bus and Ring

30 PERIODS

TOTAL 75 PERIODS

TEXT BOOKS

1. B.P.Lathi, “Modern Digital and Analog Communication Systems”, 4th Edition, Oxford University Press, 2011
2. D.Roody, J.Coolen, Electronic Communications, 4th edition PHI 2006
3. Frank Gustrau, “RF and microwave engineering: Fundamentals of wireless communications”, Wiley, 2012.
4. Behrouz A. Forouzan,Sophia Chung Fegan, “Data Communications and Networking”, Fourth Edition, McGraw-Hill, 2007.

REFERENCES

1. WaynerTomasi, Electronic Communication System, 5th Edition, Pearson Education,2008
2. B.Sklar, “Digital Communications Fundamentals and Applications”, 2nd Edition Pearson Education 2007
3. H P Hsu, Schaum Outline Series – “Analog and Digital Communications” TMH 2006
4. Couch.L., “Modern Communication Systems”, Pearson, 2001
5. Annapurna Das, Sisir K. Das, “Microwave Engineering”, McGraw Hill Education (India)private limited, Third edition,2000.

COURSE OUTCOMES:

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

- To develop analog modulation circuits
- To implement pulse and digital modulation techniques
- To describe digital data transmission schemes
- To enumerate basic RF and microwave devices and applications
- To analyze network topologies

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	3	2	1	1	-	-	-	1	1	3	2	2
CO2	3	3	3	3	2	1	1	-	-	-	1	1	3	2	2
CO3	3	3	3	3	2	1	1	-	-	-	1	1	3	2	2
CO4	3	3	3	3	2	1	1	-	-	-	1	1	3	2	2
CO5	3	3	3	3	2	1	1	-	-	-	1	1	3	2	2
Avg	3	3	3	3	2	1	1	-	-	-	1	1	3	2	2

1-low,2-medium,3-high,'-'-nocorrelation

EC3351 CONTROL SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce the components and their representation of control systems
- To learn various methods for analyzing the time response, frequency response and stability of the systems.
- To learn the various approach for the state variable analysis.

UNIT I SYSTEMS COMPONENTS AND THEIR REPRESENTATION 9

Control System: Terminology and Basic Structure-Feed forward and Feedback control theory-Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchronous –Multivariable control system

UNIT II TIME RESPONSE ANALYSIS 9

Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number-PID control-Analytical design for PD, PI,PID control systems

UNIT III FREQUENCY RESPONSE AND SYSTEM ANALYSIS 9

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot – Polar Plot- Nyquist plots-Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation

UNIT IV CONCEPTS OF STABILITY ANALYSIS 9

Concept of stability-Bounded – Input Bounded – Output stability-Routh stability criterion-Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion.

UNIT V CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS 9

State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability-Stability of linear systems-Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback.

TOTAL:45 PERIODS

COURSE OUTCOMES :

Upon successful completion of the course the student will be able to

CO1: Compute the transfer function of different physical systems.
CO2: Analyse the time domain specification and calculate the steady state error.
CO3: Illustrate the frequency response characteristics of open loop and closed loop system response.
CO4: Analyse the stability using Routh and root locus techniques.
CO5: Illustrate the state space model of a physical system and discuss the concepts of sampled data control system.

TEXT BOOK:

1. M.Gopal,"Control System – Principles and Design", Tata McGraw Hill, 4th Edition, 2012.

REFERENCES:

1. J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 5th Edition, 2007.
2. K.Ogata, "Modern Control Engineering", PHI, 5th Edition, 2012.
3. S.K.Bhattacharya, "Control System Engineering", Pearson, 3rd Edition, 2013.
4. Benjamin.C.Kuo, "Automatic Control Systems", Prentice Hall of India, 7th Edition,1995.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	3	2	2	2	-	-	-	-	2	3	3	3	3
2	3	3	3	3	2	3	-	-	-	-	2	2	3	3	3
3	3	2	3	3	2	2	-	-	-	-	2	3	3	2	3
4	3	3	3	2	2	2	-	-	-	-	2	2	3	3	3
5	2	2	3	3	2	3	-	-	-	-	2	3	2	2	3
CO	3	3	3	3	2	2	-	-	-	-	2	3	3	3	3

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

VL3402 DIGITAL VLSI DESIGN

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce SystemVerilog for design and verification of VLSI circuits.
- To understand the fundamentals of IC technology, components and their characteristics.
- To understand combinational logic circuits and design principles.
- To understand sequential logic circuits and clocking strategies.
- To understand Memory Architecture and arithmetic building blocks

UNIT I INTRODUCTION TO SYSTEM VERILOG 9

Components of System Verilog- Literal values- data Types – Arrays – Queues- Strings-Composite Type – Expressions – Behavioral modeling, Structural modeling – Packages – Tasks and Functions –Verification using System Verilog: Clocking and Program block – Events – Random constraint generation – Assertions – Immediate assertions – Concurrent assertions.

UNIT II CMOS LOGIC 9

CMOS Inverter, Logic Gates, Design of Compound Gates, Pass Transistor Gates and Transmission Gates, CMOS Fabrication Process, Layout Design Rules, Gate layout, Stick Diagrams, Propagation Delays, Elmore's constant, Logical Effort, Power Dissipation.

UNIT III COMBINATIONAL LOGIC CIRCUITS 9

Circuit Families: Static CMOS, Ratioed Circuits, CVSL, Dynamic Circuits, Pass Transistor Circuits, Examples of combinational logic design, Circuit pitfalls, Low Power Design principles.

UNIT IV SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES 9

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Non-bistable Sequential Circuits, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design.

UNIT V ARITHMETIC CIRCUITS AND MEMORY ARCHITECTURE 9

Adders-Binary adder, Ripple carry adder, Carry look ahead adder, Multiplier-array multiplier, Carry save multiplier, Booth Multiplier, Wallace tree multiplier, Shifters- Barrel shifter, Logarithmic shifter, Logic Implementation using Programmable Devices (PROM, PLA, PAL, FPGA), Memory Classification, Memory Architecture and Building Blocks.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course the student will be able to

CO1: Develop HDL description for combinational and sequential circuits design and 78erification

CO2: In depth knowledge of CMOS technology

CO3: Understand Combinational Logic Circuits and Design Principles

CO4: Understand Sequential Logic Circuits and Clocking Strategies

CO5: Understand Memory architecture and building blocks

TEXT BOOKS

1. Jan D Rabaey, AnanthaChandrakasan, "Digital Integrated Circuits: A Design Perspective", PHI, 2016.(Units II, III and IV).
2. Neil H E Weste, Kamran Eshranghian, "Principles of CMOS VLSI Design: A System Perspective," Addison Wesley, 2009.(Units – I, IV).
3. J.Bhasker, "A System Verilog : Primer", 2001 (Unit V).

REFERENCES

1. D.A.Hodges and H.G.Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. M. Morris Mano and Michael D. Ciletti, 'Digital Design', Pearson, 5th Edition, 2013.

COURSE OUTCOMES:

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

- To develop analog modulation circuits
- To implement pulse and digital modulation techniques
- To describe digital data transmission schemes
- To enumerate basic RF and microwave devices and applications
- To analyze network topologies

EC3492	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To learn discrete fourier transform, properties of DFT and its application to linear filtering
- To understand the characteristics of digital filters, design digital IIR and FIR filters and apply these filters to filter undesirable signals in various frequency bands
- To understand the effects of finite precision representation on digital filters
- To understand the fundamental concepts of multi rate signal processing and its applications
- **T**o introduce the concepts of adaptive filters and its application to communication engineering

UNIT I DISCRETE FOURIER TRANSFORM 9

Sampling Theorem, concept of frequency in discrete-time signals, summary of analysis & synthesis equations for FT & DTFT, frequency domain sampling, Discrete Fourier transform (DFT) – deriving DFT from DTFT, properties of DFT – periodicity, symmetry, circular convolution. Linear filtering using DFT. Filtering long data sequences – overlap save and overlap add method. Fast computation of DFT – Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT). Linear filtering using FFT.

UNIT II INFINITE IMPULSE RESPONSE FILTERS 9

Characteristics of practical frequency selective filters. Characteristics of commonly used analog filters – Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) – Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter – direct form I, direct form II, Cascade, parallel realizations.

UNIT III FINITE IMPULSE RESPONSE FILTERS 9

Design of FIR filters – symmetric and Anti-symmetric FIR filters – design of linear phase FIR filters using Fourier series method – FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures – linear phase structure, direct form realizations

UNIT IV FINITE WORD LENGTH EFFECTS 9

Fixed point and floating point number representation – ADC – quantization – truncation and rounding – quantization noise – input / output quantization – coefficient quantization error – product quantization error – overflow error – limit cycle oscillations due to product quantization and summation – scaling to prevent overflow.

UNIT V DSP APPLICATIONS 9

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor – Adaptive Filters: Introduction, Applications of adaptive filtering to equalization-DSP Architecture-Fixed and Floating point architecture principles

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

MATLAB / EQUIVALENT SOFTWARE PACKAGE/ DSP PROCESSOR BASED IMPLEMENTATION

1. Generation of elementary Discrete-Time sequences
2. Linear and Circular convolutions
3. Auto correlation and Cross Correlation
4. Frequency Analysis using DFT

5. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation
6. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations
7. Study of architecture of Digital Signal Processor
8. Perform MAC operation using various addressing modes
9. Generation of various signals and random noise
10. Design and demonstration of FIR Filter for Low pass, High pass, Band pass and Band stop filtering
11. Design and demonstration of Butter worth and Chebyshev IIR Filters for Low pass, High pass, Band pass and Band stop filtering
12. Implement an Up-sampling and Down-sampling operation in DSP Processor

COURSE OUTCOMES:

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

CO1: Apply DFT for the analysis of digital signals and systems
CO2: Design IIR and FIR filters
CO3: Characterize the effects of finite precision representation on digital filters
CO4: Designmultirate filters
CO5: Apply adaptive filters appropriately in communication systems

TOTAL:75 PERIODS

TEXT BOOKS:

1. 1.John G. Proakis and Dimitris G.Manolakis, Digital Signal Processing– Principles, Algorithms and Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. 2.A. V. Oppenheim, R.W. Schafer and J.R. Buck, —Discrete-Time Signal Processing", 8th Indian Reprint, Pearson, 2004.

REFERENCES

1. Emmanuel C. Ifeachor& Barrie. W. Jervis, "Digital Signal Processing", Second Edition, Pearson Education / Prentice Hall, 2002.
2. 2.Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", Tata Mc Graw Hill, 2007.
3. 3.Andreas Antoniou, "Digital Signal Processing", Tata Mc Graw Hill, 2006.

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	3	2	2	-	-	-	-	1	1	3	3	2
2	3	3	3	3	2	2	-	-	-	-	1	1	2	2	2
3	3	3	**2**	2	2	2	-	-	-	-	1	1	1	2	2
4	3	3	2	2	3	1	-	-	-	-	1	1	2	2	3
5	3	2	2	2	3	2	-	-	-	-	1	1	2	2	1
CO	**3**	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**1**	**2**	**2**	**2**

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

GE3451 ENVIRONMENTAL SCIENCES AND SUSTAINABILITY

L	T	P	C
2	0	0	2

COURSE OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness.Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

UNIT III RENEWABLE SOURCESOF ENERGY 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development ,GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT V SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles-carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio-economical and technological change.

TOTAL:30 PERIODS

COURSE OUTCOMES:

CO1:To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.

CO2:To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.

CO3:To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.

CO4:To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

CO5:To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXT BOOKS :

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES :

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 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	2	1	-	-	-	2	3	-	-	-	-	2	-	-	-
2	3	2	-	-	-	3	3	-	-	-	-	2	-	-	-
3	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
4	3	2	1	1	-	2	2	-	-	-	-	2	-	-	-
5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-
Avg.	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8	-	-	-

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

NCC Credit Course Level 2*

NX3451(ARMY WING) NCC Credit Course Level – II **L T P C**
3 00 3

PERSONALITY DEVELOPMENT **9**

PD 3Group Discussion: Change your mindset, Time Management, Social Skills 6

PD 5Public Speaking 3

LEADERSHIP **7**

L 2Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965 7

DISASTER MANAGEMENT **13**

DM 1 Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil DefenceOrganisation 3

DM 2 Initiative Training, Organising Skills, Do's &Don't's, Natural Disasters, Man Made Disasters 9

DM 3 Fire Service & Fire Fighting 1

ENVIRONMENTAL AWARENESS & CONSERVATION **3**

EA 1Environmental Awareness and Conservation 3

GENERAL AWARENESS **4**

GA 1General Knowledge 4

ARMED FORCES **6**

AF 1Armed Forces, Army, CAPF, Police 6

ADVENTURE **1**

AD 1Introduction to Adventure Activities 1

BORDER & COASTAL AREAS **2**

BCA 1History, Geography & Topography of Border/Coastal areas 2

TOTAL: 45 PERIODS

NCC Credit Course Level 2*

NX3452(NAVAL WING) NCC Credit Course Level – II **L T P C**
3 0 0 3

PERSONALITY DEVELOPMENT **9**

PD 3Group Discussion: Change your mindset, Time Management, Social Skills 6

PD 5Public Speaking 3

LEADERSHIP **7**

L 2 Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata, Rabindra Nath Tagore, Role of NCC cadets in 1965 7

DISASTER MANAGEMENT **13**

DM 1 Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil DefenceOrganisation 3

DM 2 Initiative Training, Organising Skills, Do's &Don't's, Natural Disasters, Man Made Disasters 9

DM 3Fire Service & Fire Fighting 1

ENVIRONMENTAL AWARENESS & CONSERVATION **3**

EA 1Environmental Awareness and Conservation 3

GENERAL AWARENESS **4**

GA 1General Knowledge 4

NAVAL ORIENTATION **6**

AF 1Armed Forces and Navy Capsule 3

EEZ 1EEZ Maritime Security and ICG 3

ADVENTURE **1**

AD 1Introduction to Adventure Activities 1

BORDER & COASTAL AREAS **2**

BCA 1History, Geography & Topography of Border/Coastal areas 2

TOTAL: 45 PERIODS

NCC Credit Course Level 2*

NX3453(AIR FORCE WING) NCC Credit Course Level – II **L T P C**

3 0 0 3

PERSONALITY DEVELOPMENT **9**

PD 3Group Discussion: Change your mindset, Time Management, Social Skills 6

PD 5Public Speaking 3

LEADERSHIP **7**

L 2 Case Studies: APJ Abdul Kalam, Deepa Malik, Maharana Pratap, N Narayan Murty, Ratan Tata,Rabindra Nath Tagore, Role of NCC cadets in 1965 7

DISASTER MANAGEMENT **13**

DM 1 Disaster Management Capsule: Organisation, Types of Disasters, Essential Services, Assistance, Civil DefenceOrganisation 3

DM 2 Initiative Training, Organising Skills, Do's &Don't's, Natural Disasters, Man Made Disasters 9

DM 3Fire Service & Fire Fighting 1

ENVIRONMENTAL AWARENESS & CONSERVATION **3**

EA 1Environmental Awareness and Conservation 3

GENERAL AWARENESS **4**

GA 1General Knowledge 4

GENERAL SERVICE KNOWLEDGE	**6**
GSK 1Armed Forces & IAF Capsule	2
GSK 2Modes of Entry in IAF, Civil Aviation	2
GSK 3Aircrafts – Types, Capabilities & Role	2
ADVENTURE	**1**
AD 1Introduction to Adventure Activities	1
BORDER & COASTAL AREAS	**2**
BCA 1History, Geography & Topography of Border/Coastal areas	2

TOTAL: 45 PERIODS

VL3411	**HDL PROGRAMMING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSE OBJECTIVES:

- To learn Hardware Description Language (System Verilog).
- To learn the fundamental principles of Digital System Design using HDL and FPGA.
- To learn the fundamental principles of VLSI circuit design in digital domain
- To provide hands on design experience with EDA platforms.

LIST OF EXPERIMENTS:

1. Study of programming with SystemVerilog
    - Write the HDL program in Behavioral and Structural modeling (Full adder using half adder)
    - Demonstrate Arrays and Queues, Task and Functions, Process Control.
    - Demonstrate Random sequence generation, Immediate and Concurrent assertions.

2. Write the HDL program for the following circuits. Perform functional verification, Synthesis and implement using FPGA
    - Basic combinational circuits (Logic Gates, 4x1 Multiplexer, 1x4 Demultiplexer, 4x2 Encoder, 2x4 Decoder.
    - Sequential circuits (D, T, JK, SR Flip-flops)
    - 4-bit synchronous up/down counter
    - 4-bit Asynchronous up/down counter
    - Universal Shift Register
    - Finite State Machine (Moore/Mealy)

3. Write the HDL program for the following circuits using SystemVerilog. Verify using SystemVerilog assertions and perform post synthesis timing simulation.
    - Adder (Min 8 Bit) (Binary adder, Ripple carry adder, Carry look ahead adder)
    - Multiplier (Min 8 Bit) (Array multiplier, Carry save multiplier, Booth Multiplier, Wallace tree multiplier)
    - Shift Registers (SISO, SIPO, PISO, PIPO)
    - Memories (RAM, ROM)

COURSE OUTCOMES:

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

CO1: Write HDL code for basic as well as advanced digital integrated circuit

CO2: Import the logic modules into FPGA Boards

CO3: Synthesize Place and Route the digital Ips

CO4: Design, Simulate and Extract the layouts of Digital & Analog IC Blocks using EDA tools

CO5: Test and Verification of IC design

TOTAL: 60 PERIODS

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	3	2	3	0	0	0	1	2	1	0	3	3	2
2	3	2	2	2	3	0	0	0	1	2	1	0	3	3	2
3	3	3	3	2	3	0	0	0	1	2	1	0	3	3	2
4	3	3	3	3	3	0	0	0	1	2	1	0	3	3	2
5	3	2	2	2	2	0	0	0	1	2	1	0	3	3	2
Avg.	3	2.4	2.6	2.2	2.8	-	-	-	1	2	1	-	3	3	2

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

VL3412 **LINEAR INTEGRATED CIRCUITS LABORATORY** **L T P C**

0 0 4 2

COURSE OBJECTIVES:

- To provide hands on experience in designing electronic circuits
- To learn simulation software used in circuit design
- To learn the fundamental principles of amplifier circuits
- To differentiate feedback amplifiers and oscillators.
- To differentiate the operation of various multivibrators

DESIGN AND ANALYSIS OF THE FOLLOWING CIRCUITS

1. Study of characteristics of Op-amp (Null Balance, CMRR, Slew Rate, Frequency response)
2. Sign Changer and Scale Changer using Op-amp
3. Integrator and Differentiator circuits using Op-Amp
4. Active Filters (low-pass & High pass)
5. PLL as frequency multiplier.
6. R-2R ladder type D-A converter using Op-Amp

SIMULATION USING SPICE (Using Transistor):

1. Tuned Collector Oscillator
2. Twin –T Oscillator / Wein Bridge Oscillator
3. Double and Stagger tuned Amplifiers
4. Bistable Multivibrator
5. Schmitt Trigger circuit with Predictable hysteresis
6. Analysis of power amplifier

Components and Accessories:

Transistors, Resistors, Capacitors, Inductors, diodes, Zener Diodes, Bread Boards, Transformers.
SPICE Circuit Simulation Software: (any public domain or commercial software)
Note: Op-Amps uA741, LM 301, LM311, LM 324, LM317, LM723, 7805, 7812, 2N3524, 2N3525, 2N3391, AD 633, LM 555, LM 565 may be used

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students will be able to
CO1:Analyze various types of feedback amplifiers
CO2:Design oscillators, tuned amplifiers, wave-shaping circuits and multivibrators
CO3:Design and simulate feedback amplifiers,oscillators, tuned amplifiers, wave- shaping circuits and multivibrators, filters using SPICE Tool.
CO4:Design amplifiers, oscillators, D-A converters using operational amplifiers.
CO5:Design filters using op-amp and perform an experiment on frequency response

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	-	-	-	-	-	-	1	1
CO2	2	3	3	3	-	-	-	-	-	-	1	1
CO3	2	3	3	3	-	-	-	-	-	-	1	1
CO4	2	3	3	3	2	-	-	-	-	-	1	1
CO5	-	-	-	-	-	-	-	-	-	-	-	-
Avg	2	3	3	3	2	-	-	-	-	-	1	1

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

VL3501COMPUTER ARCHITECTURE AND ORGANIZATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To make students understand the basic structure and operation of digital computer
- To familiarize with implementation of fixed point and floating-point arithmetic operations
- To study the design of data path unit and control unit for processor
- To understand the concept of various memories and interfacing
- To introduce the parallel processing technique

UNIT I COMPUTER ORGANIZATION & INSTRUCTIONS 9

Basics of a computer system: Evolution, Ideas, Technology, Performance, Power wall, Uniprocessors to Multiprocessors. Addressing and addressing modes. Instructions: Operations and Operands, Representing instructions, Logical operations, control operations.

UNIT II ARITHMETIC 9

Fixed point Addition, Subtraction, Multiplication and Division. Floating Point arithmetic, Highperformance arithmetic, Subword parallelism

UNIT III THE PROCESSOR 9

Introduction, Logic Design Conventions, Building a Datapath – A Simple Implementation scheme – An Overview of Pipelining – Pipelined Datapath and Control. Data Hazards: Forwarding versus Stalling, Control Hazards, Exceptions, Parallelism via Instructions.

UNIT IV MEMORY AND I/O ORGANIZATION **9**

Memory hierarchy, Memory Chip Organization, Cache memory, Virtual memory.
Parallel Bus Architectures, Internal Communication Methodologies, Serial Bus Architectures, Mass storage, Input and Output Devices.

UNIT V ADVANCED COMPUTER ARCHITECTURE **9**

Parallel processing architectures and challenges, Hardware multithreading, Multicore and shared memory multiprocessors, Introduction to Graphics Processing Units, Clusters and Warehouse scale computers – Introduction to Multiprocessor network topologies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to

CO1: Describe data representation, instruction formats and the operation of a digital computer
CO2: Illustrate the fixed point and floating-point arithmetic for ALU operation
CO3: Discuss about implementation schemes of control unit and pipeline performance
CO4: Explain the concept of various memories, interfacing and organization of multiple processors
CO5: Discuss parallel processing technique and unconventional architectures

TEXT BOOKS:

1. David A. Patterson and John L. Hennessey, “Computer Organization and Design”, Fifth edition, Morgan Kauffman / Elsevier, 2014. (UNIT I-V)
2. Miles J. Murdocca and Vincent P. Heuring, “Computer Architecture and Organization: AnIntegrated approach”, Second edition, Wiley India Pvt Ltd, 2015 (UNIT IV,V)

REFERENCES

1. V. Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, “Computer Organization“, Fifthedition, Mc Graw-Hill Education India Pvt Ltd, 2014.
2. William Stallings “Computer Organization and Architecture”, Seventh Edition, Pearson Education, 2006.
3. Govindarajalu, “Computer Architecture and Organization, Design Principles and Applications”,Second edition, McGraw-Hill Education India Pvt Ltd, 2014.

CO’s-PO’s & PSO’s MAPPING

Course Outcomes (Cos)	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:	3	2	-	-	2	-	-	-	-	-	-	1	2	2	1
CO2:	3	3	1	-	2	-	-	-	-	-	-	1	3	2	1
CO3:	3	3	2	1	3	-	-	-	-	-	-	1	3	3	2
CO4:	3	2	2	1	3	-	-	-	1	-	-	1	3	3	2
CO5:	3	3	2	1	3	-	-	-	1	-	-	2	2	3	3
Avg	3	2.6	1.75	1	2.6	-	-	-	1	-	--	1.2	2.6	2.6	1.8

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

VL3502 ANALOG CMOS IC DESIGNL T P C
3 0 0 3

COURSE OBJECTIVES:

- To study the basics of MOS Circuits.
- To analyse the noise characteristics of amplifiers.
- To study the performance parameters of amplifiers.
- To comprehend the compensation techniques
- To understand the detection and testing of faults.

UNIT I SINGLE STAGE AMPLIFIERS 9

Basic MOS physics and equivalent circuits and models, CS, CG and Source Follower, differential amplifier with active load, Cascode and Folded Cascode configurations with active load, design of Differential and Cascode Amplifiers – to meet specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, high gain amplifier structures.

UNIT II HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS 9

Miller effect, association of poles with nodes, frequency response of CS, CG and Source Follower, Cascode and Differential Amplifier stages, statistical characteristics of noise, noise in Single Stage amplifiers, noise in Differential Amplifiers.

UNIT III FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS 9

Properties and types of negative feedback circuits, effect of loading in feedback networks, operational amplifier performance parameters, single stage Op Amps, two-stage Op Amps, input range limitations, gain boosting, slew rate, power supply rejection, noise in Op Amps.

UNIT IV STABILITY , FREQUENCY COMPENSATION 9

Analysis of two stage OpAmp – two stage OpAmp single stage CMOS CS as second stage and using Cascode second stage, multiple systems, Phase Margin, Frequency Compensation,and Compensation of two stage OpAmps, Slewing in two stage OpAmps, Other compensationtechniques.

UNIT V VOLTAGE AND CURRENT REFERENCES 9

Current sinks and sources, Current mirrors, Wilson current source, Widlar current source, Cascode current source, Design of high swing Cascode sink, current amplifiers, Supply independent biasing, temperature independent references, PTAT and CTAT current generation, Constant-Gm Biasing.

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course the student will be able to

CO1: Design amplifiers to meet user specifications.
CO2: Analyse the frequency and noise performance of amplifiers.
CO3: Design and analyse feedback amplifiers and one stage op amps .
CO4: Analyse stability of op amp.
CO5: Testing experience of logic circuits.

TEXTBOOKS :

1. Behzad Razavi, “Design Of Analog Cmos Integrated Circuits”, Tata Mcgraw Hill, 2001.
2. Phillip E.Allen, Douglas R.Holberg, “CMOS Analog Circuit Design”, Oxford University Press, 3rd October 2013.

REFERENCES :

1. Grebene, “Bipolar And Mos Analog Integrated Circuit Design”, John Wiley &Sons,Inc.,2003. Phillip E.Allen, Douglas R .Holberg, “Cmos Analog Circuit Design”, Oxford University Press, 2nd Edition, 2002.
2. Willey M.C. Sansen, “Analog Design Essentials”, Springer, 2006.
3. Recorded Lecture Available at http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
4. Jacob Baker “CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition, 2010.

CO’s-PO’s & PSO’s MAPPING

CO	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
1	3	3	3	3	2	2	-	-	-	-	-	2	3	3	3
2	3	3	2	2	1	2	-	-	-	-	-	2	3	2	3
3	3	3	2	2	2	2	-	-	-	-	-	2	3	2	3
4	3	3	3	2	2	1	-	-	-	-	-	2	1	2	2
5	3	3	3	2	2	2	-	-	-	-	-	3	2	1	2
CO	3	3	2.6	2.2	1.8	1.8	-	-	-	-	-	2.2	2.4	2	2

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

CEC362 VLSI TESTING AND DESIGN FOR TESTABILITY L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce logic and fault simulation and testability measures.
- To study the design for testability.
- To know about interfacing and testing of memory
- To introduce power management techniques in testing
- To study testability in analog circuits

UNIT I TEST REQUIREMENTS AND METRICS 9

Validation platforms- SOC design methodology, IP components, Integration, Clocking, I/Os and interfaces, Device modes, Logic, memories, analog, I/Os, power management; Test requirements- Test handoffs, Testers Where DUT and DFT fit into design / framework; Test- ATPG, DFT, BIST, COF, TTR; Test cost metrics and test economics; Logic fault models- SAF, TDF, PDF, Iddq, St-BDG, Dy-BDG, SDD; Basics of test generation and fault simulation- Combinational circuits, Sequential; Specific algorithmic approaches, CAD framework, Optimisations.

UNIT II SCAN DESIGN AND BIST 9

Scan Design- Scan design requirements, Types of scan and control mechanisms, Test pattern construction for scan, Managing scan in Ips and SOCs, Scan design optimisations, Partitioning, Clocking requirements for scan and delay fault testing, Speed of operation; BIST – Framework, Controller configurations, FSMs, LFSRs, STUMPS architecture, Scan compression and bounds, Test per cycle, Test per scan, Self-testing and self-checking circuits, Online test.

UNIT III MEMORY TEST AND TEST INTERFACES 9

Memory Test –Memory fault models, Functional architecture as applicable to test, Test of memories, Test of logic around memories, BIST controller configuration, Test of logic around memories, DFT and architecture enhancements, Algorithmic optimisations; Test Interfaces-Test control requirements, Test interfaces – 1500, JTAG, Hierarchical, serial control, Module / IP test, SOC test, Board test, System test, Boundary scan.

UNIT IV DESIGN CONSIDERATIONS AND POWER MANAGEMENT DURING TEST 9

Design Considerations- Design considerations, Physical design congestion, Partitioning, Clocks, Test modes, Pins, Test scheduling, Embedded test, Architecture improvements, Test in the presence of security; Power management during test- Methods for low power test, ATPG methods, DFT methods, Scan methods, Low power compression, Test of power management, Implications of power excursions, Optimisations.

UNIT V ANALOG TEST 9

Test requirements. DFT methods. BIST methods. Test versus measurement. Defect tests versus performance tests. Tests for specific modules – PLL, I/Os, ADC, DAC, SerDes, etc. RF test requirements.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:Understand logic and fault simulation requirements and testability measures.
CO2:Understand the Design for Testability.
CO3:Develop interfacing and memory testing.
CO4:Perform testing with power management techniques.
CO5 :Carry-out fault Detection in analog circuits.

TEXT BOOK:

1. Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits,Vishwani Agrawal and Michael Bushnell, Springer, 2002. (UNIT I-V)

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

(Cos)	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:	3	3	1	2	3	-	-	-	-	-	-	1	3	3	2
CO2:	3	2	3	2	3	-	-	-	-	-	-	1	3	3	2
CO3:	3	3	2	2	3	-	-	-	1	-	-	1	3	3	2
CO4:	3	2	2	2	3	-	1	-	1	-	-	1	2	3	3
CO5:	3	3	2	3	3	-	-	-	-	-	-	2	3	3	3
Avg	3	2.6	2	2.2	3	-	1	-	1	-	--	1.2	2.8	3	2.4

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

VL3503 MICROPROCESSORS, MICROCONTROLLERS AND INTERFACING L T P C

3 0 2 4

OBJECTIVES:

To understand the Architecture of 8086 microprocessor.

To learn the design aspects of I/O and Memory Interfacing circuits.

To interface microprocessors with supporting chips.

To study the Architecture of 8051 microcontroller.

To design a microcontroller based system

To study the Architecture of ARM processor.

To interface ARM processors with supporting devices

UNIT I THE 8086 MICROPROCESSOR 9

Introduction to 8086 – Microprocessor architecture – Addressing modes – Instruction set andassembler directives – Assembly language programming – Modular Programming – Linking andRelocation – Stacks – Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

UNIT II 8086 SYSTEM BUS STRUCTURE 9

8086 signals – Basic configurations – System bus timing –System design using 8086 – I/Oprogramming – Introduction to Multiprogramming – System Bus Structure – Multiprocessorconfigurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT III MICROCONTROLLER 9

Architecture of 8051 – Special Function Registers(SFRs) – I/O Pins Ports and Circuits – Instruction set – Addressing modes – Assembly language programming.

UNIT IV ARM PROCESSOR 9

Processor architecture and organization-Acorn RISC Machine(ARM) – Architectural inheritance-Programmer's model-Data Processing instructions-Data transfer instructions-Control flow instructions-ARM instruction set: Exceptions, Conditional execution, Branch and branch with Link (B, BL), Branch and Branch with Link and eXchange (BX,BLX), Data processing instructions, Multiply instructions, Single and half word data transfer instructions, Multiple register transfer, Swap memory and register(SWP), Status register to general register, General register to status register transfer instructions.

UNIT V INTERFACING CONCEPTS 9

8086: Memory Interfacing and I/O interfacing – Programming and applications, Case studies: Traffic Light control, 7 Segment LED display, LCD display. **8051:** Programming 8051 Timers – Serial Port Programming – Interrupts Programming – ADC, DAC & Sensor Interfacing. **ARM7TDMI:** On chip: UART, Timer, PWM, Interrupt, External: Hex Keyboard, LED interfacing, Stepper motor

TOTAL: 45 PERIODS

PRACTICAL EXERCISES

LIST OF EXPERIMENTS:

8086 Programs using kits

1. Basic arithmetic (Addition, Subtraction, Multiplication, Division) and Logical operations (AND, OR, XOR and Complement)
2. Sorting (largest, smallest, ascending, descending) and code conversion (Hexadecimal to BCD, Hexadecimal to ASCII)

8086 Peripherals and Interfacing Experiments

3. Study of programmable parallel peripheral interface – 8255
4. Study of programmable interval timer interface – 8253

8051 Experiments using kits

5. Basic arithmetic (Addition, Subtraction, Multiplication, Division) and Logical operations (AND, OR, XOR and Complement)
6. Bit manipulations (Bitwise logical AND, OR and Complement operations)
7. Accessing parallel port IO pins

ARM Processor

8. Basic arithmetic (Addition, Subtraction, Multiplication, Division) and Logical operations (AND, OR, XOR and Complement)
9. Interrupt
10. PWM
11. Stepper motor control

30 PERIODS
TOTAL: 75 PERIODS

COURSE OUTCOMES:

At the end of the course, the students should be able to:

CO1: Explain the architecture, organization and operation of 8086 microprocessor and 8051 microcontroller.
CO2: Analyze and design memory and I/O interfacing circuits for microprocessor-based systems.
CO3: Interface microprocessors and microcontrollers with peripheral and supporting devices for embedded applications.
CO4: Describe the architecture and operational features of ARM processors and their interfacing techniques.
CO5: Design and develop microprocessor/microcontroller/ARM based systems for real-time and embedded applications.

TEXT BOOKS:

1. Yu-Cheng Liu, Glenn A.Gibson, “Microcomputer Systems: The 8086 / 8088 Family – Architecture, Programming and Design”, Second Edition, Prentice Hall of India, 2007.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, “The 8051 Microcontroller andEmbedded Systems: Using Assembly and C”, Second Edition, Pearson education, 2011.

REFERENCES:

1. Doughlas V.Hall, “Microprocessors and Interfacing, Programmingand Hardware”,TMH,2012
2. A.K.Ray,K.M.Bhurchandi, “Advanced Microprocessors and Peripherals” 3rd edition, TataMcGrawHill, 2012

CO’s-PO’s & PSO’s MAPPING

Cos	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:	3	2	-	-	2	-	-	-	-	-	-	1	3	2	1
CO2:	3	3	3	1	3	-	-	-	-	-	-	1	3	3	2
CO3:	3	3	3	2	3	-	-	-	1	-	-	1	3	3	2
CO4:	3	2	2	1	3	-	-	-	-	-	-	1	3	3	2
CO5:	3	3	3	2	3	-	1	-	1	1	-	2	3	3	3
Avg	3	2.6	2.75	1.5	2.8	-	1	-	1	1	-	1.2	3	2.8	2

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

VL3511 ANALOG AND DIGITAL CMOS IC DESIGN LABORATORYL T P C
0 0 4 2

COURSE OBJECTIVES:

To understand the characteristics and process parameters of CMOS transistors through simulation and analysis of analog and digital IC circuits.
To design and analyze basic analog CMOS circuits such as amplifiers, differential amplifiers, oscillators, and operational amplifiers using EDA tools.
To design, simulate, and verify digital CMOS circuits including logic gates, flip-flops, counters, and CMOS inverter layouts.
To perform pre-layout and post-layout simulations for evaluating circuit performance in terms of gain, bandwidth, timing, power, area, and stability.
To develop proficiency in the use of modern VLSI CAD/EDA tools for schematic design, simulation, layout generation, extraction, and verification of CMOS integrated circuits.

PRACTICAL EXERCISES:

ANALOG CMOS IC DESIGN EXPERIMENTS:

1. Extraction of process parameters of CMOS process Transistors

- Plot log ID vs. VGS at particular gate voltage (high) for NMOS, PMOS and determine IOFF and sub-threshold slope.
- Plot ID vs. VDS at different gate voltages for NMOS, PMOS and determine Channel length modulation factor.

2. Design and simulate a Common source amplifier and analyze its input impedance, output impedance, Gain and Bandwidth.
3. Design and simulate a Common drain amplifier and analyze its input impedance, output impedance, Gain and Bandwidth.
4. Design and simulate a Common gate amplifier and analyze its input impedance, output impedance, Gain and Bandwidth.
5. Design and simulate a 5 transistor differential amplifier and analyze its Gain, Bandwidth and CMRR. .
6. Design three stage and five stage ring oscillator circuit and compare its frequencies.
7. Stability Analysis of Two stage OpAmp

- Perform DC analysis and determine input common mode range.
- Perform time domain simulation and determine low frequency gain.
- Perform AC analysis and determine low-frequency voltage gain and unity gain BW.

DIGITAL CMOS IC DESIGN EXPERIMENTS:

8. Design a CMOS inverter and analyze its characteristics. Generate Manual / Automatic Layout. Perform Pre-layout and Post-layout simulation. Analyze Area, Power and Timing.
9. Design and simulate a CMOS Basic Gates (NAND, XOR). Generate Manual/ Automatic Layout. Perform Pre-layout and Post-layout simulation. Analyze Area, Power and Timing.
10. Design and simulate D Flip-Flop. Generate Manual/ Automatic Layout.
11. Design andsimulate a4-bit synchronouscounterusingFlip-Flops.

List of equipment needed for a batch of 30 students (3 in a bench):

- Cadence/Tanner/equivalent EDA Tools -10 User License

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Analyze the characteristics and process parameters of CMOS transistors using simulation techniques for analog and digital IC applications.

CO2: Design and evaluate analog CMOS circuits such as amplifiers, differential amplifiers, oscillators, and operational amplifiers using EDA tools.

CO3: Design, simulate, and verify digital CMOS circuits including logic gates, flip-flops, counters, and CMOS inverter layouts.

CO4: Perform pre-layout and post-layout simulations to analyze circuit parameters such as gain, bandwidth, timing, power, area, and stability.

CO5: Apply modern VLSI CAD/EDA tools for schematic entry, layout design, extraction, simulation, and verification of CMOS integrated circuits.

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

COs	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	3	3	2	2	3	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	3	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	3	2	3	-	-	1	1	1	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	1	1	2	3	3	3
CO5	3	2	3	2	3	-	-	1	1	1	1	3	3	3	3
Avg	3	2.8	2.8	2.4	3	-	1	1	1	1	1	2.2	3	3	2.8

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

EC3501 WIRELESS COMMUNICATION L T P C

3 02 4

COURSE OBJECTIVES:

- To study and understand the concepts and design of a Cellular System.
- To Study And Understand Mobile Radio Propagation And Various Digital Modulation Techniques.
- To Understand The Concepts Of Multiple Access Techniques And Wireless Networks

UNIT-I THE CELLULAR CONCEPT-SYSTEM DESIGN FUNDAMENTALS 9

Introduction-FrequencyReuse-ChannelAssignment Strategies-**Handoff Strategies:**Prioritizing Handoffs, Practical Handoff Considerations. **Interference And System Capacity**: Co-Channel Interference And System Capacity-Channel Planning For Wireless Systems, Adjacent Channel Interference, Power Control For Reducing Interference, TrunkingAnd Grade Of Service. **Improving Coverage And Capacity In Cellular Systems:** Cell Splitting, Sectoring.

UNIT-II MOBILE RADIO PROPAGATION 9

Large Scale Path Loss: Introduction To Radio Wave Propagation - Free Space Propagation Model – **Three Basic Propagation Mechanism:** Reflection – Brewster Angle- Diffraction- Scattering.**Small Scale Fading And Multipath:** Small Scale Multipath Propagation, Factors Influencing Small-Scale Fading, Doppler Shift, Coherence Bandwidth, Doppler Spread And Coherence Time. **Types Of Small- Scale Fading:** Fading Effects Due To Multipath Time Delay Spread, Fading Effects Due To Doppler Spread.

UNIT- III MODULATION TECHNIQUES AND EQUALIZATION AND DIVERSITY9

Digital Modulation – **An Overview**: Factors That Influence The Choice Of Digital Modulation, **Linear Modulation Techniques:** Minimum Shift Keying (MSK), Gaussian Minimum Shift

Keying(GMSK), **Spread Spectrum Modulation Techniques:** Pseudo- Noise (PN) Sequences, Direct Sequence Spread Spectrum (DS-SS)- Modulation Performance In Fading And Multipath Channels- **Equalization, Diversity And Channel Coding:** Introduction-Fundamentals Of Equalization- **Diversity Techniques:** Practical Space Diversity Considerations, Polarization Diversity, Frequency Diversity, Time Diversity.

UNIT- IV MULTIPLE ACCESS TECHNIQUES 9

Introduction: Introduction To Multiple Access- Frequency Division Multiple Access(FDMA)- Time Division Multiple Access(TDMA)- Spread Spectrum Multiple Access-Code Division Multiple Access(CDMA)- Space Division Multiple Access(SDMA)- Capacity Of Cellular Systems**:** Capacity Of Cellular CDMA, Capacity Of CDMA With Multiple Cells.

UNIT- V WIRELESS NETWORKING 9

Introduction: Difference Between Wireless And Fixed Telephone Networks, The Public Switched Telephone Network(PSTN), Development Of Wireless Networks**:** First Generation Wireless Networks, Second Generation Wireless Networks, Third Generation Wireless Networks, Fixed Network Transmission Hierarchy, TrafficRoutingInWireless Networks: Circuit Switching, Packet Switching- **Personal Communication Services/ Networks(PCS/PCNs):**Packet Vs Circuit Switching For PCN, Cellular Packet- Switched Architecture- Packet Reservation Multiple Access(PRMA)- **Network Database**s**:** Distributed Database For Mobility Management- Universal Mobile Telecommunication Systems(UMTS).

45 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Modeling of wireless communication systems using Matlab(Two ray channel and Okumura –Hata model)
2. Modeling and simulation of Multipath fading channel
3. Design, analyze and test Wireless standards and evaluate the performance measurementssuch as BER, PER, BLER, throughput, capacity, ACLR, EVM for 4G and 5G using Matlab
4. Modulation: Spread Spectrum – DSSS Modulation & Demodulation
5. Wireless Channel equalization: Zero-Forcing Equalizer (ZFE),MMSE Equalizer(MMSEE),Adaptive Equalizer (ADE),Decision Feedback Equalizer (DFE)
6. Modeling and simulation of TDMA, FDMA and CDMA for wireless communication

TOTAL:75 PERIODS

COURSE OUTCOMES :

Upon successful completion of the course the student will be able to:

CO1:UnderstandThe ConceptAnd Design OfA Cellular System.

CO2:Understand Mobile Radio Propagation And Various Digital Modulation Techniques.

CO3:Understand The Concepts Of Multiple Access Techniques And Wireless Networks

CO4:Characterize a wireless channel and evolve the system design specifications

CO5:Design a cellular system based on resource availability and traffic demands.

TEXT BOOK :

1. Rappaport,T.S.,-Wireless communications", Pearson Education, Second Edition, 2010.

REFERENCES :

1. Wireless Communication –Andrea Goldsmith, Cambridge University Press, 2011
2. Van Nee, R. and Ramji Prasad, —OFDM for wireless multimedia communications, Artech House, 2000
3. David Tse and Pramod Viswanath, —Fundamentals of Wireless Communication, Cambridge University Press, 2005.

4. Upena Dalal, —Wireless Communication", Oxford University Press, 2009.
5. Andreas.F. Molisch, —Wireless Communications", John Wiley – India, 2006.
6. Wireless Communication and Networks –William Stallings ,Pearson Education, Second Edition 2002.

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	2	2	3	3	1	-	-	-	-	-	1	3	1	1
2	3	3	2	1	3	2	-	-	-	-	-	-	3	1	2
3	3	3	3	3	2	2	-	-	-	-	-	1	3	1	2
4	2	3	2	2	2	2	-	-	-	-	-	1	2	1	1
5	2	-	3	3	2	1	-	-	-	-	-	1	2	2	2
CO	**3**	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**	**3**	**1**	**2**

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

VL3601 MACHINE LEARNING FOR IC DESIGN L T P C

3 0 2 4

COURSE OBJECTIVES:

- To understand the basics of machine learning and probabilistic learning methods
- To familiarize various supervised learning techniques
- To understand unsupervised and reinforcement learning techniques
- To understand the fundamentals and design concepts of neural networks
- To learn the applications of machine learning in IC design process through case studies

UNIT I INTRODUCTION TO MACHINE LEARNING AND PROBABILISTIC METHODS 9

Learning, Types of Machine Learning, Applications – The machine learning process, Challenges in Machine Learning – Bayesian learning : Prior, Posterior, Likelihood, Bayes rule– Maximum Likelihood and MAP estimate, Bayesian Belief Networks: Probabilistic Modeling of Problems –Inference in Bayesian Networks –Variable elimination, Approximate Inference– Markov Models: transition matrix, Applications, Hidden Markov Models - Applications.

UNIT II SUPERVISED LEARNING 10

Regression Models: Least squares, single & multiple variables - Under-fitting / Overfitting, **Classification Models**: *Discriminant function* – Least square, Perceptron algorithm, *Probabilistic discriminative model*: Logistic regression, *Probabilistic generative model*: Naive Baye's classifier with example, *Maximum margin classifier:* – Support vector machine, *Instance based Methods*: K-Nearest Neighbours – *Tree based Methods:* Decision Trees –ID3 – Evaluation of Classification Algorithms - Cross-Validation – **Ensemble Methods:** Voting -bagging –Random Forest - boosting- Adaboost, stacking.

UNIT III UNSUPERVISED AND REINFORCEMENT LEARNING 8

Unsupervised learning: Types of Clustering Algorithms –K – Means – Agglomerative Clustering – Gaussian Mixture Model - EM cluster – Evaluation of Clustering Algorithms – Dimensionality Reduction: Principal Component Analysis, feature selection, **Reinforcement Learning:** Elements – Model based Learning – Temporal Difference Learning

UNIT IV NEURAL NETWORKS 9

Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error back propagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, Elements of CNN architecture - hyper-parameter tuning, batch normalization, regularization, dropout

UNIT V APPLICATIONS OF MACHINE LEARNING IN IC DESIGN 9 Role of ML in Manufacturing Process - Reducing Maintenance Costs and Improving Reliability, Enhancing New Design, Role of ML in Mask Synthesis - Applications in Physical Design -Lithography Hotspot Detection - Pattern Matching Approach - Improving Analysis Correlation, Role of ML in Data Path Placement and Route Ability Prediction, **Case Studies:** Machine Learning for Logic Synthesis, Circuit optimization for 2D and 3D ICs, Analog Circuit Sizing, Hardware functional verification, System level modeling.

45 PERIODS

PRACTICAL EXERCISES: (Using Python or Java)

1. Implement Bayesian Network for Exam Fear problem and perform inference using variable elimination.
2. Perform simple linear regression on single and multiple variables to fit the given data.

(https://www.kaggle.com/c/vlsi-wire-resistance-estimation/data)

3. Perform classification using the following algorithms and analyze their performance in terms of suitable metrics (Ex. Confusion matrix, Accuracy, F1 score, ROC, AUC etc.)

a. Logistic regression
b. naïve Bayes models, KNN
c. Decision tree (ID3) and random forests
d. SVM model
e. Ensembling techniques (Voting, Bagging)

4. Implement clustering algorithms and evaluate their performance using suitable metrics.

f. K-means Clustering
g. Agglomerative Clustering
h. EM cluster

5. Build MLP model to implement to learn XOR logic.
6. Build deep feed forward neural network models to implement a given compound gate.(Ex. Y=ABC+D)
7. Build CNN model for classification of circuit-schematic-components. (https://www.kaggle.com/datasets/moodrammer/handdrawn-circuit-schematic-components)
8. Demonstrate hyper-parameter tuning, regularization and dropout on the above CNN model.

30 PERIODS

TOTAL: 75 PERIODS

COURSE OUTCOMES:

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

CO1: Describe the types of machine learning and probabilistic learning methods
CO2: Apply the supervised learning techniques for solving real world problems
CO3: Construct unsupervised and reinforcement learning algorithms
CO4: Design neural networks for simple applications.
CO5: Illustrate the applications of machine learning in IC design process.

TEXT BOOKS

1. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014
2. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006Tom M Mitchell, “Machine Learning”, McGraw Hill Education, 2013.
3. Machine Learning for VLSI Chip Design, Edited by Abhishek Kumar Suman Lata Tripathi and K. Srinivasa Rao, Wiley, Scrivener Publishing, 2023
4. Machine Learning Applications in Electronic Design Automation, Edited by Haoxing Ren, Jiang Hu, Springer, 2022.

REFERENCES

1. Aurélien Géron , Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, o'reilly, (2017)
2. Stephen Marsland, “Machine Learning: An Algorithmic Perspective”, Chapman & Hall/CRC, 2nd Edition, 2014.
3. Kevin Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012
4. Shai Shalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2015
5. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021.
6. Ian Good fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016

CO’s-PO’s & PSO’s MAPPING

COs	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	3	2	-	1	2	-	-	-	-	-	-	2	2	2	3
CO2	3	3	2	2	3	-	-	-	-	-	-	2	3	2	3
CO3	3	3	3	2	3	-	-	-	1	-	-	2	3	2	3
CO4	3	2	3	2	3	-	-	-	1	1	-	2	3	3	3
CO5	3	3	3	2	3	-	1	-	-	-	-	2	3	3	3
Avg	3	2.6	2.75	1.8	2.8	-	1	-	1	1	-	2	2.8	2.4	3

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

VL3602 VLSI SIGNAL PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of DSP
To learn various DSP structures and their implementation.
To know designing constraints of various filters
To design and optimize VLSI architectures for basic DSP algorithms
To enable students to design VLSI system with high speed and low power

UNIT I INTRODUCTION TO DSP SYSTEMS 9

Introduction to DSP systems – typical DSP algorithms, Representation of DSP algorithms

UNIT II ITERATION BOUND, PIPELINING AND PARALLEL PROCESSING OF FIR FILTER 9

Data-flow graph representations- Loop bound and Iteration bound- algorithms for computingiteration bound-LPM algorithm, Pipelining and parallel processing: pipelining of FIR digital filters, parallelprocessing, pipelining and parallel processing for low power.

UNIT III RETIMING, UNFOLDING AND FOLDING 9

Retiming: definitions, properties and problems- solving systems of inequalities, Properties of Unfolding, critical path, Unfolding and Retiming, applications of Unfolding, Folding transformation register minimization techniques, register minimization in folded architecture- folding of multirate systems**.**

UNIT IV FAST CONVOLUTION 9

Cook-toom algorithm- modified cook-Toom algorithm, iterated convolution, cyclic convolution, Design of fast convolution algorithm by inspection - Winograd algorithm- modified Winograd algorithm

UNIT V ARITHMETIC STRENGTH REDUCTION IN FILTERS 9

Parallel FIR filters-fast FIR algorithms-two parallel and three parallel low complexity FIR filters, Parallel architectures for rank order filters -odd-even merge-sort architecture, rank order filter architecture, parallel rank order filters-running order merge sorter, low power rank order filter.

TOTAL: 45 PERIODS

At the end of the course student will be able

CO1: acquired knowledge about fundamentals of DSP processors.
CO2: improve the overall performance of DSP system through various transformation and optimization techniques.
CO3: to understand the need of different types of instructions for DSP.
CO4: optimize design in terms of computation complexity and speed.
CO5: understand clock based issues and design asynchronous and wave pipelined systems.

TEXT BOOKS

1. Keshab K. Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation ", Wiley, Interscience, 2007

REFERENCES

1. U. Meyer – Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, 2nd Edition, 2004.

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

COs	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	3	3	1	1	2							2	3	2	1
CO2	2	3	3	2	3		1				1	2	2	3	2
CO3	3	2	1		2								3	1	1
CO4	2	2	3	2	3						3		2	3	2
CO5	3	3	2	2	3		1					1	2	3	2
Avg	2.6	2.6	2	1.75	2.6		1				2	1.7	2.4	2.4	1.6

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

NCC Credit Course Level 3*

(ARMY WING)NCC Credit Course-III **L T P C**

3 0 0 3

PERSONALITY DEVELOPMENT **9**

PD3 Group Discussion: Team Work 2
PD4 Career Counselling, SSB Procedure & Interview Skills 3
PD5 Public Speaking 4

BORDER & COASTAL AREAS **4**

BCA2 Security Setup and Border/Coastal management in the area 2
BCA3 Security Challenges & Role of cadets in Border management 2

ARMEDFORCES **3**

AF2 Modes of Entry to Army, CAPF, Police 3

COMMUNICATION **3**

C 1 Introduction to Communication & Latest Trends 3

INFANTRY **3**

INF1 Organisation of Infantry Battalion & its weapons 3

MILITARY HISTORY **23**

MH1 Biographies of Renowned Generals 4

MH2	War Heroes-PVC Awardees	4
MH3	Study of Battles-IndoPak War 1965, 1971 &Kargil	9
MH4	War Movies	6

TOTAL:45PERIODS

NCC Credit Course Level3*

NX3652	**(NAVAL WING)NCC Credit Course- III**	**LTPC 3003**
PERSONALITY DEVELOPMENT		**9**
PD3	Group Discussion: Team Work	2
PD4	Career Counselling, SSB Procedure & Interview Skills	3
PD5	Public Speaking	4
BORDER & COASTAL AREAS		**4**
BCA2	Security Setup and Border/Coastal management in the area	2
BCA3	Security Challenges & Role of cadets in Border management	2
NAVAL ORIENTATION		**6**
NO 3	Modes of Entry-IN, ICG, Merchant Navy	3
AF2	Naval Expeditions &Campaigns	3
NAVAL COMMUNICATION		**2**
NC1	Introduction to Naval Communications	1
NC2	Semaphore	1
NAVIGATION		**2**
N 1	Navigation of Ship-Basic Requirements	1
N 2	Chart Work	1
		15
SEAMANSHIP		
MH1	Introduction to Anchor Work	2
MH2	Rigging Capsule	6
MH3	Boatwork –Parts of Boat	2
MH4	Boat Pulling Instructions	2
MH5	Whaler Sailing Instructions	3
FIREFIGHTING FLOODING & DAMAGE CONTROL		**4**
FFDC1	Fire Fighting	2
FFDC2	Damage Control	2
SHIPMODELLING		**3**
SM	Ship Modelling Capsule	3

TOTAL: 45 PERIODS

NCC Credit Course Level 3*

NX3653 (AIR FORCE WING) NCC Credit Course Level – III LTPC 30 03

PERSONALITY DEVELOPMENT		**9**
PD3	Group Discussion:TeamWork	2
PD4	Career Counselling, SSB Procedure & Interview Skills	3
PD5	Public Speaking	4
BORDER & COASTAL AREAS4		
BCA2	Security Setup and Border / Coastal management in the area	2
BCA3	Security Challenges & Role of cadets in Border management	2
AIRMANSHIP		**1**
A 1	Airmanship	1
BASIC FLIGHT INSTRUMENTS		**3**
FI1	Basic Flight Instruments	3
AEROMODELLING		**3**
AM1	Aero Modelling Capsule	3
GENERAL SERVICE KNOWLEDGE		**2**
GSK4	Latest Trends &Acquisitions	2
AIRCAMPAIGNS		**6**
AC1	Air Campaigns	6
PRINCIPLESOFFLIGHT		**6**
PF1	Principlesof Flight	3
PF2	ForcesactingonAircraft	3
NAVIGATION		**5**
NM1	Navigation	2
NM2	IntroductiontoMetandAtmosphere	3
AEROENGINES		**6**
E 1	IntroductionandtypesofAeroEngine	3
E 2	AircraftControls	3
		TOTAL: 45 PERIODS

VL3611 MINI PROJECTL T P C

0 0 0 2

COURSE OBJECTIVES:

To enable the students to

The students shall individually / or as group work (Max. 2 members) on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. At the end of the semester, a detailed report should be prepared and submitted to the Head of the department. The students will be evaluated as per the Regulations.

COURSEOUTCOMES:
On completion of the course
1. Formulate and analyze problem.
2. Design and conduct experiments to verify
3. Develop working model
4. Analyze the results and provide solution for the identified problem 5. Prepare project report and make presentation.

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	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		2				3	2	2	2	2		2			1
CO2		2				3	2	3	3	2		2			1
CO3	2	3				3	2	2	2	2		3			1
CO4		1				3	2	3	2	2		2			1
CO5	2	3		2		2	1	2	2	2		3			1
Avg	2	2.2	-	2	-	2.8	1.8	2.4	2.2	2	-	2.4	-	-	1

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

VL3701 IC PACKAGING TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamentals of IC packaging, including chip characteristics, package functions, and design considerations.
- To study single-chip packaging technologies such as DIP, SOP, QFP, PGA, BGA, and chip-scale packaging with their manufacturing processes.
- To analyze multichip packaging concepts including MCM, 3D packaging, System-in-Package (SiP), and System-on-Package (SoP).
- To gain knowledge of advanced packaging techniques such as wafer-level packaging, fan-out WLP, and chiplet-based heterogeneous integration.
- To understand packaging materials, interconnect technologies, and reliability testing methods

used in modern IC packaging systems.

UNIT I INTRODUCTION TO IC PACKAGING **9**

Chip Characteristics, Package Functions and Design, Packaging Operations, Packaging Processes, Alternative Process, Transfer to Packaging Area, Package Process Flows, Package/Bare Die Strategies, Package Design, Overview of the IC Manufacturing Processes

UNIT II SINGLE CHIP PACKAGING **9**

Introduction, Functions of Single Chip Packages, Fundamentals of Single Chip Packaging, Materials, Processes, and Properties, Characteristics of Single Chip Packages, Types of Single Chip Packages, Peripheral Packages - DIP, SOP, QFP, Area Array Packages—PGA, BGA, CBGA, PBGA, TBGA, Chip scale package- Manufacturing Technologies- The µBGA

UNIT III MULTICHIP PACKAGING **9**

Multichip module(MCM) /or package, MCM Functionality and Advantages, MCM at the System Level, Types of MCM Substrates, MCM Design and Technology Comparisons, Alternatives to MCM, 3-D Packaging, System in Package (SiP), System on Package (SoP), Applications and examples

UNIT IV ADVANCED PACKAGING AND ASSEMBLY **9**

Wafer Level Packaging, Benefits and disadvantages, WLP Technologies, Fan-Out Wafer-Level Packaging (FOWLP), 3D Packaging Techniques, Advanced Packaging for Chiplet Heterogeneous Integration, Assembly Process for Advanced Packaging

UNIT V PACKAGING MATERIAL AND RELIABILITY **9**

Packaging Materials, Materials Processes, Bonding wires, Copper interconnects and low-κ dielectric materials, Future interconnect and dielectric materials, Reliability testing, Examples of reliability tests.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Rao. R. Tummala, “Fundamentals of Packaging Materials and Processes”, The McGraw-Hill, 2004 (UNIT – I-V)
2. William J. Greig, “Integrated Circuit Packaging, Assembly and Interconnections”, Springer, 2007.((UNIT – I-IV))
3. Peter Van Zant, Microchip Fabrication, 5th Ed, McGraw Hill Professional, 2004 (UNIT – I)
4. John H. Lau, “Semiconductor Advanced Packaging”, Springer, 2021. (UNIT – IV)
5. Andrea Chen, Randy Hsiao-Yu Lo, “Semiconductor Packaging Materials Interaction and Reliability”, CRC Press, 2012 (Unit - V)

COURSE OUTCOMES:

CO1: Explain the fundamentals of IC packaging, including chip characteristics, package functions, and design considerations.

CO2: Identify and describe various single-chip packaging technologies such as DIP, SOP, QFP, PGA, BGA, and chip-scale packages along with their manufacturing processes.

CO3: Analyze multichip packaging concepts including MCM, 3D packaging, System-in-Package (SiP), and System-on-Package (SoP) and their system-level applications.

CO4: Examine advanced IC packaging techniques such as wafer-level packaging, fan-out WLP, and chiplet-based heterogeneous integration.

CO5: Evaluate packaging materials, interconnect technologies, and reliability testing methods used in modern IC packaging systems.

CO’s-PO’s & PSO’s MAPPING

CO	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	3	2	1							2		2	3	2	2
CO2	3	3	2		2					2		2	3	3	2
CO3	3	3	3	2	2					2		2	3	3	3

CO4	3	3	3	3	3					2		2	3	3	3
CO5	3	3	2	3	2					2		2	3	2	2
Avg	3	2.8	2.2	2. 7	2.25					2		2	3	2.6	2.4

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

VL3711SUMMER INTERNSHIPL T P C

0 0 0 2

COURSE OBJECTIVES:

To enable the students to

- Get connected with industry / laboratory / research institute
- Get practical knowledge on production process in the industry and develop skills to solve related problems
- Develop skills to carry out research in the research institutes / laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

No. of Weeks: 04

COURSEOUTCOMES:

On completion of the course, the student will know about

CO1:System-level design processes, verification and validation techniques, manufacturing and production processes in the firm or research facilities in the laboratory/research institute

CO2: Analysis of industrial/ research problems and their solutions

CO3:Documentation of system specifications, design methodologies,process parameters, testing parameters and results

VL3811 PROJECT WORK/ INTERNSHIP L TP C

0 0 20 10

COURSE OBJECTIVES:

To train the students in

Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.

Conducting experiments, analyze and discuss the test results, and make conclusions.

Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department.The student can select any topic which is relevant to his/her specialization of the programme. Thestudent should continue the work on the selected topic as per the formulated methodology. At theend of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results anddiscussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based onthe report and viva-voce examination by a panel of examiners as per the Regulations.

TOTAL: 300 PERIODS

COURSE OUTCOMES:

At the end of the project, the student will be able to

CO1: Formulate and analyze problem / create a new product/ process.
CO2: Design and conduct experiments to find solution
CO3: Analyze the results and provide solution for the identified problem, prepare project report andmake presentation.

VERTICAL ISEMICONDUCTOR DEVICES AND TECHNOLOGY

VL3001 SEMICONDUCTOR DEVICE MODELING L T P C
3 0 0 3

COURSE OBJECTIVES:
To acquire the fundamental knowledge and to expose to the field of semiconductor theory and devices and their applications.
To gain adequate understanding of semiconductor device modelling aspects, designing devices for electronic applications
To acquire the fundamental knowledge of different semiconductor device modelling aspects.

UNIT I MOS CAPACITORS 9
Capacitances in an MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Non equilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown.

UNIT II LONG-CHANNEL MOSFETS 6
Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect,

UNIT III SHORT-CHANNEL MOSFETS 6
Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields

UNIT IV CMOS DEVICE DESIGN 12
CMOS Scaling, Constant-Field Scaling, Generalized Scaling, No scaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, No uniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel Length, Physical Meaning of Effective Channel Length, Extraction of Channel Length by C–V Measurements.

UNIT V MATHEMATICAL TECHNIQUES AND MODELS FOR DEVICE SIMULATIONS 12
Poisson equation, continuity equation, drift-diffusion equation, Noise sources in MOSFET, Flicker noise modeling: Physical mechanisms of flicker noise, Thermal noise modeling: Existing models, BSIMV4 MOSFET Models: Gate dielectric model, Enhanced model for effective DC and AC channel length and width, Threshold voltage model, Channel charge model, mobility model, Source/drain resistance model, I-V model, gate tunneling current model, substrate current models, Capacitance models, noise model, Layout-dependent parasitics model.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to
CO1: Explain the fundamental concepts of semiconductor materials, carrier transport mechanisms, and semiconductor device operation.
CO2: Analyze the characteristics and performance of semiconductor devices used in electronic applications.

CO3: Apply semiconductor theory and device modelling techniques for the design and analysis of electronic devices.

CO4: Evaluate different semiconductor device models and their suitability for practical electronic and VLSI applications.

CO5: Utilize modern simulation and analytical methods to study semiconductor devices and their applications in electronic system design.

TEXT BOOKS:

1. Yuan Taur and Tak H.Ning, "Fundamentals of Modern VLSI Devices", Cambridge University Press, 2016.(UNIT I,II,III,IV)
2. Trond Ytterdal, Yuhua Cheng and Tor A. Fjeldly Wayne Wolf, “Device Modeling for Analog and RF CMOS Circuit Design”, John Wiley & Sons Ltd, 2004 (UNIT V)
3. J P Collinge, C A Collinge, “Physics of Semiconductor devices” Springer, 2002. (UNIT V)

REFERENCES:

1. A.B. Bhattacharyya “Compact MOSFET Models for VLSI Design”, John Wiley & Sons Ltd, 2009.
2. Ansgar Jungel, “Transport Equations for Semiconductors”, Springer, 2009
3. Selberherr, S., “Analysis and Simulation of Semiconductor Devices”, Springer-Verlag., 1984
4. Behzad Razavi, “Fundamentals of Microelectronics” Wiley Student Edition, 2nd Edition, 2014
5. 8. S.M.Sze, Kwok.K. NG, “Physics of Semiconductor devices”, Springer, 2006.

CO’s-PO’s & PSO’s MAPPING

COs	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	3	2	1	1	2	-	1	1	-	1	-	2	3	2	2
CO2	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO3	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	1	1	2	3	3	3
CO5	3	2	3	3	3	-	1	1	1	2	1	2	3	3	3

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

CEC339 FUNDAMENTALS OF NANOELECTRONICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the concepts of Nano electronics and quantum electronics
- To understand the concepts of Nano electronic devices, transistors, tunnelling devices and superconducting devices
- To understand the basics of nanotube devices

UNITI INTRODUCTION TO NANO ELECTRONICS 9

Scaling to Nano - Origin of quantum mechanics - Light as a wave and particle- Electrons as waves and particles, Quantum dots, wires and well-Spin and angular momentum.

UNIT II QUANTUM AND MOLECULAR ELECTRONICS 9

Quantum electronic devices - Short channel MOS transistor - Split gate transistor - Electron wave transistor - Electron wave transistor - Electron spin transistor - Quantum cellular automata - Quantum dot array, Overview of molecular electronics, Switches based on Fullerenes and Nanotubes, Polymer Electronics, Self-Assembling Circuits, Optical Molecular Memories

UNIT III NANO ELECTRONIC TRANSISTORS 9

Coulomb blockade - Coulomb blockade in Nano capacitors - Coulomb blockade in tunnel junctions –

Single electron transistors, Semiconductor nanowire FETs and SETs, Molecular SETs and molecular electronics -

UNIT IV NANO ELECTRONIC TUNNELING AND SUPER CONDUCTING DEVICES9

Tunnel effect -Tunnelling element -Tunnelling diode - Resonant tunnelling diode - Three terminal resonant tunnelling devices- Superconducting switching devices: Cryotron- Josephson tunnelling device, Elementary Circuits: Memory Cell, Associative or Content-Addressable Memory, SQUID, Flux Quantum Device: LC- Magnetic Flux Quantum – QCA, Quantum Computer with Single-Flux Devices, SFQD, RSFQD, Application of Superconducting Devices

UNIT V NANOSTRUCTURED DEVICES 9

Classification of Nanostructured Materials, Quantum Dots: Fabrication and applications of quantum dots, Carbon Nanotubes: Types of carbon nanotubes, Synthesis, Characterization techniques in carbon nanotubes, CNT-based physical sensors, Carbon nanotube FETs and SETs, GaN nanowires and their applications, Applications of ZnOnanostructures, Titania nanotubes (TNTs).

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basics of Nano electronics including quantum wires, dots and wells

CO2: Use the mechanism behind quantum electronic devices

CO3 :Analyze the key performance aspects of tunneling and superconducting Nano electronic devices

CO4: Apply the knowledge in the development of nanotubes and nanostructure devices

TEXTBOOKS

1. Hanson, Fundamentals of Nanoelectronics, Pearson education, 2009
2. Jan Dienstuhl, Karl Goser, and Peter Glösekötter, Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer-Verlag, 2004.
3. B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday, Textbook of Nanoscience and Nanotechnology, Universities Press (India) Private Limited, 2013

REFERENCES

1. Mircea Dragoman and Daniela Dragoman, Nanoelectronics: Principles and Devices, Artech House, 2009.
2. Robert Puers, Livio Baldi, Marcel Van de Voorde and Sebastiaan E. Van Nooten, Nanoelectronics: Materials, Devices, Applications, Wiley, 2017.
3. Brajesh Kumar Kaushik, Nanoelectronics: Devices, Circuits and Systems, Elsevier science, 2018.

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

CO	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
1	3	3	2	2	2	1	-	-	-	-	-	2	2	1	1
2	3	3	3	2	2	2	-	-	-	-	-	2	3	1	1
3	3	3	3	2	2	2	-	-	-	-	-	2	3	1	1
4	3	3	2	2	2	2	-	-	-	-	-	2	3	1	1
5	3	3	3	3	3	3	-	-	-	-	-	2	3	1	2
CO	3	3	2.6	2.2	2.2	2	-	-	-	-	-	2	2.8	1	1.2

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

VL3002 ADVANCED SEMICONDUCTOR DEVICES L T P C
3 0 0 3

COURESE OBJECTIVES:

- To understand advanced semiconductor materials including compound, alloyed, wide bandgap, magnetic, and spintronic materials used in modern electronic and integrated circuit applications.
- To study the fundamental concepts and characteristics of metal–semiconductor and metal–insulator–semiconductor structures, including Schottky and Ohmic contacts and MISFET operation.
- To analyze the structure, operation, and performance of advanced field-effect and heterostructure devices such as MESFETs, MODFETs, HEMTs, and HBTs for high-speed applications.
- gain knowledge of resonant tunneling devices and hot electron devices, and understand their role in emerging quantum and nanoscale semiconductor technologies.

UNIT I MATERIALS FOR ADVANCED SEMICONDUCTOR DEVICES9

Introduction to Semiconducting Materials, Element Form Semiconducting Materials, Formulated (Compound and Alloyed) Semiconductor Materials, Choicest Materials for Different Semiconductor Devices , Spintronics and Spintronic Materials, Ferromagnetic Semiconductor, Emerging Wide Bandgap Semiconductors, Manganese Semiconductor, Diluted Magnetic Semiconductor, Silicon and Gallium Arsenide (GaAs) for Making Integrated Circuit

UNIT II METAL SEMICONDUCTOR CONTACTS AND METAL INSULATOR SEMICONDUCTOR DEVICES 9

Heterojunction, Metal-Semiconductor Contacts: Basic Characteristics, The Schottky Barrier, The Ohmic Contact - MISFET: Gate ,Fabrication Process, Threshold Voltage and Its Uniformity, Conduction-Band Discontinuit, Effects of Gate Insulator Thickness and Gate Leakage Current, Gate Current Model, Current Gain Cutoff , Frequency-Divider , Complementary Circuit

UNIT III METAL SEMICONDUCTOR FIELD EFFECT TRANSISTORS (MESFETs) 9

MESFET: Basic Device Structures, Principles of Operation, Current-Voltage Characteristics, MESFET technology - MODFET: Fundamentals, Current-Voltage Characteristics, Cutoff Frequency,

UNIT IV HIGH ELECTRON MOBILITY TRANSISTORS (HEMT) 9

HEMT :Introduction, Performance Advantages of HEMT Approaches, Self-Aligned HEMT Technologies for VLSI, HBT: HBTs for High-Speed Applications, Device Structure and Operation of HBTs, Applications of AlGaAs-GaAs HBT.

UNIT V RESONANT AND HOT ELECTRON DEVICES 9

Introduction to resonant tunneling transistors, Structure of RTD, Resonant tunneling hot electron transistor, RHET using InGaAs material, metal base, doped base and quantum well base transistors, Quantum devices.

TOTAL:45 PERIODS

TEXT BOOKS:

1. K.M. Gupta, Nishu Gupta, Advanced Semiconducting Materials and Devices, Springer, 2016
2. S. M. SZE, M. K. LEE, Semiconductor Devices Physics and Technology, John Wiley & Sons, Inc, 2012

3. Takahiko Misugi and Akihiro Shibatomi, Compound and Josephson High-Speed Devices, Springer, 1993
4. C.Y. Chang, F. Kai, GaAs High-Speed Devices: Physics, Technology and Circuit Applications, Wiley & Sons

REFERENCES

1. S.M. Sze, High Speed Semiconductor Devices, Wiley (1990) ISBN 0-471-62307-5
2. Cheng T. Wang, Ed., Introduction to Semiconductor Technology: GaAs and Related Compounds, John Wiley & Sons.
3. David K. Ferry, Ed., Gallium Arsenide Technology, Howard W. Sams & Co., 1985
4. Sandip Tiwari, Compound Semiconductor Device Physics, Academic Press (1991), ISBN 0-12-691740- X.

COURESE OUTCOMES:

CO1: Explain the properties and applications of advanced semiconductor materials including compound, alloyed, wide bandgap, magnetic, and spintronic materials used in modern electronic devices.

CO2: Analyze metal–semiconductor and metal–insulator–semiconductor structures, including Schottky and Ohmic contacts and MISFET characteristics.

CO3: Understand the structure, operation, and performance of advanced devices such as MESFETs and MODFETs for high-speed electronic applications.

CO4: Analyze and evaluate the operation and advantages of heterostructure devices such as HEMTs and HBTs in VLSI and high-frequency applications.

CO5: Apply the concepts of resonant tunneling devices and hot electron devices to understand emerging quantum and nanoscale semiconductor technologies.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	1	1	-	1	-	2	3	2	3
CO2	3	3	2	2	3	-	1	1	-	1	-	2	3	3	2
CO3	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	1	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

CEC363 WIDE BANDGAP DEVICES L T P C
2 02 3

COURSE OBJECTIVES:

- Introduce the concept of wide band gap (WBG) devices and its application in real world
- Advantages and disadvantages of WBG devices
- Provide an introduction to basic operation of WBG power devices
- Learn Design principles of modern power devices
- Ability to deal high frequency design complexity

UNIT I WBG DEVICES AND THEIR APPLICATION IN REAL WORLD 6

Review of semiconductor basics, Operation and characteristics of the SiC Schottky Barrier Diode, SiC DMOSFET and GaN HEMT, Review of Wide bandgap semiconductor technology -Advantages and disadvantages

UNIT II SWITCHING CHARACTERIZATION OF WBG 6

Turn-on and Turn-off characteristics of the device, Hard switching loss analysis, Double pulse test set-up

UNIT III DRIVERS FOR WIDE BAND GAP DEVICES 6

Gate driver, Impact of gate resistance, Gate drivers for wide bandgap power devices , Transient immunity integrated gate drivers

UNIT IVHIGH FREQUENCY DESIGN COMPLEXITY AND PCB DESIGNING 6

Effects of parasitic inductance, Effects of parasitic capacitance , EMI filter design for high frequency power converters High frequency PCB design, Conventional power loop design, High frequency power loop optimization, Separation of power from signal PCB

UNIT V APPLICATIONS OF WIDE BANDGAP DEVICES 6

Consumer electronics applications, Wireless power transfer applications, Electric vehicle applications , Renewable energy sources applications

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Conduct switching loss and Magnetic loss on Low side

2. Conduct Double pulse test (DPT) and learn IEC 60747 -8/9 standards
3. Conduct experiments for Diode reverse recovery on High side
4. Conduct Power analysis and harmonic measurement
5. Measure Turn on /off delay , . Calculate recovery softness factor , measure reverse recovery energy.

List of Equipments needed for 30 students in a batch (6 students in bench)

1. 1GHz Flexi channel oscilloscope with 6 channels - #5
2. 2ch AFG with 9inch touchscreen and built-in Double Pulse Test application to generate atleast 2 varying pulse widths, 16Mpts memory - #1
3. Power supplies - Programmable DC Power Supply, 720W (for High Voltage side) and Programmable Single Channel DC Power Supply, 192W (to drive Gate drive circuit) - #1
4. Voltage Probes to measure Vgs (low side) – passive probe or differential probe 200MHz - #15
5. Voltage Probes to measure Vgs (high side) – 1GHz, isolated probes with MMCX adapter tips – #1 nos
6. Current Probes to measure drain current – 30A with 120Mz BW - #5

COURSE OUTCOMES:

Upon successful completion of the course the student will be able to

CO1: Students master design principles of power devices
CO2: Students become familiar with reliability issues and testing methods
CO3: An ability to design and conduct experiments, as well as to analyze and interpret data
CO4: Student to get real life experience and to know practical applications of WBG
CO5: Indepth knowledge on practical usage of this technology

TOTAL:60 PERIODS

TEXT BOOKS

1. A. Lidow, J. Strydom, M. D. Rooij, D. Reusch, GaN Transistors for Efficient Power Convertion, Wiley, 2014, ISBN-13: 978-1118844762.

2. G. Meneghesso, M. Meneghini, E. Zanoni, “Gallium Nitride-enabled High Frequency and High Efficiency Power Conversion,” Springer International Publishing, 2018, ISBN: 978-3-319-77993-5

REFERENCES

1. F. Wang, Z. Zhang and E. A. Jones, Characterization of Wide Bandgap Power Semiconductor Devices, IET, ISBN-13: 978-1785614910 (2018).
2. B.J.Baliga, “Gallium Nitride and Silicon Carbide Power Devices,” World Scientific Publishing Company (3 Feb. 2017).
3. L. Corradini, D. Maksimovic, P. Mattavelli, R. Zane, “Digital Control of HighFrequency Switched-Mode Power Converters”, Wiley, ISBN-13: 978-1118935101 (9th June, 2015).

CO’s-PO’s & PSO’s MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	2	3	2	-	-	-	-	-	-	-	1	1	3
2	3	3	3	2	2	-	-	-	-	-	-	-	1	1	2
3	3	3	2	2	2	-	-	-	-	-	-		2	2	2
4	3	3	3	3	2	-	-	-	-	-	-	-	3	2	2
5	3	2	3	3	2	-	-	-	-	-	-	-	2	2	2
CO	3	3	2.6	2.6	2	-	-	-	-	-	-	-	2	2	2

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

VL3003FINFET DEVICES FOR VLSI CIRCUITS AND SYSTEMS L T P C
2 02 3

COURSE OBJECTIVES:

To understand the fundamentals of FinFET technology and its role in overcoming MOSFET scaling limitations in modern nano-scale devices.
To analyze the electrical characteristics and device operation of long-channel and short-channel FinFETs, including threshold voltage and current behavior.
To study leakage mechanisms, parasitic effects, and quantum influences in FinFET devices for accurate performance evaluation.
To design and evaluate FinFET-based circuits such as inverters and SRAM cells, and assess their performance in terms of power, delay, stability, and scalability.

UNIT I FINFET TECHNOLOGY 6

Challenges of MOSFET scaling - Overview of FinFET Technology: Introduction, FinFET Manufacturing Technology, SOI FinFET Process Flow - Independently Controlled Gates

UNIT II LONG GEOMETRY FINFETS 6

Long Channel FinFETs: Basic Features of FinFET Devices, FinFET Device Operation, Regional Drain Current Formulation for Symmetric DG-FinFETs: Threshold Voltage Formulation, Linear Region Ids Equation, Saturation Region Ids Equation, Subthreshold Conduction

UNIT III SMALL GEOMETRY FINFETS 6

Small Geometry FinFETs: Short-channel Effects on Threshold Voltage, Quantum Mechanical Effects, Surface Mobility, High Field Effects, Output resistance.

UNIT IV LEAKAGE CURRENTS AND PARASITIC ELEMENTS6

Leakage currents: Subthreshold Leakage Currents, Gate-Induced Drain and Source Leakage Currents, Impact Ionization Current, Source-Drain *pn*-Junction Leakage Current, Gate Oxide Tunneling Leakage Currents, Parasitic Elements in FinFETs, Source-Drain Parasitic Resistance, Gate Resistance, Parasitic Capacitance Elements,

UNIT VFINFET CIRCUIT DESIGN 6

Introduction, Impact of device performance on digital circuit design, SRAM design, Operational-amplifier, comparator, SOC Design and Technology Aspects, Compact models-core model: Surface potential model, I-V model, C-V model

30 PERIODS

PRACTICAL EXERCISES

1. Simulate FinFET device for DC characteristics.
2. Analyze parameters such as Subthreshold slope, DIBL, leakage current
3. Design and simulate Inverter using IG FinFET and SG FinFET
3. Design the following circuits using FinFET technology and compare the same with corresponding CMOS technology.
   - Inverter
   - 6T SRAM cell
4. Evaluate the power, delay and stability of FinFET based SRAM
5. Determine the effect of supply voltage on FinFET based SRAM cell
6. Analyse the effects of Fin width, number of fins.

30 PERIODS

TOTAL 60 PERIODS

TEXT BOOKS

1. Samar K. Saha, “FinFET Devices for VLSI Circuits and Systems”, CRC Press 2021
2. J. P. Colinge, “FinFETs and Other Multigate Transistors”, Springer Publications

REFERENCE BOOKS

1. Yogesh Singh Chauhan, Darsen D. Lu, “FinFET Modeling for IC Simulation and Design”, Elseiver 2015.
2. Nanoelectronic Circuit Design – Niraj K. Jha and Deming Chen, Springer Publications.
3. Brajesh Kumar Kaushik, Sudeb Dasgupta, Pankaj Kumar Pal, “Spacer Engineered FinFET Architectures”, CRC Press 2017.
4. Jerry G. Fossum, Vishal P. Trivedi, “Fundamentals of Ultra-Thin-Body MOSFETs and FinFETs”, Cambridge University Press 2013.
5. Weihua Han, Zhiming M. Wang, “Toward Quantum FinFET”, Springer 2013.

COURSE OUTCOMES:

CO1: Explain the fundamentals of FinFET technology and its advantages in overcoming MOSFET scaling limitations in nano-scale devices.

CO2: Analyze the electrical characteristics and operating principles of long-channel FinFETs, including threshold voltage and drain current behavior.

CO3: Evaluate short-channel effects in FinFET devices such as quantum effects, mobility degradation, and high-field effects.

CO4: Analyze leakage mechanisms and parasitic components in FinFETs to assess device performance and reliability.

CO5: Design and simulate FinFET-based circuits such as inverters and SRAM cells, and evaluate their performance in terms of power, delay, stability, and scalability.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	1	1	-	1	-	2	3	2	2
CO2	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO3	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	1	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3004 NANOSENSORS AND DEVICESL T P C
3 00 3

COURSE OBJECTIVES:

To understand the fundamentals of nanoscience, nanotechnology, nanomaterials, and their unique properties and applications in nanoelectronics, spintronics, nanophotonics, and energy devices.

To study the physical, mechanical, electronic, optical, thermal, and magnetic properties of nanomaterials and their role in advanced material systems.

To gain knowledge of various nanodevices such as GMR, MTJ, TFET, SET, nanowire devices, graphene-based FETs, and different generations of solar cells including hybrid and perovskite technologies.

To understand the working principles and applications of nanosensors and biosensors, including CNT, graphene, NEMS-based sensors, and FET-based biosensing devices for biomedical and environmental applications.

UNIT I INTRODUCTION 9

Introduction to nanoelectronics: Nanoscience, Nanotechnology, Nanomaterials, Uniqueness of Nanomaterials, Nanoelectronics, Spintronics and Nanomagnetics, Nanophotonics or Nano-optics, supercapacitors

UNIT II NANOMATERIALS9

ISO and EC Definitions, Mechanical Strength of Nanomaterials, Characterizing Parameters, Catalytic Effects, Thermal Properties, Electronic and Optical Properties, Magnetic Properties, Typical Magnetic Nanomaterials, Characterization of magnetic nanomaterials, Charge-Transport Materials for Hybrid Solar Cells

UNIT III NANODEVICES 9

Nanophotonic Devices, Giant Magnetoresistance (GMR), Magnetic Tunnel Junction (MTJ), Tunnel Field-Effect Transistor, Single Electron Transistor, Semiconductor Nanowire, GNR FET, Solar Cells: Structure and Working Principle, Photovoltaic Generations, Organic Solar Cells-DSSC structure and working priciple, Quantum Dot based Solar Cell, Organic–Inorganic Hybrid Solar Cells- Graphene-Based Hybrid Solar Cells , Polymer–Quantum Dot Hybrid Solar Cells, Perovskite Solar Cells- basic working principle.

UNIT IV NANOSENSORS 9

NEMS Sensors, Piezoresistive Sensors, Piezoelectric Sensors, Capacitive Sensors, Triboelectric Sensors, Tunneling Sensors, CNT-Based Piezoresistive, Resonator-Based Mass Sensors, Resonator-Based Strain Sensors, Types of gas sensors based on carbon-based nanomaterials, Parameters of gas sensor, Carbon nanotube-based gas sensors : Sensing mechanism, Carbon nanotube/semiconducting metal oxide nanocomposite-based gas sensors, Graphene-based gas sensors: Graphene and its derivative/ metal oxide-based gas sensors, Optical gas sensors.

UNIT V BIOSENSORS9

GNP Biosensors, Magnetic Nanoparticle, Quantum Dot (QD) Biosensors, Carbon Nanotube (CNT) Biosensors, Si Nanowire (SiNW) Biosensors, Nanocantilever Biosensor, Wearable Stain/Pressure Sensors, FET based Biosensors:ChemFET, ISFET, ENFET

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Vinod Kumar Khanna, Integrated Nanoelectronics, Springer, 2016.
2. David J. Sellmyer, YanglongHou , Magnetic Nanomaterials Fundamentals, Synthesis and Applications 2017
3. Yoon-Bong Hahn Tahmineh MahmoudiYoushengWang, Next-Generation Solar Cells Principles and Materials, Jenny Stanford Publishing Pte. Ltd, 2024
4. Brian R. Eggins, CHEMICAL SENSORS AND BIOSENSORS, Wiley 2002.
5. Navinchandra Gopal Shimpi, Shilpa Jain, “Carbon – Based Nano Materials and Nanocomposites for Gas Sensing, 2023 Elsevier

REFERENCE BOOKS:

1. Saraju P. Mohanty and Ashok Srivastava, ‘Nano-CMOS and Post-CMOS Electronics’, IET 2016.
2. Brian Cantor ‘Novel Nanocrystalline Alloys and Magnetic Nanomaterials’.

COURSE OUTCOMES:

CO1: Explain the fundamentals of nanoscience, nanotechnology, nanomaterials, and their applications in nanoelectronics, spintronics, nanophotonics, and energy devices.

CO2: Analyze the physical, mechanical, electronic, optical, thermal, and magnetic properties of nanomaterials and relate them to advanced material systems.

CO3: Understand and evaluate the working principles of nanodevices such as GMR, MTJ, TFET, SET, nanowire devices, and graphene-based FETs.

CO4: Analyze different generations of solar cells including organic, quantum dot, hybrid, and perovskite-based solar cell technologies.

CO5: Explain the working principles and applications of nanosensors and biosensors including CNT, graphene, NEMS-based sensors, and FET-based biosensing devices for biomedical and environmental applications.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	1	1	-	1	-	2	3	2	3
CO2	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO3	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO4	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO5	3	3	3	3	3	1	1	1	1	2	1	2	3	3	3

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

VL3005NANOPHOTONIC DEVICES L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of nanophotonics, including optical diffraction limits, near-field optics, and the basic principles of nanoscale light–matter interactions.
To study the working principles of nanophotonic devices such as logic gates and their interconnection with photonic systems, including room-temperature operation.
To gain knowledge of nanophotonic fabrication techniques such as near-field lithography, optical CVD, and self-assembly methods for nanoparticle control and alignment.
To understand nanophotonic systems and nano-biophotonics, including optical excitation transfer, system architecture, and advanced microscopy techniques for biological imaging.

UNIT I BASICS OF NANOPHOTONICS 9

Modern optical science and technology and the diffraction limit – Breaking through the diffraction limit – Nanophotonics and its true nature. Optical near fields and effective interactions as a base for nanophotonics

UNIT II FUNDAMENTALS OF NANOPHOTONIC DEVICES 9

Excitation energy transfer – Device operation: nanophotonic AND gate & nanophotonic NOT gate – interconnection with photonic devices – Room temperature operation.

UNIT III FUNDAMENTALS OF NANOPHOTONIC FABRICATION 9

Adiabatic nanofabrication – Nonadiabatic nanofabrications: near field optical CVD and near field photolithography – Self assembling method via optical near field interactions – Regulating the size and position of nanoparticles using size dependent resonance – Size controlled, position controlled and separation controlled alignment of nanoparticles.

UNIT IV FUNDAMENTALS OF NANOPHOTONIC SYSTEMS 9

Introduction – Optical excitation transfer and system fundamentals – Parallel architecture using optical excitation transfer – Interconnections for nanophotonics – Signal transfer and environment – tamper resistance – Hierarchy in nanophotonics and its system fundamentals.

UNIT V FUNDAMENTALS OF NANO BIOPHOTONICS 9

Introduction – The cell: scale and constituents – Origin and optical contrast mechanisms – Classical contrast mechanisms: bright field, dark field, phase contrast and interferometric contrast – Fluorescence contrast mechanism – Nonlinear microscopy based on second harmonic generation and coherent anti-Stokes Raman scattering – Reduction of the observation volume – Far field methods: 4Pi microscopy, microscopy on a mirror and stimulated emission depletion – Near field methods.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

On completion of this course, students will be able to
CO1: Demonstrate the basic principles of nanophotonics and nanofabrication using optical near fields
CO2: Analyse the performance of nanophotonic devices and systems
CO3: Identify and assess the nonadiabatic nanofabrication process using optical near fields
CO4: Design the nanophotonic system by assembling the nanophotonic devices
CO5: Describe the fundamentals of nano biophotonics

TEXT BOOKS:

1. Motoichi Ohtsu, Kiyoshi Kobayashi, Tadashi Kawazoe, Takashi Yatsui and Makoto Naruse, Principles of Nanophotonics. New York, USA: CRC Press-Taylor & Francis Group, 2008 (
2. Herve Rigneault, Jean-Michel Lourtioz, ClaudeDelalande and Ariel Levenson, Nanophotonics. London, UK: ISTE Ltd., 2006.

REFERENCES:

1. Hiroshi Masuhara, Satoshi Kawata and Fumio Tokunaga, Nano Biophotonics. Oxford, UK: Elsevier, 2007.
2. Paras. N. Prasad, Nanophotonics. New Jersey, USA: John Wiley & Sons Inc.,2004.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	1	1	-	1	-	2	3	2	3
CO2	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO3	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	2	2	2	2	1	2	1	1	1	1	2	3	2	2

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

VERTICAL II CHIP DESIGN AND TESTING

VL3006 ASIC DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

• To Focus on the Semi-Custom IC Design and introduces the Principles of Design Logic Cells, I/O Cells and Interconnect Architecture, with Equal Importance given to FPGA and ASIC styles.
• To deal with the entire FPGA and ASIC Design Flow from the Circuit and Layout Design Point of View

UNIT I INTRODUCTION TO ASICS AND ASIC LIBRARY DESIGN 9

Types of ASICs - Design Flow –Transistors as Resistors - Transistor Parasitic Capacitance- Logical Effort, Library-Cell Design, Library Architecture, Gate-Array Design, Standard-Cell Design, Datapath-Cell Design

UNIT II PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS9

Anti Fuse - Static Ram - EPROM and EEPROM Technology - ACTEL ACT- Xilinx LCA – ALTERA FLEX - ALTERA MAX

UNIT III PROGRAMMABLE ASIC I/O CELLS AND INTERCONNECTS 9

DC & AC Inputs and Outputs - Clock & Power Inputs - Xilinx I/O Blocks, **Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX**

UNIT IV ASIC SIMULATION AND TESTING 9

Types of simulation -Comparator/MUX Example- boundary scan test - fault simulation - automatic test pattern generation, Built-in Self-test.

UNIT V ASIC FLOOR PLANNING, PLACEMENT AND ROUTING 9

Floor planning - placement - physical design flow–global routing - detailed routing - special routing - circuit extraction - DRC.

TOTAL :45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will be
CO1: able to apply Logical Effort Technique for predicting Delay, Delay Minimization and FPGA Architectures
CO2: able to Design Logic Cells and I/O Cells
CO3: able to analyze the various resources of recent FPGAs
CO4: able to use Algorithms for Floor Planning and Placement of Cells and to Apply Routing Algorithms for Optimization of Length and Speed.
CO5: able to analyze High Performance Algorithms Available for ASICs

TEXT BOOKS

1. M.J.S.Smith, "Application Specific Integrated Circuits", Pearson, 2003.
2. Steve Kilts, “Advanced FPGA Design,” Wiley Inter-Science,2006

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	2	2	3	-	1	1	1	1	1	2	3	3	2
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

CEC361 VALIDATION AND TESTING TECHNOLOGY L T P C

2 02 3

COURSE OBJECTIVES:

- Getting familiar with various IC technology.
- Learn MOS theory and testing
- Learn CMOS circuit theory and testing
- Getting expertise on CMOS characterization.
- Explore circuit and device level testing methods

UNIT I TECHNOLOGY INTRODUCTION: 6

Introduction to IC Technology – MOS, PMOS, NMOS, CMOS &BiCMOS Technologies. VLSI Fabrication, Oxidation, Lithography, Diffusion, Ion Implantation, Metallization, Integrated Resistors and Capacitors.

UNIT II MOS THEORY ANALYSIS-I 6

Basic Electrical Properties of MOS Circuits: Ids-Vds Relationships, MOS Transistor Threshold Voltage Vth, gm, gds, Figure of Merit ωo, Short Channel and Narrow Channel Width Effects.

UNIT III MOS THEORY ANALYSIS- II 6

Pass Transistor, Transmission Gate, NMOS Inverter, Various Pull-ups, CMOS Inverter Analysis and Design, Bi-CMOS Inverters, Latch up in CMOS Circuits.

UNIT IV CMOS CIRCUIT CHARACTERISATION AND PERFORMANCE ESTIMATION 6

Sheet Resistance RS, conductivity and its Concept to MOS, Area Capacitance Units, Calculations - Delays, Driving Large Capacitive Loads, Delay Estimation, Logical Effort and Transistor Sizing, Power Dissipation, Reliability.

UNIT V BASIC OF SILICON VALIDATION 6

Need for Testing, Testing at Various Levels, Objectives of Testing - VLSI Test process and Test Equipment - Types of Testing: Functionality Tests, Silicon Debug, Manufacturing Tests, Defect during manufacturing - Fault Modelling, Observability and Controllability, Fault Coverage, Fault Sampling - ATE, Test economics.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. MOS TESTING for Ids-Vds Relationships
2. MOSFET testing for threshold voltage like Vth, gate breakdown voltage.
3. Sheet resistivity measurement.
4. Conductivity measurement.
5. Inverter testing
6. Designing of CMOS inverter/ logic gate and testing of delay estimation.

List of equipment needed for a batch of 30 students (3 in a bench):

- Dual channel SMU for MOSFET testing with Test script processor and IV software: 2 nos (one setup for three students)
- Resistivity and Conductivity Setup – #2 setups
- I-V SMU analyser
- Four Point Collinear Resistivity Measurement Setup
- Resistivity samples #2
- Conductivity Samples #2
- Inverter testing setup: power suppy #1, Scope with AFG and power application: #1no
- Xilinx /CAD: 5 no.

COURSE OUTCOMES:

Upon successful completion of the course the student will be able to

CO1: Complete overview to CMOS fabrication process.

CO2: Understand the fundamental concept of MOS FET and testing.

CO3: Explain the concept of MOS theory and analysis.

CO4: To give the student an understanding of CMOS performance testing and estimation.

CO5: Explain the basics of Testing and Fault Modeling

TOTAL:60 PERIODS

TEXT BOOKS:

1. Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, “Essentials of VLSI Circuits and Systems” – PHI, EEE, 2005 Edition.
2. Neil H. E. Weste and David. Harris Ayan Banerjee,, “CMOS VLSI Design” - Pearson Education, 1999.

REFERENCES

1. M.L. Bushnell and V.D. Agrawal, “Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits”, Kluwer Academic Publishers, 2004
2. N.K. Jha and S.G. Gupta, “Testing of Digital Systems”, Cambridge University Press, 2003
3. Etienne Sicard, Sonia Delmas Bendhia, “Basics of CMOS Cell Design”, TMH, EEE, 2005

CO’s-PO’s & PSO’s MAPPING

CO	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
1	3	3	3	3	2	2	1	-	-	-	2	2	3	2	3
2	2	3	3	3	2	1	1	-	-	-	2	2	3	3	2
3	3	2	2	3	2	3	3	-	-	-	3	2	2	2	2
4	3	3	2	3	2	3	3	-	-	-	2	2	1	2	1
5	3	2	3	3	3	3	2	-	-	-	2	2	1	2	1
CO	2.8	2.6	2.6	3	2.2	2.4	2	-	-	-	2	2	2	2	2

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

VL3007 NETWORK ON CHIP **L T P C**

3 0 0 3

COURSE OBJECTIVES:

The students should be made to:

- Understand the concept of Network - on - Chip
- Learn router architecture designs
- Study fault tolerance Network - on – Chip

UNIT I INTRODUCTION TO NOC **9**

Introduction to NOC – OSI Layer Roles in NOC - Interconnection Networks in Network-On-Chip: Network Topologies - Switching Techniques - Routing Strategies - Flow Control Protocol Quality- of-Service Support

UNIT II ARCHITECTURE DESIGN **9**

Switching Techniques and Packet Format - Asynchronous FIFO Design - GALS Style of Communication - Wormhole Router Architecture Design - VC Router Architecture Design - Adaptive Router Architecture Design

UNIT III ROUTING ALGORITHM 9

Packet Routing-QOS, Congestion Control and Flow Control – Router Design –Efficient and Deadlock-Free Tree-Based Multicast Routing Methods

UNIT IV TESTING OF NETWORK-ON-CHIP ARCHITECTURES 9

Sources of Faults in NoC Fabric, Permanent Fault Controlling Techniques, Transient Fault Controlling Techniques, Testing Communication Fabric: Testing NoC Links and Switches, Test Data Transport, Testing Cores: Core Wrapper Design, ILP Formulation, Heuristic Algorithms

UNITV THREE-DIMENSIONALINTEGRATIONOFNETWORK-ON-CHIP 9

3D Integration: Challenges and opportunities, Design and Evaluation of 3D NoC Architecture, Future Trends: Photonic NoC, Wireless NoC

TOTAL:45PERIODS

COURSEOUTCOMES:

Attheendofthiscourse,thestudentswillbeable to:

CO1:Compare different architecture design

CO2: Discuss different routing algorithms

CO3:ExplainthreedimensionalNetworksonChiparchitectures

CO4: TestanddesignfaulttolerantNOC

CO5: Designthreedimensionalarchitecturesof NOC

TEXT BOOKS

1. Konstantinos Tatas and Kostas Siozios, "Designing 2D and 3D Network-On-Chip Architectures" 2013
2. Santanu Kundu, Santanu Chattopadhyay “Network-on-Chip: The Next Generation of System on-Chip Integration”, CRC Press, 2014
3.Palesi, Maurizio, Daneshtalab, Masoud “Routing Algorithms in Networks-On-Chip” 2014

REFERENCES

1.ChrysostoMOSnicopoulos, Vijaykrishnan Narayanan, Chita R.Das” Networks-On - Chip
“ Architectures Holistic Design Exploration”, Springer.
2. Fayezgebali, Haythamelmiligi, Hqhahedwatheq E1-Kharashi “Networks-On-Chips Theory and Practice CRC Press

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3008MIXED SIGNAL IC DESIGN L T P C
2 0 2 3

COURSE OBJECTIVES:

To understand the fundamentals of mixed-signal circuits including analog, digital, and mixed-signal systems, and their applications in VLSI design.
To study current sources, voltage references, and biasing techniques such as current mirrors, bandgap references, and regulated power supplies for stable circuit operation.
To analyze phase-locked loops (PLLs), delay-locked loops (DLLs), and their performance parameters including jitter and real-world applications. To design and evaluate data converters, peripheral circuits, and mixed-signal testing methodologies including ADC/DAC, clock generators, and design-for-test (DfT) techniques.

UNITI INTRODUCTION 6

Mixed-Signal Circuits: Analog, Digital, Mixed-Signal, Common Types of Analog and Mixed-Signal Circuits, Applications of Mixed-Signal Circuits, Example of Analog VLSI Mixed-Signal Circuit Design, MOSFET as a switch, Basic switched capacitor, Sample-and-Hold Amplifier, Low voltage CMOS amplifier, Programmable Gain Amplifier.

UNIT II SOURCES AND REFERENCES 6

Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors, Current Sources, Self-Biased, CTAT and PTAT, Bandgap Voltage Reference, Diode-Less Voltage Reference, Regulated Power Supply.

UNIT IIIPHASE-LOCKED LOOPS 6

Simple PLL, Charge-Pump PLLs, Jitter in PLLs, Delay-Locked Loops, Applications, Case study: CD4046B PLL IC.

UNIT IV DATA CONVERTERS AND PERIPHERAL CIRCUITS 6

Digital-to-Analog Converter, Analog-to-Digital Converter, Oscillators, Non-overlapping clock generator, Schmitt Trigger Circuit, Voltage Level Shifters, Power on Reset

UNIT V DESIGN FOR TEST 6

Design for Test: Overview and advantages, Digital DfT for Mixed-Signal Circuits, Mixed-Signal Boundary Scan and BIST, AD HOC Mixed-Signal DfT.

TOTAL:30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

DESIGN AND SIMULATION OF THE FOLLOWING CIRCUITS USING SPICE TOOLS

1. Cascode current mirror, Cascode current source
2. Band gap voltage reference circuit
3. PLL characteristics and Frequency Multiplier
4. R-2R Ladder DAC and Flash ADC.
5. Non-overlapping clock generator
6. Voltage Level Shifters
7. Analog test bus with MOS T-switch.

TOTAL:60 PERIODS

COURSEOUTCOMES:

Thestudentwhoundergoesthiscoursewillbeableto

CO1: DesignBandgapreferencecircuits.

CO2:DesignLowDropOutregulatorforagivenspecification

CO3: DesignFrequencysynthesizersmeetingagivenspecification.

CO4: Chooseactivefiltertopologyanddesignforagivenspecification

CO5: Designclockgenerationcircuits inthecontextofhighspeedI/Os,HighspeedBroadBand Communication circuits and Data Conversion Circuits.

TEXT BOOKS:

1. Gordon W.Roberts, Friedrich Taenzler, Mark Burns, “An Introduction to Mixed-signal IC Test and Measurement” Oxford University Press, Inc.2012
2. Phillip E. Allen, Douglas R. Holberg, CMOS Analog Circuit Design, Third edn., 2012, Oxford University Press, Inc.
3. Arjuna Marzuki, CMOS Analog and Mixed-Signal Circuit Design Practices and Innovations, 2020 CRC Press.
4. BehzadRazavi,“DesignofAnalogCMOSIntegratedCircuits”,TataMcGrawHill, Second Ed. 2017.
5. Karl D. Stephan, Analog and Mixed Signal Electronics, 2015, John Wiley

CO’s-PO’s & PSO’s MAPPING

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CO2	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	2	3	-	1	1	-	1	1	2	3	3	2
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

CEC370 LOWPOWERICDESIGNLTP C

20 23

COURSEOBJECTIVES:

- TolearnthefundamentalsoflowpowerlowvoltageVLSI design.
- Tounderstandtheimpactofpoweronsystemperformances.
- Tounderstandthedifferentdesignapproaches.
- Todevelopthelowpowerlowvoltagememories

UNITIFUNDAMENTALSOFLOWPOWERIC DESIGN 6

Power Dissipation, Components of Power Dissipation, Dynamic Power Dissipation, Principles of Low-Power Logic Designs, Low-Power Logic Architectures, Power Management

UNIT II POWER ESTIMATION 6

Power Estimation techniques: Circuit level, gate level, architecture level, behavioral level, Simulation power analysis: Gate-level Logic Simulation, Architecture-level Analysis - Monte Carlo Power Simulation, Probabilistic Power Analysis Techniques, High level power estimation.

UNIT III LOW-POWER VLSI DESIGN METHODOLOGY 6

LP Physical Design, LP Gate-Level Design, LP Architecture-Level Design, Algorithmic-Level Power Reduction

UNIT IV SYNTHESIS FOR LOW POWER 6

Synthesis for low power: Architecture driven voltage scaling, Power optimization using operation reduction, operation substitution and pre-computation – FSM and combinational logic synthesis – Circuit Level: Circuit level transforms, CMOS Gates, Transistor sizing.

UNIT V ADVANCED TECHNIQUES **6**

Power Reduction in Clock Networks, CMOS Floating Node, Low Power Bus, Delay Balancing, Adiabatic Computation: Complementary Adiabatic Logic, Power Efficiency of Adiabatic Logic

30PERIODS

PRACTICALEXERCISES: **30PERIODS**

1. Modelingandsourcesofpowerconsumption (Short circuit, dynamic and leakage power)
2. Powerestimationatdifferentdesignlevels(circuit,transistor,andgate level)
3. Powerminimizationof an inverter using Supply voltage scaling and Device feature size scaling
4. Glitching power minimization in combinational circuits.
5. Power minimization using FSM state encoding (Eg: Sequence detector)
6. Clock gating circuits using latch and logic gates
7. Comparison of power consumption of conventional CMOS and Adiabatic Logic Gates

TOTAL:60 PERIODS

COURSEOUTCOMES:

Uponsuccessfulcompletionofthecoursethestudentwillbeableto

CO1: Understand the fundamentals of Low power circuit design.
CO2:Attaintheknowledgeofarchitecturalapproaches.
CO3:AnalyzeanddesignLow-VoltageLow-Powercombinationalcircuits.
CO4:LearnthedesignofLow-VoltageLow-PowerMemories
CO5:DesignanddevelopLowPower,LowVoltageCircuits

TEXTBOOKS:

1. Ming-BO Lin, “Introduction to VLSI Systems: A Logic, Circuit and System Perspective”, CRC Press, 2012.
2. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, Kluwer Academic Press, 2002
3. Bellamour, M. I. Elamasri, “Low-Power Digital VLSI Design Circuits And Systems”, A Kluwer Academic Press, 1995.
4. Kaushik Roy, Sharat C. Prasad, “Low Power CMOS VLSI Circuit Design”, John Wiley, & Sons, 2000.

REFERENCES

1. Ajit Pal, ‘Low-Power VLSI Circuits and Systems’, Springer, 2015.
2. Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits – Analysis and Design”, TMH, 2011.
3. Kiat-Seng Yeo, Kaushik Roy, “Low-Voltage, Low-Power VLSI Subsystems”, TMH Professional Engineering, 2004.
4. Anantha Chandrakasan, “Low Power CMOS Design”, IEEE Press, /Wiley International, 1998
5. Siva G. Narendran, Anatha Chandrakasan, “Leakage in Nanometer CMOS Technologies”, Springer, 2005

CO’s-PO’s&PSO’sMAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	3	2	-	-	-	-	-	-	2	2	2	2
2	3	2	1	2	3	-	-	-	-	-		1	2	2	1
3	3	3	3	2	2	-	-	-	-	-	-	1	2	2	2
4	2	3	3	3	3	-	-	-		-	-	1	2	3	3
5	3	3	3	2	2	-	-	-	-	-	-	2	2	2	3
CO	2.8	2.8	2.4	2.4	2.4	-	-	-		-	-	1.8	2	2	2

1-low,2-medium,3-high,'-'-nocorrelation

VL3009 ALGORITHMSFORVLSIPHYSICALDESIGNAUTOMATION L TPC 3003

COURSE OBJECTIVES:

To understand the fundamentals of VLSI design methodologies, design cycles, design styles, and modern VLSI design automation tools.

To study and apply basic data structures and graph algorithms used in VLSI physical design, including graph search, spanning trees, and shortest path algorithms.

To analyze and implement algorithms for layout compaction, placement, and partitioning in VLSI circuit design.

To understand floorplanning and routing techniques, including global and local routing algorithms for efficient chip layout design.

To gain knowledge of modeling, simulation, logic synthesis, and verification techniques used in high-level VLSI design automation.

UNIT I INTRODUCTION 9

IntroductiontoVLSIDesignMethodologies–VLSIDesignCycle–NewTrendsinVLSIDesign Cycle – Physical Design Cycle – New Trends in Physical Design Cycle – Design Styles –Reviewof VLSI Design Automation Tools.

UNITII DATASTRUCTURES ANDBASICALGORITHMS 9

Basic Data Structures, Graph Algorithms: Graph Search Algorithms, Spanning Tree Algorithms, Shortest Path Algorithms, Classes of Graphs in Physical Design, Relationship Between Graph Classes, Graph Problems in Physical Design, Algorithms for Interval Graphs, Algorithms for Permutation Graphs, Algorithms for Circle Graphs

UNITIII ALGORITHMSFORLAYOUT COMPACTION, PLACEMENTANDPARTITIONING 9

Layout Compaction: Design Rules, Symbolic Layout, Problem Formulation, Algorithms for Constraint Graph Compaction – Placement and Partitioning: Circuit Representation, Wire-length Estimation, Types of Placement Problem, Placement Algorithms, Partitioning: The Kernighan-Lin Partitioning Algorithm

UNITIV ALGORITHMSFOR FLOORPLANNING AND ROUTING 9

Floorplanning: Floorplanning Concepts, Terminology and Floorplan Representation, Optimization Problems in Floorplanning, Shape Functions and Floorplan Sizing. Routing: Types of Local Routing Problems, Area Routing, Channel Routing, Introduction to Global Routing, Algorithms for Global Routing.

UNITV MODELLING,SIMULATIONANDSYNTHESIS 9

Simulation: Gate Level Modeling and Simulation, Switch-level Modeling and Simulation – Logic Synthesis and Verification: Binary Decision Diagrams, Hardware Models for High level Synthesis.

TOTAL:45PERIODS

COURSEOUTCOMES:

CO1: Ability to use various VLSI Design Methodologies and Design Methods.

CO2:AbilitytoapplydifferentDataStructuresandAlgorithmsforVLSIDesign.

CO3: Ability to develop Algorithms for Partitioning and Placement.

CO4:AbilitytodevelopAlgorithmsforFloorplanningandRouting.

CO5:AbilitytodesignAlgorithmsforModelling,SimulationandSynthesis.

TEXT BOOKS:

1. NaveedA.Sherwani,"AlgorithmsforVLSIPhysicalDesignAutomation",3rdEdition, Springer, 2017
2. Sabih H. Gerez, "Algorithms for VLSI Design Automation", Second Edition, Wiley-India,2017

REFERENCES:

1. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, "Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3010 SYSTEM ON CHIP L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand system-on-chip (SoC) architecture including processor, memory, and interconnection systems with emphasis on design constraints such as area, power, cost, and scalability.

To study processor selection techniques for SoC design including instruction set architecture, pipeline optimization, and advanced processor architectures such as VLIW, superscalar, and vector processors.

To analyze memory system design in SoC including cache organization, multilevel memory hierarchy, and processor–memory interaction for performance optimization. To gain knowledge of interconnect architectures, FPGA-based SoC design, and embedded processor integration using hardware–software co-design approaches.

UNIT I SYSTEM ARCHITECTURE: OVERVIEW 12

Components of the system – Processor architectures – Memory and addressing – system level interconnection – SoC design requirements and specifications – design integration – design complexity – cycle time, die area and cost, ideal and practical scaling, area-time-power tradeoff in processor design, Configurability.

UNIT II PROCESSOR SELECTION FOR SOC 9

Overview – soft processors, processor core selection. Basic concepts – instruction set, branches,

interrupts and exceptions. Basic elements in instruction handling – Minimizing pipeline delays – reducing the cost ranches – Robust processors – Vector processors, VLIW processors, Superscalar processors.

UNIT III MEMORY DESIGN 9

SoC external memory, SoC internal memory, Scratch pads and cache memory – cache organization and write policies – strategies for line replacement at miss time – split I- and D-caches – multilevel caches – SoC memory systems – board based memory systems – Simple processor/memory interaction

UNIT IV INTERCONNECT ARCHITECTURES AND SOC CUSTOMIZATION 9

Bus architectures – SoC standard buses – AMBA, CoreConnect – Processor customization approaches – Reconfigurable technologies – mapping designs onto reconfigurable devices - FPGA based design – Architecture of FPGA, FPGA interconnect technology, FPGA memory, loor plan and routing

UNIT V FPGA BASED EMBEDDED PROCESSOR 6

Hardware software task partitioning – FPGA fabric Immersed Processors – Soft Processors and Hard Processors – Tool flow for Hardware/Software Co-design –Interfacing Processor with memory and peripherals – Types of On-chip interfaces – Wishbone interface, Avalon Switch Matrix, OPB Bus Interface, Creating a Customized Microcontroller - FPGA-based SignalInterfacing and Conditioning

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to identify & formulate a given problem in framework of SoC
CO2: Ability to develop NISC Architecture, ADL and ASIP
CO3: Ability to simulate SoC at various levels.
CO4: Ability to design low power SoC / Digital System
CO5: Ability to map the resources and optimize the system performance

TEXT BOOKS:

1. Michael J. Flynn and Wayne Luk, “Computer System Design: System-on-Chip”, Wiley, 2011
2. Rahul Dubey, Introduction to Embedded System Design Using Field Programmable Gate Arrays, Springer 2009

REFERENCES:

1. Hubert Kaeslin, “Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication”, Cambridge University Press, 2008.
2. B. Al Hashimi, “System on chip-Next generation electronics”, The IET, 2006.
3. RochitRajsuman, “System-on- a-chip: Design and test”, Advantest America R &DCenter, 2000.
4. P Mishra and N Dutt, “Processor Description Languages”, Morgan Kaufmann, 2008.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	1	1	1	1	1	1	2	3	3	3
CO5:	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3011 SYSTEM VERILOG FOR VERIFICATION L T P C

2 0 2 3

OBJECTIVE:

The objective of this course is to provide in-depth knowledge on
- To provide knowledge on constructing layered testbench for design verification
- To become proficient in OOPS, interface and constrained-random stimulus generation
- To get insights on threads, interprocess communication and functional coverage

UNIT I VERIFICATION METHODOLOGY 4

Verification Guidelines: Introduction, Verification Process, Verification Plan, Verification MethodologyManual, Basic Testbench Functionality, Directed Testing, Methodology Basics, Constrained-RandomStimulus, Functional Coverage, Testbench Components, Layered Testbench

UNIT II SYSTEM VERILOG BASICS AND CONCEPTS 7

Data Types: Built-in Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Creating New Types withTypedef, Creating User-Defined Structures, Enumerated Types, Constants, Strings. ProceduralStatements and Routines: Procedural Statements, Tasks, Functions, and Void Functions, connecting thetestbench and design

UNIT III OOPS 6

Introduction-Where to Define a Class- OOPS Terminology -Creating New Objects -Object Deallocation-Using Objects -Static Variables Vs. Global Variables -Class Routines -Defining Routines Outside of TheClass - Scoping Rules -Using One Class Inside Another - Understanding Dynamic Objects -CopyingObjects - Building a Testbench

UNIT IV CONSTRAINED-RANDOM STIMULUS GENERATION, THREADS AND IPC8

Randomization in System Verilog, constraint details, Working With Threads, Inter-Process communication (IPC), Events, Semaphores, Mailboxes, Building a Testbench With Threads and IPC.

UNIT V FUNCTIONAL COVERAGE AND A CASE STUDY 5

Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, CoverageOptions, Parameterized Cover Groups, Analysing Coverage Data, Measuring Coverage Statistics, Acomplete system verilog testbench – a case study

30 PERIODS

PRACTICALS:

1. Design a Testbench for 2x1 Mux using gates
2. Implementation of constrained-randomization using different constraints
3. Implementation of a Mailbox By Allocating Memory
4. Implementation and Testing of Semaphore
5. Implementation of testbench components for a Simple DUT

30 PERIODS

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of this course, students should demonstrate the ability to
CO1: Use system verilog to create testbenches for digital designs
CO2: Understand and effectively exploit new constructs in System Verilog for verification
CO3: Understand the communication between modules
CO4: Designing a complete testbench using system Verilog

TEXT BOOK:

1. System Verilog for Verification: a Guide to Learning The Testbench Language Features,

ChrisSpear, Springer 2006

REFERENCES:

1. J.Bhasker, “A System Verilog : Primer”, 2001
2. Janick Bergeron, ‘Writing Testbenches: Functional Verification of HDL Models’, Second Edition, Kluwer Academic Publishers, 2003.
3. Simon Davidman and Peter Flake, ‘System Verilog for Design: a Guide to Using System Verilog for Hardware Design and Modeling’, 2nd Edition, Stuart Sutherland, Springer
4. Mark Glasser, ‘Open Verification Methodology Cookbook’, Springer, 2009
5. Harry D. Foster, Adam C. Krolnik, David J. Lacey, ‘Assertion-Based Design’, 2nd Edition, Kluwer Academic Publishers, 2004

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	1	1	1	1	1	2	3	3	2
CO2	3	3	3	2	3	-	1	1	1	2	1	2	3	3	3
CO3	3	2	2	2	2	-	1	1	1	1	1	2	3	2	2
CO	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VERTICAL III-VLSI CIRCUITS AND SYSTEM DESIGN

VL3012 DATACONVERTERS LTPC

3003

COURSE OBJECTIVES:

To understand the fundamentals of data conversion systems, sampling techniques, and sample-and-hold circuit architectures used in analog-to-digital processing.

To study and analyze various digital-to-analog converter (DAC) architectures including resistor ladder and current steering techniques with performance metrics.

To understand and evaluate different analog-to-digital converter (ADC) architectures such as flash, pipelined, successive approximation, and interleaved systems.

To gain knowledge of sigma-delta converters and testing methodologies for data converters including static and dynamic performance evaluation of ADCs and DACs.

UNITI SAMPLE AND HOLD CIRCUITS 9

Introduction to data conversion and processing, Sampling switches, Conventional open loop and closed loop sample and hold architecture, Open loop architecture with miller compensation, multiplexed input architectures, recycling architecture, switched capacitor architecture, Current mode architectures.

UNIT II D/A CONVERTERS 9

General considerations, Performance metrics, reference multiplication and division, Resistor ladder DAC architecture, current steering DAC architecture

UNIT III A/D CONVERTERS 9

General considerations, Performance metrics, Flash architecture, Pipelined Architecture,

Successive approximation architecture, Interleaved architecture.

UNIT IV SIGMADELTACONVERTERS 9

Need for over sampling converters, Delta and delta sigma modulators, First order delta sigma modulator as ADC and DAC, basic converter architectures: First-order AID converter, Second-order AID converter, Third-order AID converter, Multi-stage sigma-delta converter (MASH), System Architectures for delta sigma DACs, Loop configurations for delta sigma DACs

V TESTING OF DATA CONVERTERS 9

Test Board, Quality and Reliability Test, Data Processing, Static DAC Testing, Dynamic DAC Testing, Static ADC Testing, Dynamic ADC Testing

TOTAL:45PERIODS

COURSEOUTCOMES:

CO1: Ability to carry out the design calculations for developing the various blocks associated with atypicalCMOSADorDAconverter.
CO2: Abilitytodesignandimplementcircuitsusingswitchedcapacitorconcepts
CO3: AbilitytoanalyzeanddesignD/Aconverters
CO4:AbilitytodesigndifferenttypesofA/Ds
CO5:Abilitytoanalyzeanddesignsigmadeltaconverters

TEXT BOOKS:

1. BehzadRazavi,“Principlesofdataconversionsystemdesign”,IEEEpress,1995.
2. ShanthiPavan,RichardSchreier,GaborC.Temes,“UnderstandingDelta-SigmaDataConverters”,Willey–IEEEPress,2nd Edition,2017.
3. RudyvandePlassche,“CMOSIntegratedAnalog-to-DigitalandDigital-to-AnalogConverters”KluwerAcedamicPublishers,Boston,2ndEdition,December2010.
4. Franco Maloberti, “Data Converters”, Springer, 2007

REFERENCES:

1. VLSIDataConversion CircuitsEE658recordedlecturesavailableat http://www.ee.iitm.ac.in/~nagendra/videolecture

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	1	1	-	1	1	2	3	3	2
CO2	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	-	1	-	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3013 RECONFIGURABLE ARCHITECTURES L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of reconfigurable computing, evolution of programmable devices, and architecture of PLDs, CPLDs, FPGAs, and coarse-grained reconfigurable systems.

To study FPGA design flow including modeling, logic synthesis, and temporal partitioning techniques used in reconfigurable system implementation.

To analyze temporal placement strategies and resource management techniques for efficient utilization of FPGA hardware.

To understand communication architectures, System-on-Programmable-Chip (SoPC), Network-on-Chip (NoC), and applications of reconfigurable systems in signal processing, cryptography, and high-performance computing.

UNIT - I INTRODUCTION 9

General purpose computing – domain specific processors – Application Specific Processors – reconfigurable computing – fields of application – evolution of reconfigurable systems – simple Programmable Logic Devices – Complex Programmable Logic Devices – Field Programmable Gate Arrays – coarse grained reconfigurable devices.

UNIT - II IMPLEMENTATION AND SYNTHESIS 12

Integration – FPGA design flow – logic synthesis – modeling – temporal partitioning algorithms – offline and online temporal placement – managing device's free and occupied spaces.

UNIT – III TEMPORAL PLACEMENT 6

Offline and online temporal placement – managing device's free and occupied spaces.

UNIT – IV COMMUNICATION AND SOPC 12

Direct communication – communication over third party – bus based communication – circuitswitching – Network on Chip – dynamic Network on Chip – System on a Programmable Chip – adaptive multi-processing on chip

UNITV APPLICATIONS 6

Pattern matching, video streaming, signal processing using distributed arithmetic, Adaptive Controller, Adaptive Cryptographic Systems, Software Defined Radio, High-Performance Computing

TOTAL:45PERIODS

COURSEOUTCOMES:

CO1:Abilitytoapplythefundamentalsofthereconfigurablecomputingandreconfigurablearchitectures.

CO2: Ability to articulate the design issues involved in reconfigurable computing systems with aspecificfocusonFieldProgrammableGateArrays(FPGAs)bothintheoreticalandapplicationlevels.

CO3:Abilitytodeveloptheperformancetrade-offsinvolvedindesigningareconfigurablecomputingplatform with a specific focus on the architecture of a configurable logic block and theprogrammable interconnect.

CO4: Ability to explore the state of the art reconfigurable computing architectures spanning finegrained (look up table based processing elements) to coarse grained (arithmetic logic unitlevelprocessingelements)architectures.

CO5: Ability to design the architect reconfigurable systems and utilize them for solving challengingcomputationalproblems.

TEXT BOOKS:

1. Christophe Bobda, "Introduction to Reconfigurable Computing Architectures, Algorithms, and Applications", Springer, 2007

REFERENCES:

1. ScottHauckand Andre` DeHon,“ReconfigurableComputing: The Theory and Practice ofFPGA-BasedComputation”,Morgan Kaufmann, July2010.
2. Stephen M. Trimberger,“Field–programmableGateArrayTechnology”,Springer,2007.
3. CliveMaxfield, “The Design Warrior’s Guide to FPGAs: Devices, Tools and Flows”, Newnes,Elsevier,2006.

CO’s-PO’s & PSO’s MAPPING

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CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3014 HARDWARE SOFTWARE CO-DESIGN FOR FPGA L T P C

3 0 0 3

COURSE OBJECTIVES:

- To acquire the knowledge about system specification and modelling
- To learn the formulation of partitioning
- To study the different technical aspects about prototyping and emulation

UNIT I SYSTEM SPECIFICATION AND MODELLING 9

Embedded Systems, Hardware/Software Co-Design, Co-Design for System Specification And Modeling, Co-Design for Heterogeneous Implementation - Processor Synthesis, Single-Processor Architectures With One ASIC, Single-Processor Architectures With Many ASICs, Multi-Processor Architectures, Comparison of Co-Design Approaches, Models of Computation, Requirements for Embedded System Specification.

UNIT II HARDWARE/SOFTWARE PARTITIONING 9

The Hardware/Software Partitioning Problem, Hardware-Software Cost Estimation, Generation of the Partitioning Graph, Formulation of the HW/SW Partitioning Problem, Optimization, HW/SW Partitioning Based On Heuristic Scheduling, HW/SW Partitioning Based On Genetic Algorithms.

UNIT III HARDWARE/SOFTWARE CO-SYNTHESIS 9

The Co-Synthesis Problem , State-Transition Graph, Refinement and Controller Generation Distributed System Co-Synthesis – Hardware/software co-synthesis algorithms: hardware – software partitioning, distributed system co-synthesis.

UNIT IV PROTOTYPING AND EMULATION 9

Introduction, Prototyping And Emulation Techniques, Prototyping and Emulation Environments, Future Developments In Emulation and Prototyping, Target Architecture, Architecture Specialization Techniques, System Communication Infrastructure, Target Architectures and Application System

Classes, Architectures for Control-Dominated Systems, Architectures for Data-Dominated Systems, Mixed Systems and Less Specialized Systems.

UNIT V DESIGN SPECIFICATION AND VERIFICATION 9

Concurrency, Coordinating Concurrent Computations, Interfacing Components, Verification, Languages for System-Level Specification and Design: System-Level Specification, Design Representation for System Level Synthesis, System Level Specification Languages, Heterogeneous Specification and Multi-Language Co-Simulation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should will be able to:

CO1: describe the broad range of system architectures and design methodologies that currently exist and define their fundamental attributes.

CO2: discuss the dataflow models as a state-of-the-art methodology to solve co-design problemsand to optimize the balance between software and hardware.

CO3: understand in translating between software and hardware descriptions through co-design methodologies.

CO4: understand the state-of-the-art practices in developing co-design solutions to problems using modern hardware/software tools for building prototypes.

CO5: understand the concurrent specification from an algorithm, analyze its behavior and partition the specification into software (C code) and hardware (HDL) components

REFERENCES

1. PatrickSchaumont,“aPracticalIntroductionToHardware/SoftwareCodesign”,Springer,2010.
2. Ralf Niemann, “Hardware/Software Co-Design for Data Flow Dominated EmbeddedSystems”, Kluwer Academic Publisher, 1998.
3. Jorgen Staunstrup, Wayne Wolf, “Hardware/Software Co-Design: Principles And Practice”,Kluwer Academic Publisher,1997.

CO’s-PO’s & PSO’s MAPPING

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CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3015POWER MANAGEMENT AND CLOCK DISTRIBUTION L T P C
3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of power sources and power management systems including linear and switching regulators, low-dropout (LDO) regulators, and bandgap reference circuits.
To study on-chip power distribution networks and analyze issues such as IR drop, L di/dt noise, substrate noise, and techniques for power supply filtering and energy scavenging.
To understand clock generation circuits including oscillators, PLLs, and voltage-controlled oscillators for stable frequency generation in VLSI systems.
To analyze clock distribution networks and digital delay-locked loop (DLL) techniques for achieving synchronization, low skew, and high-performance clocking in digital systems.

UNIT I POWER SOURCES AND REGUATORS 9

Power Supplies-Power-Supply Characteristics and Definitions, Primary Power Sources, Regulators in power management, linear Vs switching regulators Linear Voltage Regulators for Power Supplies, low voltage band gap reference, Switching Power Supplies and Regulators, Basic low dropout regulator architecture

UNIT II POWER DISTRIBUTION AND MANAGEMENT 9

Power Distribution: On-Chip Power Distribution Network, IR Drops, L di/dt Noise, On-Chip Bypass Capacitance, Power Network Modeling, Power Supply Filtering, Charge Pumps, Substrate Noise, Energy Scavenging- Power management: Low-Power Strategies, Principle of Multiple Supply Voltages, Principle of Multiple Threshold Voltages, Concept of Leakage Effective Gate Width, Impact of Supply and Threshold Voltage Variability, Stack Forcing as Leakage Reduction Technique, Principle of Power Gating

UNIT III CLOCK GENERATION CIRCUITS 9

Ring oscillators, Colpitts Oscillator, Voltage-Controlled Oscilators, Tuning in Ring Oscillators, Tuning in LC Oscillators, Simple PLL, Charge pump PLL

UNIT IV CLOCK DISTRIBUTION 9

Definitions and Design Requirements, Clock Distribution Topologies, Elements of Clock Distribution Circuits, Multiclock Domain Distributions, Skew and Jitter-Tolerant Design, Active Clock Deskew

UNIT V DIGITAL DELAY LOCK TECHNIQUES 9

Building blocks of DLL, DLL Applications, Phase detectors, DCDL Design, Advanced applications: Duty cycle correction, clock multiplication, clock data recovery,

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Ability to design Band gap reference circuits and Low Drop Out regulator for a given specification.
CO2: Ability to design specification related to Supply and Clock generation circuits
CO3: Ability to choose oscillator topology and design meeting the requirement of clock generation circuits.
CO4: Ability to design clock generation circuits in the context of high speed I/Os, High speed Broad Band Communication circuits.
CO5: Ability to design Data Conversion Circuits

TEXT BOOKS:

1. Karl D. Stephan, ‘Analog and Mixed-Signal Electronics”, Wiley, 2015.
2. Gabriel.A. Rincon-Mora, “Analog IC Design With Low-Dropout Regulators”, McGraw- Hill Professional Pub, 2 nd Edition, May 2014.
3. Ke-horngchen, ‘Power management techniques for integrated circuit design’, 2016, John Wiley
4. S. Henzler, ‘Power Management of Digital Circuits in Deep Sub-Micron CMOS Technologies’ Springer, 2007
5. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Tata McGraw Hill, 2 nd Edition, November 2017.
6. Thucydides Xanthopoulos, ‘Clocking in Modern VLSI Systems’, Springer, 2009

REFERENCES:

1. Gabriel.A. Rincon-Mora, "Voltage references from diode to precision higher order band gap circuits", John wiley& Sons Inc, 2002.
2. Floyd M. Gardner ,"Phase Lock Techniques" John wiley& Sons, Inc 2005.
3. Michiel Steyaert, Arthur H.M. van Roermund, Herman Casier, "Analog Circuit Design: High Speed Clock and Data Recovery, High-performance Amplifiers Power Management", springer, November 2010.
4. BehzadRazavi, "Design of Integrated circuits for Optical Communications", McGraw Hill, 2 nd Edition, October 2012.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	-	1	1	-	1	1	2	3	3	3
CO2	3	3	2	2	3	-	1	1	1	1	1	2	3	3	2
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	1	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3016 SEMICONDUCTOR MEMORIESL T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the architecture, operation, and design of semiconductor memory technologies including SRAM, DRAM, and their advanced variants used in modern VLSI systems.

To study non-volatile memory technologies such as ROM, PROM, EPROM, EEPROM, and Flash memories along with their structures and applications.

To analyze memory fault models, testing methodologies, and reliability issues including radiation effects and fault detection techniques in memory systems.

To gain knowledge of advanced memory technologies and packaging techniques such as FRAM, MRAM, analog memories, and multi-chip module (MCM) based memory systems.

UNIT I RANDOM ACCESS MEMORY TECHNOLOGIES 9

Static Random Access Memories (SRAMs): SRAM Cell Structures-MOS SRAM Architecture-MOS SRAM Cell and Peripheral Circuit Operation - Silicon on Insulator (SOI) Technology- SRAM Architectures and Technologies-Application Specific SRAMs. Dynamic Random Access Memories (DRAMs): DRAM Technology Development-CMOS DRAMs-DRAMs Cell Theory and Advanced Cell Strucutures-Soft Error Failures in DRAMs-Advanced DRAM Designs and Architecture-Application Specific DRAMs.

UNIT II NONVOLATILE MEMORIES 9

Masked Read-Only Memories (ROMs)-High Density ROMs-Programmable Read-Only Memories (PROMs)-BipolarPROMs-CMOS PROMs-Erasable (UV) - Programmable Road-Only Memories (EPROMs)-Floating-GateEPROM Cell-One-Time Programmable (OTP) EPROMs-Electrically Erasable PROMs (EEPROMs)-EEPROM Technology And Architecture-Nonvolatile SRAM-Flash Memories (EPROMs or EEPROM)-Advanced Flash Memory Architecture.

UNIT III MEMORY FAULT MODELING, TESTING 9

RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing-Nonvolatile Memory Modeling and Testing-IDDQ Fault Modeling and Testing- Application Specific Memory Testing

UNIT IV RELIABILITY AND RADIATION EFFECTS 9

General Reliability Issues-RAM Failure Modes and Mechanism-Design for Reliability- Reliability Test Structures-Radiation Effects-Single Event Phenomenon (SEP)-Radiation Hardening Techniques-Radiation Hardening Process and Design Issues-Radiation Hardened Memory Characteristics

UNIT V ADVANCE D MEMORIES ANDPACKAGING TECHNOLOGIES 9

Ferroelectric Random Access Memories (FRAMs)-GalliumArsenide(GaAs)FRAMs-AnalogMemories-Magnetoresistive.Random Access Memories (MRAMs)-Experimental Memory Devices. Memory Hybrids and MCMs (2D)-Memory Stacks and MCMs (3D)-Memory MCM Testing and Reliability Issues- Memory Cards-High Density Memory Packaging Future Directions.

TOTAL:45 PERIODS

TEXTBOOKS

1. AshokK.Sharma,"SemiconductorMemoriesTechnology,TestingandReliability ",Prentice-Hall of India Private Limited, New Delhi, 1997 (UNIT I-V).

REFERENCES

1. TegzeP.Haraszti,"CMOSMemoryCircuits",KluwerAcademicpublishers, 2001.
2. BettyPrince,"EmergingMemories:TechnologiesandTrends",Kluwer Academic publishers, 2002.

COURSE OUTCOMES:

CO1: Explain the architecture, organization, and operation of different semiconductor memory technologies such as SRAM and DRAM along with their peripheral circuits.

CO2: Analyze various non-volatile memory technologies including ROM, PROM, EPROM, EEPROM, and Flash memory in terms of structure and applications.

CO3: Apply memory fault models and testing techniques to evaluate the reliability and performance of semiconductor memory systems.

CO4: Evaluate reliability issues and radiation effects in memory devices and apply suitable radiation hardening techniques for robust design.

CO5: Understand and analyze advanced memory technologies and packaging approaches including FRAM, MRAM, analog memories, and multi-chip module (MCM) systems.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	1	2	3	3	2
CO2	3	3	2	2	3	-	1	1	-	1	-	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	2	2	1	1	1	1	1	2	3	3	2
CO5	3	3	2	2	2	-	1	1	1	1	1	2	3	3	3

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

VL3017 MULTICORE ARCHITECTURE AND PROGRAMMING L T P C

3 0 0 3

OBJECTIVES:

- Understand the challenges in parallel and multi-threaded programming.
- Learn about the various parallel programming paradigms, and solutions.

UNIT I MULTI-CORE PROCESSORS 9

Single Core To Multi-Core Architectures – SIMD And MIMD Systems – Interconnection Networks - Symmetric And Distributed Shared Memory Architectures – Cache Coherence – Performance Issues –Parallel Program Design

UNIT II PARALLEL PROGRAM CHALLENGES 9

Performance – Scalability – Synchronization And Data Sharing – Data Races – Synchronization Primitives (Mutexes, Locks, Semaphores, Barriers) – Deadlocks AndLivelocks – Communication Between Threads (Condition Variables, Signals, Message Queues And Pipes).

UNIT III SHARED MEMORY PROGRAMMING WITH OPENMP 9

Openmp Execution Model – Memory Model – Openmp Directives – Work-Sharing Constructs – Library Functions – Handling Data And Functional Parallelism – Handling Loops - Performance Considerations

UNIT IV DISTRIBUTED MEMORY PROGRAMMING WITH MPI 9

MPI Program Execution – MPI Constructs – Libraries – MPI Send and Receive – Point-To Point and Collective Communication – MPI Derived Datatypes – Performance Evaluation

UNIT V PARALLEL PROGRAM DEVELOPMENT 9

Case Studies - N-Body Solvers – Tree Search – Openmp and MPI Implementations and Comparison

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

CO1:Illustrate the challenges in parallel and multi threaded programming
CO2:Explain the various parallel programming paradigms and solutions.
CO3:Develop shared memory programs using openmp
CO4:Develop distributed memory programs using mpi
CO5:Compare and contrast programming for serial processors and parallel processors.

REFERENCES

1. Peter S. Pacheco, "AnIntroductionTo ParallelProgramming",Morgan-Kauffman/Elsevier, 2011.
2. Darryl Gove, "Multicore Application Programming for Windows, Linux, And OracleSolaris", Pearson, 2011

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	2	3	-	1	1	1	2	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	1	1	2	3	3	3
CO5	3	3	2	2	2	-	1	1	-	1	1	2	3	3	2

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

VL3018 SYNTHESIS AND OPTIMIZATION OF VLSI CIRCUITS L T P C
3 0 0 3

COURSE OBJECTIVE:

To understand the fundamentals of microelectronic circuit design, computer-aided synthesis, Boolean algebra, and combinational optimization techniques used in VLSI design.

To study architectural-level synthesis concepts including area and performance estimation, control unit design, and pipelined circuit synthesis.

To analyze scheduling algorithms and resource sharing techniques including ASAP, ALAP, constrained scheduling, binding, and module selection for efficient hardware design.

To apply logic-level and sequential logic synthesis techniques including minimization, encoding, retiming, and FSM optimization for designing optimized and testable digital systems.

UNIT I CIRCUITS AND HARDWARE MODELING 12

Design of Microelectronic Circuits - Computer Aided Synthesis and optimization-Combinatorial optimization-Boolean Algebra and Application–Compilation and Behavioral optimization.

UNIT II ARCHITECTURAL LEVEL SYNTHESIS AND OPTIMIZATION 6

The Fundamental Architectural synthesis Problems-Area and performance Estimation-Control unit synthesis-synthesis of pipelined circuits.

UNIT III SCHEDULING ALGORITHMS AND RESOURCE SHARING 9

Unconstrained Scheduling-ASAP Algorithm-ALAP Scheduling Algorithm- Scheduling with Resource Constraints- Scheduling pipelined circuits-Sharing and binding for Dominated circuits-Area Binding-Concurrent Binding –Module selection problems-Structural testability.

UNIT IV LOGIC-LEVEL SYNTHESIS AND OPTIMIZATION 12

Logic optimization Principles-Algorithms and logic Minimization –Encoding problems-Algorithmic approach to Multiple-level optimization-Algorithm for delay Evaluation and optimization.

UNIT V SEQUENTIAL LOGIC OPTIMIZATION 6

Sequential circuit -State Encoding-Minimization methods-Retiming- Finite state machine-testability for synchronous circuits

TOTAL: 45 PERIODS

TEXTBOOK

1. Giovanni De Micheli, “Synthesis and optimization of Digital Circuits”, TataMcGraw-Hill, 2003

REFERENCES

1.John Paul Shen, Mikko H. Lipasti, “Modern processor Design”, Tata McGraw Hill, 2003

COURSE OUTCOMES:

CO1: Apply concepts of microelectronic circuit design, Boolean algebra, and computer-aided synthesis techniques for combinational optimization.

CO2: Analyze architectural-level synthesis problems including area and performance estimation, control unit design, and pipelined circuit implementation.

CO3: Implement scheduling algorithms such as ASAP and ALAP and perform resource-constrained scheduling and binding for digital systems.

CO4: Apply logic-level synthesis and optimization techniques including Boolean minimization, encoding, and delay optimization algorithms.

CO5: Design and optimize sequential circuits using FSM minimization, retiming, and testability techniques for synchronous digital systems.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	3	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VERTICAL IV SIGNAL PROCESSING

CEC332 ADVANCED DIGITAL SIGNAL PROCESSING L T P C
2 0 2 3

COURSE OBJECTIVES:

- To introduce the concepts of discrete time random signal processing
- To know about multirate signal processing and its applications
- To understand the spectrum estimation techniques
- To learn the concept of prediction theory and filtering

UNIT I MULTIRATE SIGNAL PROCESSING 6

Review of Convolution, DFT and ZT, Multirate Signal Processing - Decimation, Interpolation, Sampling Rate Conversion by a rational factor – digital filter banks, sub band coding, Quadrature Mirror Filter.

UNIT II DISCRETE TIME RANDOM PROCESSES 6

Stationary random processes, Autocorrelation, Rational Power Spectra, Filters for generating random Processes from white noise and inverse filter – AR, MA and ARMA processes – relationship between autocorrelation and the filter parameters.

UNIT III LINEAR PREDICTION AND FILTERING 6

Linear Prediction – Forward and Backward - Wiener filters for filtering and prediction – FIR Wiener Filter – IIR Wiener Filter – Kalman Filter.

UNIT IV ADAPTIVE FILTERING 6

FIR adaptive filters – adaptive filters based on steepest descent method – LMS algorithm – Variants of LMS algorithm – adaptive echo cancellation – adaptive channel equalization – RLS Algorithm.

UNIT V SPECTRUM ESTIMATION 6

Estimation of power spectra from finite duration observations of signals – Non parametric methods of spectrum estimation – the Bartlett and the Welch method – Parametric spectrum estimation – AR, MA and ARMA.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Study of autocorrelation and Cross Correlation of random signals
2. Design and Implementation of Multirate Systems.
3. Design and Implementation of Wiener Filter
4. Design and Implementation of FIR Linear Predictor
5. Design of adaptive filters using LMS algorithm
6. Spectrum Estimation using Bartlett and Welch Methods

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon successful completion of the course the student will be able to

CO1: Comprehend multirate signal processing and demonstrate its applications
CO2:Demonstrate an understanding of the power spectral density and apply to discrete random signals and systems
CO3: Apply linear prediction and filtering techniques to discrete random signals for signal detection and estimation.
CO4: Analyze adaptive filtering problems and demonstrate its application
CO5: Apply power spectrum estimation techniques to random signals.

TOTAL:60 PERIODS

TEXT BOOKS :

1. John G. Proakis& Dimitris G.Manolakis, —Digital Signal Processing – Principles, Algorithms& Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc. 1993.

REFERENCES :

1. Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and SonsInc. New York, Indian reprint 2008.
2. Haykin, Adaptive Filter Theory, 4th Edition, Pearson Education, New Delhi, 2006.
3. Sophoncles J. Orfanidis, “Optimum Signal Processing “, McGraw Hill, 2000.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	2	2	2	-	1	1	1	1	-	2	3	3	2
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3019 DIGITAL IMAGE AND VIDEO PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide the student with basic understanding of image fundamentals and transforms
- To provide exposure to the students about image enhancement and restoration
- To impart a thorough understanding about segmentation and Recognition.
- To know the Video Processing and motion estimation
- Learning the concepts will enable students to design and develop an image processing application .

UNIT I FUNDAMENTALS OF IMAGE PROCESSING AND TRANSFORMS 9

Introduction, Image sampling, Quantization, Resolution, Image file formats, Elements of image processing system, Need for transform, image transforms, 2 D Discrete Fourier transform ,Walsh transform, Hadamard transform, Haar transform, KL transform, singular value decomposition, comparison of different image transforms. Digital Camera working principle.

UNIT II ENHANCEMENT AND RESTORATION 9

Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, image smoothing, image sharpening, Introduction to Image restoration, Image degradation, Image restoration model, Linear and Nonlinear image restoration techniques, Blind deconvolution. Color image enhancement.

UNIT III SEGMENTATION AND RECOGNITION 9

Edge detection, Edge linking via Hough transform – Thresholding – Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture – Patterns and Pattern classes – Recognition based on matching.

UNIT IV BASIC STEPS OF VIDEO PROCESSING9

Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations

UNIT V 2-D MOTION ESTIMATION9

Optical flow, optical flow constraints, General Methodologies, Pixel Based Motion Estimation, BlockMatching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, Multi resolution motion estimation, Waveform based coding, Block based transform coding, Predictive coding, Application of motion estimation in Video coding.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the digital image, representation of digital image and digital images in transform Domain.

CO2: Analyze the detection of point, line and edges in images and understand the redundancy in images, various image compression techniques.

CO3: Analyze the video technology from analog color TV systems to digital video systems, how video signal is sampled and filtering operations in video processing.

CO4: Obtain knowledge in general methodologies for 2D motion estimation, various coding used in video processing.

CO5: Design image and video processing systems.

REFERENCES:

1. Digital Image Processing – Gonzalez and Woods, 3rd Ed., Pearson, 2016
2. Handbook of Image and Video processing, Academic press, 2010 70
3. K.R.Castelman, Digital Image processing, Prentice Hall, 1996
4. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition, 2002
5. R C Gonzalez, R E Woods and S L Eddins, Digital Image Processing Using Matlab, Pearson Education , 2000

CO's-PO's & P SO's MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	2	3	-	1	1	1	1	-	2	3	3	3
CO3	3	3	2	2	2	-	1	1	1	1	-	2	3	3	2
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

CEC356 SPEECH PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

- Study the fundamentals of speech signal and extracs various speech features
- Understand different speech coding techniques for speech compression applications
- Learn to build speech enhancement, text-to-speech synthesis system

UNIT I FUNDAMENTALS OF SPEECH 9

The Human speech production mechanism, Discrete-Time model of speech production, Speech perception - human auditory system, Phonetics - articulatory phonetics, acoustic phonetics, and auditory phonetics, Categorization of speech sounds, Spectrographic analysis of speech sounds, Pitch frequency, Pitch period measurement using spectral and cepstral domain, Formants, Evaluation of Formants for voiced and unvoiced speech.

UNIT II SPEECH FEATURES AND DISTORTION MEASURES 9

Significance of speech features in speech-based applications, Speech Features – Cepstral Coefficients, Mel Frequency Cepstral Coefficients (MFCCs), Perceptual Linear Prediction (PLP), Log Frequency Power Coefficients (LFPCs), Speech distortion measures–Simplified distance measure, LPC-based distance measure, Spectral distortion measure, Perceptual distortion measure.

UNIT III SPEECH CODING 9

Need for speech coding, Waveform coding of speech – PCM, Adaptive PCM, DPCM, ADPCM, Delta Modulation, Adaptive Delta Modulation, G.726 Standard for ADPCM, Parametric Speech Coding – Channel Vocoders, Linear Prediction Based Vocoders, Code Excited Linear Prediction (CELP) based Vocoders, Sinusoidal speech coding techniques, Hybrid coder, Transform domain coding of speech

UNIT IV SPEECH ENHANCEMENT 9

Classes of Speech Enhancement Algorithms, Spectral-Subtractive Algorithms - Multiband Spectral Subtraction, MMSE Spectral Subtraction Algorithm, Spectral Subtraction Based on Perceptual Properties, Wiener Filtering - Wiener Filters in the Time Domain, Wiener Filters in the Frequency Domain, Wiener Filters for Noise Reduction, Maximum-Likelihood Estimators, Bayesian Estimators, MMSE and Log-MMSE Estimator, Subspace Algorithms.

UNIT V SPEECH SYNTHESIS AND APPLICATION 9

A Text-to-Speech systems (TTS), Synthesizers technologies – Concatenative synthesis, Use of Formants for concatenative synthesis, Use of LPC for concatenative synthesis, HMM-based synthesis, Sinewave synthesis, Speech transformations, Watermarking for authentication of a speech, Emotion recognition from speech.

COURSE OUTCOMES:

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

CO1: Understand the fundamentals of speech.
CO2: Extract various speech features for speech related applications
CO3: Choose an appropriate speech coder for a given application.
CO4: Build a speech enhancement system.
CO5: Build a text-to-speech synthesis system for various applications

TEXT BOOKS :

1. Shaila D. Apte, Speech and Audio Processing, Wiley India (P) Ltd, New Delhi, 2012
2. Philipos C. Loizou, Speech Enhancement Theory and Practice, Second Edition, CRC Press, Inc., United States, 2013

REFERENCES:

1. Rabiner L. R. and Juang B. H, Fundamentals of speech recognition, Pearson Education, 2003
2. Thomas F. Quatieri, Discrete-time speech signal processing - Principles and practice, Pearson, 2012.

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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS 03
1	1	2	1	1	2	1	-	-	-	-	-	2	3	3	3
2	1	2	1	1	2	1	-	-	-	-	-	2	2	2	2
3	1	2	1	1	2	1	-	-	-	-	-	1	1	2	2
4	3	-	3	3	-	3	-	-	-	-	-	2	2	3	3
5	3	-	3	3	-	3	-	-	-	-	-	2	2	2	2
CO	1.8	2	1.8	1.8	2	1.8	-	-	-	-	-	1.8	2	2.4	2.4

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

CCS338 COMPUTER VISION L T P C
2 02 3

COURSE OBJECTIVES:

- To understand the fundamental concepts related to Image formation and processing.
- To learn feature detection, matching and detection
- To become familiar with feature based alignment and motion estimation
- To develop skills on 3D reconstruction
- To understand image based rendering and recognition

UNIT I INTRODUCTION TO IMAGE FORMATION AND PROCESSING 6

Computer Vision - Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization.

UNIT II FEATURE DETECTION, MATCHING AND SEGMENTATION 6

Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.

UNIT III FEATURE-BASED ALIGNMENT & MOTION ESTIMATION 6

2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.

UNIT IV 3D RECONSTRUCTION 6

Shape from X - Active rangefinding - Surface representations - Point-based representations- Volumetric representations - Model-based reconstruction - Recovering texture maps and albedosos.

UNIT V IMAGE-BASED RENDERING AND RECOGNITION 6

View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Video-based rendering-Object detection - Face recognition - Instance recognition - Category recognition - Context and scene understanding- Recognition databases and test sets.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

LABORATORY EXPERIMENTS:

Software needed:

OpenCV computer vision Library for OpenCV in Python / PyCharm or C++ / Visual Studio or or equivalent

- OpenCV Installation and working with Python
- Basic Image Processing - loading images, Cropping, Resizing, Thresholding, Contour analysis, Bolb detection
- Image Annotation – Drawing lines, text circle, rectangle, ellipse on images
- Image Enhancement - Understanding Color spaces, color space conversion, Histogram equialization, Convolution, Image smoothing, Gradients, Edge Detection
- Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract ORB Image features, Feature matching, cloning, Featurematching based image alignment
- Image segmentation using Graphcut / Grabcut
- Camera Calibration with circular grid
- Pose Estimation
- 3D Reconstruction – Creating Depth map from stereo images
- Object Detection and Tracking using Kalman Filter, Camshift

1. docs.opencv.org
2. https://opencv.org/opencv-free-course/

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: To understand basic knowledge, theories and methods in image processing and computer vision.
CO2: To implement basic and some advanced image processing techniques in OpenCV.
CO3: To apply 2D a feature-based based image alignment, segmentation and motion estimations.
CO4: To apply 3D image reconstruction techniques
CO5: To design and develop innovative image processing and computer vision applications.

TEXT BOOKS:

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer- Texts in Computer Science, Second Edition, 2022.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015.

REFERENCES:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
3. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 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	1	1	1	1	-	-	-	2	1	3	2	2	1	1
2	3	3	3	2	3	-	1	-	2	1	2	2	3	1	2
3	3	3	2	2	3	-	-	-	1	1	2	2	3	2	2
4	2	3	3	2	3	-	-	-	2	1	2	3	2	2	3
5	2	3	3	2	2	2	-	-	3	1	2	3	3	3	3
AVg.	2.6	2.6	2.4	1.8	2.4	0.4	0.25	0	2	1	2.2	2.4	2.6	1.8	2.2

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

CEC337 DSP ARCHITECTURE AND PROGRAMMING L T P C
2 0 2 3

COURSE OBJECTIVES:

- Study the architecture of programmable DSP processors
- Learn to implement various standard DSP algorithms in DSP Processors
- Use the Programmable DSP Processors to build real-time DSP systems

UNIT IARCHITECTURES FOR PROGRAMMABLE DSP PROCESSORS 6

Basic Architectural features, DSP Computational building blocks, Bus architecture and memory, Data addressing capabilities, Address generation Unit, Programmability and program execution, Speed issues, Features for external interfacing

UNIT IITMS320C5X PROGRAMMABLE DSP PROCESSOR 6

Architecture of TMS320C54xx DSP processors, Addressing modes – Assembly language Instructions -Memory space, interrupts, and pipeline operation of TMS320C54xx DSP Processor, On-Chip peripherals, Block Diagram of TMS320C54xx DSP starter kit

UNIT IIITMS320C6X PROGRAMMABLE DSP PROCESSOR 6

Commercial TI DSP processors, Architecture of TMS320C6x DSP Processor, Linear and Circular addressing modes, TMS320C6x Instruction Set, Assembler directives, Linear Assembly, Interrupts, Multichannel buffered serial ports, Block diagram of TMS320C67xx DSP Starter Kit and Support Tools

UNIT IVIMPLEMENTATION OF DSP ALGORITHMS 6

DSP Development system, On-chip, and On-board peripherals of C54xx and C67xx DSP development boards, Code Composer Studio (CCS) and support files, Implementation of Conventional FIR, IIR, and Adaptive filters in TMS320C54xx/TMS320C67xx DSP processors for real-time DSP applications, Implementation of FFT algorithm for frequency analysis in real-time.

UNIT V APPLICATIONS OF DSP PROCESSORS 6

Voice scrambling using filtering and modulation, Voice detection and reverse playback, Audio effects, Graphic Equalizer, Adaptive noise cancellation, DTMF signal detection, Speech thesis using LPC, Automatic speaker recognition

30 PERIODS

PRACTICAL EXERCISES: **30 PERIODS**

1. Real-Time Sine Wave Generation
2. Programming examples using C, Assembly and linear assembly
3. Implementation of moving average filter
4. FIR implementation with a Pseudorandom noise sequence as input to a filter
5. Fixed point implementation of IIR filter
6. FFT of Real-Time input signal

HARDWARE & SOFTWARE SUPPORT TOOLS:

- TMS320C54xx/TMS320C67xx DSP Development board
- Code Composer Studio (CCS)
- Function Generator and Digital Storage Oscilloscope
- Microphone and speaker

TOTAL:60 PERIODS

COURSE OUTCOMES

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

CO1: Understand the architectural features of DSP Processors.
CO2: Comprehend the organization of TMS320C54xx DSP processors
CO3: Build solutions using TMS320C6x DSP Processor
CO4: Implement DSP Algorithms
CO5: Study the applications of DSP Processors.

TEXT BOOKS

1. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, Cengage Learning India Private Limited, Delhi 2012
2. RulphChassaing and Donald Reay, Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, Second Edition, Wiley India (P) Ltd, New Delhi, 2008

REFERENCES

1. B.Venkataramani and M.Bhaskar, “Digital Signal Processors – Architecture, Programming and Applications”, Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
2. TMS320C5416/6713 DSK user manual at https://www.ti.com

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	2	2	-	-	-	1	-	3	3	3	3
2	3	3	2	2	2	2	-	-	-	1	-	2	3	3	3
3	3	3	3	2	2	2	-	-	-	1	-	2	2	2	2
4	3	3	3	3	2	2	-	-	-	1	-	2	2	3	2
5	3	3	3	2	2	2	-	-	-	1	-	2	2	3	2
CO	3	3	3	2	2	2	-	-	-	1	-	2	2	3	2

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

VL3020 **ADAPTIVE SIGNAL PROCESSING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:
- to understand the basic principles of discrete random signal processing
- to understand the principles of spectral estimation
- to learn about the weiner and adaptive filters
- to understand the different signal detection and estimation methods
- to acquire skills to design synchronization methods for proper functioning of the system

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9
Discrete Random Processes, Random Variables, Parseval's Theorem, Wiener-Khintchine Relation, Power Spectral Density, Spectral Factorization, Filtering Random Processes, Special Types of Random Processes

UNIT II SPECTRAL ESTIMATION 9
Introduction, Nonparametric Methods – Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey Methods, Parametric Methods – ARMA, AR and MA Model Based Spectral Estimation, Solution Using Levinson-Durbin Algorithm.

UNIT III WEINER AND ADAPTIVE FILTERS 9
Weiner Filter: FIR Wiener Filter, IIR Wiener Filter, Adaptive Filter: FIR Adaptive Filters – Steepest Descent Method- LMS Algorithm, RLS Adaptive Algorithm, Applications.

UNIT IV DETECTION AND ESTIMATION 9
Bayes Detection Techniques, Map, Ml,– Detection of M-Ary Signals, Neymanpearson, Minimax Decision Criteria. Kalman Filter- Discrete Kalman Filter, The Extended Kalman Filter, Application.

UNIT V SYNCHRONIZATION 9
Signal Parameter Estimation, Carrier Phase Estimation, Symbol Timing Estimator, Joint Estimation of Carrier Phase and Symbol Timing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course, students will be able to
CO1: Analyze the basic principles of discrete random signal processing
CO2: Analyze the principles of spectral estimation
CO3: Analyze the Weiner and Adaptive filters
CO4: Analyze the different signal detection and estimation methods
CO5: Design the synchronization methods for proper functioning of the system

REFERENCES
1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 2009. 2. John G. Proakis., "Digital Communication", 4th Edition, McGraw Hill Publications, 2001.
3. Simon Haykin, "Adaptive Filter Theory", Pearson Education, Fourth Edition, 2003
4. Bernard Sklar and Pabitra Kumar Roy, "Digital Communications: Fundamentals and Applications", 2/E, Pearson Education India, 2009
5. Paulo S. R. Diniz, "Adaptive Filtering Algorithms and Practical Implementation", Springer, 2011

CO's-PO's & P SO's MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	2	2	2	-	1	1	1	1	-	2	3	3	2
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3021 BIO-INSPIRED COMPUTING L T P C
3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of evolutionary computation, genetic algorithms, and their biological inspiration for solving optimization problems.

To study and analyze bio-inspired optimization techniques such as Ant Colony Optimization, Particle Swarm Optimization, Firefly Algorithm, and Cuckoo Search Algorithm.

To understand advanced swarm intelligence algorithms including Artificial Bee Colony, Grey Wolf Optimizer, Whale Optimization, and other modern bio-inspired techniques.

To apply multi-objective optimization methods and genetic algorithm-based approaches for solving real-world engineering problems in VLSI, image processing, and wireless networks.

UNIT I EVOLUTIONARY COMPUTING & GENETIC ALGORITHM 9

Evolutionary Computation (EC), Features of EC, Genetic Algorithms, Crossover and Mutation Operators,

Selection Mechanism – Fitness Function- Ranking and Tournament selection- A simple genetic algorithm, Building Block Hypothesis and Schema Theorem.

UNIT II BIO-INSPIRED OPTIMIZATION ALGORITHMS - I 9

Ant Colony Optimization: Ants' behaviour, Ant colony algorithm, Numerical example, Particle Swarm Optimization: Original PSO algorithm, local and global version, Numerical example, Firefly Algorithm: Original Firefly Algorithm, Numerical example, Cuckoo Search Algorithm: Original cuckoo search, Numerical example

UNIT III BIO-INSPIRED OPTIMIZATION ALGORITHMS - II 9

Description and algorithms: Artificial Bee Colony Algorithm, Cat Swarm Optimization: Local and global version, Chicken Swarm Optimization: Local and global version, Crow Search Algorithm, , Grey Wolf Optimizer, Salp Swarm Algorithm, Whale Optimization Algorithm, Monarch Butterfly Optimization Algorithm

UNIT IV MULTI-OBJECTIVE OPTIMIZATION 9

Multi-Objective Optimization Problem, Principles of Multi-Objective Optimization, Difficulties with Classical ptimization Algorithms, Constraint-Handling in Genetic Algorithms, Non-Dominated Sorting Genetic Algorithm, Strength Pareto Evolutionary Algorithm, Performance Metrics.

UNIT V APPLICATIONS 9

Development of a Genetic Algorithm Technique for VLSI Testing, VLSI Macro Cell Layout Using Hybrid GA Problem Description, Genetic Layout Optimization, Designing Texture Filters with Genetic Algorithms, Genetic Algorithm Based Knowledge Acquisition on Image Processing, Object Localization in Images Using Genetic Algorithm, Problem Description, Image Pre-processing, Genetic Algorithm Approach, Genetic Algorithms for Topology Planning in Wireless Networks,

Genetic Algorithm for Wireless ATM Network Applications of PSO, Applications of Ant Colony Optimization,

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Apply the concepts of evolutionary computation and genetic algorithms to solve complex optimization problems using selection, crossover, mutation, and fitness evaluation techniques.

CO2: Analyze bio-inspired optimization algorithms such as Ant Colony Optimization, Particle Swarm Optimization, Firefly Algorithm, and Cuckoo Search for problem-solving.

CO3: Evaluate and implement advanced swarm intelligence algorithms including Artificial Bee Colony, Grey Wolf Optimizer, Whale Optimization, and related metaheuristic techniques.

CO4: Apply multi-objective optimization techniques such as NSGA and SPEA and analyze performance using appropriate evaluation metrics.

CO5: Design and implement genetic and swarm intelligence algorithms for real-world applications in VLSI, image processing, and wireless networks.

TEXT BOOKS:

1. S.N.Sivanandam · S.N.Deepa, 'Introduction to Genetic Algorithms', Springer, 2008.
2. Adam Slowik, 'Swarm Intelligence Algorithms A Tutorial', CRC Press, 2021
3. Kalyanmoy Deb, 'Multi-Objective Optimization using Evolutionary Algorithms, Wiley, 2001

REFERENCES:

1. David E.Goldberg, "Genetic Algorithms in search, Optimization & Machine Learning", Pearson Education,2006
2. Kenneth A De Jong, "Evolutionary Computation A Unified Approach", Prentice Hall of India, New Delhi,2006.
3. Xin Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland, 2015.
4. Marco Dorigo and Thomas Stutzle, "Ant Colony optimization", Prentice Hall of India, New Delhi, 2004
5. N P Padhy, "Artificial Intelligence and Intelligent Systems",Oxford University Press, 2005.
6. Engel brecht, A.P., "Fundamentals of Computational Swarm Intelligence" ,Wiley,2005

CO's-PO's & P SO's MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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CO2	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VERTICAL V RFTECHNOLOGIES

CEC350 **RF TRANSCEIVERS** **L T P C**

2 0 2 3

COURSE OBJECTIVES:

- To understand the fundamentals of RF system design
- To acquaint with the various components of RF system for wireless communications
- To know the basic techniques needed for analysis of RF systems
- To enable the students to verify the basic principles and design aspects involved in RF systems components

- To conduct experiments to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts

UNIT I CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES 6

CMOS: Introduction to MOSFET Physics - Noise: Thermal, shot, flicker, popcorn noise - Transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR - Phase noise - Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low-IF Architectures - Transmitter: Direct-up conversion, Two-step up conversion schemes

UNIT II IMPEDANCE MATCHING NETWORKS AND AMPLIFIERS 6

Review of S-parameters and Smith chart - Passive IC components - Impedance matching networks - Amplifiers: Common Gate, Common Source Amplifiers - OC Time constants in bandwidth estimation and enhancement - High frequency amplifier design - Low Noise Amplifiers: Power match and Noise match, single-ended and differential LNAs

UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS 6

Feedback Systems: Stability of feedback systems, Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation - Power Amplifiers: General model - Class A, AB, B, C, D, E and F amplifiers - Linearization Techniques - Efficiency boosting techniques - ACPR metric

UNIT IV FILTERS, OSCILLATORS AND MIXERS 6

Overview - basic resonator and filter configuration, special filter realizations, filter implementation - Basic oscillator model, high-frequency oscillator configuration, Colpitt's oscillator - basic characteristics of mixers, single and double-balanced mixers

UNIT V PLL AND FREQUENCY SYNTHESIZERS 6

PLL: Linearized Model, Noise properties, Phase detectors, Loop filters and Charge pumps- Frequency Synthesizers: Integer-N frequency synthesizers - Direct Digital Frequency Synthesizers

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Measurement of S-parameters for impedance matching circuits, and RF filters using network analyzer
2. Design of RF inductor and capacitor
3. Design and characterization of LNA
4. Design of impedance matching network
5. Design of low-pass and band-pass filter at RF
6. Design and characterization of mixer

TOTAL:60 PERIODS

COURSE OUTCOMES:

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

CO1: Interpret the nonlinear effects in RF circuits

CO2: Design RF circuits

CO3: Analyze the performance of RF circuits

CO4: Apply knowledge to identify a suitable architecture and systematically design an RF System

CO5: Comprehensively record and report the measured data, and would be capable analyzing, interpreting the experimentally measured data and produce the conclusions

TEXTBOOKS

1. Lee T, Design of CMOS RF Integrated Circuits, Cambridge, Second Edition, 2004
2. Razavi B, RF Microelectronics, Pearson Education, Second Edition, 2012

REFERENCES

1. Ludwig R, and Bretchko P, RF Circuit Design Theory and Applications, Prentice Hall, 2000
2. Razavi B, Design of Analog CMOS Integrated Circuits, McGraw Hill, Second Edition, 2017
3. Kyung-WhanYeom, Microwave Circuit Design - A Practical Approach using ADS, Pearson Education, 2015

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

CO	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
1	3	3	2	3	2	-	-	-	-	1	-	2	1	1	3
2	3	3	3	2	2	-	-	-	-	1	-	2	1	1	2
3	3	3	2	2	2	-	-	-	-	1	-	2	2	2	2
4	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
5	3	2	3	3	2	-	-	-	-	1	-	2	2	2	2
CO	3	3	3	3	2	-	-	-	-	1	-	2	2	2	2

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

VL3022 SIGNAL INTEGRITY FOR HIGH SPEED DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of signal integrity in high-speed digital systems including noise mechanisms such as crosstalk, ground bounce, EMI, and rail-collapse effects.
To study transmission line theory including characteristic impedance, reflections, losses, and effects of discontinuities in high-speed interconnects.
To analyze crosstalk phenomena in transmission lines including capacitive and inductive coupling, near-end and far-end crosstalk, and mitigation techniques.
To understand differential signaling, clock distribution systems, and clock oscillators for improving timing accuracy, signal quality, and synchronization in VLSI systems.

UNIT I INTRODUCTION 9

Introduction to Signal Integrity, Signal Quality on a Single Net, Cross Talk, Rail-Collapse Noise, Electromagnetic Interference (EMI), Signal-Integrity Solutions in Terms of Impedance: Impedance of ideal resistor, capacitor and inductor in time domain, Impedance in the Frequency Domain, Bulk Resistivity, Resistance per Length, Sheet Resistance, Power and Ground Planes and Decoupling Capacitance, Capacitance per Length, Self-Inductance and Mutual Inductance, Partial Inductance Effective, Total, or Net Inductance and Ground Bounce, Loop Self- and Mutual Inductance, Loop Inductance per Square of Planes, Loop Inductance of Planes and Via Contacts

UNIT II TRANSMISSION LINES AND REFLECTIONS 9

Speed of a Signal in a Transmission Line, Instantaneous Impedance of a Transmission Line, Characteristic Impedance and Controlled Impedance, Return Paths , Frequency Variation of the Characteristic Impedance, Reflections, Reflections from Resistive Loads, Source Impedance, Bounce Diagrams, Reflections from Short Series and Short-Stub Transmission Lines, Reflections from Capacitive End Terminations, Reflections from Capacitive Loads in the Middle of a Trace, Capacitive Delay Adders, Effects of Corners and Vias, Loaded Lines, Reflections from Inductive Discontinuities, Compensation, Losses in Transmission Lines, Sources of Loss: Conductor Resistance and Skin Depth, The Dielectric, Dissipation Factor

UNIT III CROSSTALK 9

Coupling: Capacitance and Inductance, Cross Talk in Transmission Lines, Cross Talk in Uniform Transmission Lines and Saturation Length, Capacitively Coupled Currents, Inductively Coupled

Currents, Near-End Cross Talk, Far-End Cross Talk, Decreasing Far-End Cross Talk, Guard Traces, Cross Talk and Dielectric, Cross Talk and Timing, Switching Noise.

UNIT IV DIFFERENTIAL SIGNALING **9**

Differential Signaling, A Differential Pair, Differential Impedance with No Coupling, The Impact from Coupling, Calculating Differential Impedance, The Return-Current Distribution in a Differential Pair, Ideal Coupled Transmission-Line Model or an Ideal Differential Pair, Cross Talk in Differential Pairs, Crossing a Gap in the Return Path.

UNIT V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS **9**

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, canceling parasitic capacitance, Clock jitter.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Analyze signal integrity issues in high-speed digital systems including noise mechanisms such as crosstalk, EMI, ground bounce, and rail-collapse noise.

CO2: Apply transmission line theory to evaluate impedance, reflections, losses, and signal behavior in high-speed interconnects.

CO3: Evaluate crosstalk effects in transmission lines and apply mitigation techniques such as guard traces, termination, and layout optimization.

CO4: Analyze differential signaling techniques and their impact on impedance matching, signal quality, and return current distribution.

CO5: Design and analyze clock distribution networks and oscillators considering timing margin, jitter, slew, and delay optimization techniques.

TEXT BOOKS

1. Signal and Power integrity Simplified -Eric Bogatin, Pearson, 3rd Edition

2. High Speed Digital Design by Howard Johnson and Martin Graham, Prentice Hall,1st Edition (UNIT V)

REFERENCES

1. High Speed Signal Propagation and Howard Johnson,Prentice Hall,1st Edition

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3

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

VL3023 VLSI INTERCONNECTS L T P C
3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of VLSI interconnects including types, scaling trends, coupling effects, and on-chip and package-level interconnection technologies.
To study interconnect modeling techniques using lossless and lossy transmission line models and analyze delay, power, and scaling effects in VLSI systems.
To analyze crosstalk phenomena in interconnects including mutual capacitance/inductance, noise generation, delay impact, and mitigation techniques.
To understand noise detection and avoidance techniques in VLSI interconnects and explore future interconnect technologies such as optical, nano-wire, and quantum-based systems.

UNIT I INTRODUCTION 10

Types of interconnects, Interconnect Trends, Coupling capacitance, Inductive effects, Interconnect metrics, Signal transmission on interconnects, On-chip interconnections, Package level interconnections, Design Methodologies for Interconnect, Stress void and Electromigration phenomenon, Interconnections for VLSI Applications, Copper Interconnections, Fabrication and Damascene processing, Electromigration in Copper Interconnections, Scaling of interconnects.

UNIT II INTERCONNECT MODELING 10

Lossless and Lossy transmission line model, Optimum line model selection, Circuit Models of Interconnect - Ideal, Capacitive, Resistive Interconnects, Resistive Interconnect Trees, Scaling Effects on Interconnect Delay, Cross-Capacitances and Their Decoupling with Miller Factor, Interconnect Power.

UNIT III CROSSTALK IN INTERCONNECTS 10

Definition of Cross talk, Mutual inductance and mutual capacitance, Inductance and capacitance matrix, crosstalk-induced noise, Simulating crosstalk using equivalent circuit models, Minimization of crosstalk, Crosstalk induced delay - Energy dissipation due to crosstalk- Crosstalk effects in logic VLSI circuits.

UNIT IV NOISE DETECTION AND AVOIDANCE IN INTERCONNECTS 10

Cross talk avoidance, Switching noise avoidance, noise detection problem, crosstalk-induced spurious signal detection, IDDx test approaches to crosstalk detection.

UNIT V FUTURE INTERCONNECTIONS 5

Demands in Future Interconnects, Introduction to optical and superconducting interconnects, Silicon Nano-wires and Metallic Interconnections, Nano-tube Interconnections, Quantum-Cell-Based Wireless Interconnections.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the types of VLSI interconnects, their scaling trends, coupling effects, and physical phenomena such as electromigration and stress voids.
CO2: Apply interconnect modeling techniques using lossless, lossy, capacitive, and resistive models to evaluate delay and power in VLSI systems.
CO3: Evaluate crosstalk effects in interconnects using mutual capacitance and inductance concepts and apply methods for noise and delay reduction.
CO4: Analyze noise detection and avoidance techniques in interconnect systems including crosstalk-induced noise and IDDx-based testing approaches.
CO5: Understand and evaluate emerging interconnect technologies such as optical, nano-wire, superconducting, and quantum-based interconnect systems.

TEXT BOOKS:

1. Ashok K. Goel, “High-Speed VLSI Interconnections”, Second Edition, IEEE-Wiley, 2007
2. Francesc Moll, Miquel Roca, “Interconnection Noise in VLSI Circuits” , Kluwer Academic Publishers, 2004
3. Mustafa Celik, Lawrence Pileggi, Altan Odabasioglu, “IC Interconnect Analysis”, Kluwer Academic Publishers, 2002.
4. Konstantin Moiseev, Avinoam Kolodny, Shmuel Wimer, “Multi-Net Optimization of VLSI Interconnect, Springer, 2015.

REFERENCES:

1. Stephen H. Hall, Garrett W. Hall, James A. McCall, High-Speed Digital System Design—A Handbook of Interconnect Theory and Design Practices, Wiley, 2000.
2. Sandeep Saini “Low Power Interconnect Design”, Springer, 2015
3. Brajesh Kumar Kaushik, Manoj Kumar Majumder, “Carbon Nanotube Based VLSI Interconnects Analysis and Design”, Springer, 2015.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	2	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	1	1	1	1	2	1	2	3	3	3
CO5	3	3	2	2	2	-	1	1	1	1	1	2	3	3	3

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

CEC341 MICs AND RF SYSTEM DESIGN L T P C

2 02 3

COURSE OBJECTIVES:

- To study the characteristics of Active components and applications.
- To design the RF filter and analyze the circuits operated at millimeter wavelength
- To understand the basics of Microwave integrated circuits
- To learn the concepts of non reciprocal components for MICs
- To design the antenna and analyze its performance using measurement techniques

UNIT I ACTIVE RF COMPONENTS AND APPLICATIONS 6

RF diodes, BJT, RF FET’S, High electron mobility transistors, matching and biasing networks-impedance matching using discrete components, microstripline matching networks, amplifier classes of operation and biasing networks.

UNIT II RF FILTER DESIGN 6

Overview, Basic resonator and filter configuration, special filter realizations, smith chart based filter design, coupled filter.

UNIT III INTRODUCTION TO MICROWAVE INTEGRATED CIRCUITS 6

Overview of ABCD and S parameters - Overview of Planar transmission lines (Stripline, Microstripline, Slotline, CPW, Finline)-Design Parameters for Strip Line AndMicrostripline- Active Device Technologies- Design ApproachesMultichip Module Technology- Substrates

UNIT IV NON RECIPROCAL COMPONENTS FOR MICs 6

Microstrip on Ferrimagnetic substrates, Microstrip circulators. Isolators and phase shifters, Design of microstrip circuits – high power and low power circuits.

UNIT V INTEGRATED ANTENNA DESIGN AND MEASUREMENTS 6

Integrated Antenna Design- Photonic Band Gap Antennas - Micro Machined Antenna - Micro Electro Mechanical System Antennas - Test Fixture Measurements - Probe Station Measurements -Thermal and Cryogenic Measurements- Experimental Field Probing Techniques.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Design of low pass, high pass, band pass and band stop filter at RF using any software tool
2. Design of low pass, high pass, band pass and band stop filter at RFDesign of low pass, high pass, band pass and band stop filter at RF
3. Design of low pass, high pass, band pass and band stop filter at RF
4. Design of low pass, high pass, band pass and band stop filter at RF
5. Measurement of S parameters for a) Inductor b) Capacitor c) impedance matching circuits, filters using network analyzer
6. Design a microstrip circuits

COURSE OUTCOMES:

Upon successful completion of the course the student will be able to

CO1: Apply knowledge of S parameter theory to any RF active component design circuit for obtaining performance measure.

CO2: Analyze microwave circuits for filters design.

CO3 Evaluate the performance of any practical Microwave integrated circuits

CO4: Create communication circuits and subsystems with practical design parameters fornon-reciprocal components in MICs.

CO5: Design microwave integrated antenna design circuit for the required Performance using professional software tools.

TOTAL:60 PERIODS

TEXTBOOKS

1. Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications, Pearson Education Asia, First Edition, 2001.(Unit – I, II)
2. Bharathi Bhat, Shiban K. Koul, “Stripline-like Transmission Lines for Microwave Integrated Circuits”, New Age International Pvt Ltd Publishers, 2007.(Unit –III ,V)
3. Gupta KC and Amarjit Singh, “Microwave Integrated circuits”, Wiley Eastern, 1974.(Unit – IV)

REFERENCES

1. MathewM. Radmanesh, Radio Frequency & Microwave Electronics, Pearson Educat ion Asia, Second Edition, 2002.
2. Ulrich L. Rohde and David P. NewKirk, RF / Microwave Circuit Design, John Wiley & Sons USA 2000.
3. RolandE. Best, Phase – Locked Loops: Design, simulation and applications, McGra w Hill Publishers 5TH edition 2003
4. David Pozar ,Microwave Engineering, Addison Wesley 3rd Edition
5. Ravender Goyal, “Monolithic MIC; Technology & Design”, Artech House, First Edition 1989.

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

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2	3	3	3	2	3	2	2	-	2	1	-	1	3	2	2
3	3	3	2	2	3	2	2	-	2	1	-	1	3	2	2
4	3	3	2	2	3	2	2	-	2	1	-	1	3	2	2
5	3	3	1	2	3	2	2	-	2	1	-	1	3	2	2
CO	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**-**	**2**	**1**	**-**	**1**	**3**	**2**	**2**

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

CEC338 EMI / EMC PRE COMPLIANCE TESTING L T P C
2 0 2 3

COURSE OBJECTIVES:

- To introduce the basic concepts of Electromagnetic Interference
- To teach the importance of measurement device for EMI.
- To explain the EMI coupling & control principles
- To understand receivers & Analyzer functionalities
- To impart knowledge on design issues in EMI/EMC

UNIT I NATURE AND ORIGINS OF ELECTROMAGNETIC COMPATIBILITY 6

Introduction-Visualisiong the EMI problem-Source of EMI,EMI coupling to victim equipment, Intersystem and Intrasystem EMI, EMC standards and specifications

UNIT II TYPES of EMI COUPLING 6

Conducted, radiated and transient coupling; Common ground impedance coupling; Common mode and ground loop coupling; Differential mode coupling, Near field cable to cable coupling; Field to cable coupling, Power mains and Power supply coupling; Transient EMI

UNIT III MEASUREMENT DEVICES FOR EMI 6

Introduction – Measurement by direct connection, Inductively coupled devices, EMC antennas – Basic antenna parameters, Antennas for radiated emission testing, Wideband antennas - Magnetic field antennas, Type of antennas used in susceptibility testing

UNIT IV RECEIVERS, ANALYSERS AND MEASUREMENT EQUIPMENT 6

EMI receiver, Spectrum Analyzers, RF power meter Frequency meters. Standards requiring immunity tests, Automatic EMC tests, Electromagnetic transient testing, Transient types, Continuous and transient signal, ESD-electrostatic discharge

UNIT V PRE-COMPLIANCE TESTING TO AVOID EMC PROBLEMS 6

Need for Pre-Compliance Testing; Intersystem and Intrasystem EMC - Developing an approach to EMC design - Process flow chart, - EMC strategy – Self certification; Solutions to avoid EMC: ESD Shielding, EMI Filters; Grounding; Bonding, Isolation transformer, Transient suppressors; EMI Suppression Cables.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Basic spectrum measurement and power measurement with markers
2. Perform environment scan and detect various signals available
3. DPX, Spectrogram and transient capture with mask test and act on violation

4. EMI spurious detection and measurement against EMI limit lines
5. Use of LISN and measurement concept of Conducted emission

List of equipments for needed for a batch of 30 students (3 in a bench):

1. Real Time Spectrum Analyseruptoatleast 6.2GHz and 40MHz BW – 10 nos
2. Near Field Probes kit – 10 nos
3. 25MHz to 300 MHz Biconical antenna – 10 nos
4. 300 MHz to 1GHz Compact Log Periodic Antenna – 10 nos
5. line impedance stabilization network (LISN) - 3
6. EMI EMC Test Software – 10 nos
7. Tripod Stand – 10 nos

COURSE OUTCOMES:

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

CO1: Perceive the various types and mechanisms of Electromagnetic Interference
CO2: Propose a suitable EMI mitigation technique.
CO3: Evaluate EMI coupling & control principles
CO4: Explain the importance receivers & Analyzer functionalities
CO5: Inspect the design issues in EMI/EMC

TOTAL:60 PERIODS

TEXTBOOKS

1. David Morgan , "A Handbook for EMC Testing and Measurement", IET Electrical Measurement, 2012
2. Tim Williams , "EMC for Product Designers", 5th Edition, Newnes Elsevier, 2017

REFERENCES

1. 1.V.P.Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press, Newyork, 1996
2. Paul, C.R., “Introduction to Electromagnetic Compatibility”, 2nd ed., Wiley (2010)
3. David K. Cheng, “Field and Wave Electromagnetics”, 2nd ed. Pearson Education, 2009

CO’s-PO’s & PSO’s MAPPING

CO	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
1	3	2	2	3	3	1	1	-	-	1	-	1	2	1	2
2	3	3	2	1	3	2	1	-	-	1	-	2	2	2	2
3	3	3	3	3	2	2	1	-	-	1	-	2	2	2	2
4	3	3	2	2	2	2	1	-	-	1	-	2	2	1	2
5	3	-	3	3	2	2	1	-	-	1	-	2	2	2	2
CO	3	3	2	2	2	2	1	-	-	1	-	2	2	2	2

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

CEC349 RFID SYSTEM DESIGN AND TESTING L T P C
2 0 2 3

COURSE OBJECTIVES:

- To discuss the fundamentals of near field and far field RFID communications
- To articulate the standards and protocols used in RFID systems
- To describe the operating principles of RFID tag and reader
- To introduce the security aspects and system architecture of RFID systems
- To illustrate the industrial and scientific applications of RFID systems

UNIT I INTRODUCTION 6

RFID Principles: Near-field based RFID – Properties of Magnetic field – Far-field based RFID – Properties of Backscatter RF Systems – Modulation techniques – Frequency based property comparison of RFID Systems

UNIT II RFID STANDARDS AND PROTOCOLS 6

RFID Industry standards: EPC global – ISO15693 Vicinity cards and RFID – ISO14443 Proximity cards and RFID – The NFC forum – Reading collocated RFID tags: Query Tree protocol – Query Slot protocol

UNIT III OPERATING PRINCIPLES 6

RFID Tag components: RFID tag types – the 1-Bit Transponder and Chipless Tags – RFID readers and middleware component – Communication fundamentals: Coupling, Data encoding, multi-path effect – Tag, Reader and sensor communication.

UNIT IV DATA INTEGRITY AND SECURITY 6

The checksum procedure – Multiaccess procedures – Attacks on RFID Systems – Protection by Cryptographic measures

UNIT V RFID ENABLED SENSORS AND APPLICATIONS 6

RFID enabled Sensors: Antenna design challenges – IC design – Integration of sensors and RFID – Power consumption and Link budget.

Applications: Contactless smart cards – Access control – Electronic passport – Industrial Automation – Medical applications – Challenges and opportunities.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Design of a passive RFID Tag Antenna
2. Design of an RFID reader antenna
3. Determination of read range of the RFID tag at UHF and Microwave frequencies
4. Determination of RFID tag performance for different standards

COURSE OUTCOMES:

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

CO1: Classify RFID systems based on frequency, architecture and performance
CO2: Define standards for RFID technology
CO3: Illustrate the operation of various components of RFID systems
CO4: Describe the privacy and security issues in RFID Systems
CO5: Discuss the construction and applications of RFID enabled sensor

TOTAL:60 PERIODS

TEXTBOOKS

1. Roy Want, RFID Explained, Springer 2022.
2. Amin Rida, Li Yang, Manos M. Tentzeris, RFID Enabled Sensor Design and Applications, Artech House, 2010

REFERENCES

1. Klaus Finkenzeller, RFID Handbook, 3rd Edition, Wiley, 2010
2. Syed Ahson, Mohammad Ilyas, RFID Handbook, CRC Press, 2008
3. Paris Kitsos, Security in RFID and Sensor Networks, CRC Press, 2016.

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

CO	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
1	3	3	3	2	2	3	1	-	-	1	-	3	2	3	2
2	3	2	3	2	2	2	1	-	-	1	-	3	3	2	2
3	3	3	3	2	3	2	1	-	-	1	-	3	2	3	2
4	3	3	3	2	2	2	1	-	-	1	-	2	3	2	2
5	3	3	2	2	2	2	2	-	-	1	-	3	2	2	2
CO	3	3	3	2	3	3	1	-	-	1	-	2	3	3	2

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

VL3024 INTRODUCTION TO MEMS AND NEMS L T P C
3 00 3

COURSE OBJECTIVES:

To understand the fundamentals of MEMS and NEMS, their evolution, microsystem concepts, materials, and applications in micro and nanotechnology.
To study fabrication processes of MEMS and NEMS including photolithography, thin film deposition, etching techniques, and micromachining methods.
To analyze the working principles of micro and nano sensors including thermal, magnetic, pressure, chemical, and inertial sensors used in various applications.
To understand micro and nano actuators along with packaging techniques and characterization methods such as SEM, TEM, AFM, and STM for MEMS/NEMS systems.

UNIT I INTRODUCTION TO MEMS AND NEMS 9

MEMS, Microsystem and microelectronics, Applications of MEMS, Materials for MEMS: Silicon, silicon compounds, polymers. Introduction to NEMS, Nano scaling, classification of nano structured materials, Applications of nanomaterials.

UNIT II FABRICATION OF MEMS AND NEMS 9

Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching; Micromachining: Bulk Micromachining, Surface Micromachining, LIGA

UNIT III MICRO AND NANO SENSORS 9

MEMS Gyroscopes, Thermistors, Thermodevices, Thermocouple, MEMS Thermovessels, Magnetoresistive Sensor, MEMS Magnetic Sensor, Pressure Sensor Utilizing MOKE, DNA Sensors, Surface Acoustic Wave (SAW) Sensors, MOEMS-related sensors: Displacement sensors, Chemical sensors, Fluorescence detection sensors, Inertial sensors: accelerometers, Pressure sensors

UNIT IV MICRO AND NANO ACTUATORS 9

Microactuator, Electrostatic actuators: Electrostatic electrode actuator, Comb drive, Scratch drive actuator, Linear electrostatic micromotor, Rotary electrostatic micromotors - Thermal actuators: Pseudo-bimorph actuator, Bent-beam electrothermal actuator, U-shaped and serpentine-shaped electrothermal actuators, Linear microvibromotor, Rotary actuator - Shape memory actuators: Linear SMA microactuators - Piezoelectric actuators: LIGA piezoelectric actuator, Linear microworms, Inchworm, Rotary micromirror, Microgrippers, Micromotors, Microvalves, Micropumps

UNIT V PACKAGING AND CHARACTERIZATION OF MEMS AND NEMS 9

Micro / nano systems packaging, Essential packaging technologies, Selection of packaging materials; Nano material characterization - SEM, TEM, AFM, STM.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1: Understand the fundamental concepts of MEMS and NEMS, including microsystems, nanostructures, materials, and their engineering applications.

CO2: Analyze MEMS and NEMS fabrication processes such as photolithography, deposition, etching, and micromachining techniques.

CO3: Evaluate the working principles and performance of micro and nano sensors including thermal, magnetic, pressure, chemical, and inertial sensors.

CO4: Analyze different types of micro and nano actuators and understand their operating mechanisms and applications in micro/nano systems.

CO5: Apply knowledge of MEMS/NEMS packaging and characterization techniques such as SEM, TEM, AFM, and STM for material and device analysis.

TEXT BOOKS:

1. Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata Mcgraw Hill, 2002.
2. Murty B.S, Shankar P, Raj B, Rath, B.B, Murday J, Textbook of Nanoscience and Nanotechnology, Springer publishing, 2013
3. Manouchehr E Motamedi, "MOEMS: Micro-Opto-Electro-Mechanical Systems", SPIE press, First Edition, 2005.
4. Mahalik N P, MEMS, Tata McGraw Hill, 2007

REFERENCES:

1. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures", CRC Press, 2002
2. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006
3. Vinod Kumar Khanna, "Nanosensors: Physical, Chemical, and Biological", CRC press, 2012.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	3	3	-	1	1	1	1	1	2	3	3	3
CO3	3	3	3	3	2	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	2	3	3	1	1	1	1	2	1	2	3	3	3

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

VERTICAL VI - IOT AND APPLICATIONS

VL3042 EMBEDDED SYSTEMS AND IOT **L T P C**

2 0 2 3

COURSE OBJECTIVES:

Introduce the fundamentals of embedded systems, ARM processor architecture, programming techniques, and the embedded system design process.
Develop an understanding of real-time operating systems, task scheduling, inter process communication, and distributed embedded system architectures.
Explain the architecture, enabling technologies, communication protocols, and system management concepts of the Internet of Things (IoT).

Enable students to design, develop, and implement IoT-based applications using Node MCU, Raspberry Pi, and Python for real-world domains such as smart cities, agriculture, and environmental monitoring.

UNIT I EMBEDDED PROCESSOR **6**

Embedded System Design Process – ARM Processor – Instruction Set Preliminaries – CPU – Programming Input and Output – Supervisor Mode – Exceptions and Trap – Models for programs – Assembly, Linking and Loading – Compilation Techniques

UNIT II REAL TIME PROCESSES AND OPERATING SYSTEMS **6**

Structure of a real – time system – Task Assignment and Scheduling – Multiple Tasks and Multiple Processes – Multirate Systems – Pre emptive real – time Operating systems – Priority based scheduling – Interprocess Communication Mechanisms

UNIT III DISTRIBUTED EMBEDDED SYSTEM AND SHARED MEMORY PROCESSOR 6
Distributed Embedded Systems – MPSoCs and Shared Memory Multiprocessors – Design Example – Audio Player, Engine Control Unit and Video Accelerator.

UNIT IV IOT ARCHITECTURE AND PROTOCOLS **6**

Internet – of – Things – Physical Design, Logical Design – IoT Enabling Technologies – Domain Specific IoTs – IoT and M2M – IoT System Management with NETCONF – YANG – IoT Reference Architecture – IoT Protocols - MQTT, XMPP, Modbus, CANBUS and BACNet.

UNIT V IOT DESIGN TOOLS AND APPLICATIONS **6**

Basic building blocks of an IoT device – Node MCU programming structure – I/O pins using node MCU sketches - Raspberry Pi – Board – Linux on Raspberry Pi – Interfaces – Programming with Python – Case Studies: Smart Cities, Environment and Agriculture.

30 PERIODS

PRACTICAL EXERCISES:

Experiments using ARM

- Interfacing ADC and DAC
- Interfacing of LEDs (Blinking, Ring counter and Johnson counter)
- Interfacing LCD
- Interfacing Hex Keypad
- Interfacing Stepper Motor

IoT Experiments (using node MCU/ Raspberry Pi)

- **Accessing digital IO pins in IoT device**

- **Accessing analog IO pins in IoT device**
- **Connecting IoT device with WiFi**
- **Data logging in web using IoT device**

30 PERIODS

TOTAL: 60 PERIODS

COURSEOUTCOMES:

CO1: Learn the programmers model and programming concept of ARM.
CO2:Developa modelofanembeddedsystem.
CO3: List the concepts of real time operating systems.
CO4: Learn the architecture and protocols of IoT.
CO5:DesignanIoTbasedsystemforanyapplication.

TEXTBOOKS:

1. Marilyn Wolf, Computers as Components – Principles of Embedded Computing SystemDesign, Third Edition,Morgan Kaufmann,2012.(Unit–I,II,III)
2. Arshdeep Bahga, Vijay Madisetti, Internet – of- Things – A Hands on Approach, UniversitiesPress,2015.(Unit–IV,V)

REFERENCES:

1. MayurRamgir,Internet–of–Things,Architecture,ImplementationandSecurity, First Edition,PearsonEducation,2020.
2. LylaB.Das,EmbeddedSystems:AnIntegratedApproach,PearsonEducation 2013.
3. Jane.W.S.Liu, Real –TimeSystems,PearsonEducation, 2003.

CO's-PO's&PSO'sMAPPING

C	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO	PSO	PSO
1	3	3	3	2	2	-	-	-	-	-	-	-	3	2	1
2	3	3	3	2	2	-	-	-	-	-	-	-	3	2	1
3	3	3	2	2	2	-	-	-	-	-	-	-	2	1	1
4	3	3	2	2	2	-	-	-	-	-	-	-	3	3	2
5	3	3	3	3	3	-	-	-	-	-	-	-	3	3	2
C	**3**	**3**	**2.6**	**2.2**	**2.2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.8**	**2.2**	**1.4**

1 -low,2-medium, 3-high,'-'-nocorrelation

CEC365 WIRELESS SENSOR NETWORK DESIGN L T P C

3 0 0 3

COURSE OBJECTIVES :

- To understand the fundamentals of wireless sensor network
- To gain knowledge on the MAC and Routing Protocols of WSN
- To get exposed to 6LOWPAN technology

- To acquire knowledge on the protocols required for developing real time applications using WSN and 6LOWPAN.
- To gain knowledge about operating system related to WSN and 6LOWPAN

UNIT I INTRODUCTION 9

Principle of Wireless Sensor Network -Introduction to wireless sensor networks- Challenges, Comparison with ad hoc network, Node architecture and Network architecture, design principles, Service interfaces, Gateway, Short range radio communication standards-IEEE 802.15.4, Zigbee and Bluetooth. Physical layer and transceiver design considerations.

UNIT II MAC AND ROUTING PROTOCOLS 9

MAC protocols – fundamentals, low duty cycle protocols and wakeup concepts, contention and Schedule-based protocols - SMAC, BMAC,TRAMA, Routing protocols – Requirements, Classification -SPIN, Directed Diffusion, COUGAR, ACQUIRE, LEACH, PEGASIS.

UNIT III 6LOWPAN 9

6LoWPAN Architecture - protocol stack, Adaptation Layer, Link layers – Addressing, Routing - Mesh-Under - Route-Over, Header Compression - Stateless header compression - Context- based header compression, Fragmentation and Reassembly , Mobility – types, Mobile IPv6, Proxy Home Agent, Proxy MIPv6, NEMO –Routing – MANET, ROLL, Border routing.

UNIT IV APPLICATION 9

Design Issues, Protocol Paradigms -End-to-end, Real-time streaming and sessions, Publish/subscribe, Web service paradigms, Common Protocols -Web service protocols, MQ telemetry transport for sensor networks (MQTT-S), ZigBee compact application protocol (CAP),Service discovery, Simple network management protocol (SNMP), Real-time transport and sessions, Industry- Specific protocols.

UNIT V TOOLS 9

TinyOS – Introduction, NesC, Interfaces, modules, configuration, Programming in TinyOS using NesC, TOSSIM, Contiki – Structure, Communication Stack, Simulation environment – Cooja simulator, Programming

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To be able to design solutions for WSNs applications
CO2: To be able to develop efficient MAC and Routing Protocols
CO3: To be able to design solutions for 6LOWPAN applications
CO4: To be able to develop efficient layered protocols in 6LOWPAN
CO5: To be able to use Tiny OS and Contiki OS in WSNs and 6LOWPAN applications

REFERENCES:

1. Holger Karl , Andreas willig, “Protocol and Architecture for Wireless Sensor Networks”, John Wiley Publication, 2006.
2. Anna Forster, “Introduction to Wireless Sensor Networks”, Wiley, 2017.
3. Zach Shelby Sensinode and Carsten Bormann, “ 6LoWPAN: The Wireless Embedded Internet” John Wiley and Sons, Ltd, Publication, 2009.
4. Philip Levis, “TinyOS Programming”, 2006 –www.tinyos.net.
5. The Contiki Operating System.http://www.sics.se/contiki.

CO’s-PO’s & PSO’s MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
1	3	3	2	2	2	1	-	-	-	-	2	2	3	1	1
2	3	3	2	2	2	1	-	-	-	-	-	2	3	2	2
3	3	3	3	2	2	1	-	-	-	-	-	3	3	2	2
4	3	3	3	3	2	2	-	-	-	-	-	2	2	1	2
5	2	-	1	1	3	2	-	-	-	-	-	2	2	2	1
CO	**2.8**	**3**	**2.2**	**2**	**2.2**	**1.4**	**-**	**-**	**-**	**-**	**2**	**2.2**	**2.6**	**1.6**	**1.6**

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

CEC369 IOT PROCESSORS L T P C

2 0 2 3

COURSE OBJECTIVES:

- Learn the architecture and features of ARM.
- Study the exception handling and interrupts in CORTEX M3
- Program the CORTEX M3
- Learn the architecture of STM 32L15XXX ARM CORTEX M3/M4 microcontroller.
- Understand the concepts of System – On – Chip(SoC)

UNIT I OVERVIEW OF ARM AND CORTEX-M3 6

ARM Architecture – Versions, Instruction Set Development, Thumb 2 and Instruction Set Architecture, Cortex M3 Basics: Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence , CORTEX M3 Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions, CORTEX M3 – Implementation Overview: Pipeline, Block Diagram. Bus Interfaces, I – Code Bus, D – Code Bus, System Bus- External PPB and DAP Bus.

UNIT II CORTEX EXCEPTION HANDLING AND INTERRUPTS6

Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending behaviour, Fault Exceptions, Supervisor Call and Pendable Service Call, NVIC: Nested Vector Interrupt Controller, Overview, Basic Interrupts, SYSTICK Time, Interrupt Behaviourm Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail – Chaining Interrupts, Late Arrivals and Interrupt Latency.

UNIT III CORTEX M3/M4 PROGRAMMING 6

Cortex M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS Using Assembly, Excepiton Programming Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation, Memory Protection Unit and other CORTEX M3 Features, MPU Registers, Setting up the MPU, Power Management, Multiprocessor Configuration.

UNIT IV STM32L15XXX ARMCORTEX M3/M4 MICROCONTROLLER 6 AND DEBUGGING TOOLS

STM32L15XXX ARM CORTEX M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control, STM32L15XXX Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART Development and Debugging Tools: Software and Hardware tools like Cross Assemblerm Compiler, Debugger, Simulator, In – Circuit Emulator(ICE), Logic Analyser.

UNIT V INTRODUCTION TO SYSTEM – ON – CHIP 6

System Architecture: An Overview, Components of the System Processors, Memories and Interconnects, Processor Architectures, Memory and Addressing, System Level Interconnection – An Approach for SOC Design – Chip basics – Cycle Time – Die Area – Power and Cost – Area, Power and Time Trade – Offs in Processor Design – Reliability and Configurability – SOC Design Approach – Application Studies – AES, 3D Graphics Processor. Image Compression and Video Compression.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

ARM Assembly Programming

1. Write a program to add two 32-bit numbers stored in r0 and r1 registers and write the result to r2. The result is stored to a memory location. a) Run the program with breakpoint and verify the result b) Run the program with stepping and verify the content of registers at each stage.
2. Write ARM assembly to perform the function of division. Registers r1 and r2 contain the dividend and divisor, r3 contains the quotient, and r5 contains the remainder.

Embedded C Programming on ARM Cortex M3/M4 Microcontroller

1. Write a program to turn on green LED (Port B.6) and Blue LED (Port B.7) on STM32L-Discovery by configuring GPIO.
2. Transmit a string “Programming with ARM Cortex” to PC by configuring the registers of USART2. Use polling method.

ARM Cortex M3/M4 Programming with CMSIS

1. Write a program to toggle the LEDs at the rate of 1 sec using standard peripheral library. Use Timer3 for Delay.
2. Transmit a string “Programming with ARM Cortex” to PC by using standard peripheral library with the help of USART3. Use polling method.

COURSE OUTCOMES:

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

CO1: Explain the architecture and features of ARM.
CO2: List the concepts of exception handling.
CO3: Write a program using ARM CORTEX M3/M4.
CO4: Learn the architecture of STM32L15XXX ARM CORTEX M3/M4.
CO5: Design an SoC for any application.

TOTAL:60 PERIODS

TEXTBOOKS

1. Joseph Yiu, The Definitive Guide to the ARM CORTEX M3/M4, Second Edition, Elsevier, 2010.(Unit – I, II)
2. Andrew N Sloss, Dominic Symes, Chris Wright, ARM System Developers Guide Designing and Optimising System Software, Elsevier, 2006 (Unit – III, IV)
3. Michael J Flynn and Wayne Luk, Computer System Design, System On Chip, Wiley India 2011.(Unit – V)

REFERENCES

1. Steve Furber, ARM System – on – Chip Architecture, 2nd Edition, Pearson, 2015.
2. CORTEX M Series ARM Reference Manual
3. CORTEX M3 Technical Reference Manual
4. STM32L152XX ARM CORTEX M3 Microcontroller Reference Manual 5/97

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

CO	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
1	3	3	3	2	2	2	-	-	-	-	-	3	3	3	3
2	3	3	3	3	2	2	-	-	-	-	-	2	3	3	3
3	3	3	3	3	2	2	-	-	-	-	-	2	2	2	2
4	3	3	2	2	2	2	-	-	-	-	-	2	2	2	2
5	3	3	2	2	2	1	-	-	-	-	-	3	3	2	2
CO	3	3	2.6	2.4	2	1.8	-	-	-	-	-	2.4	2.6	2.4	2.4

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

VL3025IoT PROTOCOLS L TP C

3 0 0 3

Course Objective:

To understand the fundamentals of IEEE 802.15.4 LR-WPAN including physical layer, MAC layer, addressing, frame formats, and security mechanisms.
To study ZigBee architecture, protocol layers, networking concepts, routing algorithms, and application profiles for wireless sensor networks.
To analyze Bluetooth Low Energy (BLE) architecture, services, characteristics, beacons, and mesh networking along with IoT mobile application development.
To understand IP-based IoT protocols such as 6LoWPAN and RPL and explore real-world IoT use cases in EV charging, industrial automation, and smart buildings.

UNIT I - LRWPAN (802.15.4) 6

IEEE 802.15.4 - ThePhysicalLayer-Interferences with OtherTechnologies, Choice of a 802.15.4 Communication Channel, Energy Detection,Link Quality Information, Sending a Data Frame, Media-Access Control Layer- 802.15.4 Reduced Function and Full Function Devices, Coordinators, and the PAN Coordinator, Association, 802.15.4 Addresses, 802.15.4 Frame Format, Security, Uses of 802.15.4, 802.15.4e and 802.15.4g.

UNIT II - ZIGBEE 9

ZigBeeArchitecture- ZigBee and 802.15.4, ZigBee Protocol Layers, NodeTypes, Association-Forming a Network, Joining a Parent Node in a Network Using 802.15.4 Association, Using NWK Rejoin, ZigBee Network Layer- Short-Address Allocation, Network Layer Frame Format, Packet Forwarding, Routing Support Primitives, Routing Algorithms, ZigBee APS Layer- Endpoints, Descriptors, APS Frame, ZigBee Device Object(ZDO) and the ZigBee Device Profile(ZDP)- ZDP Device and Service Discovery Services(Mandatory), ZDP Network Management Services(Mandatory), ZDP Binding Management Services(Optional), Group Management, ZigBee Application Profiles-Home Automation(HA) Application Profile, ZigBee Smart Energy 1.0 (ZSE or AMI), ZigBee Gateway Specification for Network Devices, ZGD, GRIP Binding, SOAP Binding, REST Binding, Example IPHA–ZGD Interaction Using the REST Binding, Z-Wave Protocol.

UNIT III - BLUETOOTH 9

Bluetooth Low Energy- Architecture, Profiles, Services, Characteristics, Indications, notifications, Bluetooth 5, Meshes and beacons, BLE sensors, Setting up system to write Android and iOS applications, configuring the firebase cloud backend, Introduction to RaspberryPi and GitHub.

UNIT IV - BLE SERVICE EXPLORER AND IP BASED PROTOCOLS FOR IoT 12

BLE-Central peripheral architecture for BLE, Services and characteristics, creating a service explorer app for android and iOS, Introduction to Beacons-Eddystone, iBeacon, creating a beacon with RaspberryPi, writing an App to detect beacon in Android and iOS applications, **IP Based Protocols:** 6LoWPAN- Adaptation Layer, Mesh Addressing Header, Fragment Header, IPv6 Compression Header, Context-Based Compression:IPHC, RPL- Control Messages, Construction of the DODAG and Upward Routes, Downward Routes, Multicast Membership, Packet Routing, RPL Security.

UNIT V IoT USE CASES **9**

Electric Vehicle Charging:Charging Standards Overview,Basic Use Cases, Thermal Preconditioning of the Car, IndustrialAutomation:Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation: commercial building automation today,commercial building automation in the future

TOTAL:45PERIODS

TEXT BOOKS

1. OliverHersent,DavidBoswarthickandOmarElloumi“TheInternetofThings”,Wiley,2016
2. Madhur Bhargava, "IoT Projects with Bluetooth Low Energy: Harness the power of connected things", Packt ,2017
3. Jan Ho¨ller, Vlasios Tsiatsis, Catherine Mulligan, "From Machine-to-Machine to the Internet of Things", Elseiver, 2014

COURSEOUTCOMES:

CO1: Explain the architecture and operation of IEEE 802.15.4 LR-WPAN including PHY and MAC layer functionalities, addressing, and frame structures.

CO2: Analyze ZigBee architecture, networking concepts, routing mechanisms, and application profiles for IoT-based wireless sensor networks.

CO3: Understand Bluetooth Low Energy (BLE) architecture, services, characteristics, beacons, and mesh networking for IoT applications.

CO4: Apply IP-based IoT protocols such as 6LoWPAN and RPL for addressing, routing, and data communication in constrained networks.

CO5: Design and evaluate IoT solutions for real-world applications such as electric vehicle charging, industrial automation, and smart building systems.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	1	1	-	1	-	2	3	3	2
CO2	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO3	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	3	3	3	3	3	1	1	1	1	2	1	2	3	3	3

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

VL3026 **IoTSECURITY** **L T P C**
3 0 0 3

COURSEOBJECTIVES:

- TounderstandthesecurityrequirementsinIoT.
- TolearnthefundamentalsofcryptographicinIoT
- TounderstandtheworkingofembeddeddevicesintheIoT
- TofamiliarizewithIoTprotocolsinsecurity
- Torealizesecurityissuesforvariousapplicationsusingcasestudies

UNITI INTRODUCTION **9**

IntroductiontoIoTSecurity–
Vulnerabilities,AttacksandCountermeasures.InformationAssurance.Attacktypes.Newsecuritythreatsandvulnerabilities.FaultTreesandCPS.ThreatModeling. Attack, Defense, and Network Robustness of Internet of Things, A Solution-BasedAnalysisofAttackVectorsonSmartHomeSystems.

UNITII SECURITYMANAGEMENT&CRYPTOLOGY **9**

Building security in to design and development, Safety and security design, SecurityManagement&Cryptology-SecurityControls-
Authentication,Confidentiality,Integrity;Access Control, Key Management, Communication and messaging Protocols, Cipher –Symmetric Key Algorithms, Public Private Key Cryptography; Attacks – Dictionary and BruteForce,LookupTables,ReverseLookTables,RainbowTables,Hashing–
MDS,SHA256.SHA512,RipeMD.

UNIT III EMBEDDEDDEVICES **9**

AttackSurface andThreatAssessment–Embedded Devices– UART, SPI,I2C,JTAG,Attacks–Softwareandcloudcomponents,Firmwaredevices,WebandMobileApplications.

UNITIV IoTPROTOCOLS **9**

IoTProtocolBuilt-inSecurityFeatures–
TransportLayer,COAP,UDP,TCP,MQTT,SSL/TLS,DTLS,LIGHTWEIGHTM2M,XMPP,Zigbee,LoRa,BLE,Kerberos,CloudsecurityforIoT.

UNITV IoTAPPLICATIONS **9**

CaseStudiesandDiscussion:SmartAgriculture,Cities,Grid,Healthcare,SmartHomes,smartstreetlighting,Smartbuilding,Smartparking,smartirrigation,SupplyChain,andTransportation,ApplicationofSecurityConceptstoCreateIoTsystem.

TOTAL:45PERIODS

COURSEOUTCOMES:

Studentsableto

CO1 Define thesecurityrequirementsinIoTArchitecture.L1
CO2 ExplainthedifferentcryptographictechniquesinIoTSecurity.L5
CO3 ClassifyvariousembeddeddevicesrelatedtoIoT.L2
CO4 AnalyzeIoTprotocols.L4
CO5 InterpretIoTapplicationsinseveralfields.L3

TEXTBOOKS:

1. BrianRussell,DrewVanDuren,“PracticalInternetofThingsSecurity”,PacktPublishingLimited,2nd Edition,2018.
2. Fei Hu, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, andImplementations,”CRCPress(Taylor&FrancisGroup),2016,ISBN:978-1-4987-23190.

3. Sunil Cheruvu, Anil Kumar, Ned Smith, David M. Wheeler, “Demystifying Internet ofThingsSecurity”,2020.

REFERENCES:

1. ShancangLiandLiDaXu,“SecuringtheInternetofThings”,Elsevier,2017.
2. SridiptaMisra,MuthucumaruMaheswaran,SalmanHashmi,“SecurityChallengesandApproachesinInternetof Things,” Springer,2016.
3. ArshdeepBahga,VijayMadisetti,“InternetofThings–AHands-onapproach,”VPTPublishers,2014,ISBN:978-0996025515.
4. Fotios Chantzis, Ioannis Stais, Paulino Calderon, Evangelos Deirmentzoglou, and Beau Woods, "Practical IoT Hacking: The Definitive Guide to Attacking the Internet of Things", No Starch Press,2021.
5. IoTPROTOCOLS-https://www.avsystem.com/blog/iot-protocols-and-standards/
6. IoTAPPLICATIONS-https://www.jigsawacademy.com/top-uses-of-iot/

ListofOpenSourceSoftware/Learningwebsite:

7. https://www.cybrary.it/course/iot-security/
8. https://www.udemy.com/course/hacking-iot/
9. https://www.edx.org/course/cybersecurity-and-privacy-in-the-iot
10. https://www.netacad.com/courses/cybersecurity/iot-security
11. https://stalwartlearning.com/iot-security/#1571760778613-fb76c66d-5ce2f2dc-0b723b65-c1c6
12. IoT Security Software: Quantum Armor,Azure IoT Hub, AWS IoT, SonicWall CaptureClient,nuPSYS,Forescout,Sectrio,MicrosoftdefenderforIoT,CruzIoTDeviceDirector, OverWatch, Google cloud IoT core, Darktrace, EJBCA, DxOdyssey, Ciscocybervision,Temperedetc…

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	2	1	1	2	-	1	-	2	2	3	2
CO2	3	3	2	2	3	-	1	2	1	2	1	2	3	3	3
CO3	2	2	2	1	2	-	1	1	-	1	-	2	2	3	2
CO4	3	3	3	3	3	-	1	1	1	2	1	2	3	3	3
CO5	2	3	2	2	2	1	1	1	1	2	1	2	3	3	3

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

CEC367 INDUSTRIAL IOT AND INDUSTRY 4.0 L T P C
2 0 2 3

COURSE OBJECTIVES:

- IoT Nodes & Sensors
- IoT Gateways
- IoT Cloud Systems
- IoT Cloud Dashboards
- Challenges in Iot system Design – Hardware & Software

UNIT I UNDERSTANDING IOT CONCEPT AND DEVELOPMENT PLATFORM 6

IOT Definition, Importance of IoT, Applications of IOT, IoT architecture, Understanding working of Sensors, Actuators, Sensor calibration, Study of Different sensors and their characteristics

UNIT II ANALYZING & DECODING OF COMMUNICATION PROTOCOL USED IN IOT DEVELOPMENT PLATFORM 6

UART Communication Protocol, I2C Protocol device interfacing and decoding of signal, SPI Protocol device interfacing and decoding of signal, WIFI and Router interfacing, Ethernet Configuration, Bluetooth study and analysis of data flow, Zigbee Interfacing and study of signal flow

UNIT III IOT PHYSICAL DEVICES AND ENDPOINTS AND CONTROLLING HARDWARE AND SENSORS 6

IoT Physical Devices and Endpoints- Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming – Python program with Raspberry PI with focus on interfacing external gadgets, controlling output, reading input from pins.

Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors;

Sensors- Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors,Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor.

UNIT IV CLOUD SERVICES USED IN IOT DEVELOPMENT PLATFORM 6

Configuration of the cloud platform, Sending data from the IOT nodes to the gateways using different communication options; Transferring data from gateway to the cloud; Exploring the web services like mail, Messaging (SMS) and Twitter etc.;Tracking of cloud data as per the requirement; Google Cloud service architect; AWS clod Services architect; Microsoft Azure cloud services Architect; OEN source Cloud Services; Initial State Iot Dashboard & Cloud Services

UNIT V CHALLENGES IN IOT SYSTEM DESIGN – HARDWARE & SOFTWARE 6

Antenna design and placement, Chip-package system development, Power electronics, electromagnetic interference/compatibility (EMI/EMC), Electronics reliability; Battery simulation.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

Study and Program different Sensors for IoT applications

- LDR sensor, IR sensor, Temperature Sensor, Ultrasound Sensor, Gas sensor
- Write a program using IR sensor for working morning alarm and night lamp
- Write a program using Temperature sensor for detecting heat / fire
- Write a program using Gas sensor for detecting LPG gas leak
- Write a program using Ultrasound sensor for range detection
- Write a program using sensors for carparking assist
- Write a program using sensors for water level indicator and overflow detection

2. Designing and debugging complex mixed signal devices (analog, digital, and RF)

- Write a program to interface Bluetooth and implement DC Motor.
- Write a program to control LEDs using Alexa Echo Dot.
- Write a program to control Buzzer using Alexa Echo Dot.
- Write a program to control DC motor using Google Assistance.
- Write a program to control Stepper motor using Google Assistance
- Studying and decoding Computer Bus (RS-232, UART).
- Studying Bluetooth analysis and measurement of Signals
- studying WLAN analysis of 802.11a/b/g/j/p, 802.11n, 802.11ac Signals

3. Understanding battery requirements

- Determining ultra-low deep sleep current of Node
- Measuring Transmit and Receive current signals of Node
- Capturing short transients and fast transients signals of node
- Recording Device(node) operations over extended states.

- Create stable low noise voltage supply for every state of your IOT devices, from sleep to transmit .
- Record and Generate Battery sources with the battery simulation options

4. Understanding Modulation techniques –

- Understanding of ASK, FSK Modulation and measurements
- Capturing the live ASK Signal and decoding it.
- Understanding the BPSK, QPSK & QAM Modulation Techniques and analysis.
- Understanding the APSK & APCO modulation & analysis.

List of equipment for a batch of 30 students (3 in a bench):

- Real time Spectrum Analyseruptoatleast 6.2GHz and 40MHz bandwidth – Qty #1
- DC Power supply - 120W with Battery simulation – Qty #1
- Graphical Digital Multimeter with built-in digitizer and datalogging for 20 channels – Qty #1
- 200MHz 6 channel scope with Serial trigger & decode capability for I2C, SPI, RS-232/422/485/UART buses, and built-in 50MHz AFG and 8 digital channel analysis – Qty #1
- AI Node with pre-configured SSD, USB Camera, USB Hub, USB Mouse, and USB Keyboard. – Qty 1no
- Sensor IOT Application Board with built-in 7 sensors (LDR #2, IR #2, Temperature #1, Ultrasound #1 and LPG Gas sensors #1); Embedded uC mother board, LCD display, Buzzer, Power supply (12V,1A) with adaptor and PCB Base plate; - Qty 5 nos
- All in One General Purpose Board
- IOT Gateway – Qty 1no
- Bluetooth Module– Qty 1no
- Router – Qty 1no
- Portable Sensor Kit – Qty 1no
- IOT sensor kit – Qty 1no
- RFID Module – Qty 1no
- Finger Print Module – Qty 1no
- Stepper Motor – Qty 1no
- DC Motor – Qty 1no
- Amazon Echo device – Qty 2nos

COURSE OUTCOMES:

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

CO1: Understand the building blocks of IoT technology and explore the vast spectrum of IoT applications

CO2: Use processors & peripherals to design & build IoT hardware

CO3: Assess, select and customize technologies for IoT applications

CO4: Connect numerous IOT applications with the physical world of humans and real life problem solving.

CO5: Design and implement IOT applications that manage big data

TOTAL:60 PERIODS

TEXT BOOKS

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759

REFERENCES

1. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895

2. N. Ida, Sensors, Actuators and Their Interfaces, SciTech Publishers, 2014.
3. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. Editors Ovidiu Vermesan

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

CO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
1	3	2	2	2	1	2	-	-	-	-	-	2	3	2	2
2	3	2	2	2	1	2	-	-	-	-	-	2	3	3	2
3	3	2	2	2	2	2	-	-	-	-	-	2	3	3	2
4	3	2	3	2	3	2	-	-	-	-	-	2	3	3	2
5	3	3	3	3	3	3	-	-	-	-	-	1	3	2	3
CO	**3**	**2.25**	**2.4**	**2.2**	**2**	**2.2**	**-**	**-**	**-**	**-**	**-**	**1.8**	**3**	**2.6**	**2.2**

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

VL3027 DATA ANALYTICS FOR IOT L TP C

3 0 0 3

COURSE OBJECTIVES

- To learn the concepts of big data analytics.
- To get exposure on IOT cloud analytics environment.
- To be familiar with general strategies on IOT analytics.
- To get exposure on social impact of multimedia.
- To identify applications that makes use of multimedia Big Data and IOT.

UNIT I INTRODUCTION TO TECHNOLOGICAL DEVELOPMENTS 9

Defining IOT Analytics and Challenges- Defining IOT analytics, IOT analytics challenges, Business value concerns, IOT Devices and Networking Protocols- IOT devices, Networking basics, IOT networking connectivity protocols, Analyzing data, IOT Analytics for the Cloud- Building elastic analytics, Designing for scale, Cloud security and analytics, The AWS, Microsoft Azure, The ThingWorx overview

UNIT II CLOUD ANALYTICS ENVIRONMENT 9

The AWS Cloud Formation, The AWS Virtual Private Cloud (VPC), terminate and clean up the Environment, data processing for analytics, big data technology to storage, Apache Spark for data processing, Handling change, Exploring and visualizing data, Techniques to understand data quality Techniques to understand data quality, R and RStudio.

UNIT III GENERAL STRATEGIES ON EXTRACTING VALUE FROM DATASETS 9

Decorating Your Data, Communicating with Others Visualization and Dashboarding, Applying Geospatial Analytics to IOT Data, Data Science for IOT Analytics- Machine learning (ML), deep learning

UNIT IV SOCIETAL IMPACT OF MULTIMEDIA BIG DATA 9

Multimedia Social Big Data Mining: Process Model, SWOT Analysis, Techniques for Social Big Data Analytics - Advertisement Prediction, MMBD Sharing on Data Analytics Platform , Legal/Regulatory Issues.

UNIT V APPLICATION ENVIRONMENTS 9

Big Data Computing for IOT Applications-Precision Agriculture, Machine Learning in Improving Learning Environment, Network-Based Applications of Multimedia Big Data Computing, Recent Trends in IOT-Based Analytics and Big Data, Future Directions and Challenges of Internet of Things.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to
CO1: Describe big data and IOT. L2
CO2:Define cloud based IOT analytic environment. L1
CO3:Apply various Big data strategies. L3
CO4:Analyse social impact of multimedia big data. L4
CO5:Design smart IOT systems with big data. L5

TEXT BOOKS:

1. Andrew Minteer, “Analytics for the Internet of Things (IOT): Intelligent analytics for your intelligent devices”, Packt Publishing, first edition, July 2017 (UNIT I,II,III).
2. Sudeep Tanwar, Sudhanshu Tyagi, Neeraj Kumar, “Multimedia Big Data Computing for IOT Applications:Concepts, Paradigms and Solutions”, Springer, 2020 (UNIT IV,V).

REFERENCES:

1. John Soldatos, “Building Blocks for IOT Analytics”, River Publishers Series In Signal, Image and Speech Processing, 2017.
2. Nilanjan Dey, Aboul Ella Hassanien, Chintan Bhatt, Amira S. Ashour, Suresh Chandra Satapathy, “Internet of Things and Big Data Analytics Toward Next-Generation Intelligence”, Springer International Publishing, 2018.
3. Stackowiak, R., Licht, A., Mantha, V., Nagode, L.,” Big Data and The Internet of Things Enterprise Information Architecture for A New Age”, Apress, 2015.
4. John Soldatos, “Building Blocks for IOT Analytics”, River Publishers Series In Signal, Image and Speech Processing, 2017.
5. Nilanjan Dey, Aboul Ella Hassanien, Chintan Bhatt, Amira S. Ashour, Suresh Chandra Satapathy, “Internet of Things and Big Data Analytics Toward Next-Generation Intelligence”, Springer International Publishing, 2018.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	–	–	–	–	–	–	–	–	–	1	2	1
CO2	2	1	–	–	2	–	–	–	–	–	–	1	2	2
CO3	2	3	3	–	3	–	–	–	–	–	–	1	3	2
CO4	1	1	–	–	–	3	2	3	2	2	–	1	2	1
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VERTICAL VII- VLSI APPLICATIONS

VL3028 VLSI ARCHITECTURES FOR IMAGE PROCESSING L T P C
3 0 0 3

COURSE OBJECTIVES:

The students will be able to acquire knowledge on image and video processing algorithms
The students will be able to acquire knowledge on design of VLSI architectures.

UNIT I IMAGE PROCESSING ALGORITHMS AND ARCHITECTURES 9

Image Processing Tasks - Low Level Image Processing Operations - Intermediate Level Operations, Image Processor Architecture: Requirements and Classification - Uni and Multi Processors - MIMD Systems - SIMD Systems – Pipelines.

UNIT II 3D BINARY IMAGE PROCESSING 9

Overview of 3D Image - Types and Characteristics of 3D Image Processing - Examples of 3D - Labeling of a Connected - Shrinking- Surface Thinning and Axis Thinning: Requirements of thinning, Examples of surface/axis thinning algorithms (Sequential type, Parallel type), Surface thinning algorithm accompanying the Euclidean distance transformation - Distance Transformation and Skeleton: Significance of DT and skeleton, Classification of algorithms, Examples, Skeleton - Border Surface Following-Knot and Link .- Voronoi Division of a Digitized Image

UNIT III PIPELINED IMAGE PROCESSING ARCHITECTURES 9

Cellular logic processing -Devices for cellular logic processing- Design method for special architectures - Architecture of a Cellular Logic Processing Element

UNIT IV REAL TIME IMAGE PROCESSING ARCHITECTURES 9

Design aspects of real time low level image processors - Real Time Pipeline for Low Level Image processing

UNIT V 2D AND 3D IMAGE PROCESSING ARCHITECTURES 9

Design Aspects of 3D and intermediate level Image Processing Architectures –General design considerations - Implementation of Low Level 2D and 3D operations, Intermediate Level Algorithms

TOTAL:45 PERIODS

COURSE OUTCOMES:

Upon Completion of The Course, Students Will Be Able to Demonstrate An Ability to

CO1:Analyze Various Architectures to Realize Image Processing Algorithms and Explain The 3D Image Processing Algorithms

CO2:Explore Various Processing Techniques of Image and Design Different Architectures for Image Processing.

CO3: Analyze various pipelined hardware architecture for 2D and 3D Image processing

CO4: Realize binary image processing algorithm in VLSI systems

CO5: Implement filter techniques in 2D and 3D image.

TEXT BOOKS:

1. Pieter Jonker, "Morphological Image Processing: Architecture and VLSI Design", Springer, First Edition, 1992. (UNIT I, III, IV,V)

2. Junichiro Toriwaki · Hiroyuki Yoshida, "Fundamentals of Three-Dimensional Digital Image Processing", Springer 2009. (UNIT II)

REFERENCES

1. King-Sun Fu, "VLSI for Pattern Recognition and Image Processing", Springer-Verlag, 1984.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	2	–	–	–	–	–	–	1	3	2
CO2	3	2	3	–	2	–	–	–	–	–	–	1	3	3
CO3	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO4	2	3	3	–	3	–	–	–	–	–	–	1	3	2

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO5	3	3	2	–	3	–	–	–	–	–	–	1	3	3

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

VL3029 VLSI CIRCUITS FOR BIOMEDICAL APPLICATIONS L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the physiological systems of the human body and the fundamental principles of biomedical instrumentation used in healthcare systems.
To gain knowledge about biomedical sensing technologies, implantable devices, and wireless connectivity used in modern medical systems.
To study and analyze CMOS circuit design techniques for biomedical implantable devices and wireless medical applications, including power and data transmission methods.
To develop understanding of biomedical integrated circuits such as pacemaker systems, neural interfacing circuits, and biochip applications for advanced healthcare solutions.

UNIT I INTRODUCTION 9

Physiological Systems of the Body, Sources of Biomedical, Basic Medical Instrumentation System, Performance Requirements of Medical Instrumentation Systems, Intelligent Medical Instrumentation Systems, Consumer and Portable Medical Equipment, Implantable Medical Devices, Micro-Electro-Mechanical Systems, Wireless Connectivity in Medical Instruments, General Constraints in Design of Medical Instrumentation Systems, Regulation of Medical Devices, Role of Engineers in Healthcare Facilities

UNIT II BIO MEDICAL SENSING 10

Neuro chemical sensing-Neuro potential sensing- RF telemetry and Power harvesting in Implant devices- Multimodal Electrical and Chemical Sensing- Micro needles – Types, Fabrication, Drug delivery and biosensing, Sensing microelectrodes

UNIT III CMOS CIRCUITS FOR BIOMEDICAL IMPLANTABLE DEVICES 10

Inductive link to deliver power implants- Data transmission through inductive links- Energy and Bandwidth issues in multi-channel recording- Strain Measurement and motivation for self-power sensing-Piezoelectric transduction and power delivery- Sub-Micro watt Piezo powered VLSIcircuits- Design and calibration of floating gate sensor array.

UNIT IV CMOS CIRCUITS FOR WIRELESS MEDICAL APPLICATIONS 6

Spectrum for medical Use- Integrated transmitter and receiver architectures- Radio architecture selection-Low noise amplifiers- Mixers-Poly phase filters -Power Amplifiers and PLL.

UNIT V BIOMEDICAL ICS 10

Cardiac Rhythm Management IC: Introduction to pacemakers, Basic pacemaker functions, sensing circuits, ADC, pace driver and MUX, MCU, Sensor I/O, Telemetry, Clock generator and power management, , Integrated Circuits for Neural Interfacing: Neural signal Amplification – Circuit architecture and design techniques, Neurochemical Recording – Sensor and Circuit Technologies, Neural stimulation - Stimulus generator architecture and front end circuits, Neuromimetic ICs – Criteria for design strategies, Example of a Series of ASICs, Bio chip application for DNA.

45 PERIODS

TEXT BOOKS:

1. Khandpur RS, "Handbook of Biomedical Instrumentation", McGraw Hill, New Delhi, 2014 (UNIT I)
2. Krzysztof Iniewski, "VLSI Circuits for Biomedical Applications" Artech house Inc. 2008.(UNIT II-V)
3. Hoi-Jun Yoo, Chris van Hoof (Eds), "Bio-Medical CMOS ICs", Springer, 2011.(V)

REFERENCES:

1. Rahul Sarpeshkar, “Ultra Low Power Bioelectronics: Fundamentals, Biomedical Applications and Bio-inspired Systems", Cambridge University Press, 2010.

COURSE OUTCOMES:

CO1: Explain the physiological systems of the human body and the basic principles of biomedical instrumentation, including system requirements and regulatory aspects.

CO2: Describe biomedical sensing techniques such as neurochemical sensing, neuro potential sensing, RF telemetry, and micro-needle based biosensing systems.

CO3: Analyze CMOS circuit design techniques for implantable biomedical devices, including inductive power/data transfer and energy harvesting mechanisms.

CO4: Evaluate wireless medical communication circuits, including RF architecture, low-noise amplifiers, mixers, filters, and power amplifiers used in medical applications.

CO5: Design and interpret biomedical integrated circuits such as pacemakers, neural interfacing systems, and biochips for advanced healthcare applications.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	2	2	–	2	–	–	–	–	–	–	1	3	3
CO3	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO4	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VL3030 VLSI STRUCTURES FOR DSP L T P C
3 0 0 3

COURSE OBJECTIVES:

To understand the fundamental concepts of DSP system architectures and various hardware models such as multiprocessor, systolic array, and shared-memory architectures.

To study and analyze pipelined, parallel, recursive, and adaptive digital filter structures for efficient DSP system implementation.

To gain knowledge of digital lattice filter structures, their derivation, implementation, noise analysis, and low-power VLSI design techniques.

To explore and design bit-level arithmetic architectures and pipelined systems including synchronous, wave, and asynchronous pipelining for high-performance DSP applications.

UNIT I DSP ARCHITECTURES 9

DSP System Architectures, Ideal DSP Architectures, Multiprocessors and Multicomputer, Message-Based Architectures, Systolic Arrays, Systolic array design methodology, FIR Systolic arrays, Wave Front Arrays, Shared-Memory Architectures

UNIT II PIPELINED, PARALLEL RECURSIVE AND ADAPTIVE FILTERS 9

Pipeline interleaving in Digital Filters, Pipelining in 1st-order and higher order IIR digital filters, Parallel processing for IIR filters, Combined pipelining and parallel processing for IIR filters, Low-Power IIR filter design using Pipelining and parallel processing, Pipelined adaptive digital filters.

UNIT III DIGITAL LATTICE FILTER STRUCTURES 9

Introduction, Schur algorithm, Digital basic Lattice filters, Derivation of one-multiplier lattice filter, Derivation of normalized and scaled-normalized Lattice filter, Round off Noise calculation in Lattice Filters, Pipelining of Lattice IIR digital filters, Low-power CMOS Lattice IIR filters.

UNIT IV BIT-LEVEL ARITHMETIC ARCHITECTURES 9

Intoduction-Parallel multipliers-Interleaved Floor-plan and Bit-plane-based digital filters, Bit-Serial multipliers, Bit-Serial filter design and implementation, Canonic signed digit arithmetic, Distributed arithmetic.

UNIT V SYNCHRONOUS, WAVE AND ASYNCHRONOUS PIPELINES 9

Introduction, Synchronous Pipelining and Clocking styles, Clock Skew and clock distribution in Bit-level pipelined VLSI designs- Wave Pipelining- Constraint Space diagram and degree of wave pipelining, Implementation of wave-pipelined systems, Asynchronous Pipelining- Signal transition graphs- Use of STG to design interconnection circuits- Implementation of computational units.

TOTAL :45 PERIODS

TEXT BOOKS

1. Lars Wanhammar, “DSP Integrated Circuits”, Academic Press, 1999 (UNIT I).
2. Keshab K. Parhi, “VLSI Digital Signal Processing Systems, Design and Implementation “, Wiley, Interscience, 2007 (UNIT II-V).

COURSE OUTCOMES:

CO1: Explain various DSP system architectures including multiprocessor, multicomputer, systolic arrays, wave-front arrays, and shared-memory architectures.

CO2: Analyze pipelined, parallel, recursive, and adaptive digital filter structures for efficient DSP system design.

CO3: Derive and evaluate digital lattice filter structures including Schur algorithm-based implementations and noise analysis techniques.

CO4: Design and implement bit-level arithmetic architectures such as bit-serial, parallel multipliers, and distributed arithmetic for DSP applications.

CO5: Apply synchronous, wave, and asynchronous pipelining techniques to develop high-performance VLSI-based DSP systems.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO3	3	3	2	–	2	–	–	–	–	–	–	1	3	2
CO4	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO5	3	3	3	3	3	–	–	–	–	–	–	1	3	3

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

VL3031VLSI DESIGN OF NEURAL NETWORKS L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of artificial neural networks, including neuron models, learning rules, and major network architectures such as perceptron, MLP, Hopfield, and associative memory systems.

To study and analyze different VLSI design methodologies for neural networks, including analog,

digital, mixed-signal, pulse-coded, and floating-gate approaches.
To gain knowledge of neural network hardware implementation techniques such as synaptic circuits, programmable weights, and neurocomputing circuit design using CMOS technology.
To explore and design neural network-based VLSI systems and applications including adaptive learning circuits, associative memories, and intelligent signal processing systems for real-world applications.

UNIT I ARTIFICIAL NEURAL NETWORK ALGORITHMS 9

Features of Neural Network Approaches, Submicron VLSI Technologies for Digital and Analog Systems, Smart VLSI and Intelligent Machines, Hebbian Learning and Perceptron, Multi-layered Perceptron Network, Recursive Neural Networks and Hopfield Nets, Bidirectional Associative Memory , Hamming Network and , Self-Organizing Neural Networks , Adaptive Resonance Theory Networks Boltzmann Machine

UNIT II DESIGN METHODOLOGIES OF VLSI NEURAL NETWORKS 6

Purely Analog Signal Approach, Purely Digital Signal Approach, Mixed-Signal Approach, Pulse-Coded Method, Floating-Gate Approach.

UNIT III NEURAL NETWORKS IMPLEMENTATION – I 12

Artificial Neural Systems: Overview of Actual Models, Node Numbers and Complexity of Computing Systems, Neurocomputing Hardware Requirements, Digital and Analog Electronic Neurocomputing Circuits, Integrated Circuit Synaptic Connections: Voltage-controlled Weights, Analog Storage of Adjustable Weights, Digitally Programmable Weights, Learning Weight Implementation

UNIT IV NEURAL NETWORKS IMPLEMENTATION – II 12

Active Building Blocks of Neural Networks: Current Mirrors, Inverter-based Neuron, Differential Voltage Amplifiers, Scalar Product and Averaging Circuits with Transconductance Amplifiers, Current Comparator, Template Matching Network, Analog Multipliers and Scalar Product Circuits: Depletion MOSFET Circuit, Enhancement Mode MOS Circuit, Analog Multiplier with Weight Storage, Floating-Gate Transistor Multipliers, Associative Memory Implementations, Electronic Neural Processor.

UNIT V APPLICATIONS AND SYSTEM PROTOTYPING 6

Multi-Layered Neural, Reconfigurable Networks, Dedicated On-Chip Learning Circuitry, Wireless Channel Equalizer, Optical-Input Smart-Pixel Cellular Networks, Superconducting Neural Networks, A Video Motion Detection Neuroprocessor, Chaotic Neural Chips

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Bing J. Sheu, Joongho Choi, Neural Information Processing and VLSI, Kluwer Academic Publishers, 1995.(UNIT I, II, V)
2. Jacek M. Zurada, Introduction to artificial neural systems, West publishing company, 1992.(UNIT III, IV)

REFERENCES:

1. Jose G. Delgado-Frias, William R. Moore, “VLSI For Artificial Intelligence And Neural Networks”, Springer Science Business Media, LLC, 2001.
2. Mohamed I. Elmasry, “VLSI Artificial Neural Networks Engineering”, Springer Science Business Media, LLC, 2000.
3. Sied Mehdi Fakhraie, Kenneth C. Smith, “VLSI - Compatible Implementations for Artificial Neural Networks”, Springer Science Business Media, LLC, 1996

COURSE OUTCOMES:

CO1: Explain the fundamentals of artificial neural networks including learning rules, perceptron, multilayer networks, Hopfield networks, and self-organizing maps.

CO2: Compare and analyze different VLSI design methodologies for neural networks such as analog, digital, mixed-signal, pulse-coded, and floating-gate approaches.
CO3: Design and evaluate neural network hardware architectures including synaptic connections, weight storage techniques, and neurocomputing circuits.
CO4: Implement and analyze active building blocks of neural networks such as current mirrors, differential amplifiers, multipliers, and associative memory circuits.
CO5: Develop and apply neural network-based VLSI systems for real-world applications including adaptive learning systems, signal processing, and intelligent neuroprocessors.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	3	2	–	2	–	–	–	–	–	–	1	3	3
CO3	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO4	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VL3032 VLSI FOR WIRELESS COMMUNICATIONS L T P C
3 0 0 3

COURSE OBJECTIVES:
- To understand the concepts of basic wireless communication concepts.
- To study the parameters in receiver and low noise amplifier design.
- To study the various types of mixers designed for wireless communication.
- To study and design PLL and VCO.
- To understand the concepts of transmitters and power amplifiers in wireless
- communication.

UNIT I COMMUNICATION CONCEPTS 9
Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.

UNIT II RECEIVER ARCHITECTURE 6
Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure & Input intercept point.

UNIT III & LOW NOISE AMPLIFIERS AND MIXERS 12
LNA: Matching networks – Wideband LNA design – Narrow band LNA: Core amplifier. **Mixers:** Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Noise - A Complete Active Mixer. Switching Mixer –Practical Unbalanced Switching Mixer. Sampling Mixer.

UNIT IV LOOP FILTER AND SYSTEM DESIGN 9
Loop filters: General consideration, Design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider.

UNIT V TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS 9
Transmitter back end design – Quadrature LO generator – Power amplifier design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the student should be able to

CO1: Able to recollect basic wireless communication concepts.

CO2: To understand the parameters in receiver and design a low noise amplifier

CO3: In a position to apply his knowledge on various types of mixers designed for wireless communication.

CO4: Design PLL and VCO

CO5: Understand the concepts of transmitters and utilize the power amplifiers in wireless communication.

REFERENCES

1. Bosco H Leung "VLSI for Wireless Communication", Pearson Education, 2002.

2. B.Razavi,"RF Microelectronics" , Prentice-Hall ,1998.

3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" McGraw-Hill, 1999.

4. Emad N Farag and Mohamed I Elmasry, "Mixed Signal VLSI wireless design – Circuits & Systems", Kluwer Academic Publishers, 2000.

5. J. Crols and M. Steyaert, "CMOS Wireless Transceiver Design," Boston, Kluwer Academic Pub., 1997.

6. Thomas H.Lee, "The Design of CMOS Radio – Frequency Integrated Circuits", Cambridge University Press ,2003.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	–	–	–	–	–	–	–	–	–	2	2	1
CO2	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO3	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO4	3	3	3	3	3	–	–	–	–	–	–	1	3	3
CO5	3	3	3	2	3	–	–	–	–	–	–	1	3	3

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

VL3033 INTEGRATED CIRCUITS FOR OPTICAL COMMUNICATION L T P C
3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of optical communication systems, including optical fiber structures, system components, design challenges, and performance considerations.

To study and analyze integrated optical sources and photodetectors such as lasers, LEDs, photodiodes, and avalanche photodiodes implemented in CMOS and SOI technologies.

To gain knowledge of CMOS optical receiver and transmitter architectures including transimpedance amplifiers, laser/LED drivers, noise analysis, and optical fiber link design.

To explore and design high-speed optical communication circuits such as clock and data recovery systems, limiting amplifiers, output buffers, multiplexers, and related VLSI architectures.

UNIT I INTRODUCTION 9

Introduction to optical communications: Motivations for Lightwave Communications, Optical Spectral Bands, Decibel Units, Generic optical system, Design challenges, State-of-the-art, Optical Fiber versus Copper Wire, Types and modes of optical fiber , Integration of Optical Communication Systems, The Optical Communication Link, System Considerations, The Optical Driver, The Optical Receiver

UNIT II INTEGRATED OPTICAL SOURCES AND PHOTODETECTORS 9

Structures of Laser diode and LEDs, Integrated Detectors in Standard CMOS Processes: PN Photodiodes, Double Photodiodes, Interrupted-P-Finger Photodiode -Spatially-Modulated-Light Detector, PIN Photodiode: Lateral and vertical types,Avalanche Photodiodes, Single-Photon Avalanche Diodes, Photodiodes in Silicon-on-Insulator

UNIT III CMOS OPTICAL RECEIVERS AND TRANSMITTERS 9

The Simple Resistor Optical Receiver, The Transimpedance Amplifier: Input and Output Impedance, Bandwidth and Stability, Transimpedance-Bandwidth Product, Open loop gain, Multiple-Stages Feedback Amplifiers, Noise Aspects of the Transimpedance Amplifier, The Post-amplifier, CMOS Laser Driver Circuits, The LED Driver, Integrated CMOS Optical Fiber Link

UNIT IV CLOCK AND DATA RECOVERY ARCHITECTURES 9

Phase-Locked Loops: Simple and charge pump PLL, Delay-Locked Loops, Open-Loop CDR Architectures-Phase-Locking CDR Architectures:Full-Rate and Half-Rate Architectures Oscillators, Phase Detectors, Frequency Detectors, Decision Circuits

UNIT V LIMITING AMPLIFIERS, OUTPUT BUFFERS AND MULTIPLEXERS 9

Limiters: performance considerations, Cascaded Gain Stages, Broadband Techniques, Output Buffers:Differential Signaling, Double Termination, Predriver Design, Multiplexers: 2-to-l MUX, MUX Architectures, Frequency Dividers

TOTAL:45 PERIODS

TEXT BOOKS:

1. M. Ingels M. Steyaert, Integrated CMOS Circuits for Optical Communications, Springer, 2004.(I,II, III, IV)
2. Horst Zimmermann, Silicon Optoelectronic Integrated Circuits, Second Edition, Springer, 2018. (I, II,)
3. Gerd Keiser, Optical Fiber Communications, Fourth Edition, McGraw-Hill, 2000.(I, IV)
4. B. Razavi, Design of Integrated Circuits for Optical Communications, McGraw Hill, 2003. (I,IV)
5. Jafar Savoj, Behzad Razavi, High-Speed CMOS Circuits For Optical Receivers, Kluwer Academic Publishers, 2001(IV)

COURSE OUTCOMES:

CO1: Explain the fundamentals of optical communication systems including optical fiber types, system architecture, optical link design, and performance considerations.

CO2: Analyze integrated optical sources and photodetectors such as LEDs, laser diodes, PN/PIN photodiodes, APDs, and SOI-based detectors.

CO3: Design and evaluate CMOS optical transmitter and receiver circuits including transimpedance amplifiers, laser/LED driver circuits, and optical fiber link interfaces.

CO4: Apply clock and data recovery techniques using PLL, DLL, oscillators, and phase/frequency detectors for high-speed optical communication systems.

CO5: Develop and assess high-speed optical VLSI subsystems such as limiting amplifiers, output buffers, multiplexers, and frequency dividers for communication applications.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	3	2	–	2	–	–	–	–	–	–	1	3	3
CO3	3	3	3	–	3	–	–	–	–	–	–	1	3	3

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO4	3	3	3	3	3	–	–	–	–	–	–	1	3	3
CO)	3	3	3	3	3	–	–	–	–	–	–	1	3	3

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

VL3034 HARDWARE ARCHITECTURES FOR DEEP LEARNING L T P C
3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of deep neural networks (DNNs), including architectures such as CNNs, layer types, training vs inference, and common applications.

To study and analyze hardware design principles for DNN processing, including architectural paradigms, dataflow models, memory management, and NoC-based accelerator design.

To gain knowledge of convolution optimization techniques and efficient DNN accelerator architectures such as Eyeriss, including compression, buffering, and processing element design.

To explore and design efficient DNN systems through co-design techniques such as quantization, sparsity, neural architecture search, knowledge distillation, and emerging technologies like PIM and FPGA-based acceleration.

UNIT I INTRODUCTION TO DEEP NEURAL NETWORKS 9

Background on DNN, Training versus Inference, Applications of DNNs, Attributes of Connections Within a Layer, Attributes of Connections Between Layers, Types of Layers in DNNs, Convolutional Neural Networks, Popular CNN Models, Other DNNs, DNN Development Resources.

UNIT II DESIGN OF HARDWARE FOR PROCESSING DNNS 9

Key Metrics and Design Objectives, temporal or spatial architectural paradigms, Matrix Multiplication with Toeplitz, Tiling for Optimizing Performance, Computation Transform Optimizations, DNN Hardware Design, Architectural Techniques, Dataflow Taxonomy, DNN Accelerator Buffer Management Strategies, Flexible NoC Design for DNN Accelerators

UNIT III CONVOLUTION OPTIMIZATION 9

Deep Convolutional Neural Network Accelerator: System Architecture, Filter Decomposition, Streaming Architecture, Pooling, Convolution Unit (CU) Engine, Accumulation (ACCU) Buffer, Model Compression, System Performance, Eyeriss Accelerator, Eyeriss System Architecture, StationaryDataflow, Row Stationary (RS) Dataflow, Run-Length Compression (RLC), Global Buffer, Processing Element Architecture, Network-on-Chip (NoC).

UNIT IV CO-DESIGN OF DNN HARDWARE AND ALGORITHMS 9

Reducing Precision: Quantization – Sources of sparsity: Sparsity Due to relu, weight sparsity - Improving efficiency of CONV layers, FC layers and network architecture after training, Neural architecture search, Shrinking the Search Space, Improving the Optimization Algorithm, Accelerating the Performance Evaluation, Example of Neural Architecture Search, Knowledge Distillation, Design Considerations for Efficient DNN Models, DNN accelerator mapping flow, Block diagram of a mapper

UNIT V ADVANCED TECHNOLOGIES 9

Processing Near Memory- Processing in Memory: NVM, SRAM, DRAM, Design Challenges, Processing in Sensor, Processing in the Optical Domain, FPGAs for Deep learning: Xilinx Zynq, Intel Stratix 10 NX Architecture

TOTAL: 45 PERIODS

TEXT BOOKS

1. Vivienne Sze, Yu-Hsin Chen, Tien-Ju Yang, Joel S. Emer, “Efficient Processing of Deep Neural Networks”, Morgan & Claypool, 2020 (UNIT I,II,IV,V)
2. *Ian Goodfellow, Yishuv Bengio and Aaron Courville, “Deep Learning.” MIT Press. 2016. ISBN:978-0262035613. Available online for free at: http://www.deeplearningbook.org (UNIT I)*
3. Albert Chun Chen Liu and Oscar Ming Kin Law, Artificial Intelligence Hardware Design: Challenges and Solutions, IEEE-Wiley, 2021. (UNIT III)
4. Anuradha D. Thakare, Sheetal Umesh Bhandari, Artificial Intelligence Applications and Reconfigurable Architectures, Wiley and Scrivener, 2023. (UNIT V)

COURSE OUTCOMES:

CO1: Explain the fundamentals of deep neural networks including CNN architectures, layer structures, training vs inference, and key DNN applications.

CO2: Analyze hardware design methodologies for DNN processing including architectural paradigms, dataflow taxonomy, and memory management strategies.

CO3: Design and evaluate convolutional neural network accelerators including filter decomposition, streaming architectures, and processing element design.

CO4: Apply co-design techniques for optimizing DNN performance using quantization, sparsity, neural architecture search, and knowledge distillation methods.

CO5: Evaluate advanced DNN acceleration technologies including processing-in-memory, processing-at-sensor, and FPGA-based deep learning architectures.

CO’s-PO’s & PSO’s MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO3	3	3	3	3	3	–	–	–	–	–	–	1	3	3
CO4	3	3	3	2	3	–	–	–	1	1	–	1	3	3
CO5	3	3	3	3	3	–	–	–	–	–	–	1	3	3

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

VERTICAL VIII- FABRICATION AND ADVANCED DESIGN TECHNIQUES

VL3035 MICROCHIP FABRICATION L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of semiconductor device fabrication, including lithography, photolithography processes, and basic NMOS/CMOS process flows used in VLSI technology.

To study and analyze oxidation, diffusion, and ion implantation techniques along with dopant redistribution, junction formation, and process simulation methods in semiconductor manufacturing.

To gain knowledge of thin film deposition techniques, interconnection technologies, contact formation, and advanced packaging methods used in integrated circuits.

To explore and understand process integration techniques including CMOS layout design rules, isolation methods, SOI and GaAs technologies, micromachining processes, and modern semiconductor manufacturing and yield control techniques.

UNITI LITHOGRAPHY 9

Overview of Monolithic Fabrication, Processes and Structures, Basic NMOS Process, Basic Complementary MOS (CMOS) Process, The Photolithographic Process, Etching Techniques, Photomask Fabrication, Exposure Systems, Exposure Sources, Optical and Electron Microscopy

UNIT II OXIDATION AND DIFFUSION 9

The Oxidation Process, Modeling Oxidation, Factors Influencing Oxidation Rate, Dopant Redistribution During Oxidation, Masking Properties of Silicon Dioxide, Technology of Oxidation, Oxide Quality, Selective Oxidation and Shallow Trench Formation, Oxide Thickness Characterization, Process Simulation, The Diffusion Process, Mathematical Model for Diffusion, The Diffusion Coefficient, Successive Diffusions, Solid-Solubility Limits , Junction Formation and Characterization, Sheet Resistance, Generation-Depth and Impurity Profile Measurement, Diffusion Simulation, Diffusion Systems, Gettering

UNIT III ION IMPLANTATION AND FILM DEPOSITION 9

Implantation Technology, Mathematical Model for Ion Implantation, Selective Implantation, Junction Depth and Sheet Resistance, Channeling, Lattice Damage, and Annealing, Shallow Implantations, Evaporation Sputtering, Chemical Vapor Deposition, Epitaxy.

UNIT IV INTERCONNECTIONS, CONTACTS AND PACKAGING9

Interconnections in Integrated Circuits, Metal Interconnections and Contact Technology, Diffused Interconnections, Polysilicon Interconnections and Buried Contacts Silicides and Multilayer-Contact Technology The Liftoff Process, multilevel Metallization, Copper Interconnects and Damascene Processes Testing, Wafer Thinning and Die Separation, Die Attachment, Wire Bonding

UNIT V PROCESS INTEGRATION AND MANUFACTURING 9

MOS Transistor Layout and Design Rules, Complementary MOS (CMOS) Technology, Junction and oxide isolation, LOCOS methods, Silicon on Insulator, SOI isolation techniques, GaAs Technologies, Bulk micromachining etching techniques and process flow, surface micromachining basics and process flow, Yield predicton and tracking, particle control, statistical process control, computer integrated manufacturing.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Richard C. Jaeger, Introduction to Microelectronic Fabrication, Vol. 5 of Modular Series on Solid State Devices (2nd Edition) Prentice Hall, 2001.
2. S.A. Campbell, The Science and Engineering of Microelectronic Fabrication (2nd Edition), Oxford University Press, 2001.

REFERENCES:

1. Microchip Fabrication: (5th Edition) by Peter Van Zant, McGraw Hill, 2004.

COURSE OUTCOMES:

CO1: Explain the fundamentals of semiconductor fabrication processes including lithography, photomask fabrication, etching techniques, and CMOS process flow.

CO2: Analyze oxidation and diffusion processes in semiconductor manufacturing, including dopant redistribution, junction formation, and process simulation.

CO3: Evaluate ion implantation techniques and thin film deposition processes such as evaporation, sputtering, chemical vapor deposition, and epitaxy.

CO4: Understand interconnection technologies, contact formation, packaging techniques, and multilevel metallization in integrated circuits.

CO5: Apply process integration concepts including CMOS layout design rules, isolation techniques, SOI/GaAs technologies, and modern semiconductor manufacturing and yield control methods.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	3	2	–	2	–	–	–	–	–	–	1	3	2
CO3	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO4	3	3	3	2	2	–	–	–	–	–	–	1	3	2
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VL3036 EVOLVABLE HARDWARE L T P C

3 0 0 3

COURSE OBJECTIVES:

To study about the evolvable systems algorithms, multi-objective utility functions
Understand the concepts of reliability, design-in redundancy, fault tolerance anddefect tolerance
Design of evolvable systems using Programmable Logic Devices (like FPGAs) andmodular subsystems with identical components and generalized controller algorithms

UNIT I INTRODUCTION 6

Characteristics of Evolvable Circuits and Systems, Pros and cons of evolvable hardware (EHW), Technology, Evolvable Hardware and Evolved Hardware, Extrinsic and Intrinsic Evolution, offline and Online Evolution, Applications and Scope of EHW.

UNIT II EVOLUTIONARY COMPUTATION 9

Introduction to evolutionary algorithms, components of EA, variants of EA, Genetic Algorithms, genetic programming, evolutionary strategies, evolutionary programming, parallel implementations –evolutionary design and optimizations, EA design, EHW – current problems and potential solutions

UNIT III RECONFIGURABLE DIGITAL AND ANALOG DEVICES 9

Basic architectures – Programmable Logic Devices, Field Programmable Gate Arrays (FPGAS), using reconfigurable hardware – design phase, execution phase, reconfigurable analog devices: Basic architectures – Field Programmable Transistor Arrays (FPTAS), analog arrays

UNIT IV EVOLVABLE COMPONENTS AND COMPUTATIONAL MACHINES 9

Evolvable Components: System Decomposition, Interface. Hardware Implementation, Extension of Evolvable Components, Computational Machines and Evolutionary Design, Evolvable Non-Uniform Cellular Automaton, General Evolvable Computational Machine, Dynamic Environment, Evolvable Computational System, Properties of Evolvable Machine, The Power of an Evolvable System

UNIT V EHW IN USE 12

Synthesis vs. Adaptation, designing self-adaptive systems, fault-tolerant systems, real-time systems, intrinsic reconfiguration for online systems, EHW based fault recovery and future work

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students should will be able to:

CO1: understand the fundamentals of computational models and computers which have appearedat the intersection of hardware and artificial intelligence to solve hard computationalproblems.
CO2: understand the principles of bio-inspired and unconventional computational systems.
CO3: discuss about the reconfigurable digital architectures and its computational

intelligencetechniques.
CO4: discuss about the reconfigurable analog architectures and its computational intelligencetechniques.
CO5: discuss about the typical applications of bio-inspired and other unconventional techniques inthe phase of design, implementation and runtime of a computational device.

TEXT BOOKS:

1. Garrison W. Greenwood and Andrew M. Tyhrrell, "Introduction to Evolvable Hardware: a Practical Guide for Designing Self- Adaptive Systems", Wiley-Ieee Press, 2006.
2. Lukas Sekanina, "Evolvable Components: From Theory to Hardware Implementations", Springer, 2004

REFERENCES

1. Tetsuya Higuchi, Xin Yao and Yong Liu, "Evolvable Hardware", Springer-Verlag, 2004.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	3	2	–	2	–	–	–	–	–	–	1	3	2
CO3	3	3	3	–	3	–	–	–	–	–	–	1	3	3
CO4	3	3	3	2	2	–	–	–	–	–	–	1	3	2
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VL3037 RELIABILITY IN VLSI CIRCUITS L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the fundamental concepts of reliability in integrated circuits, including failure rate, MTBF, availability, and reliability analysis of CMOS systems.
To study and analyze transistor aging mechanisms such as Hot Carrier Injection, Bias Temperature Instability, and Time-Dependent Dielectric Breakdown, and their impact on device reliability.
To gain knowledge of soft error mechanisms in semiconductor devices including single-event effects, particle strikes, and techniques for soft error tolerant circuit design.
To explore and evaluate IC reliability simulation techniques and failure-resilient circuit design approaches including deterministic, stochastic, and self-healing systems for improving circuit lifetime and robustness.

UNIT I INTRODUCTION 9

Basic concept of reliability: Definition, Reliability and failure rate, relation between reliability and MTBF, Maintainability, Availability, Reliability of series and parallel systems, Reliability in Nanometer CMOS, Design for Reliability, Origin of CMOS Unreliability, Spatial Unreliability, Temporal Unreliability

UNIT II TRANSISTOR AGING COMPACT MODELING 9

Hot Carrier Injection, Bias Temperature Instability, Time-Dependent Dielectric Breakdown, Aging-Equivalent Transistor Model, Aging Model for Hand Calculations

UNIT III SOFT ERROR MODELING 9

Impacts of Particle Strike on Semiconductor Devices, Single-Event Transient Modeling, Impact of a Particle Hit on Combinational Circuits, Single Event Effects in Electronic Devices and Systems, Sensitivity of Devices: SET, SEU, MBU, MCU, SEFI, Single Event Latch-Up, Soft Error Tolerant Circuit Design Using Partitioning-Based Gate Sizing

UNIT IV IC RELIABILITY SIMULATION **12**

Berkeley Reliability Tools, Other Reliability Simulators, Commercial Reliability Simulators Deterministic Reliability Simulation, Stochastic Reliability Simulation, Hierarchical Reliability Simulation

UNIT V INTEGRATED CIRCUIT RELIABILITY **6**

Assessment, Failure-Resilient Circuits: Intrinsically Robust Circuits, Self-healing Circuits, Case Study: Digital Circuits- Digital Circuit Lifetime, Minimum Circuit Lifetime with Example Circuit.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Elie Maricau, Georges Gielen, Analog IC Reliability in Nanometer CMOS, Springer, 2013.
2. Michael Nicolaidis (Ed), Soft Errors in Modern Electronic Systems, Springer, 2011.
3. Behnam Ghavami, Mohsen Raji, Soft Error Reliability of VLSI Circuits, Analysis and Mitigation Techniques, Springer, 2011.
4. Prag K. Lala, Fault tolerant and fault testable hardware design, BS Publications, 2014.(Unit I)

REFERENCES:

1. Rajesh Garg, Sunil P. Khatri, Analysis and Design of Resilient VLSI Circuits, Mitigating Soft Errors and Process Variations, Springer, 2010.

COURSE OUTCOMES:

CO1: Explain the fundamental concepts of IC reliability including failure rate, MTBF, maintainability, availability, and reliability analysis of CMOS systems.

CO2: Analyze transistor aging effects such as Hot Carrier Injection, Bias Temperature Instability, and Time-Dependent Dielectric Breakdown using compact and equivalent models.

CO3: Evaluate soft error mechanisms in semiconductor devices including single-event effects (SET, SEU, MBU, MCU, SEFI) and their impact on circuit operation.

CO4: Apply reliability simulation techniques using deterministic, stochastic, and hierarchical methods for analyzing IC performance and failure behavior.

CO5: Design and assess failure-resilient and self-healing circuits to improve IC reliability and lifetime under nanometer CMOS technologies.

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

COs	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
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	3	2	2	2	–	–	–	–	–	–	1	3	2
CO3	3	3	3	3	3	–	–	–	–	–	–	1	3	3
CO4	3	3	3	3	3	–	–	–	–	–	–	1	3	3
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VL3038 CRYPTOGRAPHY AND HARDWARE SECURITY L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the fundamental concepts of symmetric and asymmetric cryptography, including mathematical foundations, encryption algorithms, and key management techniques.

To study and analyze public key cryptographic systems such as RSA, Diffie-Hellman, ElGamal, and Elliptic Curve Cryptography for secure communication.

To gain knowledge of side channel analysis techniques including differential fault attacks, power analysis, cache attacks, and scan chain based attacks on cryptographic hardware.

To explore and evaluate hardware security threats such as hardware Trojans and develop

countermeasures and secure hardware design techniques for reliable cryptographic systems.

UNIT I SYMMETRIC CRYPTOGRAPHY 9

Security Goals, Attacks, Techniques, MATHEMATICS OF SYMMETRIC KEY CRYPTOGRAPHY: Algebraic structures – Modular arithmetic-Euclid's algorithm- Congruence and matrices - Groups, Rings, Fields- Finite fields- SYMMETRIC KEY CIPHERS: SDES – Block cipher Principles of DES – Strength of DES – Differential and linear cryptanalysis - Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Advanced Encryption Standard - RC4 – Key distribution.

UNIT III PUBLIC KEY CRYPTOGRAPHY 9

MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing – Factorization – Euler's totient function, Fermat's and Euler's Theorem - Chinese Remainder Theorem – Exponentiation and logarithm - ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange - ElGamal cryptosystem – Elliptic curve arithmetic-Elliptic curve cryptography.

UNIT III SIDE CHANNEL ANALYSIS AND DFA9

Introduction, Difference of SCA and Conventional Cryptanalysis, Types of Side Channel Attacks, Power Attacks, Fault Attacks, Cache Attacks, Scan Chain Based Attacks, DFA: Introduction, DFA and Associated Fault Models, Principle of Differential Fault Attacks on AES, State-of-the-art DFAs on AES, DFA countermeasures, Invariance based DFA Countermeasures, Improved Countermeasure

UNIT IV CACHE, POWER AND SCAN CHAIN BASED ATTACKS9

Cache Attacks : Memory Hierarchy, Timing Attacks Due to CPU Architecture, Trace-Driven Cache Attacks, Access-Driven Cache Attacks, Time-Driven Cache Attacks, Countermeasures for Timing Attacks, Power Attacks: Power Attack Setup and Power Traces, Power Models, Differential Power Analysis, Correlation Power Attack, Metrics to Evaluate a Side Channel Analysis, Countermeasures, Scan Chain Based Attacks, Scan Attack, Testability of Cryptographic Designs

UNIT V HARDWARE TROJANS9

Introduction, Trojan Taxonomy and Examples, Multi-level Attacks Effect of Hardware Trojan on Circuit Reliability, Statistical Approach for Trojan Detection, Multiple-parameter Analysis based Trojan Detection, Simulation Verification, Hardware Validation, FPGA-based Design Technique for Trojan Isolation, A Design Infrastructure Approach to Prevent Circuit Malfunction

TOTAL: 45 PERIODS

TEXT BOOK:

1. William Stallings, Cryptography and Network Security: Principles and Practice, PHI, 3rd Edition, 2006.
2. BehrouzA.Foruzan, Cryptography and Network Security, Tata McGraw Hill 2007.
3. Debdeep Mukhopadhyay, Rajat Subhra Chakraborty, Hardware Security Design, Threats, and Safeguards, CRC Press, 2015

REFERENCES:

1. Chester Rebeiro, Debdeep Mukhopadhyay, Sarani Bhattacharya, Timing Channels in Cryptography A Micro-Architectural Perspective, Springer, 2015.
2. Douglas R. Stinson, Maura B. Paterson, Cryptography Theory and Practice, Fourth Edition, CRC Press, 2019.

COURSE OUTCOMES:

CO1: Explain the principles of symmetric cryptography, including classical encryption techniques, DES, AES, RC4, and key distribution mechanisms.

CO2: Analyze asymmetric cryptographic algorithms such as RSA, Diffie–Hellman, ElGamal, and Elliptic Curve Cryptography using mathematical foundations of public key systems.

CO3: Evaluate side channel analysis techniques and differential fault attacks on cryptographic systems, along with suitable countermeasures.

CO4: Analyze cache-based, power-based, and scan chain based attacks on hardware cryptographic implementations and assess their security implications.

CO5: Design and assess secure hardware systems by identifying hardware Trojans and applying detection, isolation, and prevention techniques for trusted computing systems.

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

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	–	2	–	–	–	–	–	–	2	3	2
CO2	3	3	2	–	2	–	–	–	–	–	–	1	3	3
CO3	3	3	3	3	3	–	–	–	–	–	–	1	3	3
CO4	3	3	3	3	3	–	–	–	1	1	–	1	3	3
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VL3039 IP CORE DESIGN AND PROTECTION L T P C

3 0 0 3

COURSE OBJECTIVES:

To understand the concepts of Intellectual Property (IP) cores in VLSI design, including IP classification, modeling, verification, optimization, and reuse-based design methodologies.

To study and analyze hardware intellectual property protection techniques such as obfuscation using state transition graph and control/data flow graph modifications.

To gain knowledge of constraint-based watermarking and fingerprinting techniques for protecting IP ownership and user rights in hardware designs.

To explore and evaluate IP authentication methods including pattern matching, forensic engineering, and public detectable watermarking techniques for secure hardware systems.

UNIT I IP CORES DESIGN 9

Introduction: IP cores in a typical VLSI design flow, Classification of hardware IP, IP Modeling, IP Verifi cation, IP Optimization, IP Protection, Gates as IP, Subsystems as IP, IP Components, Intellectual Property in Reuse-Based Design

UNIT II HARDWARE INTELLECTUAL PROPERTY PROTECTION 9

Functional Obfuscation through State Transition Graph Modification, Extension of STG Modification for RTL Designs, Obfuscation through Control and Dataflow Graph (CDFG) Modification, Measure of Obfuscation Level, Design Flow ,Implementation Results, Effect of Key Length

UNIT III CONSTRAINT-BASED IP PROTECTION 9

Challenges and the Generic Approach, Mathematical Foundations for the Constraint-Based Watermarking Techniques, Optimization-Intensive Watermarking Techniques.

UNIT IV IP USER'S RIGHT PROTECTION **9**

Motivation and Challenges, Fingerprinting Objectives, Constraint-Based Fingerprinting Techniques

UNIT V IP AUTHENTICATION **9**

Introduction, Pattern Matching Based Techniques, Forensic Engineering Techniques, Public Detectable Watermarking Techniques

TOTAL:45 PERIODS

TEXT BOOK:

1. Wayne wolf, "Modern VLSI Design:IP-based Design", Pearson Education,2009

2. Debdeep Mukhopadhyay, Rajat Subhra Chakraborty, Hardware Security Design, Threats, and Safeguards, CRC Press, 2015

3. Qu gang, Miodrag potkonjak, "Intellectual Property Protection in VLSI Designs: Theory and Practice", kluwer academic publishers,2003

COURSE OUTCOMES:

CO1: Explain the role of IP cores in VLSI design flow, including classification, modeling, verification, optimization, and reuse-based design concepts.

CO2: Analyze hardware IP protection techniques such as functional obfuscation using state transition graphs, RTL modifications, and control/data flow graph transformations.

CO3: Apply constraint-based watermarking techniques using mathematical foundations for protecting intellectual property in hardware designs.

CO4: Evaluate fingerprinting techniques to ensure IP user rights protection and trace unauthorized usage of hardware designs.

CO5: Assess IP authentication methods including pattern matching, forensic engineering, and public detectable watermarking for secure VLSI system design.

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

COs	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
CO1	3	2	2	–	2	–	–	–	–	–	–	2	3	2
CO2	3	3	3	2	3	–	–	–	–	–	–	1	3	3
CO3	3	3	3	2	3	–	–	–	–	–	–	1	3	3
CO4	3	3	2	2	2	–	–	–	1	1	–	1	3	3
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VL3040 ARTIFICIAL INTELLIGENCE IN VLSI DESIGN **L T P C**

3 0 0 3

COURSE OBJECTIVES:

To understand the fundamentals of Artificial Intelligence including problem-solving agents, search strategies, and constraint satisfaction problems.

To study and analyze expert systems and knowledge representation techniques used in AI-based VLSI design automation.

To gain knowledge of VLSI system design methodologies including logic design, high-level system design, and ASIC design concepts.

To explore and evaluate AI and machine learning techniques in VLSI design verification, testing, layout design, placement, routing, and neural network-based applications.

UNIT I AI AND PROBLEM SOLVING 10

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – constraint satisfaction problems (CSP).

UNIT II AI AND EXPERT SYSTEMS 9

The AI Approach to Computer-Aided Chip Design - Artificial Intelligence: Heuristic Methods of Solving, Expert Systems, Powerful AI Applications - Expert Systems Fundamentals, Knowledge Representation, Knowledge Processing, Programming Environments, Applications of Expert Systems

UNIT III VLSI SYSTEM DESIGN 10

Logic-Circuit Design, High-Level System Design, ASIC Design

UNIT IV VLSI DESIGN VERIFICATION AND TESTING 6

Hardware Verification and Expert Systems, Expert Systems for Digital-Circuit Verification, Expert Systems for Analog Circuits, Expert Systems for Fault Diagnosis, Expert Systems for Test Generation, Expert Systems for VLSI Design Testability.

UNIT V LAYOUT DESIGNAND PROBLEM-SOLVING TOOLS 10

Placement and Routing, Layout Design of Block Structures, Local Routing, Layout Verification, Machine Learning, Neural Networks, VLSI Applications of Neural Networks

TOTAL: 45 PERIODS

TEXT BOOK:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021
2. F. Schwarz, Handbook of VLSI Chip Design and Expert Systems, Academic Press, 1993

REFERENCES:

1. Thaddeus J. Kowalski, An artificial intelligence approach to VLSI design, Springer, 1985.
2. Marwan A. Jabri, An Artificial Intelligence Approach to Integrated Circuit Floorplanning, Springer, 2012.
3. R. Joobbani, An Artificial Intelligence Approach to VLSI Routing, Kluwer Academic Publishers, 2012.

COURSE OUTCOMES:

CO1: Explain artificial intelligence concepts including problem-solving agents, search algorithms, heuristic search strategies, and constraint satisfaction problems.

CO2: Analyze expert systems concepts including knowledge representation, inference mechanisms, and AI applications in VLSI design automation.

CO3: Apply VLSI system design principles including logic design, high-level system design, and ASIC design methodologies.

CO4: Evaluate AI-based techniques for VLSI design verification and testing, including fault diagnosis and test generation using expert systems.

CO5: Utilize machine learning and neural network approaches for VLSI layout design, placement, routing, and design optimization tasks.

CO’s-PO’s & PSO’s MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	3	2	–	–	–	–	–	–	–	–	2	3	2
CO2	3	3	3	2	2	–	–	–	–	–	–	1	3	3
CO3	3	3	3	2	3	–	–	–	–	–	–	1	3	3

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO4	3	3	3	3	3	–	–	–	1	1	–	1	3	3
CO5	3	3	3	3	3	–	–	–	1	1	–	2	3	3

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

VL3041 QUANTUM COMPUTING L T P C
2 0 2 3

COURSE OBJECTIVES:

- To know the background of classical computing and quantum computing.
- To learn the fundamental concepts behind quantum computation.
- To study the details of quantum mechanics and its relation to Computer Science.
- To gain knowledge about the basic hardware and mathematical models of quantum computation.
- To learn the basics of quantum information and the theory behind it.

UNIT I QUANTUM COMPUTING BASIC CONCEPTS 6

Complex Numbers - Linear Algebra - Matrices and Operators - Global Perspectives Postulates of Quantum Mechanics – quantum states – classical bits - Quantum Bits - Representations of Qubits - Bloch sphere – Superpositions - advantage of quantum computing over classical computing

UNIT II QUANTUM GATES AND CIRCUITS 5

Universal logic gates - Basic single qubit gates - Multiple qubit gates - Circuit development – Quantum error correction

UNIT III QUANTUM ALGORITHMS 7

Quantum parallelism - Deutsch's algorithm - The Deutsch–Jozsa algorithm - Quantum Fourier transform and its applications - Quantum Search Algorithms: Grover's Algorithm

UNIT IV QUANTUM INFORMATION THEORY 6

Data compression - Shannon's noiseless channel coding theorem - Schumacher's quantum noiseless channel coding theorem - Classical information over noisy quantum channels

UNIT V QUANTUM CRYPTOGRAPHY 6

Classical cryptography basic concepts - Private key cryptography - Shor's Factoring Algorithm - Quantum Key Distribution - BB84 - Ekart 91

30 PERIODS

PRACTICAL EXERCISES 30 PERIODS

1. Single qubit gate simulation - Quantum Composer
2. Multiple qubit gate simulation - Quantum Composer
3. Composing simple quantum circuits with q-gates and measuring the output into classical bits.
4. IBM Qiskit Platform Introduction
5. Implementation of Shor's Algorithms
6. Implementation of Grover's Algorithm
7. Implementation of Deutsch's Algorithm
8. Integer factorization using Shor's Algorithm

COURSE OUTCOMES:

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

CO1: Understand the basics of quantum computing.

CO2: Understand the background of Quantum Mechanics.

CO3: Analyze the computation models.

CO4: Model the circuits using quantum computation environments and frameworks.

CO5: Understand the quantum operations such as noise and error–correction.

TOTAL: 60 PERIODS

TEXTBOOKS:

1. Parag K Lala, Mc Graw Hill Education, “Quantum Computing, A Beginners Introduction”, First edition (1 November 2020).

2. Michael A. Nielsen, Issac L. Chuang, “Quantum Computation and Quantum Information”, Tenth Edition, Cambridge University Press, 2010.

3. Chris Bernhardt, The MIT Press; Reprint edition (8 September 2020), “Quantum Computing for Everyone”.

REFERENCES

1. Scott Aaronson, “Quantum Computing Since Democritus”, Cambridge University Press, 2013.

2. N. David Mermin, “Quantum Computer Science: An Introduction”, Cambridge University Press, 2007.

CO’s-PO’s & PSO’s MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO2	3	2	1	–	–	–	–	–	–	–	–	2	3	2
CO3	3	3	3	2	2	–	–	–	–	–	–	1	3	3
CO4	3	3	3	3	3	–	–	–	–	–	–	1	3	3
CO5	3	3	3	3	3	–	–	–	1	1	–	1	3	3

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

SOFT CORE – MANAGEMENT

GE3751 PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers-managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

UNIT V CONTROLLING 9

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

TOTAL:45PERIODS

COURSE OUTCOMES:

CO1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.

CO2: Have same basic knowledge on international aspect of management.

CO3: Ability to understand management concept of organizing.

CO4: Ability to understand management concept of directing.

CO5: Ability to understand management concept of controlling.

TEXT BOOKS:

1. Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGraw Hill,1998.
2. Stephen P. Robbins and Mary Coulter, “ Management”, Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.

REFERENCES:

1. Robert Kreitner and MamataMohapatra, “ Management”, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo andMary Coulter, “Fundamentals of Management” Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, “Principles of Management”, Tata Mcgraw Hill, 1999.

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	-	-	-	-	-	-	2	1	1
2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-
3	1		-	2	-	-	1	-	2	-	1	1	-	-	2
4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1
5	1		-	-	1	1	-	-	-	3	-	1	1	-	1

AVg.	1.66	1	1	1.5	1.5	1	1	1	2	3	1	1	1.5	1	1.25

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

GE3752 TOTALQUALITYMANAGEMENT LTP C

3003

COURSE OBJECTIVES:

- Teach theneedfor quality,Itsevolution,basicconcepts,contributionofqualitygurus,TQMframework,BarriersandBenefitsofTQM.
- ExplaintheTQMPrinciplesforapplication.
- DefinethebasicsofSixSigmaandapplyTraditionaltools,Newtools,BenchmarkingandFMEA.
- DescribeTaguchi'sQualityLossFunction,PerformanceMeasuresandapplyTechniqueslikeQFD, TPM,COQand BPR.
- IllustrateandapplyQMSandEMSinanyorganization.

UNITI INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of productandservicequality–DefinitionofTQM—BasicconceptsofTQM-GurusofTQM(Briefintroduction)--TQMFramework-BarrierstoTQM–BenefitsofTQM.

UNITII TQMPRINCIPLES 9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning-Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, ServiceQuality,KanoModelandCustomerretention–Employeeinvolvement–Motivation,Empowerment,TeamandTeamwork,Recognition&RewardandPerformanceAppraisal—Continuousprocessimprovement–JuranTrilogy,PDSAcycle,5SandKaizen-Supplierpartnership–Partnering,Supplierselection,Supplier RatingandRelationshipdevelopment.

UNITIII TQMTOOLS& TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six-sigma Process Capability-Benchmarking-Reasonstobenchmark,Benchmarkingprocess,WhattoBenchMark,UnderstandingCurrent Performance, Planning, StudyingOthers, Learning from the data, Usingthe findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages:DesignFMEA andProcess FMEA.

UNITIV TQMTOOLS& TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts,improvementneeds– Performancemeasures-CostofQuality-BPR.

UNITV QUALITY MANAGEMENTSYSTEM 9

Introduction-BenefitsofISORegistration-ISO9000SeriesofStandards-Sector-SpecificStandards - AS9100,TS16949andTL 9000--ISO9001Requirements-Implementation-Documentation-InternalAudits-Registration-ENVIRONMENTALMANAGEMENTSYSTEM:Introduction—ISO14000SeriesStandards—Conceptsof ISO14001—RequirementsofISO14001-Benefitsof EMS.

TOTAL:45PERIODS

COURSE OUTCOMES:

CO1: Abilityto applyTQMconcepts in aselectedenterprise.

CO2: AbilitytoapplyTQMprinciplesin aselectedenterprise.

CO3: AbilitytounderstandSixSigmaandapplyTraditionaltools,Newtools,BenchmarkingandFMEA.

CO4: AbilitytounderstandTaguchi'sQualityLossFunction,PerformanceMeasuresandapplyQFD,TPM,COQand BPR.

CO5: AbilitytoapplyQMSandEMSinanyorganization.

TEXTBOOK:

1. DaleH.Besterfiled,CarolB.Michna,GlenH.Besterfield,MaryB.Sacre, HemantUrdhwaresheandRashmiUrdhwareshe,"TotalQualityManagement",PearsonEducationAsia,RevisedThirdEdition,Indian Reprint, SixthImpression,2013.

REFERENCES:

1. Joel.E.Ross,"TotalQualityManagement–TextandCases",Routledge.,2017.
2. Kiran.D.R,"TotalQualityManagement:Keyconceptsandcasestudies,Butterworth–HeinemannLtd,2016.
3. Oakland,J.S."TQM–TextwithCases",Butterworth–HeinemannLtd.,Oxford,ThirdEdition,2003.
4. Suganthi,LandAnandSamuel,"TotalQualityManagement",PrenticeHall(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

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

GE3753 ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING L T P C

3 0 0 3

COURSE OBJECTIVES:

- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better
- understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

UNIT I DEMAND & SUPPLY ANALYSIS 9

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function -Supply elasticity.

UNIT II PRODUCTION AND COST ANALYSIS 9

Production function - Returns to scale - Production optimization - Least cost input -

Isoquants- Managerial uses of production function.Cost Concepts - Cost function - Determinants of cost - Short run and Long run costcurves - Cost Output Decision - Estimation of Cost.

UNIT III PRICING 9

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) 9

Balance sheet and related concepts - Profit & Loss Statement and related concepts - - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) 9

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Students able to

CO1: Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions
CO2: Evaluate the economic theories, cost concepts and pricing policies
CO3: Understand the market structures and integration concepts
CO4: Understand the measures of national income, the functions of banks and concepts of globalization
CO5: Apply the concepts of financial management for project appraisal

TEXT BOOKS:

1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi,2001.
2. Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

REFERENCES:

1. Chan S.Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2011.
2. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and analysis” Engg. Press, Texas, 2010.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 2011.
4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
5. Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 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	-	3	-	-	-	-	-	-	-	2	-	-	1	3	-
2	-	3	-	-	-	-	-	-	-	-	-	-	-	2	2
3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	3	3	-	2	-	-	-	-	-	-	-	2	3	-
5	3	3	3	-	2	-	-	-	-	-	-	-	2	-	2
AVg.	2.5	2.4	3	-	2	-	-	-	-	2	-	-	1.8	2.6	2

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

GE3754 HUMAN RESOURCE MANAGEMENT L TP C

3 0 0 3

COURSE OBJECTIVE:

- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance

- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

UNIT I INTRODUCTION TO HUMAN RESOURCE MANAGEMENT 9

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

UNIT II HUMAN RESOURCE PLANNING 9

Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization.

UNIT III TRAINING AND EXECUTIVE DEVELOPMENT 9

Types of training and Executive development methods – purpose – benefits.

UNIT IV EMPLOYEE COMPENSATION 9

Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.

UNIT V PERFORMANCE EVALUATION AND CONTROL 9

Performance evaluation – Feedback - The control process – Importance – Methods – grievances –Causes – Redressal methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Students would have gained knowledge on the various aspects of HRM
CO2: Students will gain knowledge needed for success as a human resources professional.
CO3: Students will develop the skills needed for a successful HR manager.
CO4: Students would be prepared to implement the concepts learned in the workplace.
CO5: Students would be aware of the emerging concepts in the field of HRM

TEXT BOOKS:

1. Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.
2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

REFERENCES:

1. Luis R,. Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, “Managing Human Resources", 7th Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited, 2007.

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	1	2	2	2	1	1	2	1	1	1	1	1	1
2	3	3	2	3	2	2	2	2	3	1	2	1	1	2	1
3	3	3	3	3	3	3	2	2	3	1	2	1	1	2	1

4	3	3	2	3	3	2	2	2	2	1	1	1	1	1	1
5	3	3	1	2	2	2	2	2	2	1	1	1	1	1	1
AVg.	2.8	2.8	1.8	2.6	2.6	2.2	1.8	1.8	2.4	1	1.4	1	1	1.4	1

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

GE3755 KNOWLEDGE MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

The student should be made to:

- Learn the Evolution of Knowledge management.
- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies.

UNIT I INTRODUCTION 9

Introduction: An Introduction to Knowledge Management - The foundations of knowled ge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING 9

Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS 9

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

UNIT IV KNOWLEDGE MANAGEMENT APPLICATION 9

Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, KnowledgeManagement in the Health Sciences, Knowledge Management in Developing Countries).

UNIT V FUTURE TRENDS AND CASESTUDIES 9

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student should be able to:

CO1: Understand the process of acquiry knowledge from experts

CO2: Understand the learning organization.

CO3: Use the knowledge management tools.

CO4: Develop knowledge management Applications.

CO5: Design and develop enterprise applications.

TEXT BOOK:

1. Srikantaiah, T.K., Koenig, M., "Knowledge Management for the Information Professional" Information Today, Inc., 2000.

REFERENCE:

1. Nonaka, I., Takeuchi, H., "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation", Oxford University Press, 1995.

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					1										
2					2								1		
3					2									2	
4				1	1				1					1	
5				1	1				1					1	
AVg.				1	1.4				1				1	1.33	

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

GE3792 INDUSTRIAL MANAGEMENT LTP C
3003

COURSE OBJECTIVES

- To study the basic conceptsof management; approachesto management; contributors to management studies; variousforms ofbusiness organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

UNIT – I INTRODUCTION TO MANAGEMENT 9

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative– PublicSector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

UNIT – II FUNCTIONS OF MANAGEMENT – I9

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

UNIT –III FUNCTIONS OF MANAGEMENT - II 9

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

UNIT –IV ORGANIZATION THEORY 9

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; IntraGroup; InterGroup; ConflictManagement – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept ofChange; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

UNIT – V PRODUCTIVITY AND MODERN TOPICS 9

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain basicconcepts ofmanagement; approachesto management; contributors to management studies; variousforms ofbusiness organization and trade unionsfunction in professional organizations.

CO2 Discuss the planning; organizing and staffing functions of management in professional organization.

CO3 Apply the leading; controlling and decision making functions of management in professional organization.

CO4 Discuss the organizational theory in professional organization.

CO5 Apply principles of productivity and modern concepts in management in professional organization.

TEXTBOOKS:

1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2. Koontz. H. and Weihrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGrawhill, New Delhi, 2010.

REFERENCES:

1. Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.
2. Saxena, P. K., "Principles of Management: A Modern Approach",GlobalIndia Publications, 2009.
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012.
5. S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.

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	2	3	2	3	1	3	1	1	1
2	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
3	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
4	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
5	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1

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

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:

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/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.

5.5Final 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

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

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 - UyirThathukkal**(**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
2. A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England 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, NewYork, 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:

CO1:Learn the importance of different components of health

CO2:Gain confidence to lead a healthy life

CO3:Learn new techniques to prevent lifestyle health disorders

CO4:Understand the importance of diet and workouts in maintaining health

MX3086HISTORY 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 1st 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)

COURSE 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

COURSE 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

COURSE 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?

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.

TOTAL : 45 PERIODS

MX3089 INDUSTRIAL SAFETY L T P C
3 0 0 0

COURSE 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:

Course outcomes on completion of this course the student will be able:

CO1:Understand the basic concept of safety.

CO2:Obtain knowledge of Statutory Regulations and standards.

CO3:Know about the safety Activities of the Working Place.
CO4:Analyze on the impact of Occupational Exposures and their Remedies
CO5: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														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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

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

OPEN ELECTIVES I

OAS351	SPACE SCIENCEL T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To outline the space environment and their effects.
- To extend the origin of universe and development.
- To classify the galaxies and their evolution.
- To interpret the variable stars in the galaxies.
- To explain theory of formation of our solar system.
-

UNIT I INTRODUCTION 9

Introduction to space science and applications – historical development – Space Environment-Vacuum and its Effects, Plasma & Radiation Environments and their Effects, Debris Environment and its Effects - Newton's Law of gravitation – Fundamental Physical Principles.

UNIT II ORIGIN OF UNIVERSE 9

Early history of the universe – Big-Bang and Hubble expansion model of the universe – cosmic microwave background radiation – dark matter and dark energy.

UNIT III GALAXIES 7

Galaxies, their evolution and origin – active galaxies and quasars – Galactic rotation – Stellar populations – galactic magnetic field and cosmic rays.

UNIT IV STARS 10

Stellar spectra and structure – stellar evolution – Nucleo-synthesis and formation of elements – Classification of stars – Harvard classification system – Hertsprung-Russel diagram – Luminosity of star – variable stars – composite stars (white dwarfs, Neutron stars, black hole, star clusters, supernova and binary stars) – Chandrasekhar limit.

UNIT V SOLAR SYSTEM 10

Nebular theory of formation of our Solar System – Solar wind and nuclear reaction as the source of energy – Sun and Planets: Brief description about shape size – period of rotation about axis and period of revolution – distance of planets from sun – Bode's law – Kepler's Laws of planetary motion – Newton's deductions from Kepler's Laws – correction of Kepler's third law – determination of mass of earth – determination of mass of planets with respect to earth – Brief description of Asteroids – Satellites and Comets.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1:Obtain a broad, basic knowledge of the space sciences.
CO2:Explain the scientific concepts such as evolution by means of natural selection, age of the Earth and solar system and the Big-Bang.
CO3:Describe the main features and formation theories of the various types of observed galaxies, in particular the Milky Way.
CO4:Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories;
CO5:Describe the presently accepted formation theories of the solar system based upon observational and physical constraints;

TEXT BOOKS:

1. Hess W., "Introduction to Space Science", Gordon & Breach Science Pub; Revised Ed., 1968.
2. Krishnaswami K. S., "Astrophysics: A modern Perspective", New Age International, 2006.

REFERENCES:

1. Arnab Rai Choudhuri, "Astrophysics for Physicists", Cambridge University Press, New York, 2010.
2. Krishnaswami K. S., "Understanding cosmic Panorama", New Age International, 2008.

OIE351 INTRODUCTION TO INDUSTRIAL ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

The objective of this course is to provide foundation in Industrial Engineering in order to enable the students to make significant contributions for improvements in diverse organizations.

- Explain the concepts productivity and productivity measurement approaches.
- Explain the basic principles in facilities planning and plant location.
- Apply work study and ergonomic principles to design workplaces for the improvement of human performance
- Impart knowledge to design and implement Statistical Process control in any industry.
- Recognize the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages

UNIT I INTRODUCTION 9

Concepts of Industrial Engineering – History and development of Industrial Engineering – Roles of Industrial Engineer – Applications of Industrial Engineering – Production Management Vs Industrial Engineering – Production System – Input Output Model – Productivity – Factors affecting Productivity – Increasing Productivity of resources – Kinds of Productivity measures.

UNIT II PLANT LOCATION AND LAYOUT 9

Factors affecting Plant location – COURSE OBJECTIVES of Plant Layout – Principles of Plant Layout – Types of Plant Layout – Methods of Plant and Facility Layout – Storage Space requirements – Plant Layout procedure – Line Balancing methods.

UNIT III WORK SYSTEM DESIGN& ERGONOMICS 9

Need – COURSE OBJECTIVES – Method Study procedure – Principles of Motion Economy – Work Measurement procedures – Time Study –Work sampling- Ergonomics and its areas of application in the work system - Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing.

UNIT IV STATISTICAL QUALITY CONTROL 9

Definition and Concepts – Fundamentals – Control Charts for variables – Control Charts for attributes – Acceptance Sampling- O.C curve –Single sampling plan- Double sampling plan.

UNIT V PRODUCTION PLANNING AND CONTROL 9

Forecasting – Qualitative and Quantitative forecasting techniques – Types of production – Process planning – Economic Batch Quantity– Loading – Scheduling and control of production – Dispatching–Progress control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, Students will be able to

CO1: Ability To define the concepts of productivity and productivity measurement approaches.

CO2: Ability to evaluate appropriate location models for various facility types and design various facility layouts

CO3: Ability To conduct a method study and time study to improve the efficiency of the system.

CO4: Ability to Control the quality of processes using control charts in manufacturing/service industries.

CO5: Ability to define the Planning strategies and Material Requirement Plan.

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	2	2	3	2											
3	2	2	2	1	1			2			1		2		
4	2	2	3	1	1										
5	1	2	2									1			3
AVg.	2.2	2	2.5	1.3	1			2			1	1	2	1	3

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

TEXT BOOK:

1. O.P.Khanna, 2010, Industrial Engineering and Management, Dhanpat Rai Publications.

REFERENCES:

1. Ravi Shankar, 2009, Industrial Engineering and Management, Galgotia Publications & Private Limited.
2. Martand Telsang,2006, Industrial Engineering and Production Management, S. Chand and Company

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	**2**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**1**	**1**	**-**	**3**	**1**	**1**	**3**

	energy sources and their differences compared to fossil fuels.															
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 - low, 2 - medium, 3 - high, '-' - no correlation

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OCE351ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT L T P C

3 0 0 3

COURSE OBJECTIVE:

- To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects

UNIT I INTRODUCTION 9

Impacts of Development on Environment – Rio Principles of Sustainable Development-Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework–Stakeholders and their Role in EIA– Selection & Registration Criteria for EIA Consultants

UNIT II ENVIRONMENTAL ASSESSMENT 9

Screening and Scoping in EIA – Drafting of Terms of Reference,Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction – Analysis of alternatives

UNIT III ENVIRONMENTAL MANAGEMENT PLAN 9

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Review of EIA Reports – Public Hearing-Environmental Clearance Post Project Monitoring

UNIT IV SOCIO ECONOMIC ASSESSMENT 9

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis-

UNIT V CASE STUDIES 9

EIA case studies pertaining to Infrastructure Projects – Real Estate Development - Roads and Bridges – Mass Rapid Transport Systems - Ports and Harbor – Airports - Dams and Irrigation projects - Power plants – CETPs- Waste Processing and Disposal facilities – Mining Projects.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students completing the course will have ability 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:plan environmental impact assessments and environmental management plans

CO4:evaluate environmental impact assessment reports

TEXTBOOKS:

1. Canter, R.L, “Environmental impact Assessment “, 2nd Edition, McGraw Hill Inc, New Delhi,1995.
2. Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, “Environmental Impact Assessment for Developing Countries in Asia”, Volume 1 – Overview, Asian Development Bank,1997.
3. Peter Morris, Riki Therivel “Methods of Environmental Impact Assessment”, Routledge Publishers,2009.

REFERENCES:

1. Becker H. A., Frank Vanclay,“The International handbook of social impact assessment” conceptual and methodological advances, Edward Elgar Publishing, 2003.

2. Barry Sadler and Mary McCabe, “Environmental Impact Assessment Training Resource Manual”, United Nations Environment Programme, 2002.
3. Judith Petts, “Handbook of Environmental Impact Assessment Vol. I and II”, Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

OEE351 RENEWABLE ENERGY SYSTEM L T P C
3 0 0 3

COURSE OBJECTIVES:

- To Provide knowledge about various renewable energy technologies
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy system.
- To Provide knowledge about various possible hybrid energy systems
- To gain knowledge about application of various renewable energy technologies

UNIT I INTRODUCTION 9

Primary energy sources, renewable vs. non-renewable primary energy sources, renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies.

UNIT II SOLAR ENERGY 9

Solar Radiation and its measurements, Solar Thermal Energy Conversion from plate Solar Collectors, Concentrating Collectors and its Types, Efficiency and performance of collectors,. Direct Solar Electricity Conversion from Photovoltaic, types of solar cells and its application of battery charger, domestic lighting, street lighting, and water pumping, power generation schemes. Recent Advances in PV Applications: Building Integrated PV, Grid Connected PV Systems,

UNIT III WIND ENERGY 9

Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications.

UNIT IV BIO-ENERGY 9

Energy from biomass, Principle of biomass conversion technologies/process and their classification, Bio gas generation, types of biogas plants, selection of site for biogas plant, classification of biogas plants, Advantage and disadvantages of biogas generation, thermal gasification of biomass, biomass gasifies, Application of biomass and biogas plants and their economics.

UNIT V OTHER TYPES OF ENERGY 9

Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-

hydel power plants and their economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Attained knowledge about various renewable energy technologies

CO2: Ability to understand and design a PV system.

CO3: Understand the concept of various wind energy system.

CO4: Gained knowledge about various possible hybrid energy systems

CO5: Attained knowledge about various application of renewable energy technologies

REFERENCES

1. Twidell&Wier,**'**Renewable Energy Resources' CRC Press(Taylor& Francis).
2. Tiwari and Ghosal/ Narosa,'Renewable energy resources'.
3. D.P.Kothari, K.C.Singhal,'Renewable energy sources and emerging technologies', P.H.I.
4. D.S.Chauhan, S.K. Srivastava, 'Non – Conventional Energy Resources', New Age Publishers, 2006.
5. B.H.Khan, 'Non – Conventional Energy Resources', Tata Mc Graw Hill, 2006.

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

	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	SO1	SO2	SO3
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	3	3
CO2	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
CO3	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
CO4	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
CO5	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3
Avg.	3	2	-	-	-	-	-	-	-	-	-	2	3	3	3

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

OEI351 INTRODUCTION TO INDUSTRIAL INSTRUMENTATION AND CONTROL

L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce common unit operations carried out in process industries.
- To impact knowledge about the important unit operations taking place in process industries.
- To prepare them to take up a case study on selected process industries like petrochemical industry, power plant industry and paper & pulp industry to make the students understand the different measurement and control techniques for important processes.
- Facilitate the students to apply knowledge to select appropriate measurement technique and control strategy for a given process.

UNIT - I COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -I 9

Unit Operation, Measurement and Control:-Transport of solid, liquid and gases - Evaporators – Crystallizers-Dryers.

UNIT -II COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -II 9

Unit Operation, Measurement and Control: - Distillation – Refrigeration processes – Chemical reactors.

UNIT - III PROCESS MEASUREMENT AND CONTROL IN PETROCHEMICAL INDUSTRY 9

Process flow diagram of Petro Chemical Industry - Gas oil separation in production platform – wet gas processing – Fractionation Column – Catalytic Cracking unit – Catalytic reforming unit

UNIT - IV PROCESS MEASUREMENT AND CONTROL IN THERMAL POWER PLANT INDUSTRY 9

Process flow diagram of Coal fired thermal Power Plant– Coal pulverizer - Deaerator – Boiler drum - Superheater – Turbines.

UNIT - V PROCESS MEASUREMENT AND CONTROL IN PAPER & PULP INDUSTRY 9

Process flow diagram of paper and pulp industry – Batch digestor – Continuous sulphatedigestor – Control problems on the paper machine.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

5

Study the characteristics of various processing units involved in chemical plant.
Develop the process model by using predefined unit operations (e.g. mixing, distillation, heating) from the library of any process simulator.
Analyse the functioning of each processing units with help of virtual unit operations packages.
Perform a physical property analysis using simulation packages
Implement distillation column analysis using simulation software.
Create process flow models and diagrams

COURSE OUTCOMES:

Students able to

CO1 understand common unit operations in process industries. L2
CO2 Identify the dynamics of important unit operations in petro chemical industry. L2
CO3 develop understanding of important processes taking place selected case studies namely petrochemical industry, power plant industry and paper & pulp industry. L5
CO4 Select appropriate measurement techniques for selective processes. L5
CO5 Develop controller structure based on the process knowledge. L5
CO6 Analyze the operation and challenges in integrated industrial processes. L4

TEXT BOOKS:

1. Balchen ,J.G., and Mumme, K.J., " Process Control structures and applications", Van Nostrand Reinhold Co., New York, 1988
2. Warren L. McCabe, Julian C. Smith and Peter Harriot, "Unit Operations of Chemical Engineering", McGraw-Hill International Edition, New York, Sixth Edition, 2001.

REFERENCES:

1. Liptak B.G., "Instrument and Automation Engineers' Handbook: Process Measurement and Analysis", Fifth Edition, CRC Press, 2016.
2. James R.couper, Roy Penny, W., James R.Fair and Stanley M.Walas, "Chemical ProcessEquipment: Selection and Design", Gulf Professional Publishing, 2010.
3. Austin G.T and Shreeves, A.G.T., "Chemical Process Industries", McGraw–Hill International student, Singapore, 1985.
4. Luyben W.C., "Process Modeling, Simulation and Control for Chemical Engineers", McGraw-Hill International edition, USA, 1989.
5. K. Krishnaswamy, Process Control, new age publishers , 2009.

List of Open Source Software/ Learning website:

1. https://www.aspentech.com/en
2. http://avtechscientific.com/
3. https://www.chemstations.com/CHEMCAD/
4. https://www.prosim.net/en/product/prosimplus-steady-state-simulation-and-optimization-of-processes/
5. https://www.cocosimulator.org/
6. https://dwsim.fossee.in/

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	3	1					1		1					
CO2	3	3	1					1		1	2				2
CO3	3	3	1					1		1					
CO4	3	3	1	3	3			1		1			3	3	
CO5	3	3	3			3		1		1			3	3	3
CO6	3	3	2	3	2	1	2	1		2	1	1			2
Avg	3	3	1.5	3	2.5	2	2	1		1.16	1.5	1	3	3	2.33

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

OMA351 GRAPH THEORY L T P C

3 00 3

COURSE OBJECTIVES

- To understand the graph models and basic concepts of graphs.
- To study the characterization and properties of trees and graph connectivity.
- To provide an exposure to the Eulerian and Hamiltonian graphs.
- To introduce Graph colouring and explain its significance.
- To provide an understanding of Optimization Graph Algorithms.

UNIT I INTRODUCTION TO GRAPHS 9

Graphs and Graph Models – Connected graphs – Common classes of graphs – Multi graphs and Digraphs – Degree of a vertex – Degree Sequence – Graphs and Matrices – Isomorphism of graphs.

UNIT II TREES AND CONNECTIVITY 9

Bridges – Trees – Characterization and properties of trees – Cut vertices – Connectivity.

UNIT III TRAVERSABILITY 9

Eulerian graphs – Characterization of Eulerian graphs – Hamiltonian graphs – Necessary condition for Hamiltonian graphs – Sufficient condition for Hamiltonian graphs.

UNIT IV PLANARITY AND COLOURING 9

Planar Graphs – The Euler Identity – Non planar Graphs – Vertex Colouring – Lower and Upper bounds of chromatic number.

UNIT V OPTIMIZATION GRAPH ALGORITHMS 9

Dijkstra's shortest path algorithm – Kruskal's and Prim's minimum spanning tree algorithms – Transport Network – The Max-Flow Min-Cut Theorem – The Labeling Procedure – Maximum flow problem.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of this course, the student will be able to

CO1:Apply graph models for solving real world problem.

CO2:Understand the importance the natural applications of trees and graph connectivity.

CO3:Understand the characterization study of Eulerian graphs and Hamiltonian graphs.

CO4:Apply the graph colouring concepts in partitioning problems.

CO5:Apply the standard optimization graph algorithms in solving application problems.

TEXT BOOKS

1. Gary Chatrand and Ping Zhang, "Introduction to Graph Theory", Tata McGraw – Hill companies Inc., New York, 2006.
2. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics, An applied introduction" Fifth edition, Pearson Education, Inc, Singapore, 2004.

REFERENCES

1. Balakrishnan R. and Ranganathan K., "A Text Book of Graph Theory", Springer – Verlag, New York, 2012.
2. Douglas B. West, "Introduction to Graph Theory", Pearson, Second Edition, New York, 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	PS O1	PS O2	PS O3
CO1	3	3	3												
CO2		2	2		2										
CO3		2	2	2						2					
CO4	2	2	2												
CO5		3	2		2					3					
CO6															

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

CCW332 DIGITAL MARKETING L TP C

2 0 2 3

COURSE OBJECTIVES:

- The primary objective of this module is to examine and explore the role and importance of digital marketing in today's rapidly changing business environment.
- It also focuses on how digital marketing can be utilized by organizations and how its effectiveness can be measured.

UNIT I INTRODUCTION TO ONLINE MARKET 6

Online Market space- Digital Marketing Strategy- Components - Opportunities for building Brand Website - Planning and Creation - Content Marketing.

UNIT II SEARCH ENGINE OPTIMISATION 6

Search Engine optimisation - Keyword Strategy- SEO Strategy - SEO success factors -On-Page Techniques - Off-Page Techniques. Search Engine Marketing- How Search Engine works- SEM components- PPC advertising -Display Advertisement

UNIT III E- MAIL MARKETING 6

E- Mail Marketing - Types of E- Mail Marketing - Email Automation - Lead Generation - Integrating Email with Social Media and Mobile- Measuring and maximizing email campaign effectiveness. Mobile Marketing- Mobile Inventory/channels- Location based; Context based; Coupons and offers, Mobile Apps, Mobile Commerce, SMS Campaigns-Profiling and targeting

UNIT IV SOCIAL MEDIA MARKETING 6

Social Media Marketing - Social Media Channels- Leveraging Social media for brand conversations and buzz. Successful /benchmark Social media campaigns. Engagement Marketing- Building Customer relationships - Creating Loyalty drivers - Influencer Marketing.

UNIT V DIGITAL TRANSFORMATION 6

Digital Transformation & Channel Attribution- Analytics- Ad-words, Email, Mobile, Social Media, Web Analytics - Changing your strategy based on analysis- Recent trends in Digital marketing.

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Subscribe to a weekly/quarterly newsletter and analyze how its content and structure aid with the branding of the company and how it aids its potential customer segments.
2. Perform keyword search for a skincare hospital website based on search volume and competition using Google keyword planner tool.
3. Demonstrate how to use the Google WebMasters Indexing API
4. Discuss an interesting case study regarding how an insurance company manages leads.
5. Discuss negative and positive impacts and ethical implications of using social media for political advertising.
6. Discuss how Predictive analytics is impacting marketing automation

COURSE OUTCOMES:

CO1: To examine and explore the role and importance of digital marketing in today's rapidly changing business environment..

CO2: To focuses on how digital marketing can be utilized by organizations and how its effectiveness can be measured.

CO3: To know the key elements of a digital marketing strategy.

CO4: To study how the effectiveness of a digital marketing campaign can be measured

CO5: To demonstrate advanced practical skills in common digital marketing tools such as SEO, SEM, Social media and Blogs.

TOTAL:60 PERIODS

TEXT BOOKS

1. Fundamentals of Digital Marketing by Puneet Singh Bhatia;Publisher: Pearson Education;
2. First edition (July 2017);ISBN-10: 933258737X;ISBN-13: 978-9332587373.
3. Digital Marketing by Vandana Ahuja ;Publisher: Oxford University Press (April 2015). ISBN-10: 0199455449
4. Marketing 4.0: Moving from Traditional to Digital by Philip Kotler;Publisher: Wiley; 1st edition (April 2017); ISBN10: 9788126566938;ISBN 13: 9788126566938;ASIN: 8126566930.
5. Ryan, D. (2014). Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited..

6. Barker, Barker, Bormann and Neher(2017), Social Media Marketing: A Strategic Approach, 2E South-Western ,Cengage Learning.
7. Pulizzi,J Beginner's Guide to Digital Marketing ,Mcgraw Hill Education

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	3	-	-	-	1	2	3	3	3	3	3
2	2	2	2	1	3	-	-	-	1	2	3	3	3	3	3
3	1	1	1	2	2	-	-	-	1	2	1	1	3	2	1
4	3	2	2	3	1	-	-	-	1	3	2	3	2	3	2
5	2	3	1	3	3	-	-	-	2	3	1	2	1	2	1
AVg.	2.2	2.2	1.6	2	2.4	-	-	-	1.2	2.4	2	2.4	2.4	2.6	2

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

OIE352 RESOURCE MANAGEMENT TECHNIQUES L T P C
3 0 0 3

COURSE OBJECTIVES:

- Learn to formulate linear programming problems and solve LPP using simple algorithm
- Learn to solve networking problems
- Learn to formulate and solve integer programming problems
- Learn to solve Non Linear programming problems
- Learn to understand and solve project management problems

UNIT I LINEAR PROGRAMMING 9

Principal components of decision problem – Modeling phases – LP formulation and graphic solution – Resource allocation problems – simplex method – sensitivity analysis.

UNIT II DUALITY AND NETWORKS 9

Definition of dual problems – primal – Dual relationships – Dual simplex method –post optimality analysis – Transportation and assignment model – Shortest route problem.

UNIT III INTEGER PROGRAMMING 9

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

UNIT IV CLASSICAL OPTIMISATION THEROY: 9

Unconstrained external problems, Newton – Ralphson method – Equality constraints –Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

UNIT V OBJECT SCHEDULOING: 9

Network diagram representation – Critical path method – Time charts and res ource leveling – PERT.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon Completion of the course, the students should be able to:

CO1 : Understand to formulate linear programming problems and solve LPP using simple lgorithm

CO2 : Understand to solve networking problems
CO3 : Understand to formulate and solve integer programming problems
CO4 : Understand to solve Non Linear programming problems
CO5 : Understand to understand and solve project management problems

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
2		3	3	2									3	2	3
3		3	3	2									3	2	3
4		3	3	2									3	2	3
5		3	3	2									3	2	3
AVg.		3	3	2									3	2	3

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

TEXT BOOK:

1. H.A. Taha, "Operation Research", Prentice Hall of India, 2002.

RFERENCES:

1. Paneer selvam, 'Operations Research' Prentice Hall of India, 2002.
2. Anderson 'Quantitative Methods for Business', 8th Edition, Thomson Learning, 2002.
3. Winston 'Operations Research for Business', Thomson Learning, 2003.
4. Vohra, 'Quantitative Techniques in Management', Tata Mc Graw Hill, 2002.
5. Anand sarma, 'Operation Research' Himalaya Publishing House, 2003.

OMG351 FINTECH REGULATION L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To learn about Laws and Regulation
2. To acquire the knowledge of Regulations of Fintech firm and their role in Market

UNIT I INTRODUCTION 9

The Role of the Regulators, Equal Treatment and Competition, Need for a regulatory assessment of Fintech, India Regulations, The Risks to Consider, Regtech and SupTech, The rise of TechFins, Regulatory sandboxes, compliance and whistleblowing.

UNIT II INNOVATION AND REGULATION 9

The technology, market and the law, Regulation and Innovation in Banking and Finance, Regulations of Fintech Firms and their role in Market-Based Chains, Current Regulatory Approach, Fintech Innovations in Banking, Asset Management, Insurance, Pensions and Healthcare Schemes, Patentability of FinTech inventions.

UNIT II CROWDFUNDING AND DIGITAL ASSETS 9

Types of crowdfunding, The Jobs Act, Regulation crowdfunding, Regulation A+, Regulation D crowdfunding, Intrastate offerings, Digital Assets – Three uses of Digital Assets, A world of Altcoins, Stablecoins, Digital Asset Forks, Initial Coin Offerings, Regulatory Framework for Digital and Crypto Assets, Central Bank Digital Currencies.

UNIT IV MARKETPLACE LENDING AND MOBILE PAYMENTS 9

Online Lending Business Models, Payday Loans, Consumer Protection Laws, Debt Collection, Equal Credit Opportunity Act, Contract Formation and the E-Sign Act, Military Lending Act, Securities Laws Considerations, Mobile Devices, Payment Cards and the Law, Truth in Lending Act and Regulation Z, Card Act, Electronic Fund Transfer Act and Regulation E, Fair Credit Reporting Act, Federal Bank Secrecy Act, State Money Transmitter Laws.

UNIT V ANTI-MONEY LAUNDERING AND CYBERSECURITY 9

Reporting requirements under the Bank Secrecy Act, Patriot Act, Panalties for violating the BSA, Virtual currencies and the Bank Secrecy Act, Cybersecurity Frameworks, Cybersecurity Act of 2015, Contractual and Self Regulatory obligations.

TOTAL:45 PERIODS

REFERENCES

1. JelenaMadir, FinTech – Law and Regulation, Edward Elgar Publishing Limited, 2019
2. Valerio Lemma, Fintech Regulation : Exploring New Challenges of the Capital Markets Union, Palgrave Macmillan, 2020
3. Chris Brummer, Fintech Law in a Nutshell, West Academic Publishing, 2020
4. Bernardo Nicoletti, The Future of Fintech, Integrating Finance and Technology in Financial Services, Springer Nature, 2017
5. Kevin C. Taylor, FinTech Law : A Guide to Technology Law in the Financial Services Industry, BNA Books, 2014
6. Lee Reiners, FinTech Law and Policy, 2018

OFD351 HOLISTIC NUTRITION L T P C

3 0 0 3

UNIT I NUTRITION AND HEALTH 9

Introduction to the principles of nutrition; Basics of nutrition including; micronutrients (vitamins and minerals), the energy-yielding nutrients (Carbohydrates, Lipids and Proteins), metabolism, digestion, absorption and energy balance. Lipids: their functions, classification, dietary requirements, digestion & absorption, metabolism and links to the major fatal diseases, heart disease and cancer.

UNIT II AYURVEDA – MIND/BODY HEALING 9

Philosophy of Holistic Nutrition with spiritual and psychological approaches towards attaining optimal health; Principles and practical applications of Ayurveda, the oldest healing system in the world. Three forces – Vata, Pitta and Kapha, that combine in each being into a distinct constitution. Practical dietary and lifestyle recommendations for different constitutions will also be explored in real case studies.

UNIT III NUTRITION AND ENVIRONMENT 9

Based on an underlying philosophy that environments maintain and promote health and that individuals have a right to self-determination and self-knowledge, Nutrition principles which promote health and prevent disease. Safety of our food supply, naturally occurring and environmental toxins in foods, microbes and food poisoning.

UNIT IV COMPARATIVE DIETS 9

Evaluating principles of food dynamics, nutrient proportions, holistic individuality, the law of opposites, food combining, and more. Therapeutic benefits and limitations of several alternative

diet approaches, including: modern diets (intermittent fasting, macrobiotics), food combining (colour-therapy/rainbow diet), high protein diets (Ketogenic, Paleo), Vegetarian approaches (plant-based/vegetarian/vegan variations, fruitarian, raw food), as well as cleansing and detoxification diets (caffeine, alcohol, and nicotine detoxes, juice fasts).

UNIT V PREVENTIVE HEALTH CARE 9

Proper nutrition protection against, reverse and/or retard many ailments including: osteoporosis, diabetes, atherosclerosis and high blood pressure, arthritis, cancer, anemia, kidney disease and colon cancer. Current research developments on phytochemicals, antioxidants and nutraceuticals will be explored.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1 Discuss the role of essential nutrients in physical, mental and emotional wellness
CO2 Discuss the role of deficiencies in essential nutrients in the disease process
CO3 Explain how the standard American diet relates to the disease process
CO4 Identify five contemporary eating “styles” and lists the pros and cons of each
CO5 Discuss the concept of whole foods nutrition and its relationship to wellness

TEXTBOOKS

1. Desai, B. B., Handbook of Nutrition and Diet. Marcel Dekker, New York. 2000
2. Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press

REFERENCES

1. Modern Nutrition in Health & Disease by Young &Shils.
2. Food, Nutrition and Diet Therapy – by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350
3. Nutritive Value of Indian Foods.- by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published by National Institute of Nutrition, Indian Council of Medical Research, 1989

AI3021 IT IN AGRICULTURAL SYSTEM L TP C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the students to areas of agricultural systems in which IT and computers play a major role.
- To also expose the students to IT applications in precision farming, environmental control systems, agricultural systems management and weather prediction models.

UNIT I PRECISION FARMING 9

Precision agriculture and agricultural management – Ground based sensors, Remote sensing, GPS, GIS and mapping software, Yield mapping systems, Crop production modeling.

UNIT II ENVIRONMENT CONTROL SYSTEMS 9

Artificial light systems, management of crop growth in greenhouses, simulation of CO_2 consumption in greenhouses, on-line measurement of plant growth in the greenhouse, models of plant production and expert systems in horticulture.

UNIT III AGRICULTURAL SYSTEMS MANAGEMENT 9

Agricultural systems - managerial overview, Reliability of agricultural systems, Simulation of crop growth and field operations, Optimizing the use of resources, Linear programming, Project scheduling, Artificial intelligence and decision support systems.

UNIT IV WEATHER PREDICTION MODELS9

Importance of climate variability and seasonal forecasting, Understanding and predicting world's climate system, Global climatic models and their potential for seasonal climate forecasting, General systems approach to applying seasonal climate forecasts.

UNIT V E-GOVERNANCE IN AGRICULTURAL SYSTEMS 9

Expert systems, decision support systems, Agricultural and biological databases, e-commerce, e-business systems & applications, Technology enhanced learning systems and solutions, e-learning, Rural development and information society.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. National Research Council, "Precision Agriculture in the 21st Century", National Academies Press, Canada, 1997.
2. H. Krug, Liebig, H.P. "International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation", 1989.

REFERENCES:

1. Peart, R.M., and Shoup, W. D., "Agricultural Systems Management", Marcel Dekker, New York, 2004.
2. Hammer, G.L., Nicholls, N., and Mitchell, C., "Applications of Seasonal Climate", Springer, Germany, 2000.

COURSE OUTCOME:

CO1:The students shall be able to understand the applications of IT in remote sensing applications such as Drones etc.

CO2:The students will be able to get a clear understanding of how a greenhouse can be automated and its advantages.

CO3:The students will be able to apply IT principles and concepts for management of field operations.

CO4:The students will get an understanding about weather models, their inputs and applications.

CO5:The students will get an understanding of how IT can be used for e-governance in agriculture.

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	3	3	3	3	3	3
PO3	Design/ Development of Solutions	3	3	3	3	3	3
PO4	Investigations	2	3	2	1	2	2
PO5	Modern Tool Usage	3	3	3	3	3	3
PO6	Individual and Team work	1	1	2	2	3	2

PO7	Communication	3	3	3	3	3	3
PO8	The Engineer and Society	3	3	2	3	3	3
PO9	Ethics	1	1	2	1	2	1
PO10	Environment and Sustainability	3	3	3	3	3	3
PO11	Project Management and Finance	3	3	3	3	3	3
PO12	Life Long Learning	3	3	3	3	3	3
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

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

OEI352 INTRODUCTION TO CONTROL ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

- To introduce the control system components and transfer function model with their graphical representation
- To understand the analysis of system in time domain along with steady state error.
- To introduce frequency response analysis of systems.
- To accord basic knowledge in design of compensators.
- To introduce the state space models.

UNIT – I MATHEMATICAL MODELLING 9

Introduction – transfer function – simple electrical, mechanical, ,pneumatic , hydraulic and thermal systems–analogies

UNIT -II FEEDBACK CONTROL SYSTEMS9

Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios

UNIT - III TIME DOMAIN ANALYSIS 9

Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

UNIT - IV STABILITY ANALYSIS9

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability,Rootlocus and Bodetechniques, Concept and construction,frequency response.

UNIT - V STATE SPACE TECHNIQUE 9

State vectors–state space models-Digital Controllers–design aspects.

TOTAL: 45 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc) 5

1. Explore various controllers presently used in industries.
2. Develop control structures for industrial processes.
3. Implement the controllers for various transfer functions of industrial systems.
4. Using software tools for practical exposures to the controllers used in industries by undergoing training.
5. Realisation of various stability criterion techniques for economical operation of process.

COURSE OUTCOMES:

CO1 To represent and develop systemsin differentforms using the knowledge gained (L5).
CO2 To analyses the system in time and frequency domain (L4).
CO3 Ability to Derive Transfer function Model of Electrical and Mechanical Systems. (L2)
CO4 Ability to Obtain the transfer Function by the Reduction of Block diagram & Signal flow graph (L3)
CO5 To analyses the stability of physical systems(L4).
CO6 To acquire and analyse knowledge in State variable model for MIMO systems(L1)

TEXT BOOKS:

1. Nagarath, I.J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers,2017.
2. Benjamin C. Kuo, “Automatic Control Systems”, Wiley, 2014

REFERENCES:

1. Katsuhiko Ogata, “Modern Control Engineering”, Pearson, 2015.
2. Richard C. Dorf and Bishop, R.H., “Modern Control Systems”, Pearson Education,2009.
3. John J.D., Azzo Constantine, H. and HoupisSttuart, N Sheldon, “Linear Control System Analysis and Design with MATLAB”, CRC Taylor& Francis Reprint 2009.
4. RamesC.Panda and T. Thyagarajan, “An Introduction to Process Modelling Identification and
Control of Engineers”, Narosa Publishing House, 2017.
5. M. Gopal, “Control System: Principle and design”, McGraw Hill Education, 2012.
6. NPTEL Video Lecture Notes on “Control Engineering “by Prof. S. D. Agashe, IIT Bombay.

List of Open Source Software/ Learning website:

1. https://nptel.ac.in/courses/112107240
2. https://onlinecourses.nptel.ac.in/noc20_me25/preview
3. https://onlinecourses.nptel.ac.in/noc20_ee90/preview
4. https://www.classcentral.com/course/swayam-automatic-control-9850

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 L5	3	3	3	3	-	-	-	1	-	1	-	1			
2 L4	3	3	3	2	-	-	-	1	-	1	-	1			
3 L2	2	1	2	1	-	-	-	1	-	1	-	1			
4 L5	3	3	3	3	-	-	-	1	-	1	-	1			
5 L4	3	3	3	2	-	-	-	1	-	1	-	1			
6 L4	3	3	3	2	-	-	-	1	-	1	-	1			
AVg.	2.8	2.6	3	2.1	-	-	-	1	-	1	-	1			

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

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

CME365 RENEWABLE ENERGY TECHNOLOGIES L T PC

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 ;2 nd edition(1January 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)															

OAE351 AVIATION MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

- To acquire solid background of managerial skills in aviation management
- To develop personality to face business difficulties.
- To control multicultural conditions.
- To identify the relevant analytical and logical skills to deal with problems in the airline industry.
- To learn the concepts of performing well in teams, professionalism, and the knowledge acquired in the field of airport planning, airport security, passengers forecasting, aerodromes work etc

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UNIT I INTRODUCTION 9

History of aviation – organisation, global, social & ethical environment – history of Aviation in India – major players in the airline industry - swot analysis of the different Airline companies in India – market potential of airline industry in India – new airport Development plans – current challenges in the airline industry - competition in the Airline industry – domestic and international from an Indian perspective

UNIT II AIRPORT INFRASTRUCTURE AND MANAGEMENT 8

Airport planning – terminal planning design and operation – airport operations – Airport functions – organisation structure in an airline - airport authority of India - Comparison of global and Indian airport management – role of AAI -airline privatisation - full Privatisation - gradual privatisation – partial privatization

UNIT III AIR TRANSPORT SERVICES 12

Various airport services - international air transport services – Indian scenario – an Overview of airports in Delhi, Mumbai, Hyderabad and Bangalore – the role of private Operators – airport development fees, rates, tariffs

UNIT IV INSTITUTIONAL FRAMEWORK 8

Role of DGCA - slot allocation – methodology followed by AFC and DGCA -management of Bilaterals – economic regulations

UNIT V CONTROLLING 8

Role of air traffic control - airspace and navigational aids – control process – case Studies in airline industry – Mumbai Delhi airport privatisation – Navi Mumbai airport Tendering process – 6 cases in the airline industry

TOTAL : 45 PERIODS

TEXT BOOKS

1. Graham.A. Managing Airports: An International Perspective - Butterworth - Heinemann, Oxford 2001.
2. Wells.A. Airport Planning and Management, 4th Edition McGraw- Hill, London 2000.

REFERENCES

1. Doganis. R. The Airport Business Routledge, London 1992
2. Alexender T. Wells, Seth Young, Principles of Airport Management, McGraw Hill 2003
3. P S SenguttavanFundementals of Air Transport Management , Excel Books 2007
4. Richard de Neufille, Airport Systems: Planning, Design and Management, McGraw-Hill London 2007.
5.. Manual of Aerodrome licensing of AAI airports – AAI website – freely downloadable – issue may 2010

COURSE OUTCOMES:

CO1:To interpret business difficulties.
CO2:To Dissect multicultural conditions.
CO3:To identify and apply the relevant analytical and logical skills to deal with problems in the airline industry.
CO4:To Develop well in teams, professionalism etc.
CO5:To apply the knowledge acquired in the field of airport planning, airport security, passengers forecasting, aerodromes work etc.

CCS342 **DEVOPS** **L T P C**

2 02 3

COURSE OBJECTIVES:

- To introduce DevOps terminology, definition & concepts
- To understand the different Version control tools like Git, Mercurial
- To understand the concepts of Continuous Integration/ Continuous Testing/ Continuous Deployment)
- To understand Configuration management using Ansible
- Illustrate the benefits and drive the adoption of cloud-based Devops tools to solve real world problems

UNIT I INTRODUCTION TO DEVOPS 6

Devops Essentials - Introduction To AWS, GCP, Azure - Version control systems: Git and Github.

UNIT II COMPILE AND BUILD USING MAVEN & GRADLE 6

Introduction, Installation of Maven, POM files, Maven Build lifecycle, Buildphases(compile build, test, package) Maven Profiles, Maven repositories(local, central, global),Maven plugins, Maven create and build Artificats, Dependency management, Installation of Gradle, Understand build using Gradle

UNIT III CONTINUOUS INTEGRATION USING JENKINS 6

Install & Configure Jenkins, Jenkins Architecture Overview, Creating a Jenkins Job, Configuring a Jenkins job, Introduction to Plugins, Adding Plugins to Jenkins, Commonly used plugins (Git Plugin, Parameter Plugin, HTML Publisher, Copy Artifact and Extended choice parameters). Configuring Jenkins to work with java, Git and Maven, Creating a Jenkins Build and Jenkins workspace.

UNIT IV CONFIGURATION MANAGEMENT USING ANSIBLE 6

Ansible Introduction, Installation, Ansible master/slave configuration, YAML basics, Ansible modules, Ansible Inventory files, Ansible playbooks, Ansible Roles, adhoc commands in ansible

UNIT V BUILDING DEVOPS PIPELINES USING AZURE 6

Create Github Account, Create Repository, Create Azure Organization, Create a new pipeline, Build a sample code, Modify azure-pipelines.yaml file

COURSE OUTCOMES:

CO1: Understand different actions performed through Version control tools like Git.

CO2: Perform Continuous Integration and Continuous Testing and Continuous Deployment using Jenkins by building and automating test cases using Maven & Gradle.

CO3: Ability to Perform Automated Continuous Deployment

CO4: Ability to do configuration management usingAnsible

CO5: Understand to leverage Cloud-based DevOps tools using Azure DevOps

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

1. Create Maven Build pipeline in Azure
2. Run regression tests using Maven Build pipeline in Azure
3. Install Jenkins in Cloud
4. Create CI pipeline using Jenkins
5. Create a CD pipeline in Jenkins and deploy in Cloud

6. Create an Ansible playbook for a simple web application infrastructure
7. Build a simple application using Gradle
8. Install Ansible and configure ansible roles and to write playbooks

TEXT BOOKS

1. Roberto Vormittag, “A Practical Guide to Git and GitHub for Windows Users: From Beginner to Expert in Easy Step-By-Step Exercises”, Second Edition, Kindle Edition, 2016.
2. Jason Cannon, “Linux for Beginners: An Introduction to the Linux Operating System and Command Line”, Kindle Edition, 2014

REFERENCES

1. Hands-On Azure Devops: Cicd Implementation For Mobile, Hybrid, And Web Applications Using Azure DevopsAnd Microsoft Azure: CICD Implementation for ... DevOps and Microsoft Azure (English Edition) Paperback – 1 January 2020
2. by Mitesh Soni
3. Jeff Geerling, “Ansible for DevOps: Server and configuration management for humans”, First Edition, 2015.
4. David Johnson, “Ansible for DevOps: Everything You Need to Know to Use Ansible for DevOps”, Second Edition, 2016.
5. Mariot Tsitoara, “Ansible 6. Beginning Git and GitHub: A Comprehensive Guide to Version Control, Project Management, and Teamwork for the New Developer”, Second Edition, 2019.
6. https://www.jenkins.io/user-handbook.pdf
7. https://maven.apache.org/guides/getting-started/

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	2	3	-	-	-	-	-	-	-	2	2	2
2	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
3	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
4	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
5	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2
AVg.	3	3	3	2	3	-	-	-	-	-	-	-	2	2	2

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

CCS361 ROBOTIC PROCESS AUTOMATION L T P C

2 02 3

COURSE OBJECTIVES:

- To understand the basic concepts of Robotic Process Automation.
- To expose to the key RPA design and development strategies and methodologies.
- To learn the fundamental RPA logic and structure.
- To explore the Exception Handling, Debugging and Logging operations in RPA.
- To learn to deploy and Maintain the software bot.

UNIT I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION 6

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files.

UNIT II AUTOMATION PROCESS ACTIVITIES 6

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events

UNIT III APP INTEGRATION, RECORDING AND SCRAPING 6

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.

UNIT IV EXCEPTION HANDLING AND CODE MANAGEMENT 6

Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.

UNIT V DEPLOYMENT AND MAINTENANCE 6

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open SourceRPA, Future of RPA

30 PERIODS

PRACTICAL EXERCISES: 30 PERIODS

Setup and Configure a RPA tool and understand the user interface of the tool:

1. Create a Sequence to obtain user inputs display them using a message box;
2. Create a Flowchart to navigate to a desired page based on a condition;
3. Create a State Machine workflow to compare user input with a random number.
4. Build a process in the RPA platform using UI Automation Activities.
5. Create an automation process using key System Activities, Variables and Arguments
6. Also implement Automation using System Trigger
7. Automate login to (web)Email account
8. Recording mouse and keyboard actions.
9. Scraping data from website and writing to CSV
10. Implement Error Handling in RPA platform
11. Web Scraping
12. Email Query Processing

TOTAL:60 PERIODS

TEXT BOOKS:

1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, PacktPublishing, 2018.
2. Tom Taulli , “The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems”, Apress publications, 2020.

REFERENCES:

1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018
2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018
3. A Gerardus Blokdyk, “Robotic Process Automation RpaA Complete Guide “, 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	2	2	1	3	-	-	-	1	3	3	2	2	2	1
2	1	1	2	3	3	-	-	-	1	2	3	1	3	2	1
3	2	3	2	3	3	-	-	-	2	3	1	1	3	3	3
4	1	2	1	2	2	-	-	-	1	2	1	3	3	3	2
5	3	3	3	3	3	-	-	-	3	1	1	1	3	2	1
AVg.	2	2.2	2	2.4	2.8	-	-	-	1.6	2.2	1.8	1.6	2.8	2.4	1.6

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

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:

1. Selecting sensors to develop mechatronics systems.
2. Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
3. Designing appropriate interfacing circuits to connect I/O devices with microprocessor.
4. Applying PLC as a controller in mechatronics system.
5. 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 alsointerpret and develop programs.
CO3: Design appropriate interfacing circuits to connect I/O devices withmicroprocessor.
CO4: Apply PLC as a controller in mechatronics system.
CO 5: Design and develop the apt mechatronics system for an application.

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

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. NitaigourPremchand 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.

OMR353 **SENSORS** **LT P C**
3 00 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.

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

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. NitaigourPremchand 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.

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

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

OAS352 SPACE ENGINEERING L TP 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 manoeuvressix orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Illustrate the history of aviation & developments over the years
- Ability to identify the types & classifications of components and control systems
- Explain the basic concepts of flight & Physical properties of Atmosphere
- Identify the types of fuselage and constructions.
- 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.

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.

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

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.

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

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. DoebelinDhaneshN.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.

OML352 ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALSL 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.

REFERENCE BOOKS:

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	PO10	PO11	PO12	PSO1	PSO2	PSO3
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

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

OML353 NANOMATERIALS AND APPLICATIONS L TP 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 characterisethe 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
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

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

CCS355 NEURAL NETWORKS AND DEEP LEARNING LTPC

2 023

COURSE OBJECTIVES:

- To understand the basics in deep neural networks
- To understand the basics of associative memory and unsupervised learning networks
- To apply CNN architectures of deep neural networks

- To analyze the key computations underlying deep learning, then use them to build and train deep neural networks for various tasks.
- To apply autoencoders and generative models for suitable applications.

UNIT I INTRODUCTION 6

Neural Networks-Application Scope of Neural Networks-Artificial Neural Network: An Introduction-Evolution of Neural Networks-Basic Models of Artificial Neural Network- Important Terminologies of ANNs-Supervised Learning Network.

UNIT II ASSOCIATIVE MEMORY AND UNSUPERVISED LEARNING NETWORKS 6

Training Algorithms for Pattern Association-Autoassociative Memory Network-Heteroassociative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks-Iterative Autoassociative Memory Networks-Temporal Associative Memory Network-Fixed Weight Competitive Nets-Kohonen Self-Organizing Feature Maps-Learning Vector Quantization-Counter propagation Networks-Adaptive Resonance Theory Network.

UNIT III THIRD-GENERATION NEURAL NETWORKS 6

Spiking Neural Networks-Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model-Convolutional Neural Networks: The Convolution Operation – Motivation – Pooling – Variants of the basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms – Neuroscientific Basis – Applications: Computer Vision, Image Generation, Image Compression.

UNIT IV DEEP FEEDFORWARD NETWORKS 6

History of Deep Learning- A Probabilistic Theory of Deep Learning- Gradient Learning – Chain Rule and Backpropagation - Regularization: Dataset Augmentation – Noise Robustness -Early Stopping, Bagging and Dropout - batch normalization- VC Dimension and Neural Nets.

UNIT V RECURRENT NEURAL NETWORKS 6

Recurrent Neural Networks: Introduction – Recursive Neural Networks – Bidirectional RNNs – Deep Recurrent Networks – Applications: Image Generation, Image Compression, Natural Language Processing. Complete Auto encoder, Regularized Autoencoder, Stochastic Encoders and Decoders, Contractive Encoders.

30 PERIODS

LAB EXPERIMENTS:

1. Implement simple vector addition in TensorFlow.
2. Implement a regression model in Keras.
3. Implement a perceptron in TensorFlow/Keras Environment.
4. Implement a Feed-Forward Network in TensorFlow/Keras.
5. Implement an Image Classifier using CNN in TensorFlow/Keras.
6. Improve the Deep learning model by fine tuning hyper parameters.
7. Implement a Transfer Learning concept in Image Classification.
8. Using a pre trained model on Keras for Transfer Learning
9. Perform Sentiment Analysis using RNN
10. Implement an LSTM based Autoencoder in TensorFlow/Keras.
11. Image generation using GAN

Additional Experiments:

12. Train a Deep learning model to classify a given image using pre trained model
13. Recommendation system from sales data using Deep Learning
14. Implement Object Detection using CNN

15. Implement any simple Reinforcement Algorithm for an NLP problem

30 PERIODS
TOTAL:60 PERIODS

COURSE OUTCOMES:

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

CO1: Apply Convolution Neural Network for image processing.
CO2: Understand the basics of associative memory and unsupervised learning networks.
CO3: Apply CNN and its variants for suitable applications.
CO4: Analyze the key computations underlying deep learning and use them to build and train deep neural networks for various tasks.
CO5: Apply autoencoders and generative models for suitable applications.

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
2. Francois Chollet, “Deep Learning with Python”, Second Edition, Manning Publications, 2021.

REFERENCES:

3. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, Oreilly, 2018.
4. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner’s Approach”, O’Reilly Media, 2017.
5. Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook”, Springer International Publishing, 1st Edition, 2018.
6. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
7. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
8. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017.
9. S Rajasekaran, G A Vijayalakshmi Pai, “Neural Networks, FuzzyLogic and Genetic Algorithm, Synthesis and Applications”, PHI Learning, 2017.
10. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017
11. James A Freeman, David M S Kapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Addison Wesley, 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	3	2	3	1	-	-	2	1	-	-	2	2	1
2	3	1	2	1	-	-	-	-	-	1	2	2	-	1	-
3	3	3	3	3	3	1	-	-	2	1	-	-	2	2	1
4	3	3	3	3	3	-	-	-	2	-	2	3	2	2	2
5	1	1	3	2	3	-	-	-	2	-	-	-	1	1	-
AVg.	2.6	2	2.8	2.2	2.4	0.4	0	0	1.6	0.6	0.8	1	1.4	1.6	0.8

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

OPEN ELECTIVE – II

OHS351 ENGLISH FOR COMPETITIVE EXAMINATIONS L TP 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.

UNITII **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.

UNITIII **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.

UNITIV **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.

UNITV **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:writetopic based essays with precision and accuracy

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	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.

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.

REFERENCEBOOKS:

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/

OBT351 FOOD, NUTRITION AND HEALTH L T P C

3 0 0 3

COURSE OBJECTIVES:

- Build knowledge and an overview on general aspects of nutrition and health.
- Distinguish the nutritive value of various food items, BMI calculation differentiating super junk, and functional foods in the market.
- To Solve the real-world problems based on nutrition and health

UNIT-I FOOD AND MICROBIOLOGY OF HEALTH: 9

Food resources (plant, animal, microbes); Overview of current production systems; constraints and necessity of novel strategies.Functional and "Super" Foods - role in optimal nutrition. Sugar, protein and fat substitutes. Food and behaviour- physiological disturbances in alcoholism, drug abuse and smoking.Food Related Laws: Inspection – Microbial Indicators of product quality – Indicators of food safety – 229 Microbiological safety of foods - control strategies – Hazard Analysis Critical Point System (HACCP concept)- Microbiological criteria.

UNIT-II NUTRIENTS AND FOOD ADDITIVES: 9

Macro nutrients- carbohydrates, proteins and lipids. Micronutrients-Minerals: Calcium, Magnesium, Iron, Zinc, Copper and Selenium; Vitamins. Nutritional Physiology**:** Digestion, absorption, and utilization of major and minor nutrients. Biotechnology of food additives- Bioflavors and colors, microbial polysaccharides, recombinant enzymes in food sector.

UNIT-III NANO FOOD TECHNOLOGY: 9

Nano materials as food components, food packaging and nano materials, policies on usage of nanomaterials in foods. Food product development: steps involved in food product development, shelf-life assessment.

UNIT-IV FOOD RELATED NUTRITIONAL DISORDERS AND ENERGY CALCULATION9

Type I Disorders-Causes of life style and stress related diseases. Cardio-vascular diseases, hypertension, obesity. Type-II Disorders: Cancer, diabetics, ulcers, electrolyte and water imbalance. Health indices. Preventive and remedial measures.Energy balance and methods to calculate individual nutrient and energy needs. Planning a healthy diet.

UNIT-V CONSUMERS ON GM FOODS AND CONTEMPORARY ISSUES: 9

Global perspective of consumers on GM foods; Major concerns of transgenic, foods GM ingredients in food products. (labeling, bioavailability, safety aspects); regulatory agencies involved in GM foods, Case studies- GM foods.

TOTAL:45 PERIODS

TEXT BOOK(S):

1. P.J. Fellows.2009. Food Processing Technology -Principles and Practice (Third Edition). A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition.
2. Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto, Robert E. Levin. 2015. Food Biotechnology. CRC Press. Second edition.

REFERENCE BOOKS:

1. Understanding Nutrition. 2010. Ellie Whitney, Sharon Rady Rolfes, 11e. Thompson Wadsworth. 2.

2. Nutritional Sciences- From Fundamentals to Food.2013. Michelle McGuire, Kathy A. Beerman, 2 nd e. Thompson Wadsworth.
3. Yasmine Motarjemi, Huub Lelieveld, Food Safety Management - A Practical Guide for the Food Industry (2014), 1st Edition, Academic Press, London, UK

EXPECTED COURSE OUTCOME:

1.To be able to understand the nutritional values of the various types of foods
2.To be able to Analyze the role of food in the metabolic activity of the healthy diet
3. To be able to Infer the BMI calculation and stress related diseases.
4. To be able to Elaborate the independent decision on the choice of food to prevent life style disorders and diseases
5. To be able to Assess about the food laws governance
6. To be able to Compare junk, modified and super foods

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.

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 MinimumUsable Prototype [MUP] -MUP challengebrief - Designing & Craftingthe 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 Hours

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 Hours

.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 Hours

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 Hours

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 Hours

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.

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 GROUPDYNAMICS 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

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

OIE354 QUALITY ENGINEERING L TP 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

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		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

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

OSF351 FIRE SAFETY ENGINEERING L TP C

3 00 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

- Roytman, M. Y,"Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi,1975
- John A. Purkiss,"Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK,2009.

REFERENCES:

2. 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.
3. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A.1983.
4. 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
5. Frank R. Spellman, Nancy E. Whiting,"The Handbook of Safety Engineering: Principles and Applications", 2009

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	-	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	-	-	-

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

OML351 INTRODUCTION TO NON-DESTRUCTIVE TESTING LTP 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	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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

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

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 REMOTESENSING 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 MATERIAL9

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 PLATFORMS9

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 TECHNIQUES9

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

CO 1 Understand the concepts and laws related to remote sensing
CO 2 Understand the interaction of electromagnetic radiation with atmosphere and earth material
CO 3 Acquireknowledgeaboutsatelliteorbitsanddifferenttypesofsatellites
CO 4 Understandthedifferent typesofremote sensors
CO 5 Gainknowledgeabouttheconcepts ofinterpretation ofsatelliteimagery

TEXTBOOKS:

1. ThomasM.Lillesand,RalphW.KieferandJonathanW.Chipman,RemoteSensingandImageinterpretation,JohnWiley andSons,Inc,New York,2015.
2. GeorgeJosephandCJeganathan,FundamentalsofRemoteSensing,ThirdEditionUniversities Press(India) Privatelimited,Hyderabad,2018

REFERENCES:

1. Janza, F.Z.,Blue H.M.and Johnson,J.E. ManualofRemoteSensing.Vol.1, AmericanSocietyofPhotogrametry,Virginia,USA,2002.
2. Verbyla,David,SatelliteRemoteSensing ofNatural Resources.CRCPress,1995
3. PaulCurran P.J.Principles ofRemote Sensing.Longman, RLBS,1988.
4. IntroductiontoPhysicsandTechniquesofRemote Sensing, CharlesElachi and JacobVanZyl,2006EditionII,Wiley Publication.
5. BasudebBhatta,RemoteSensing andGIS,Oxford UniversityPress,2011

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

PO	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						
PO 7	Environment and Sustainability						
PO 8	Ethics						
PO 9	Individual and Team Work						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning	3		3	3	3	3
PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

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

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		CO1	CO2	CO3	CO4	CO5	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
PSO1	To make expertise in design and engineering problem solving approach in agriculture with proper knowledge and skill	1	2	1	1	2	1
PSO2	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
PSO3	To inculcate entrepreneurial skills through strong Industry-Institution linkage.	1	2	1	2	1	2

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

OEN351 DRINKING WATER SUPPLY AND TREATMENT LTP C

300 3

COURSE OBJECTIVE:

- To equipthestudentswiththeprinciplesanddesignofwatertreatmentunitsanddistribution system.

UNITI SOURCES OF WATER 9

Publicwatersupplysystem–
Planning,Objectives,Designperiod,Populationforecasting;Waterdemand–
Sourcesofwaterandtheircharacteristics,SurfaceandGroundwater–ImpoundingReservoir–
Developmentandselectionofsource–SourceWaterquality–Characterization–Significance–
DrinkingWater quality standards.

UNITII CONVEYANCEFROM THESOURCE 9

Watersupply–intakestructures–Functions;Pipesandconduitsforwater–Pipematerials–Hydraulicsofflowinpipes–Transmissionmaindesign–Laying,jointingandtestingofpipes–appurtenances–Typesandcapacity ofpumps–Selection ofpumps andpipematerials.

UNITIII WATERTREATMENT 9

Objectives–Unitoperationsandprocesses–Principles,functions,anddesignofwatertreatmentplantunits,aeratorsofflashmixers,Coagulationandflocculation–-sandfilters-Disinfection-–Construction,Operation and Maintenanceaspects.

UNITIV ADVANCEDWATERTREATMENT 9

Watersoftening–Desalination-R.O.Plant–demineralization–Adsorption-Ionexchange–MembraneSystems-IronandManganeseremoval-Defluoridation-Construction and Operation and Maintenanceaspects

UNITV WATERDISTRIBUTIONANDSUPPLY 9

Requirementsofwaterdistribution– Components– Selectionofpipe material – Servicereservoirs - Functions–Networkdesign–Economics- Computerapplications – Appurtenances– Leakdetection - Principlesofdesignofwatersupplyinbuildings–Houseserviceconnection–Fixturesandfittings,systemsofplumbingandtypesofplumbing.

TOTAL:45PERIODS

COURSE OUTCOMES

CO1: anunderstandingofwaterqualitycriteriaandstandards,andtheirrelationtopublichealth
CO2: the ability to design the water conveyance system
CO3: theknowledgeinvariousunitoperationsandprocessesinwatertreatment
CO4: an ability to understandthevarious systems for advanced watertreatment
CO5: aninsightintothestructureofdrinkingwaterdistribution system

TEXTBOOKS:

1. Garg.S.K.,"Water SupplyEngineering",KhannaPublishers,Delhi,September 2008.
2. PunmiaB.C,ArunK.Jain,AshokK.Jain,“WatersupplyEngineering”Lakshmipublication privatelimited, NewDelhi,2016.
3. Rangwala "WaterSupply andSanitary Engineering", February 2022
4. Birdie.G.S., "WaterSupply andSanitary Engineering",Dhanpat Rai andsons,2018.

REFERENCES:

1. Fair.G.M.,Geyer.J.C.,"WaterSupplyandWastewaterDisposal",JohnWileyandSons,1954.
2. Babbit.H.E,andDonald.J.J,"WaterSupplyEngineering" ,McGrawHillbookCo,1984.
3. Steel.E.W.et al.,"Water SupplyEngineering" ,McGrawHillInternational bookCo,1984.
4. Duggal.K.N.,“ElememtsofpublicHealthEngineering”,S.ChandandCompanyLtd, NewDelhi,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.

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	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
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

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

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

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

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

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														
		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 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 of composite nano materials and their interference	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**-**	**1**	**1**	**-**	**3**	**2**	**1**	**3**
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**

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

OCH352 FUNCTIONAL MATERIALS L T P C

3 00 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.

OPY351 PHARMACEUTICAL NANOTECHNOLOGY L T P C

3 0 0 3

COURSE OBJECTIVES:

- The goal of this course is to provide an insight into the fundamentals of nanotechnology in biomedical and Pharmaceutical research. It will also guide the students to understand how nanomaterials can be used for a diversity of analytical and medicinal rationales.

UNIT I NANOSTRUCTURES 9

Preparation, properties and characterization - Self-assembling nanostructure - vesicular and micellar polymerization-nanofilms - Metal Nanoparticles- lipid nanoparticles- nanoemulsion - Molecular nanomaterials: dendrimers, etc.,

UNIT II NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY 9

Reconstructive Intervention and Surgery- Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis -in vivo imaging- genetic defects and other disease states — Nanorobotics in Surgery –Nanocarriers: sustained, controlled, targeted drug delivery systems.

UNIT III NANOTECHNOLOGY IN CANCER THERAPY 9

Cancer Cell Targeting and Detection- Polymeric Nanoparticles for cancer treatment – mechanism of drug delivery to tumors -advantages and limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.

UNIT IV NANOTECHNOLOGY IN COSMETICS 9

Polymers in cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-conditioners -Micellar self-assembly Sun-screen dispersions for UV protection – Color cosmetics.

UNIT V NANOTOXICITY 9

NanoToxicology- introduction, dose relationship- Hazard Classification-Risk assessment and management - factors affecting nano toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular effects of Nanoparticles - Gene–Cellular and molecular Interactions of Nanomaterials.

TOTAL:45 PERIODS

COURSE OUTCOMES:

The student will be able to

CO1:Identify the process for the preparation and characterization of the different nanostructured materials.

CO2:Apply the nanotechnology in biomedical discipline with related to drug delivery and disease diagnosis

CO3:Develop the process, experiments and apply in identifying in a societal and global context.

CO4:Design and develop the process with suitable equipment for the preparation of nanomaterials in developing cosmetic products.

CO5:Understand the ethical principles to confirm the safety of the nano products with respect to risk assessment and its management.

CO6:Have the knowledge about nanotechnology products and its different applications in a societal and global context.

TEXT BOOKS:

1. Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag 2004
2. Nanobiotechnology: Concepts, Applications and Perspectives,.CM.Niemeyer C A. Mirkin, (Eds) , Wiley, 2004
3. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, Second Edition, CRC Press, 2013
4. Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead “Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics”, American Chemical Society, 2006.

REFERENCES:

1. Nanotechnology in Biology and Medicine: Methods, Devices and Applications, Tuan VoDinh, CRC Press, 2007
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag 2004
3. Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.

CO’s-PO’s & PSO’s MAPPING

Course Outcome Statements	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4

CO1	3	3							1	2		2	3			2
CO2	3	3			2	2	3							3		
CO3		3	3	3	2	2			1				3		3	
CO4			3	3		2			1						3	
CO5						3		3	2			2	3			3
CO6	3		3			2						2	3		3	2
OverallCO	3	3							1	2		2	3			2

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

(1, 2and3arecorrelationlevelswithweightingsasSlight (Low), Moderate(Medium)and Substantial (High) respectively.)

CPE334 ENERGYCONSERVATIONANDMANAGEMENT LTPC 3003

COURSE OBJECTIVES:

Attheendofthecourse,thestudentisexpectedto

- understandandanalysetheenergydataof industries
- carryoutenergyaccountingandbalancing
- conductenergyauditandsuggestmethodologiesforenergysavingsand
- utilisetheavailableresourcesinoptimalways

UNITIINTRODUCTION 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.

UNITII ELECTRICALSYSTEMS 9

ComponentsofEBbilling –HTandLTsupply,Transformers,CableSizing,ConceptofCapacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy EfficientMotors,Illumination –Lux,Lumens,Typesof lighting,Efficacy,LEDLighting andscopeof Encon in Illumination.

UNITIII THERMALSYSTEMS 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

UNITIV ENERGYCONSERVATIONINMAJORUTILITIES 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNITVECONOMICS 9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Uponcompletionofthiscourse,thestudentscanabletoanalyzetheenergydataof 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.

TEXTBOOKS:

1. EnergyManagerTrainingManual(4Volumes)availableatwww.energymanagertraining.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,"IndustrialEnergyManagementand Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W."Design and Managementfor EnergyConservation", Pergamon Press, Oxford, 1981.
3. Dryden.I.G.C.,"TheEfficientUseofEnergy"Butterworths,London,1982
4. Turner.W.C.,"EnergyManagementHandbook",Wiley,NewYork,1982.
5. Murphy.W.R.andG.McKAY,"EnergyManagement",Butterworths,London1987

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 Proposetroubleshootingmechanismsfordefectsfoundinplasticsproductsmanufacturedbyvariousprocessingtechniques

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).

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 INDUSTRY9

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.															

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

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.	**3**	**1**	**1**	**1**	**1**										

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

OMA352 OPERATIONS RESEARCHL TP C

3 0 0 3

COURSE OBJECTIVES:

This coursewill helpthe students to

- determine theoptimum solutionfor Linearprogramming problems.
- study theTransportation andassignment modelsand 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 andmixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.

UNIT IV DYNAMIC PROGRAMMING PROBLEMS 9

Recursive natureof computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution ofL.P.P bydynamic 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 theend ofthe course, studentswill beable to

CO1: Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply thesimplex methodfor solvinglinear 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:determinethe optimumsolution fornon linear programming problems.

TEXT BOOKS:

1. Kanti Swarup, P.K.Guptaand ManMohan, " Operations Research " , Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.
2. Taha. H.A, " Operations Research –An Introduction, PearsonEducation, NinthEdition ,New Delhi, 2012.

REFERENCES :

1. J.K.Sharma , " Operations Research - Theory and Applications " MacMillan IndiaLtd , Second Edition , New Delhi , 2003.
2. Richard Bronson &GovindasamiNaadimuthu , " Operations Research " (Schaum's Outlines – TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford UniversityPress, NewDelhi , 2012.
4. J.P.Singhand N.P.Singh , " Operations Research , Ane Books Pvt.L.td, NewDelhi , 2014.
5. F.S.Hillierand G.J.Lieberman, "Introduction toOperations Research" , Tata McGraw Hill, EighthEdition , 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	-	-	-

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

OCE353 LEAN CONCEPTS, TOOLS AND PRACTICES L T P C
3 00 3

COURSE OBJECTIVE:

- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

UNIT I INTRODUCTION 9

Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

UNIT II LEAN MANAGEMENT 9

Introduction to lean management - Toyota's management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

UNIT III CORE CONCEPTS IN LEAN 9

Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

UNIT IV LEAN TOOLS AND TECHNIQUES 9

Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting- Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

UNIT V LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY 9

Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

TOTAL : 45 PERIODS

COURSE OUTCOME:

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

CO1 Explains the contemporary management techniques and the issues in present scenario.
CO2 Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.
CO3 Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
CO4 Apply lean techniques to achieve sustainability in construction projects.
CO5 Apply lean construction techniques in design and modeling.

REFERENCES:

1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

OHS352 PROJECT REPORT WRITING L TP 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.

UNITI **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.

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.

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.

OMA355 ADVANCED NUMERICAL METHODS L T P C
3 00 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 EQUATIONSAND EIGENVALUE PROBLEM9

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 FORORDINARY 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; Waveequation : 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	-	-	-

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

OMA357 QUEUEING AND RELIABILITY MODELLING L T P C
3 00 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 – PollaczekKhinchinformula - 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 phenomenonwhich 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	-	-	-

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

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 :

CO 1 To understand the basics and functions of Production and Operation Management for business owners.

CO 2 To learn about the Production & Operation Systems.

CO 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.

CO 4 To known about the Production & Operations Management Processes in organisations.

CO 5 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.

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.

CO3:Develop Feasibility Studies & reporting of New Product development

CO4:Analyzing the New product qualification and Market Survey on similar products of new product development

CO5:Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

TEXT BOOKS:

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

REFERENCES:

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. 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
1 - low, 2 - medium, 3 - high, '-' - no correlation															

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 UserInterface Design - Layout andcomposition forWeb, Mobileand 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 - Introductionto AppDevelopment - Types of Apps- web Development - understandingStack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing datato cloud- Embedding ML models toApps - Deploying application.

UNIT III INDUSTRIAL DESIGN 9

Introduction toIndustrial 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

COURSEOUTCOMES

Attheendofthecourse,learners willbeableto:

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

TEXTBOOKS

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN AmericaLlc(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-started.html
2. https://developer.android.com/guide
3. https://help.autodesk.com/view/fusion360/ENU/courses/
4.https://help.prusa3d.com/en/category/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 P C
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 **t**o 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.

REFERENCE BOOKS

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

OIE353 OPERATIONSMANAGEMENT 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.

UNITI INTRODUCTION TOOPERATIONS MANAGEMENT 9

Operations Management – Nature, Importance, historical development,transformation processes,differences between services and goods, a system perspective, functions, challenges, currentpriorities,recenttrends;OperationsStrategy– Strategicfit,framework;SupplyChainManagement

UNITII FORECASTING,CAPACITYAND FACILITY DESIGN 9

DemandForecasting– Need,Types,COURSE OBJECTIVESandSteps.OverviewofQualitativeandQuantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives.Overviewofsalesandoperationsplanning.OverviewofMRP,MRPIIandERP.Facility Location – Theories, Steps in Selection, Location Models.Facility Layout – Principles,Types,Planningtoolsandtechniques.

UNITIII DESIGNOFPRODUCT,PROCESSAND WORKSYSTEMS 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 ProductivityandMethodstoimproveproductivity.

UNITIV MATERIALSMANAGEMENT 9

MaterialsManagement–COURSE OBJECTIVES,Planning,BudgetingandControl.Purchasing– COURSE OBJECTIVES,Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout,ClassificationandCoding.Inventory–COURSE OBJECTIVES,Costsandcontroltechniques.OverviewofJIT.

UNITV SCHEDULINGANDPROJECTMANAGEMENT 9

ProjectManagement–SchedulingTechniques,PERT,CPM;Scheduling-workcenters– nature,importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson"sAlgorithm–Ganttcharts;personnelschedulinginservices.

TOTAL:45PERIODS

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.

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	3											3	3
3		2	3	3									2	3	
4		3	3	3									2	3	
5			3	2											
AVg.	3	2.6	3	2.6								2	2	3	3

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

TEXTBOOKS

1. RichardB.Chase,RaviShankar,F.RobertJacobs,NicholasJ.Aquilano, OperationsandSupplyManagement, TataMcGraw Hill,12th Edition,2010.
2. Norman Gaither and Gregory Frazier, Operations Management, South Western CengageLearning,2002.

REFERENCES

1. WilliamJStevenson,OperationsManagement, TataMcGrawHill,9th Edition,2009.
2. RusselandTaylor,Operations Management,Wiley,FifthEdition,2006.
3. KanishkaBedi, Production andOperations Management, OxfordUniversityPress,2004.
4. CharyS. N,Production andOperationsManagement, TataMcGrawHill,ThirdEdition,2008.
5. AswathappaKandShridharaBhatK,ProductionandOperationsManagement,HimalayaPublishingHouse,RevisedSecondEdition,2008.
6. Mahadevan B,OperationsManagementTheoryand practice, PearsonEducation,2007.
7. PannerselvamR,ProductionandOperationsManagement,PrenticeHallIndia,SecondEdition,2008.

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 EDUCATION9

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 ,acidfumes ,smoke, fog on human health, Vibration: effects.

TOTAL PERIODS: 45

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

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		-	-	1	-	-	-	1	-	-	-	-
3	-		-		2	-	-	-	-	-	2	-	-	-	-
4	-		-		-	-	-	-	2	-	3	-	-	-	-
5	-		-		-	-	-	1	-	-	-	-	-	-	-
AVg.	2	-	2	-	-	-	1	1	2	-	2		-	-	-

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

OSF353 CHEMICAL PROCESS SAFETY L TP 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 andprocesses, Reactivity as a process hazard, Detonations, Deflagrations, andRunaways, 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 betweeninherent safetyand engineeredsafety and recognize the importance of safetyin 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

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

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.

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

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

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.

OGI352 GEOGRAPHICAL INFORMATION SYSTEM **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- 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 MODELS9

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 TOPOLOGY9

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 STANDARDS9

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.

REFERENCES:

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: GEOGRAPHICAL INFORMATION SYSTEM

PO	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	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						
PO 10	Communication						
PO 11	Project Management and Finance						
PO 12	Life-long Learning						

PSO 1	Knowledge of Geoinformatics discipline	3	3	3	3	3	3
PSO 2	Critical analysis of Geoinformatics Engineering problems and innovations	3	3	3	3	3	3
PSO 3	Conceptualization and evaluation of Design solutions	3	3	3	3	3	3

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

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 ININDIANCONTEXT 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:LEGALPERSPECTIVE 9

Importance of agribusiness in Indian economy - International trade-WTO agreements-Provisionsrelatedtoagreementsinagriculturalandfoodcommodities-Agreementson 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)-sensitivityanalysis.

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.

UNITV 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), contractframing (CF) andJoint 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, NewDelhi
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 theFarm Business, Prentice Hall Inc, NewJersey
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, NewJersey
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, NewJersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, NewJersey.

CO’s-PO’s & PSO’s MAPPING

PO/PSO		**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**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

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

OEN352 BIODIVERSITY CONSERVATION LTP C
300 3

COURSE OBJECTIVE:

- Theidentificationofdifferentaspectsofbiologicaldiversityandconservationtechniques.

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:45PERIODS

TEXTBOOKS:

1. AtextbookofBotany:Angiosperms-Taxonomy,Anatomy,EconomicBotany&Embryology.S.Chand,Limited,Pandey, B. P. January 2001
2. PrinciplesofSystematic Zoology,Mcgraw-HillCollege,Ashlock, P.D.,LatestEdition.
3. Microbiology, MacGrawHill Companies Inc, Prescott,L.M.,Harley, J.P., and KleinD.A.(2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L.Case, 13th Edition 2019

REFERENCES:

1. Ecological Census Technique: AHandbook,Cambridge UniversityPress, Sutherland,W.
2. Encyclopedia ofBiodiversity,Academic Press, Simonson AsherLevin.

COURSE OUTCOMES

Uponsuccessfulcompletionofthiscourse,studentswill:

CO1: Aninsightintothestructureandfunctionofdiversityforecosystemstability.

CO2: Understand the concept of animal diversity and taxonomy

CO3: Understand socio-economic issues pertaining to biodiversity

CO4: Anunderstandingofbiodiversityincommunityresourcemanagement.

CO5: Studentcanapplyfundamentalknowledgeofbiodiversityconservationtosolveproblems associatedwith infrastructuredevelopment.

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		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.

OCH354 SURFACE SCIENCE L T P C

3 00 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

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.

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

TOTAL:45 PERIODS

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.	3	2	1	1	2			1					1		1

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

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 managementand informationsystem, Functional capabilities of a computerized HI S, 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

REFERENCES:

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.	3	2	1	1	2			1					1	1	1

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

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.

REFERENCE BOOKS

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

LEARNING 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 INVESTMENTLT 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, defaultriskandcreditrating.

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

InsurTechIntroduction , Business model disruption AI/ML in InsurTech ● IoT and InsurTech ,RiskModeling ,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

REFERENCE

1. Swanson Seth, Fintech for Beginners: Understanding and Utilizing the power of technology, Createspace Independent Publishing Platform,2016.
2. Models AuTanda, Fintech BigtechAnd 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 entreprenerushiip - NGO Entrepreneurship – Recent Entrperneruial Develoments - Local – National – Global perspectives.

TOTAL45 : PERIODS

COURSE OUTCOMES:

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of Entrepreneurship

CO 2 Understand the business ownership patterns and evnironment

CO 3 Understand the Job opportunites in Industries relating to Technopreneurship

CO 4 Learn about applications of tehnopreneurship and successful technopreneurs

CO 5 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:

CO 1 Learn the basics of managing teams for business.

CO 2 Understand developing effective teams for business management.

CO 3 Understand the fundamentals of leadership for running a business.

CO 4 Learn about the importance of leadership for business development.

CO 5 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 TP 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:

CO 1 Learn the basics of creativity for developing Entrepreneurship

CO 2 Understand the importance of creative inteligence for business growth
CO 3 Understand the advances through Innovation in Industries
CO 4 Learn about applications of innovation in building successful ventures
CO 5 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

CO 2 Understand the marketing environment

CO 3 Acquaint about product and pricing strategies

CO 4 Knowledge of promotion and distribution in marketing management.

CO 5 Comprehend the contemporary marketing scenairosand 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.

CMG341HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS

L	T	P	C
3	0	0	

3COURSE 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 - Challengesin HRM.

UNIT IIHUMAN 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 IIIRECRUITMENT 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:

CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers

CO 2 To learn about the HR Planning Methods and practices.

CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.

CO 4 To known about the methods of Training and Employee Development.

CO 5 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 45 : PERIODS

COURSE OUTCOMES:

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

CO 1 Learn the basics of starting a new business venture.
CO 2 Understand the basics of venture financing.
CO 3 Understand the sources of debt financing.
CO 4 Understanf the sources of equity financing.
CO 5 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
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.Chandand 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
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. BhakaraRao .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. CroziorM : 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.

VERTICAL 4: BUSINESS DATA ANALYTICS

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:

- To facilitate objective solutions in business decision making.
- To understand and solve business problems
- To apply statistical techniques to data sets, and correctly interpret the results.
- To develop skill-set that is in demand in both the research and business environments
- 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, Ïntroduction 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 OBJECTIVE:

- 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 OUTCOME:

- The learners will be conversant about HR metrics and ready to apply at work settings.
- 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 ANALYTICSL 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:

- 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.

CMG354FINANCIAL 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

- 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
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:BelhavenPress,ISBN:1852930039.
7. Munier N, "Introduction to Sustainability", Springer2005
8. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.
9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009
10. 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
11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

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

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

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

COURSEOUTCOME

- Oncompletionofthe course,the studentis expected to beable 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 (Al_2O_3) -Zirconia (ZrO_2)-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:Studentswill 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 nanobiomaterialsin 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. Donglushi "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.AuliceScibioh
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 BOOKS

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														
	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	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

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

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

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

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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.