ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (NON-AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: B.Tech – Biotechnology **Regulations:** 2025

Abbreviations:

HUM – Humanities (Languages, Management, Heritage, and others)

BS – Basic Science (Mathematics, Physics, Chemistry)

ES – Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**) & Emerging Technology (**ET**))

SD – Skill Development

SL – Self Learning

CDP – Capstone Design Project

OE – Open Elective

L – Laboratory Course

T – Theory

LIT – Laboratory Integrated Theory

PW – Project Work

IPW – Internship cum Project Work

DIC – Department Introductory Course

TCP – Total Contact Period(s)

Program Outcomes

1. **Engineering Knowledge**: Apply math, science, and engineering fundamentals to complex problems.
2. **Problem Analysis**: Identify and analyze complex problems using research and sustainability principles.
3. **Design Solutions**: Design systems and processes considering health, safety, cost, culture, and environment.
4. **Investigations**: Use experiments, modelling, and data analysis to reach valid conclusions.
5. **Engineering Tools**: Apply modern tools for modelling and problem-solving, recognizing their limits.
6. **Society & Environment**: Assess societal, legal, and environmental impacts of engineering solutions.
7. **Ethics**: Commit to ethics, human values, diversity, and legal compliance.
8. **Teamwork**: Work effectively as an individual and in multidisciplinary teams.
9. **Communication**: Communicate clearly in reports, presentations, and documentation across diverse groups.
10. **Management & Finance**: Apply management and economic principles in projects and teamwork.

11. **Lifelong Learning**: Engage in continuous learning, adapt to new technologies, and think critically.

Program Specific Outcomes:

PSO 1: Design and develop efficient biotechnical systems in real time applications.

PSO 2: Use modern tools and implement sustainable practices for addressing complex problems in the various fields of biotechnology.

PSO 3: Upskill in-line with industrial trends, and demonstrate research aptitude and collaborate in multidisciplinary teams.

Semester – I							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T- P	**TCP**		
1.	EN25C01	English Essentials – I	T	2-0-0	2	2	HUM
2.	MA25C01	Applied Calculus	T	3-1-0	4	4	BS
3.	UC25H01	தமிழர் மரபு / Heritage of Tamils	T	1-0-0	1	1	HUM
4.	BT25101	Introduction to Biotechnology	T	2-1-0	3	3	ES (PC)
5.	PH25C01	Applied Physics - I	LIT	2-0-2	4	3	BS
6.	CY25C01	Applied Chemistry - I	LIT	2-0-2	4	3	BS
7.	CS25C02	Computer Programming: Python	LIT	2-0-2	4	3	ES (PC)
8.	ME25C04	Makerspace	L	0-0-4	4	2	SD
9.	UC25A01	Life Skills for Engineers – I	---	1-0-2	3	1	HUM
10.	UC25A02	Physical Education – I	---	0-0-4	4	1	HUM
11.		NCC / NSS / NSO/ YRC	---	---	---	---	---
Total Credits					**33**	**23**	

Semester – II							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T- P	**TCP**		
1.	MA25C02	Linear Algebra	T	3-1-0	4	4	BS
2.	BT25201	Bioorganic Chemistry	T	3-0-0	3	3	ES (PC)
3.	EE25C01	Basic Electrical and Electronics Engineering	T	3-0-0	3	3	ES (G)
4.	UC25H02	தமிழர்களும் தொழில்நுட்பமும் / Tamils and Technology	T	1-0-0	1	1	HUM
5.	PH25C06	Applied Physics (Tech) – II	T	2-1-0	3	3	BS
6.	ME25C01	Engineering Drawing	LIT	2-0-4	6	4	ES (G)
7.	EN25C02	English Essentials – II	LIT	1-0-2	3	2	HUM
8.	ME25C05	Re-Engineering for Innovation	L	0-0-4	4	2	SD
9.	UC25A03	Life Skills for Engineers – II	---	1-0-2	3	1	HUM
10.	UC25A04	Physical Education – II	---	0-0-4	4	1	HUM
11.		Foreign Language^	LIT	1-0-2	3	1	HUM
			Total Credits		**37**	**25**	

^ Deutsch / Japanese / Korean

Semester – III							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T- P	**TCP**		
1.	MA25C09	Computational Differential Equations	T	3-1-0	4	4	BS
2.	BT25301	Process Calculations	T	2-1-0	3	3	ES (PC)
3.	BT25302	Biothermodynamics	T	2-1-0	3	3	ES (PC)
4.	BT25303	Biochemistry	LIT	3-0-4	7	5	ES (PC)
5.	BT25304	Microbiology	LIT	3-0-4	7	5	ES (PC)
6.	BT25305	Cell Biology	LIT	3-0-2	5	4	ES (PC)
7.	EN25C03	English Communication Skills Laboratory – I	L	0-0-2	2	1	HUM
8.	-	Skill Development Course – I	LIT	1-0-2	3	2	SD
			Total Credits		**34**	**27**	

Semester – IV							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T- P	**TCP**		
1.	BT25401	Enzyme Technology	T	2-1-0	3	3	ES (PC)
2.	BT25402	Basic Industrial Biotechnology	T	3-0-0	3	3	ES (PC)
3.	BT25403	Artificial Intelligence in Biotechnology	T	3-0-0	3	3	ES (PC)
4.	BT25404	Introduction to Standards in Biotechnology	T	1-0-0	1	1	ES (PC)
5.	BT25405	Molecular Biology	LIT	3-0-4	7	5	ES (PC)
6.	BT25406	Fluid Flow and Heat Transfer Operations	LIT	3-0-4	7	5	ES (PC)
7.	EN25C04	English Communication Skills Laboratory – II	L	0-0-2	2	1	HUM
8.	-	Skill Development Course – II	LIT	1-0-2	3	2	SD
			Total Credits		**29**	**23**	

Semester – V							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.		Protein Engineering	T	3-0-0	3	3	ES (PC)
2.		Mass Transfer Operations in Biotechnology	T	2-1-0	3	3	ES (PC)
3.		Programme Elective – I	T	3-0-0	3	3	ES (PE)
4.		Programme Elective – II	T	3-0-0	3	3	ES (PE)
5.		Bioprocess Engineering	LIT	3-0-4	7	5	ES (PC)
6.		Analytical Techniques in Biotechnology	LIT	3-0-2	5	4	ES (PC)
7.		Skill Development Course – III	LIT	1-0-2	3	2	SD
8.		Industry Oriented Course – I	LIT	1-0-2	3	1	SD
				Total Credits	**30**	**24**	
For Honours Degree							
1.		Capstone Design Project – Level I	CDP	0-0-12	12	6	SDC
(OR)							
1.		Honours Elective – I	T	3-0-0	3	3	
2.		Honours Elective – II	T	3-0-0	3	3	

For Minor Degree							
1.		Minor Elective – I	T	3-0-0	3	3	
2.		Minor Elective – II	T	3-0-0	3	3	

Semester – VI							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.		Biochemical Reaction Engineering	T	2-1-0	3	3	ES (PC)
2.		Programme Elective – III	T	3-0-0	3	3	ES (PE)
3.		Programme Elective – IV	T	3-0-0	3	3	ES (PE)
4.		Open Elective	T	3-0-0	3	3	ES (OE)
5.		Bioprocess Technology	LIT	3-0-4	7	5	ES (PC)
6.		Genetic Engineering	LIT	3- 0-4	7	5	ES (PC)
7.		Industry Oriented Course – II	LIT	1-0-2	3	1	SD
Total Credits					**29**	**23**	
For Honours Degree							
1.		Capstone Design Project – Level II	CDP	0-0-12	12	6	SD
(OR)							
1.		Honours Elective – III	T	3-0-0	3	3	
2.		Honours Elective – IV	T	3-0-0	3	3	
for Minor Degree							
1.		Minor Elective – III	T	3-0-0	3	3	
2.		Minor Elective – IV	T	3-0-0	3	3	

Semester – VII

S. No.	Course Code	Course Name	Course Type	Periods / Week		Credits	Category
				L-T-P	TCP		
		Climate Change and Sustainability	T	2-0-0	2	2	HUM
1		Bioentrepreneurship, Biosafety and Regulatory Affairs	T	3-0-0	3	3	ES (PC)
2		Programme Elective – V	T	3-0-0	3	3	ES (PE)
3		Project Management	T	2-0-0	2	2	HUM
4		Bioseparation Technology	LIT	3-0-4	7	5	ES (PC)
5		Bioinformatics	LIT	3-0-4	7	5	ES (PC)
6		Immunology	LIT	3-0-4	7	5	ES (PC)
7		Summer Internship*	---	---	---	2	SD
Total Credits					**31**	**27**	
For Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1.		Capstone Design Project – Level III	CDP	0-0-12	12	6	SD
(OR)							
1.		Honours Elective – V	T	3-0-0	3	3	
2.		Honours Elective – VI	T	3-0-0	3	3	
For Minor Degree							
1.		Minor Elective – V	T	3-0-0	3	3	
2.		Minor Elective – VI	T	3-0-0	3	3	

Semester – VIII							
S. No.	**Course Code**	**Course Name**	**Course Type**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP**		
1		Project Work / Internship cum Project Work	PW / IPW	0-0-16	16	8	SD
Total Credits					**16**	**8**	

Total Credits of the Programme: 180

PROGRAMME ELECTIVE COURSES – STREAMS

Bio Engineering	Microbial Technology	Medical Biotechnology	Industrial Biotechnology	Molecular Biotechnology
Metabolic Engineering	Food Process Technology	Human Genetics	Fermentation Technology	Plant Biotechnology
Membrane Technology	Biomass conversion and Bio-refinery	Cancer Biology	Marine Biotechnology	Animal Biotechnology
Process optimization in Biotechnology	Bioenergy and Biofuels	Stem Cell Technology	Functional Foods and Nutraceuticals	Biomaterials &Tissue Engineering
Bioprocess Modeling and Simulation	Green Technology	Vaccine Technology	Biopharmaceutical Technology	Genomics and Proteomics
Bioreactor Design and Scale Up process	Bio nanotechnology	Molecular Therapeutics and Diagnostics	IPR and Bioethics	Structural Biology
Bioreactor Instrumentation and control	Environmental Biotechnology	Clinical Trials and Healthcare in Biotechnology	Biotechnology Quality Management system	Computer Aided Drug Design

Semester I

EN25C01	English Essentials – I	L	T	P	C
		2	0	0	2

Course Objectives:

- Enhance learners' listening and speaking skills to understand and deliver speeches effectively
- Equip students with the skills to write clear, coherent, and grammatically correct texts for various purposes.
- Strengthen the ability to comprehend, interpret, and analyse written English across diverse contexts.

Speaking Skills: Self-Introduction (Tenses, Adjectives) Expressing opinions (Subject-Verb Agreement), Participating in Conversations (Speech Acts - agreeing & disagreeing – synonyms and antonyms**)**

Suggested Activities: Self-Introduction, Just a Minute (JAM) Video recording, Situational role plays, Spell Bee, Word Substitution, Usage of Apps.

Listening Skills: Listening to Simple Conversations (Understanding tone and intent), Short Speeches / Stories, Extracting information, Pronunciation, Listening to Various Accents.

Suggested Activities: Listening and Repeating, Gap fill exercises, Note-taking

Reading Skills: Reading Strategies – (Skimming, scanning, predicting) intensive reading - short passages and long passages on suggested themes (Sentence Patterns, Prefixes and suffixes, idioms and phrases).

Activities: Reading - newspaper and digital articles, Cloze, Reading comprehension, note making and summarising,

Writing Skills: Word Substitution, Sentence Formation, Hints Development (Guided Writing), Writing Different Types of Paragraphs - (Sentence Structure) – Letter Writing / Emails (Informal)

Activities: Error Detection, Picture and poster description, Descriptive, Narrative and Comparative paragraphs, Brainstorming and Mind Mapping - Informal letters/ Emails

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (10%), Assignments (20%), Speaking Task (10%), Reading Task (10%), Writing Task (10%), Internal Examinations (40%).

References:

1. Miller, K. Q., & Wahl, S. T. (2023). *Business and Professional Communication: KEYS for Workplace Excellence* (5th ed.). SAGE Publications.
2. Kumar, Sanjay & Pushpalatha. (2018). *English Language and Communication Skills for Engineers*. India: Oxford University Press.
3. Sharma, S., & Mishra, B. (2024). *Communication Skills for Engineers and Scientists* (2nd ed.). PHI Learning.

E-resources:

1. Cambridge English – https://www.cambridgeenglish.org/learning-english/grammar-and-vocabulary/
2. Perfect English Grammar – https://www.perfect-english-grammar.com/
3. British Council – Learn English - https://learnenglish.britishcouncil.org/grammar
4. Speechling – https://speechling.com/
5. mePro by Pearson – https://mepro.pearson.com/
6. TED Talks – https://www.ted.com/

	Description of CO	**PO**	**PSO**
CO1	Listen and comprehend spoken English, take and draft notes.	---	---
CO2	Apply vocabulary and grammar appropriately to communicate in written and spoken forms.	PO1(3)	PSO1(2) PSO3(3)
CO3	Analyze texts in different contexts using appropriate reading strategies.	PO2(2)	PSO2(1)
CO4	Communicate thoughts and ideas in real life situations.	PO9(2)	PSO3(2)
CO5	Develop communication skills relevant to engineering and technology.	PO11(1)	PSO3(3)

MA25C01	Applied Calculus	L	T	P	C
		3	1	0	4

Course Objectives:

- To provide technical competence of modelling engineering problems using calculus.
- To apply the calculus concepts in solving engineering problems using analytical methods and computational tools.

Differential Calculus: Functions, graph of functions, New functions from old functions, Limit of a function, Continuity, Limits at infinity, Derivative as a function, Maxima and Minima of functions of single variable, Mean value theorem, Effect of derivatives on the shape of a graph.

Activities: Visualization of the functions, Maxima and Minima of a function using open-source software, Solving of Competitive Examination questions (Ex. GATE).

Functions of Several Variables: Partial derivatives, Chain rule, Total derivative, Maxima and minima of functions of two variables, Method of Lagrange's Multipliers, Application problems in engineering.

Activities: Partial Derivatives with two or three variables, Maxima and Minima of a function using open-source software, Solving of Competitive Examination questions (Ex. GATE).

Integral Calculus: Fundamental theorem of Calculus, Indefinite integrals and the Net Change Theorem, Improper integrals, Arc Length, Area of Region, Area of surface of revolution.

Activities: Definite and Indefinite Integrals, Determination of Area, Solving of Competitive Examination questions (Ex. GATE).

Multiple Integrals: Iterated integrals and Fubini's theorem, Evaluation of double integrals, change of order of integration, change of variables between Cartesian and polar co-ordinates, evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates.

Activities: Double integrals and triple integrals using open-source software, Solving of Competitive Examination questions (Ex. GATE).

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Assignments (20%), Solution to application-oriented problems using software (20%), Solving of GATE questions (20%), Internal Examinations (40%).

References:

1. Anton, H., Bivens, I. C., & Davis, S. (2021). Calculus: Early transcendentals. John Wiley & Sons.
2. Ron Larson and David C. Falvo, (2013), Calculus: an Applied Approach. Cengage Learning.
3. Stewart, J., Clegg, D., & Watson, S. (2019). Calculus: Early transcendentals.
4. Thomas, G. B., Jr., Weir, M. D., Hass, J., & Heil, C. (2018). Thomas' calculus: Early transcendentals. Pearson.
5. Singh, K. (2019). Engineering mathematics through applications. Bloomsbury Publishing.
6. Grewal, B. S. (2012). Higher engineering mathematics. Khanna Publishers.

E-resources:

1. https://math.libretexts.org/Bookshelves/Calculus/Map%3A_Calculus__Early_Transcendentals_(Stewart)/
2. https://openstax.org/books/calculus-volume-1/
3. https://tutorial.math.lamar.edu/Classes/CalcII/CalcII.aspx
4. SCILAB, https://www.scilab.org/

	Description of CO	PO	PSO
CO1	Explain the meaning of derivative, integral, and their geometric and physical interpretations.	---	---
CO2	Apply differentiation and integration techniques to compute maxima, minima, and area.	PO1(3)	PSO1(2) PSO2(2)
CO3	Analyze the behavior of single and multivariable functions using derivatives and partial derivatives.	PO2(3)	PSO1(2) PSO3(1)
CO4	Utilize modern computational software and online platforms to deepen understanding, perform complex calculations, and visualize mathematical concepts.	PO5(2) PO11(1)	PSO2(3) PSO3(1)

UC25H01	தமிழர் மரபு	L	T	P	C
		1	0	0	1

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

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

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

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

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

References:

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

UC25H01	Heritage of Tamils	L	T	P	C
		1	0	0	1

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

Heritage - Rock Art Paintings to Modern Art – Sculpture: 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.

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

Thinai Concept of Tamils: 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.

Contribution of Tamils to Indian National Movement and Indian Culture: 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.

References:

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

BT25101	Introduction to Biotechnology	L	T	P	C
		2	1	0	3

Course Objectives:

To provide foundational knowledge on the principles of biotechnology, its historical background, and to enable understanding of the biochemical, clinical, and industrial relevance of biomolecules, diagnostics, and bio waste management.

Nature of Biotechnology: History and scope, Major scientific discoveries, Biotechnology and developing world, Cell works on solar energy, Bacterially produced acidic preservative, Molds and bacteria in cheese production, Yeast in alcoholic fermentation, Enzyme sources: Amylase in brewing and baking, pectinase in fruit and vegetable juice production.

Activities: Virtual Demonstration of cheese production, vegetable juice production and fermentation process.

Vitamins and Nutrition: Classification, fat soluble and water soluble vitamins, Biochemical function; Vitamin A and vision, Rods and cones, colour vision, Vitamin deficiency: vitamin D and Vitamin A, Nutritional importance, Fiber in nutrition, beneficial and adverse effect of fiber, Nutritional disorders : Protein energy metabolism and marasmas.

Activities: Demonstrate to identify different types of vitamins and their sources with suitable examples.

Plasma Protein and Hemoglobin: Albumin, functions of albumin, clinical significance of albumin, Globulin : alpha antitrypsin, heptoglobin, transferring, Immunoglobulins, Blood clotting: conversion of fibrinogen to fibrin, prothrombin to thrombin, Anticoagulants, Hemoglobin, Hemoglobin derivates, Abnormal haemoglobin; Sickle cell anemia , Thalassemias.

Activities: Demonstration of various tools/techniques used to identify the plasma protein, hemoglobin

Biotechnology in Health Care: Detection of disease, Diagnosis of pathogenic microbes: Classical and modern methods, Diagnosis using protein and enzyme markers, DNA based diagnosis for infectious diseases: Tuberculosis, Malaria, Diagnosis for genetic disease: Alzheimers disease, cystic fibrosis, Vaccines.

Activities: Interpret biotechnological tools used in medical diagnostics and treatment.

Biotechnology for Waste Management: Types of waste biomass, Nature of biomass feedstocks, Solid waste management, Value addition of waste biomass, biomass plant for industrial applications, Biocomposting, Role of microorganisms in composting, Biocompost quality, Perspective of biofuels from wastes.

Activities: Demonstrate understanding of environmental biotechnology for pollution control.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Assignments (20%), Quiz (10%), Reviewing of GATE questions (20%), Internal Examinations (50%).

References:

1. Renneberg, R., Sabbier, D., Berkling, V., & Loroch, V. (2023). *Biotechnology for beginners* (3rd ed.). Academic Press.
2. Thieman, W. J., & Palladino, M. A. (2019). *Introduction to biotechnology* (4th ed.). Pearson.
3. Smith, J. E. (2009). *Biotechnology* (5th ed.). Cambridge University Press.
4. Satyanarayana, U. (2021). *Biotechnology* (6th ed.).
5. Satyanarayana, U. (2013). *Biochemistry* (4th ed.).

E-Resources:

1. NPTEL: Fundamentals of Biotechnology by Dr. Vishal Trivedi, IIT, Guwahati https://nptel.ac.in/courses/102103045
2. MOOC – Industrial Biotechnology, Coursera, University of Manchester. https://www.coursera.org/learn/industrial-biotech

COs	CO Description	PO	PSO
CO1	Explain the fundamentals of biotechnology in various core fields Engineering.	---	
CO2	Apply biotechnological tools in medical diagnostics and treatment.	PO1 (3) PO2 (1)	PSO2(3)
CO3	Apply the appropriate methods and interpret data in biotechnology applications	PO1 (2) PO2 (2)	PSO3(2)

PH25C01	Applied Physics – I	L	T	P	C
		2	0	2	3

Course Objective(s):

- To impart knowledge and expose the essentials of physics in various engineering applications.

Properties of Matter: Elasticity, Cantilever –Young's modulus (non-uniform bending), Girders: Bridges and buildings, Viscosity: Stokes method – Surface tension: drop weight method, Thermal expansion, Thermal stress, Bimetallic strips, Expansion joints

Practicals: Non-Uniform bending, Young's modulus of the material, Torsional pendulum, Rigidity modulus of the wire and moment of inertia of the disc.

Activities: Virtual demonstration of thermal stress.

Oscillations: Simple Harmonic motion, Torsional pendulum, Couple per unit twist, Damped and Forced Oscillation

Waves: Waves on a stretched string, Energy and Power, standing waves, Ultrasonics, piezo-electric method, Acoustic grating, Electromagnetic waves: Maxwell equation, Production of EM waves by dipole antenna, Propagation of EM waves in free space, wave equation, Cell phone reception

Practicals: Melde's string experiment, Frequency of an electrically vibrating metal tip.

Activities: Virtual demonstration of propagation of EM waves

Quantum Mechanics: Black body radiation, Photoelectric effect, de Broglie hypothesis-Schrodinger Wave equation, Particle in a box (infinite potential well, three-dimensional box), Barrier penetration and quantum tunnelling.

Practicals: Photo-electric effect – Determination of Planck's constant.

Activities: Virtual demonstration of Scanning Transmission Electron Microscope

Applied Optics: Interference: Air wedge, Michelson's Interferometer, Fiber optics: Structure of a fiber – Fiber Optic Communication System – Fiber Sensors (Virtual demo) – Displacement, pressure sensor and Temperature sensor - Einstein Co-efficient - Nd:YAG laser, CO_2 laser (construction, functioning and applications), dye laser

Practicals: Ruling width of Compact disc using Laser, Thickness of a thin sheet/wire using Air wedge Method.

Activities: Demonstration of sensors and applications of Lasers

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Assignments (20%), Flipped Class (5%), Practical (30%), Internal Examinations (40%)

References:

1. Young, H. D., & Freedman, R. A. (2020). University physics with modern physics. Pearson.
2. Gaur, R. K., & Gupta, S. L. (2022). Engineering physics. Dhanpat Rai Publications.
3. Mathur, D. S. (2010). Elements of properties of matter. S. Chand Publishing.
4. Griffiths, D. J. (2018). Introduction to quantum mechanics. Cambridge University Press.
5. Silfvast, W. T. (2008). Laser fundamentals (2nd ed.). Cambridge University Press.

E-resources:

1. Barrier penetration problem and Quantum tunnelling: https://archive.nptel.ac.in/courses/115/104/115104096/
2. EM waves and wireless channelling: https://onlinecourses.nptel.ac.in/noc24_ee31/preview
3. CO2 Laser : https://onlinecourses.nptel.ac.in/noc25_ph03/preview
4. Bimetallic Strips _ https://www.youtube.com/watch?v=WZQ8lvxdzDk
5. Cell phone Reception_ https://www.youtube.com/watch?v=1JZG9x_VOwA
6. Dipole Antenna_ https://www.youtube.com/watch?v=4xF1Fq2wB1I
7. Optical Sensors_ https://auece.digimat.in/nptel/courses/video/108106173/L02.html
8. Scanning Tunnelling Electron Microscope_ https://www.youtube.com/watch?v=XNYZYbXNWQA

	Description of CO	PO	PSO
CO1	Explain the physics concepts in various applications.	---	---
CO2	Apply the principles of wave optics and laser physics in practical systems.	PO1(3)	PSO1(2) PSO2(2)
CO3	Analyse the behaviour of materials under different conditions.	PO2(2)	PSO1(2) PSO3(1)
CO4	Conduct experiments in groups and interpret the data.	PO4(3) PO8(1)	PSO1(2) PSO2(2)

CY25C01	Applied Chemistry – I	L	T	P	C
		2	0	2	3

Course Objectives:

- To provide students with a solid understanding of the chemical principles for engineering applications.
- To introduce the chemical properties of materials and how these properties influence the selection and use of materials in engineering systems.
- To impart practical applications of chemistry in commonly used engineering devices.

Water Technology: Water quality parameters and standards. Industrial feed water – Remediation. Municipal water treatment. Desalination.

Practicals: Analysis of alkalinity, hardness and dissolved oxygen.

Activities: Coagulation of water sample using Alum

Nano-chemistry: Classification, Size-dependent properties. Preparation of nanomaterials – Top-down and Bottom-Up approaches, Applications (Flipped classroom).

Practicals: Preparation of nanoparticles by Sol-Gel method.

Electrochemistry: Electrochemical cell - Electrode potential- Redox reaction. Conductivity of electrolytes – Factors.

Practicals: Conductometric titrations

Activities: Electrochemical cell demonstration

Corrosion & Control: Chemical and electrochemical corrosions, galvanic series, factors influencing corrosion, Electrochemical protection. Organic and Inorganic coating.

Practicals:

• Corrosion study by weight loss and salt spray method.
• Potentiometry/UV-visible spectrophotometer.

Activities: Case Study on Corrosion in Pipelines and Electronics, Control measures for a corroded metal

Batteries: Conventional, Contemporary and Emerging battery storage technologies, Primary & Secondary Batteries, Battery Pack, Battery Materials, Performance Parameters, Testing, Safety aspects.

Practicals: Measurement of EMF, Internal Resistance, Charge and Discharge Characteristics.

Activities: Demonstration of battery pack in e-vehicles.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Assignments (20%), Flipped Class (5%), Practical (30%), Internal Examinations (40%)

References:

1. Jain, P. C., & Jain, M. (2015). *Engineering Chemistry* (17th ed.). Dhanpat Rai

Publishing Company (P) Ltd.
2. Dara, S. S. (2004). *A Textbook of Engineering Chemistry*. Chand Publications.
3. Sachdeva, M. V. (2011). *Basics of Nano Chemistry*. Anmol Publications Pvt Ltd.
4. Friedrich, E. (2014). *Engineering Chemistry*. Medtech.

E-Resources:

1. Water and Wastewater Engineering (Prof. Ligy Philip, IIT Madras) – https://nptel.ac.in/courses/105106202.
2. Electrochemical Energy Systems (Prof. S. Mitra, IIT Madras) – https://nptel.ac.in/courses/113106028.
3. Corrosion (Prof. Kallol Mondal, IIT Kanpur) – https://nptel.ac.in/courses/112104088
4. Chemistry of Battery Systems (Prof. V. R. Marathe, IIT Madras) – https://nptel.ac.in/courses/115106130
5. Resource on all battery types, testing, and safety – https://batteryuniversity.com/articles

	Description of CO	**PO**	**PSO**
CO1	Understand the importance of chemistry applications with underlying mechanisms.	---	
CO2	Apply the chemistry concepts in widely used devices.	PO1(3)	PSO1(2) PSO2(2)
CO3	Analyse the effect of various chemical parameters on performance of engineering systems.	PO2(2)	PSO1(2) PSO2(1)
CO4	Perform experimentations as a group and interpret the results.	PO4(3) PO8(1)	PSO2(2) PSO3(2)
CO5	Communicate findings through case studies and reports	PO9(1)	PSO2(2) PSO3(3)

CS25C02	Computer Programming: Python	L	T	P	C
		2	0	2	3

Course Objectives:

- To equip engineering students with the foundational knowledge and practical skills in Python programming to analyse and solve computational problems effectively.
- To foster problem-solving, critical thinking, and modular programming skills essential for engineering domains.

Introduction to Python: Problem Solving, Problem Analysis Chart, Developing an Algorithm, Flowchart and Pseudocode, Interactive and Script Mode, Indentation, Comments, Error messages, Variables, Reserved Words, Data Types, Arithmetic operators and expressions, Built-in Functions, Importing from Packages.

Practicals: Problem Analysis Chart, Flowchart and Pseudocode Practices. (Minimum three)

Control Structures: if, if-else, nested if, multi-way if-elif statements, while loop, for loop, nested loops, pass statements.

Practicals: Usage of conditional logics in programs. (Minimum three)

Functions: Hiding redundancy, complexity; Parameters, arguments and return values; formal vs actual arguments, named arguments, Recursive & Lambda Functions.

Practicals: Usage of functions in programs. (Minimum three)

Strings & Collections: String Comparison, Formatting, Slicing, Splitting, Stripping, Lists, tuples, and dictionaries, basic list operators, searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values.

Practicals: String manipulations and operations on lists, tuples, sets, and dictionaries. (Minimum three)

File Operations: Create, Open, Read, Write, Append and Close files. Manipulating directories, OS and Sys modules, reading/writing text and numbers, from/to a file; creating and reading a formatted file (csv, tab-separated, etc.).

Practicals: Opening, closing, reading and writing in formatted file format and sort data. (Minimum three)

Packages: Built-in modules, User-Defined modules, Numpy, SciPy, Pandas, Scikit-learn**.**

Practicals: Usage of modules and packages to solve problems. (Minimum three), Project (Minimum Two)

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Project (15%), Assignment Programs (25%), Practical (25%), Internal Examinations (30%)

References:

1. Matthes, E. (2019). *Python crash course: A hands-on, project-based introduction to programming* (2nd ed.). No Starch Press.
2. Brown, M. C. (2018). *Python: The complete reference* (4th ed.). McGraw Hill Publishers.
3. Guttag, J. V. (2016). *Introduction to computation and programming using Python: With applications to understanding data* (2nd ed.). MIT Press.
4. McKinney, W. (2017). *Python for data analysis: Data wrangling with pandas, NumPy, and IPython*. Shroff/O'Reilly.

E-resources:

1. Official Python Documentation – https://docs.python.org/3/
2. Python Tutorials – https://www.w3schools.com/python/
3. NumPy – https://numpy.org/doc/
4. SciPy – https://scipy.org/
5. Google's Python class – https://developers.google.com/edu/python/

	Description of CO	**PO**	**PSO**
CO1	Explain the potential usage of Python in engineering applications	---	---
CO2	To apply the concepts of Python in solving engineering problems and formulate new projects.	PO1 (2) PO5 (2)	PSO2(2) PSO3(1)
CO3	To interpret the data and effectively communicate in groups.	PO2 (3) PO8 (1) PO9 (1)	PSO3(1) PSO3(2)
CO4	Adapt new programming concepts and technologies in the profession.	PO11 (1)	PSO2(2)

ME25C04	Makerspace	L	T	P	C
		0	0	4	2

Course Objectives:

- To impart practical skills in the assembly, disassembly, and welding of components using appropriate tools and techniques.
- To provide hands-on training in electrical wiring practices, and the use of electronic components, sensors, and actuators.

List of Activities

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.
ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.
iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.
iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.
ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.
iii. Hands-on session of preparing base material & Joint groove for welding.
iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.
ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box.
iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.
iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.
ii. Dis-assembly and assembly of Computers.
iii. Hands-on session of Soldering Practices in a Printed Circuit Board.
iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.
v. Hands-on session of integration of sensors and actuators with a Microcontroller.
vi. Demonstration of Programmable Logic Control Circuit.

(E). Contemporary Systems

i. Demonstration of Solid Modelling of components.
ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.
iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

References:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)

Course Outcomes:

	Description of CO	PO	PSO
CO1	Demonstrate proper use and handling of basic hand and power tools.	---	---
CO2	Carry out electrical wiring installations and repairs, applying safety measures in domestic applications.	PO1(3)	PSO2(1)
CO3	Develop solid innovative models through software.	PO5(2)	PSO2(2)
CO4	Adapt and follow safety protocols in the work environment.	PO11(2)	PSO3(2)

UC25A01	Life Skills for Engineers – I	L	T	P	C
		1	0	2	1

Course Objectives:

- To equip engineering students with essential life skills encompassing personal and emotional development, effective management of time and stress, financial literacy, digital safety, and civic responsibility.
- To enhance self-awareness, interpersonal skills, and resilience to prepare students for the professional and personal challenges of engineering careers and life beyond academics.

Personal and Emotional Development: Self-Awareness & Personality, Emotional Intelligence & Empathy, Positive thinking, Right attitude, Stress & Anger Management, Goal-Setting & Time Management, Growth Mindset & Resilience.

Activities: Personality tests (MBTI, DISC), reflection journals, Empathy circle, role-playing difficult conversations, Guided mindfulness sessions, stress relief toolkit creation, Vision board creation, weekly time audit and planner, Group challenge scenarios, resilience journal.

Management Skills: Financial Literacy: Budgeting & Saving, Nutrition, Health, and Hygiene, Digital Literacy & Online Safety, Civic Responsibility & Ethics

Activities: Create a monthly budget, financial simulation game, Meal planning workshop, physical wellness challenge, Social media audit, privacy and safety scenarios, Community service, values debate.

Weightage: Continuous Assessment: 100%

Assessment Methodology: Assignments (20%), Flipped Class & Worksheets (10%), Practical (30%), Internal Examinations (40%)

References:

1. Khera, S. (2003). *You can win*. Macmillan.
2. Levesque, H. (n.d.). *Life skills 101: A practical guide to leaving home and living on your own*. (Publication year not specified)
3. Mitra, B. K. (2017). *Personality development & soft skills* (3rd impression). Oxford University Press.
4. ICT Academy of Kerala. (2016). *Life skills for engineers*. McGraw Hill Education (India) Private Ltd.

	Description of CO	PO	PSO
CO1	Understand personality traits and emotional intelligence, in interpersonal interactions.	---	---
CO2	To work and execute as a team through successful implementation of set goals.	PO7 (1) PO8 (2) PO9 (2)	PSO3(2)
CO3	Develop and implement best practices in day-to-day life, in terms of planning and execution.	PO11 (3)	PSO3(2)

UC25A02	Physical Education - I	L	T	P	C
		0	0	4	1

Course Objectives:

- To impart the fundamentals of physical education for development of students' physical, mental, and social well-being.
- To instill a lifelong appreciation for physical Activities towards the development of positive attitude and fostering values of team work and sportsmanship.

Introduction to physical education: Exercise for Good Posture – Conditioning and Calisthenics for Before start, Jogging, Bending, Twisting, Standing, Sitting and Relaxation, Training on First Aid practices.

Participation of athletic events: Rules and regulations of important athletic events, Sprint, Jumps, Throws and Hurdles.

Skill development in any one of the following outdoor games: Basket Ball, Volley Ball, Ball Badminton, Football, Hockey, Kho-Kho, Kabaddi, Cricket, Hand ball and Tennis.

Skill development in any one of the following indoor games: Shuttle Badminton, Chess and Table Tennis.

Weightage: Continuous Assessment: 100%

Assessment Methodology: Attendance (60%), Quiz (10%), Participation in Sports and Games (20%) and Viva Voce (10%)

References:

1. Singh, A. (2008). Essentials of physical education. Kalyani Publishers.
2. Kamlesh, M. L. (2006). Psychology in physical education and sport (3rd ed.). Metropolitan Book Co.
3. Mangal, S. K. (2009). *Psychology of sports performance*. Sports Publication.

E-resources:

1. **https://www.who.int/health-topics/physical-Activities**

	CO Description	PO	PSO
CO1	Understand and explain the importance of physical Activities for mental and physical health.	---	---
CO2	Apply basic principles of exercise science in the routine life.	PO1(3)	PSO1(1)
CO3	Develop teamwork, discipline, and leadership through sports and group activities and collaborate effectively.	PO8(3)	PSO3(2)
CO4	Demonstrate independent learning in health, nutrition, and fitness-related topics.	PO11(2)	PSO3(2)

Semester II

MA25C02	Linear Algebra	L	T	P	C
		3	1	0	4

Course Objectives:

- To impart foundational knowledge in linear algebra essential for analysing and solving problems in engineering applications.
- To provide the knowledge on computation using software and interpret key linear algebra concepts using software.

Vector Spaces Introduction to Vector Spaces, Examples, Subspaces, Linear Combinations, Span, Generating Sets, Linear Dependence and Independence, Basis and Dimension, Dimension of Subspaces.

Activities: Open-Source software, exercises to test linear dependence and independence using rank, compute span and basis of a set of vectors, determine the dimension of subspaces, and illustrate the concept of subspace and basis in $\boldsymbol{R^2}/\boldsymbol{R^3}$ with visualization.

Linear Transformations and Diagonalization: Null space, Range, Dimension Theorem (statement only), Matrix representation of a linear transformation, Eigenvalues & Eigenvectors, Diagonalizability.

Activities: Open-Source software, exercises to compute the matrix representation of a linear transformation, find the null space and range of a matrix, and compute eigenvalues and eigenvectors of a matrix.

Inner Product Spaces: Inner product, Norms, Cauchy, Schwarz inequality, Gram, Schmidt orthogonalization, Simple problems (up to $\boldsymbol{R^3}$).

Activities: Open-Source software, exercises to compute inner products and vector norms.

Matrix Decomposition: Orthogonal transformation of a symmetric matrix to diagonal form - Positive definite matrices, QR decomposition, Singular Value Decomposition (SVD), Least squares solutions- simple problems (up to $3 \times 3\ matrices$).

Activities: Open-Source software, exercises to check if a matrix is positive definite, perform QR decomposition and SVD using built-in functions.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Assignment (20%), Software Activities (20%), Quiz (20%), Internal Examinations (40%).

References:

1. Friedberg, S. H., Insel, A. J., & Spence, L. E. (2022). *Linear algebra*. Pearson.
2. Lay, D. C., Lay, S. R., & McDonald, J. J. (2020). *Linear algebra and its applications with MATLAB*. Pearson.
3. Bronson, R. (2011). *Schaum's outline of matrix operations*. McGraw-Hill Education.
4. Strang, G., & Thomson, R. (2005). *Linear algebra and its applications*. Brooks/Cole.

5. Lipschutz, S., & Lipson, M. (2009). *Schaum's outline of linear algebra*. McGraw-Hill.
6. Kreyszig, E. (2018). *Advanced engineering mathematics*. Wiley India.

	Description of CO	**PO**	**PSO**
CO1	Explain the fundamental concepts of Linear Algebra.	---	
CO2	Compute and interpret eigenvalues and eigenvectors.	PO1(3)	PSO1(2)
CO3	Apply inner product concepts and perform orthogonalization.	PO1 (3)	PSO1(1)
CO4	Compute least squares solutions of linear system of equations.	PO1 (2) PO2 (2)	PSO3(1)
CO5	Use MATLAB to implement and validate key linear algebra concepts	PO5 (1) PO11 (1)	PSO2(2)

BT25201	Bioorganic Chemistry	L	T	P	C
		3	0	0	3

Course Objectives:

To introduces the chemical principles linking organic chemistry and biology, focusing on bio molecular interactions, stereochemistry, mechanism of organic reactions, carbohydrates and protein chemistry.

Introduction To Bioorganic Chemistry: Basic considerations - Historical Connection between Organic and Biological Chemistry - Weak Interactions in Organic and Biological World – Proximity Effects in Organic Chemistry - Molecular Adaptation - Molecular Recognition and the Supramolecular Level.

Activities: Seminar on Historical Connection between Organic and Biological Chemistry.

Bonding And Stereochemistry: Atoms, Electrons and orbital's - Covalent Bonds - Octet rule - Polar covalent Bonds - Electro negativity- formal charge - Arrhenius and Bronsted Lowry Theories - Acid Base equilibria – Molecular dipole moments - SP^3 hybridization – Conformation analysis ethane, butane and cyclohexane - Conformation of the peptide bond.

Activities: Virtual Demonstration Stereochemistry

Mechanisms of Substitution And Addition Reactions: S_N1 and S_N2 reactions on tetrahedral carbon - nucleophiles - nucleophilic addition on Acetals - Aldehyde and ketone groups – reactions of carbonyl group with amines - acid catalyzed ester hydrolysis – Saponification of an ester- Hydrolysis of amides - Ester enolates.

Activities: Demonstration of Saponification of an ester.

Catalysis: Chemical and biological catalysis - Catalysis and reaction energetic – Acid-Base Catalysis: Catalysis Involving Proton Donors or Acceptors - Covalent Catalysis: Catalysis Involving Covalent Bond Formation – Metal ion catalysis – Enzyme catalysis by approximation - Proximity and orientation effects in enzyme catalysis – Advantages and disadvantages of biocatalysis - Inclusion complexation.

Activities: Seminar presentation on Advantages and disadvantages of biocatalyst.

Bioorganic Reactions: Timing of Bond formation and fission – Acyl group transfer – C-C bond formation and fission – Catalysis of proton transfer reactions – Transfer of hydride ion – Alkyl group. Transfer – Terpene biosynthesis – Merrifield state peptide synthesis – Sanger method for peptide and DNA sequencing.

Activities: Virtual demonstration of DNA sequencing

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (10%), Assignments (20%), Review of GATE Questions (20%), Internal Examinations (50%)

References:

1. Dugas, H. (n.d.). Bioorganic chemistry: A chemical approach to enzyme action (3rd ed.).
2. Carey, F. A. (2009). Organic chemistry (7th ed.). Tata McGraw Hill.
3. Bahl, B. S., & Bahl, A. (2017). Advanced organic chemistry. S. Chand Publishing.
4. Page, M. I., & Williams, A. (2010). Organic and bio-organic mechanisms. Pearson.
5. Sharma, V., & Sharma, P. (2023). Essentials of bio-organic chemistry. A Pragati Edition.

E-Resources:

1. https://nptel.ac.in/courses/104106128
2. https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/
3. https://archive.nptel.ac.in/courses/104/103/104103018/

CO Mapping with POs and PSOs:

COs	CO Description	PO	PSO
CO1	Describe the core concepts of bioorganic chemistry and its application.	-	
CO2	To analyse and to explain the bonding and stereochemistry of compounds	PO1 (3)	PSO1(1)
CO3	To interpret the mechanism of organic and biochemical reactions	PO1 (3), PO2 (2),	PSO2(1)
CO4	Demonstrate the knowledge of biocatalyst in biochemical process.	PO11 (1)	PSO3(2)

EE25C01	Basic Electrical and Electronics Engineering	L	T	P	C
		3	0	0	3

Course Objectives:

- To impart foundational knowledge in principles and applications of electrical and electronics engineering.

DC Fundamentals: Current and Voltage sources, Resistance, Inductance and Capacitance; Ohm's law, Kirchhoff's law, Series parallel combination of R, L and C components, Voltage Divider and Current Divider Rules.

Activities: Virtual Demonstration of electrical laws & circuits, Hands-on Breadboarding, Solving GATE questions.

AC Fundamentals: Faraday's Laws of Electro-magnetic Induction, Definition of Self and Mutual Inductances, Generation of sinusoidal voltage, Instantaneous & RMS values of sinusoidal signals, Introduction to 3-phase systems, Electrical Safety, Fuses and Earthing.

Activities: Virtual Demonstration of electromagnetic induction, Measurement of instantaneous and RMS values of AC signals, Solving GATE questions.

Electric Machines: DC Machines, Transformers, Star and delta Connections, Three phase Induction motors, Synchronous Generators, Single Phase Induction Motors, Stepper Motor, Universal Motor and BLDC motor.

Activities: Virtual demonstration of step-up and step-down transformers, Virtual working models of Universal and BLDC motors, Solving GATE questions.

Semiconductor Devices: PN junction diodes, Zener Diode, Voltage regulator, BJT & FET Transistors, Timers, Operational Amplifiers.

Activities: Virtual demonstration of V-I characteristics of PN junction and Zener diodes using simulation, inverting/non-inverting amplifiers, Solving GATE questions.

Digital Electronics: Boolean algebra, Basic and Universal Gates, adders, multiplexers, demultiplexers and flip-flops.

Activities: Online logic gate simulators, Solving GATE questions.

Microcontrollers: Introduction, Architecture, Potential Applications.

Activities: Physical demonstration of a microcontroller and online simulation of microcontroller.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (5%), Assignments (25%), GATE Questions (20%), Internal Examinations (50%)

References:

1. Del Toro, V. (2022). *Electrical engineering fundamentals*. Pearson Education.
2. Hambley, A. R. (Year). *Electrical engineering: Principles and applications* (Edition if known). Publisher.
   (Note: Please provide the year and edition for complete citation)
3. Mehta, V. K., & Mehta, R. (2006). *Principles of electrical engineering and electronics*. S. Chand Publishing.

E-resources:

1. https://archive.nptel.ac.in/courses/108/106/108106172/
2. Circuit Simulator – https://www.falstad.com/circuit/

	Description of CO	PO	PSO1
CO1	Understand and explain basic electrical and electronic concepts.	---	
CO2	Apply and analyse electrical circuits in real-time applications.	PO1 (3) PO2 (1)	PSO1(2)
CO3	Identify and utilise key electronic devices used in engineering applications	PO2 (2)	PSO1(2)

UC25H02	தமிழர்களும் தொழில்நுட்பமும் / Tamils and Technology	L	T	P	C
		1	0	0	1

நெசவு மற்றும் பானைத் தொழில்நுட்பம்: சங்க காலத்தில் நெசவுத் தொழில், பானைத் தொழில்நுட்பம், கருப்பு சிவப்பு பாண்டங்கள், பாண்டங்களில் கீறல் குறியீடுகள்.

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

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

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

அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: அறிவியல் தமிழின் வளர்ச்சி, கணித்தமிழ் வளர்ச்சி. தமிழ் நூல்களை மின்பதிப்பு செய்தல். தமிழ் மென்பொருட்கள் உருவாக்கம். தமிழ் இணையக் கல்விக்கழகம். தமிழ் மின் நூலகம். இணையத்தில் தமிழ் அகராதிகள். சொற்குவைத் திட்டம்.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (20%), Assignments (30%), Internal Examinations (50%)

References

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by:

International Institute of Tamil Studies.)

9. Keeladi – 'Sangam City 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 Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC25H02	Tamils and Technology	L	T	P	C
		1	0	0	1

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

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

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

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

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

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (20%), Assignments (30%), Internal Examinations (50%)

References

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

PH25C06	Applied Physics (Tech) – II	L	T	P	C

		2	1	0	3

Course Objectives:

- To impart knowledge on physics concepts and explore the potential applications in the fields of engineering and technology.

Thermal Physics: Thermal Expansion- Thermal stress- Thermal resistance - Heat transfer- Thermal conductivity (Virtual demo) - Lee's disc method - Forbe's method - conduction through compound media –thermo-electric power.

Activities: Measurement of thermal conductivity of bad conductors.

Dielectric Properties: Dielectric- ferroelectric materials - Internal field – Clausius Mosotti equation – dielectric loss – Piezo, Pyro electric materials – Applications

Activities: Virtual demonstration of Piezoelectric sensor.

Optical Properties: Classification of optical materials – Luminescence-Phosphors -Polarization – Optical anisotropy - Optical processes in semiconductors – LED characteristics (Virtual demo)

Activities: Virtual demonstration of LED Characteristics

New Engineering Materials: Ceramics –Composites - fibre reinforced plastics - fibre reinforced metals – Shape memory alloys (Virtual Demo) – Biomaterials – hydroxyapatite – Bio-sensors – Polymer semiconductors – CNT (Carbon Nano Tubes)

Activities: Virtual demonstration of 3D structure of CNTs.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (10%), Assignments (30%), Flipped Class (10%), Internal Examinations (50%)

References:

1. Raghavan, V. (2007). *Materials science and engineering*. Prentice Hall of India.
2. Brijlal, & Subramaniyan, N. (2018). *Heat, thermodynamics and statistical physics*. S. Chand.
3. Askeland, D. R. (2010). *Materials science and engineering*. Brooks/Cole.
4. Kasap, S. O. (2007). *Principles of electronic materials and devices*. McGraw-Hill Education.

E-resources:

1. Thermal conductivity -Understanding Thermal Conductivity in Solids - https://youtu.be/VcFqqdGcwrw-
2. Applications of Piezo and pyro electric materials -NDLI: Lecture 40- Applications of Piezoelectric and Pyroelectric Materials
3. White LED_ https://archive.nptel.ac.in/courses/108/108/108108122/
4. Shape memory alloys: https://nescacademy.nasa.gov/video/00a31561480547248033a1c2df6f87831d

	Description of CO	PO	PSO
CO1	Explain the concepts of physics in technology stream.	---	
CO2	Apply appropriate techniques in physics to solve engineering problems.	PO1(3)	PSO1(3)
CO3	Analyse physical systems and interpret data from the virtual studies in the core branches in technology streams.	PO2(2)	PSO1(2)

ME25C01	Engineering Drawing	L	T	P	C
		2	0	4	4

Course Objectives:

- To impart knowledge on dimensions and drawing standards.
- To explore the orthographic projection of lines and solids.
- To provide the understanding of orthographic, isometric and perspective views.

Fundamentals: Drawing instruments, Drawing standards (BIS), Lettering in engineering, Sheet layout, elements of dimensioning, Systems of dimensioning. Free hand sketching of 2D & 3D objects, Conics, Ellipse, Parabola and Hyperbola.

Activities: Virtual Demonstration of Conics and Cycloids.

Orthographic Projection: First angle projection, Projection of points, straight lines and planes.

Projection of Solids: Simple Solids, Section of Solids, Development of Surfaces

Activities: Development of models of various solids and virtual demonstration of sectioning, CAD modelling of 2D objects.

Isometric Projection: Isometric Scale, Projection of Simple solids.

Activities: Conversion of 3D into 2D orthographic views, CAD modelling of 3D objects.

Perspective Projection: Simple solids projection

Activities: Virtual demonstration of perspective views.

Project: Development of 2D objects and 3D objects using CAD tools.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Project – 10%, Models - 5%, Assignments - 35% and Internal Examinations - 50%

References:

1. Natarajan, K. V. (2025). A Text Book of Engineering Graphics. Dhanalakshmi Publisher.
2. Venugopal, K., & Prabhu Raja, V. (2022). Engineering Drawing + AutoCAD. New Age International Publishers.

E-Resources:

1. **CAD Software –** https://www.freecadweb.org/
2. **Engineering Drawing and Computer Graphics, Prof. Rajaram Lakkaraju (IIT Kharagpur) –** https://onlinecourses.nptel.ac.in/noc22_me105/preview
3. **MIT Design Handbook: Engineering Drawing and Sketching –** https://ocw.mit.edu/courses/2-007-design-and-manufacturing-i-spring-2009/pages/related-resources/drawing_and_sketching/

	CO Description	PO	PSO
CO1	Explain the advantages of engineering drawing in engineering applications	---	
CO2	Apply the concepts of projections in formulating various solid parts in engineering systems.	PO1(3)	PSO1(2)
CO3	Analyse the various view and interpret the engineering drawings.	PO2(3)	PSO1(2)
CO4	Use CAD tools for creation of various models.	PO3(1)	PSO2(2)
CO5	Critically think and develop innovative models.	PO11(1)	PSO3(1)

EN25C02	English Essentials – II	L	T	P	C
		1	0	2	2

Course Objectives

- Enable learners to improve fluency and accuracy in spoken and written communication.
- Develop learners' ability to articulate ideas clearly and effectively in formal and informal spoken interactions.
- Help learners construct well-organised written documents relevant to academic and workplace contexts.

Oral Communication: Types (Verbal and Nonverbal), Interpersonal and group communication, Telephonic conversation.

Suggested Activities: Short presentations, Debates, Formal Speeches (Welcome, Vote of Thanks and introducing guests), Listen and respond to short podcasts.

Business Correspondence: Email Communication, Formal Letters (Types), Business Meeting.

Suggested Activities: Email and letter writing (Complaint, request, permission), Agenda, minutes of the meeting.

Academic Writing: Paraphrasing, Summarizing, Essay Writing, Instructions and Recommendations.

Suggested Activities: Essay writing (Cause and effect, argumentative, persuasive), User guides/ manuals, policy document.

Team Work: Leadership Skills (Team building, Team Leader, Team player), Negotiation and Problem solving skills

Suggested Activities: SWOT Analysis, Brainstorming and Group discussions.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Worksheets (10%), Group Activities (20%), Report Writing (20%), Internal Examinations (50%)

References:

1. Koneru Aruna. (2020). English Language Skills for Engineers. McGraw Hill Education.
2. Taylor, Shirley & Chandra .V. (2010). Communication for Business A Practical Approach. India: Pearson Longman.
3. Ian Badger, et al., (2014). Listening: B2 (Collins English for Life: Skills), Collins.
4. Raymond Murphy (2019), Grammar in Use, Cambridge University Press.

E-resources:

1. Communication for Business Success - https://open.umn.edu/opentextbooks/textbooks/8
2. TED Talks – https://www.ted.com/

	Description of CO	PO	PSO
CO1	Understand the importance of communication and drafting skills in engineering and technology.	---	
CO2	Apply listening strategies to comprehend spoken English in various contexts.	PO1(3)	PSO3(2)
CO3	Participate actively in group discussions by analysing critically from different views.	PO2(2) PO8(1)	PSO3(3)
CO4	Create written reports coherently for various purposes.	PO9(2)	PSO3(2)
CO5	Adapt communication styles to global, multicultural environments.	PO11(1)	PSO2(2)

ME25C05	Re-Engineering for Innovation	L	T	P	C
		0	0	4	2

Course Objectives:

- To cultivate foundational skills in prototyping, and automation for development of prototypes with real-world applications.
- To provide a comprehensive, hands-on exposure to product development through reverse engineering concepts.

Bootcamp 1: Introduction to Product Development, Reverse Engineering, Overview of the product lifecycle, Hands-on disassembly of simple products, Practice of basic measurements and sketching, Introduction to CAD modeling of disassembled parts, Virtual assembly of parts.

Bootcamp 2: Embedded System Programming (Open-source platforms), Practice of interfacing sensors, reading data, automation in home, healthcare and agriculture.

Reverse Engineering: Sketch and prototype alternative designs, Group brainstorming sessions, Manufacture prototype parts using 3D printing and / or workshop tools, Assemble prototype product.

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%

Assessment Methodology: Project (30%), Assignment (10%), Practical (30%), Internal Examinations (30%)

References:

1. Wang, W. (2010). Reverse engineering: Mechanisms, structures, systems & materials. CRC Press.
2. Margolis, M. (2020). Arduino cookbook: Recipes to begin, expand, and enhance your projects (3rd ed.). O'Reilly Media.

E-Resources:

1. GrabCAD – https://grabcad.com/
2. GitHub – https://github.com/

	Description of CO	PO	PSO
CO1	Understand the product development lifecycle, including stages such as concept generation, design, prototyping, and testing.	---	
CO2	Apply reverse engineering techniques to analyze and document existing products.	PO1 (3) PO2 (2)	PSO1(2)
CO3	Collaborate in teams to fabricate prototypes using appropriate tools.	PO5 (2) PO8 (1) PO9 (1)	PSO3(3)
CO4	Engage in independent learning and continuously adapt to emerging technologies in product design	PO11(2)	PSO2(2) PSO3(2)

UC25A03	Life Skills for Engineers – II	L	T	P	C
		1	0	2	1

Course Objectives:

- To impart and cultivate analytical reasoning, innovative thinking, effective collaboration, and ethical leadership to prepare students for complex challenges in professional and personal environments.

Critical Thinking: Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity, Critical thinking Vs Creative thinking, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence.

Activities: Two-Brainstorm Method, “30 Circles” Challenge, “Desert Survival” Simulation, Lateral thinking riddles and puzzles, "What If?" Scenario Writing, Fast vs. Slow Thinking Game, Creativity Myth Busters

Problem Solving: Techniques, Six Thinking Hats, Mind Mapping, Forced Connections. Analytical Thinking, Numeric, symbolic, and graphic reasoning. Scientific temperament and Logical thinking.

Activities: Case study analysis, Escape Room challenge.

Leadership: Leadership Styles & Self-Assessment, Communication & Active Listening, Decision-Making & Responsibility, Teamwork & Delegation, Empathy, Integrity & Conflict Management, Vision, Motivation & Goal-Setting.

Activities: Crisis Leadership Simulation, Tower Challenge, Leadership Dilemmas Role-Play, Team Vision Board

Weightage: Continuous Assessment: 100%

Assessment Methodology: Assignments (20%), Flipped Class & Worksheets (10%), Practical (30%), Internal Examinations (40%)

References:

1. De Bono, E. (2017). *Six thinking hats*, Little, Brown Book Group.
2. Facione, P. A. (2015). *Critical thinking: What it is and why it counts*. Insight Assessment.
3. Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.
4. Whetten, D. A., & Cameron, K. S. (2016). *Developing management skills*. Pearson.

	Description of CO	PO	PSO
CO1	Explain the importance of leadership and management skills in life.	---	
CO2	Apply and demonstrate creative thinking techniques to generate innovative solutions.	PO7 (3)	PSO1(1) PSO2(1)
CO3	Exhibit effective collaboration and communication skills through teamwork, active listening, and conflict resolution strategies.	PO8 (2)	PSO3(3)
CO4	Integrate scientific temperament and logical reasoning into c problem solving in engineering and real-world contexts.	PO11 (2)	PSO2(1) PSO3(2)

UC25A04	Physical Education - II	L	T	P	C
		0	0	4	1

Course Objectives:

- To impart knowledge on gymnastic exercises and pressing needs for upskilling in a particular game.

Basic gymnastics exercises: Warming up, Suitable exercise, Lead up games, Safety education, Movement education, Balanced Walk, execution, floor exercise, tumbling/acrobatics, grip, release, swinging, parallel bar exercise, horizontal bar exercise, flic-flac-walk and pyramids.

Upskilling in any one of the athletics: Broad Jump, High Jump, Triple Jump, Relay Sprints, Javelin Throw, Discuss Throw, Shot Put, Short and Long-distance Running.

Advance skills in any one of the indoor/outdoor games, which has been opted by the student in the I semester.

Weightage: Continuous Assessment: 100%

Assessment Methodology: Attendance (60%), Quiz (10%), Participation in Sports and Games (20%) and Viva Voce (10%)

References:

1. Singh, A. (2008). Essentials of physical education. Kalyani Publishers.
2. Kamlesh, M. L. (2006). Psychology in physical education and sport (3rd ed.). Metropolitan Book Co.
3. Mangal, S. K. (2009). *Psychology of sports performance*. Sports Publication.
4. Kandappan, K. (2004). *Foundations of physical education*. Friends Publications.

E-resources:

1. **https://www.who.int/health-topics/physical-Activities**

	CO Description	PO	PSO
CO1	Understand and explain the importance of physical Activities for mental and physical health.	---	
CO2	Apply safety principles and methods during sports activities.	PO1(3)	PSO3(1)
CO3	Develop teamwork, discipline, and leadership through sports and group activities and collaborate effectively.	PO8 (3)	PSO3(2)
CO4	Demonstrate the advanced technical skills and strategic understanding in the game of their interest.	PO11(1)	PSO3(2)

FOREIGN LANGUAGE^

UC25F01	Deutsch – I	L	T	P	C
		1	0	2	1

Course Objectives:

- To impart fundamentals of the Deutsch language, including reading, writing systems, pronunciation, and speaking.

Basics & Introduction: German alphabet and pronunciation, Basic greetings and farewells, Introducing yourself and others (Ich heiße…, Wer bist du?), Numbers 1–100 and days of the week, Personal pronouns (ich, du, er, sie…), Sentence structure (SVO word order).

Activities: Alphabet spelling game, short skits, Use color-coded cards for SVO sentences.

Grammar Essentials & Everyday Vocabulary: Present tense of regular verbs (spielen, arbeiten, machen…), Common irregular verbs: sein (to be), haben (to have), gehen, kommen, Articles and gender (der, die, das; ein, eine), Simple questions and negation (nicht, kein), Describing people and things: adjectives and colors, Family, school, food, and common objects vocabulary.

Activities: Conjugate regular and irregular verbs, “Question Chain” game, Create a simple family tree.

Everyday Communication in German: Asking for and giving directions, Telling the time and talking about schedules, Ordering food and drinks at a café or restaurant, Talking about hobbies, weather, and daily routines, Listening to short conversations and responding appropriately, Introduction to German culture and formal/informal language use (du vs Sie).

Activities: Ordering food and drinks, Give directions, Formal / Informal greetings, Do’s and Don’ts.

Weightage: Continuous Assessment: 100%

Assessment Methodology: Assignments (30%), Quiz (10%) and Internal Examinations 60%

References:

1. Funk, H., Kuhn, C., & Demme, S. (2015). *Menschen A1: Deutsch als Fremdsprache Kursbuch*. Hueber Verlag.

	CO Description	PO	PSO
CO1	Understand simple spoken Deutsch in everyday contexts.	---	
CO2	Communicate with widely used Deutsch words effectively.	PO9 (2)	PSO3(2)
CO3	Develop the skills necessary for self-directed learning and continuous improvement in Deutsch language.	PO11 (1)	PSO3(2)

UC25F02	Japanese – I	L	T	P	C
		1	0	2	1

Course Objectives:

- To impart fundamentals of the Japanese language, including reading, writing systems, pronunciation, and speaking.

Writing Systems & Basic Communication: Introduction to Hiragana: vowels, basic characters, reading & writing, Introduction to Katakana: basic characters and usage, Basic greetings and farewells (こんにちは, おはようございます, さようなら), Introducing yourself (名前、出身、年齢), Basic sentence structure: Subject–Object–Verb, Numbers 1–100, days of the week, classroom expressions.

Activities: Flashcard games and writing drills, Self-introduction, Numbers & date-matching, Greeting expressions, Listening to audio.

Grammar & Everyday Vocabulary: Particles: は (wa), を (wo), の (no), へ (e), に (ni), Present tense verbs: です, ます-form conjugation (たべます、のみます), Negative forms: ではありません, ません, Describing people and objects using adjectives (い and な), Question formation: なに、どこ、だれ、いつ, Vocabulary for family, food, colors, and basic actions.

Activities: Verb conjugation drills, Guessing game, Picture description, “Shopping” with food vocab and counters

Conversation & Cultural Etiquette: Talking about routines and schedules (daily verbs, time expressions), Asking and giving simple directions (〜はどこですか？), Ordering food and making polite requests (〜をください、〜をおねがいします), Expressing likes and dislikes (すき・きらい), Listening to short conversations and identifying key phrases, Introduction to formal/informal speech and Japanese etiquette.

Activities: Skits and role-plays, daily schedule, beginner-level dialogue, Group discussion on etiquette.

Activities: Practice worksheets and flashcards for hiragana, Writing drills and reading simple katakana words, Dialogue practice for greetings and self-introduction, Sentence construction exercises with basic SOV structure, Particle usage exercises and short dialogues, Role-play scheduling, shopping, and telling time, Verb conjugation drills for common verbs, Descriptive sentence exercises using adjectives, Practice Q&A dialogues forming questions and negations, Kanji writing practice and quizzes for basic characters, Vocabulary tests and conversational practice on daily topics, Oral presentations and listening comprehension quizzes.

Weightage: Continuous Assessment: 100%

Assessment Methodology: Assignments (30%), Quiz (10%) and Internal Examinations 60%

References:

1. Banno, E., Ikeda, Y., Ohno, Y., Shinagawa, C., & Tokashiki, K. (2011). Genki I: An integrated course in elementary Japanese. The Japan Times.
2. The Japan Foundation. (2017). Marugoto Japanese language and culture starter (A1) course book for communicative language activities. Goyal Publishers.

	CO Description	PO	PSO
CO1	Understand simple spoken Japanese in everyday contexts.	---	
CO2	Communicate with widely used Japanese words effectively.	PO9 (2)	PSO3(2)
CO3	Develop the skills necessary for self-directed learning and continuous improvement in Japanese language.	PO11 (1)	PSO3(2)

UC25F03	Korean – I	L	T	P	C
		1	0	2	1

Course Objectives:

- To impart fundamentals of the Korean language, including reading, writing systems, pronunciation, and speaking.

Fundamentals of Korean: Introduction to Hangul: consonants and vowels, Basic pronunciation and syllable formation, Common greetings and self-introductions, Numbers (Sino-Korean and Native Korean basics), Basic sentence structure (Subject-Object-Verb), Simple expressions (e.g., 감사합니다, 안녕하세요).

Activities: Writing and reading Hangul practice sheets, Pronunciation drills and audio repetition, Dialogue practice for greetings and self-introduction, Counting and number exercises.

Essential Grammar and Vocabulary: Particles (은/는, 이/가, 을/를) and usage, Basic verbs and present tense conjugation, Sentence patterns: affirmative, negative, interrogative, Common adjectives and descriptive sentences, Expressing possession and location, Asking simple questions (어디, 뭐, 누구).

Activities: Verb conjugation and sentence formation drills, Role-play conversations for shopping and daily routines, Descriptive writing and speaking exercises, Question and answer practice.

Everyday Korean Communication: Polite speech levels and honorifics introduction, Talking about time, dates, and schedules, Ordering food, shopping phrases, counting objects, Simple directions and transportation vocabulary, Listening practice with short dialogues, Cultural notes on etiquette and communication.

Activities: Role-play ordering at a restaurant or buying items, Listening comprehension exercises, Giving and asking for directions practice, Group conversations and presentations.

Weightage: Continuous Assessment: 100%

Assessment Methodology: Assignments (30%), Quiz (10%) and Internal Examinations 60%

References:

1. King, R., Yeon, J., & Brown, A. (2015). Elementary Korean (2nd ed.). Tuttle Publishing.
2. Cho, Y., Lee, H., Schulz, C., Sohn, H.-M., & Sohn, S.-O. (2001). Integrated Korean: Beginning 1. University of Hawai‘i Press.

	CO Description	PO	PSO
CO1	Understand simple spoken Korean in everyday contexts.	---	
CO2	Communicate with widely used Korean words effectively.	PO9 (2)	PSO3(2)
CO3	Develop the skills necessary for self-directed learning and continuous improvement in Korean language.	PO11 (1)	PSO3(2)

Semester III

MA25C09	Computational Differential Equations	L	T	P	C
		3	1	0	4

Course Objectives: The Objectives of the course are to equip students with the ability to formulate and solve various types of Ordinary and Partial Differential Equations (ODEs & PDEs) and to develop proficiency in applying numerical methods and computational tools for solving differential equations encountered in engineering problems.

First Order Ordinary Differential Equations: Basic concepts of ordinary differential equations–Formation of first order differential equations from physical problems–First order and first-degree ODE: Variables separable–Exact equations–Leibnitz's equation – Bernoulli's equation – Numerical Methods: Solving first order ODE by Euler's formula, Taylor series and Runge Kutta method of 4th order.

Activities: Application and Visualization of the first order ODE using open-source software and solving Competitive Examination questions

Higher Order Ordinary Differential Equations: Formation of second order differential equations from physical problems–Linear equations of second and higher order with constant coefficients – Euler's linear equations – Method of variation of parameters– Numerical Methods: Solving second order ODE by Runge-Kutta method of 4th order and finite difference method.

Activities: solving ordinary differential equations using open-source software and solving of Competitive Examination questions

First Order Partial Differential Equations: Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Solution of PDE by variable separable method – Solution of standard types of first order partial differential equations (excluding reducible to standard types) – Lagrange's linear equation – Numerical Methods for first order PDE by Method of lines with Runge-Kutta method of order fourth.

Activities: Application and Visualization of the Partial Differential Equations using open-source software and solving Competitive Examination questions

Higher Order Partial Differential Equations: Linear homogeneous partial differential equations of second and higher order with constant coefficients. Numerical Methods: Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain—Solution of one-dimensional heat equation using Bender Schmidt and Crank Nicholson difference schemes—Solution of one-dimensional wave equation by explicit scheme.

Activities: Application of the second order PDE using open-source software of 1-D wave, 1-D heat equations, Laplace and Poisson equations and Solving Competitive Examination questions

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Assignments (20%), Solution to application-oriented problems using software (20%), Solving Competitive Examination questions (20%),

Internal Examinations (40%).

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, (11th ed.), John Wiley & Sons, USA,2025.
2. Joe D. Hoffman, Numerical *Methods for Engineers and Scientists* (3rd ed.). CRC Press (Taylor & Francis Group), 2001.
3. Steven C. Chapra and Raymond P. Canale. *Numerical Methods for Engineers* (8th ed.). McGraw-Hill Education, 2021.
4. William E. Boyce and Richard C. DiPrima. *Elementary Differential Equations and Boundary Value Problems,* (11thed.). John Wiley & Sons, USA,2017.
5. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 45th Edition, 2026.
6. Randall J. LeVeque, Finite Difference Methods for Ordinary and Partial Differential Equations, SIAM,2007.

E-resources:

1. https://ocw.mit.edu/courses/18-03-differential-equations-spring-2010/
2. https://archive.nptel.ac.in/content/syllabus_pdf/111107063.pdf
3. https://github.com/patrickwalls/mathematicalpython

	Description of CO	**PO**	**PSO**
CO1	Explain first and higher-order ODEs using appropriate analytical and numerical techniques.	-	-
CO2	Solve higher-order PDEs using classical and finite difference methods.	PO1(3) PO5(3)	PSO1(2)
CO3	Apply various solution methods to differential equations arising in engineering contexts.	PO1 (3) PO5(3)	PSO2(1)
CO4	Interpretation of numerical solutions for partial differential equations and using open-source software.	PO2(3) PO5(3) PO11(2)	PSO2(1)

BT25301	Process Calculations	L	T	P	C
		2	1	0	3

Course objectives:

- To provide a comprehensive understanding of stoichiometry of different unit operations and process involved in chemical and biotechnology industries with systematic application laws and appropriate dimensions and ability to solve mass and energy balance calculations.

Basic Chemical Calculations: Dimension – Systems of units esp. engineering FPS, Engineering MKS & SI systems – Conversion of units – Pressure, volume, force, work, power, Viscosity and other derived units related to basic chemical process and fundamental units, Dimensionless numbers and Dimensional analysis.

Activities: Create a comparative chart of fundamental and derived units, solve the problem using dimensionless numbers and state its significance

Gas Equations and Elemental Balance: Ideal and actual gas equations, Application to pure gas & gas mixtures -partial pressures, partial volumes, Raoult's law, Henry's law, Dalton and Amaghat's law, Composition of mixtures and solutions - mass fraction, mass %, mole fraction, mole %, average molecular weight, density by ideal gas law molarity, molality, normality, ppm. Concept of vapour pressure and effect of temperature on vapour pressure, Humidification.

Activities: Comprehend various real gas equations and select suitable equation of state for various properties

Material Balance for Unit Operations: Material balance calculation for unit operations- Mixing, Absorption and stripping, Distillation, Liquid extraction, Leaching, drying, evaporation, crystallization.

Activities: Draw the material balance for the equipment related to process industries.

Material Balance Involving Chemical Reaction: Principles of stoichiometry -Limiting, excess reactant, Degree of completion, excess ratio, yield, selectivity and percentage conversion for simple and multiple reactions. Recycle and Bypass purging calculation. Degree of reduction and yield coefficient in microbial growth and product formation.

Activities: Solve stoichiometric calculations involving chemical reactions and recycle operations

Energy Balance: General calculations for enthalpy changes involving specific heat capacity, sensible heat and latent heat, Heat of a Reaction, Heat of formation, Heat of combustion, Adiabatic reaction temperature, Combustion Reactions – Theoretical oxygen demand, excess air, Orsat analysis, Calorific value of fuel. Thermal death kinetics and sterilization concepts in bioprocess.

Activities: Draw the energy balance across the equipment used in process industries

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Assignments (15%), Solving of competitive exams questions (15%), Internal Examinations (70%).

References:

1. Bhatt B.I & S M Vora, Stoichiometry - Fifth edition Tata McGraw Hill 2017
2. K.A.Kavhane, Introduction to Process calculations, Nirali Publishers,1st Edition,2016
3. D.C. Sikdhar, chemical process calculations, PHI learning private ltd, 2013,
4. K.Asokan, Chemical process calculations, University Press India Private Ltd, 2018.
5. K.V.Narayanan, B.Laksmikutty, stoichiometry and Process calcualtions,PHI learning private ltd, 2017.

E-resources:

1. https://archive.nptel.ac.in/courses/103/103/103103165/

CO Mapping with PO & PSO:

CO's	CO Description	PO	PSO
CO1	Explain the fundamental concepts of units, dimensions, gas laws, thermodynamic properties, and composition of chemical systems.	-	-
CO2	Apply principles of material and energy balances, gas equations, and stoichiometry to solve chemical engineering problems.	PO1(3) PO2 (3) PO3(2)	PSO1(2) PSO 2(3)
CO3	Analyze chemical and bioprocess systems involving unit operations, reactive processes, and phase behavior to determine system performance.	PO1(3) PO2 (3) PO3(2)	PSO2(3)
CO4	Evaluate material and energy balance solutions for accuracy, feasibility, and efficiency in chemical processes.	PO2 (3) PO3 (3) PO4 (3)	PSO3(1)
CO5	Develop integrated models for material and energy balances in complex chemical and bioprocess systems, including reactive and thermal processes.	PO4 (2) PO5(3)	PSO1(3) PSO2(2)

BT25302	Biothermodynamics	L	T	P	C
		2	1	0	3

Course Objectives:

- To understand thermodynamics principles and their application to biological systems, including fluids, solutions, equilibria, and bioenergetics in metabolic pathways.

Introduction to Thermodynamics: Thermodynamic Systems and State Functions- Laws of Thermodynamics -Enthalpy and Entropy in Biological Contexts: Real Fluids and Non-Ideal behavior: Thermodynamic Relationships: thermodynamic potentials-Maxwell's relations: Gibbs Free Energy and Biochemical Reactions.

Activities: Classify cell components as open, closed, or isolated systems based on energy and matter exchange, Compare energy balance in running and resting by identifying heat loss and work done

Thermodynamics of Solutions and Biochemical Mixtures: Thermophysical Properties of Liquids and Solutions: Ideal and Non-Ideal behavior of Gases and Solutions: Partial Molar Properties and Their Biochemical Significance: Chemical Potential-Fugacity- Activities and Activities Coefficients - Gibbs - Duhem Equation in Multicomponent Systems.

Activities: Classify solutions as ideal or non-ideal based on intermolecular interactions, Observe osmosis in biological samples to understand water movement due to concentration gradient

Phase Equilibria: Fundamentals of Phase Equilibrium and Stability- Phase Diagrams and Phase Rule: Vapor-Liquid Equilibrium (VLE)- VLE Data and Consistency Checks: Azeotropes- Liquid-Liquid Equilibrium (LLE)- Solid-Liquid Equilibria.

Activities: Interpret phase diagrams by identifying stable regions, triple and critical points, Observe vapor–liquid equilibrium during distillation to understand liquid–vapor composition changes.

Chemical Reaction Equilibria: Fundamentals of Chemical Reaction Equilibrium- Equilibrium Constant and Its Evaluation- Effect of Temperature and Pressure- Equilibrium Conversion and Yield Calculations: Multiple Reactions- Reaction Equilibria in Biochemical Systems.

Activities: Study equilibrium shifts by changing concentration or temperature and explain them using Le Chatelier's principle, Calculate equilibrium constants to predict reaction direction.

Thermo-Bioenergetics: Thermodynamics of Metabolic Pathways: Oxygen Demand and Heat Generation in Aerobic Growth: Energy Coupling and ATP Economy: Thermodynamics of Redox Reactions- Bioenergetics of Macromolecular Interactions: Systems and Synthetic Biology Perspective.

Activities: Identify energy-releasing, ATP-producing, and redox steps in metabolic pathways, Examine ATP use in muscle contraction and active transport, focusing on energy coupling.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Assignments (15%), Solving of competitive exams questions (15%), Internal Examinations (70%).

References:

1. J.M. Smith, H.C. Van Ness, M.M. Abbott – Introduction to Chemical Engineering Thermodynamics, 8th Ed., McGraw-Hill, 2018.
2. Sandler, S.I. – Chemical, Biochemical, and Engineering Thermodynamics, 5th Ed., Wiley, 2020.
3. Michael L. Shuler & Fikret Kargi – Bioprocess Engineering: Basic Concepts, 3rd Ed., Prentice Hall, 2017.
4. Stephanopoulos, G., Metabolic Engineering: Principles and Methodologies, Academic Press, 2022.
5. Feist AM, Palsson BØ**.** – The biomass objective function, Nature Reviews Microbiology, 2020.

E-Resources: NIST Chemistry WebBook, BioNumbers, eQuilibrator

CO Mapping with PO & PSO:

COs	CO Description	PO Mapping	PSO
CO1	Apply the thermodynamic concepts to biological systems.	PO1 (3)	PSO1(2)
CO2	Analyze the thermodynamic behaviour of ideal and non-ideal fluids and solutions, including partial molar properties and chemical potential	PO2 (3) PO5 (3)	PSO1(2) PSO2(1) PSO3(3)
CO3	Interpret phase equilibria using phase diagrams and apply phase rules to biochemical and multicomponent systems.	PO5 (2) PO7 (2)	PSO1(2) PSO4(1)
CO4	Evaluate chemical reaction equilibria, equilibrium constants, and the effects of	PO5 (2) PO7 (2)	PSO2(3)

COs	CO Description	PO Mapping	PSO
	environmental conditions on biochemical reaction systems.		PSO3(2)
CO5	Assess energy transformations in metabolic pathways, including redox reactions, ATP coupling, and thermodynamic efficiency in biological processes.	PO1 (3) PO3 (2)	PSO1(2) PSO2(3)

BT25303	Biochemistry	L	T	P	C
		3	0	4	5

Course Objectives:

- To impart the basics of carbohydrates, lipids, proteins, and nucleic acids as well as metabolism of carbohydrates, lipids and amino acids and knowledge in clinical biochemistry

Structure And Properties of Carbohydrates: Functions and classifications of carbohydrate – Biologically important monosaccharides – Structural aspects of monosaccharides – Reactions of monosaccharides - Disaccharides – Oligosaccharides - Polysaccharides: Homopolysaccharides and Heteropolysaccharide

Practicals:

1. Qualitative tests for carbohydrates: (i) Aldose Vs. Ketose, (ii) Reducing Vs. Non-reducing and (iii) Hexose Vs. Pentose
2. Preparation of buffer solutions

Activities: Create models for structure of carbohydrates, Seminar on comparative studies of various carbohydrates

Structure and properties of lipids, proteins and nucleic acids: Lipids: Classification and functions of lipids, fatty acids, triglycerols, phospholipids, glycolipids, lipoproteins, steroids, amphipathic lipids – Proteins: Classification and functions of proteins, amino acids, structure of proteins, properties of proteins-denaturation – Nucleic acids: Functions of nucleic acids, nucleotides, structure of DNA and RNA

Practicals:

1. Estimation of protein by Bradford's method
2. Estimation of protein by Lowry's method
3. Estimation of protein by Biuret method

Activities: Create models and poster presentation on structural aspects of lipids, proteins and nucleic acids

Metabolism of Carbohydrates: Introduction to metabolism – Pathways of carbohydrate metabolism: Glycolysis, citric acid cycle, gluconeogenesis, pentose phosphate shunt and glyoxalate cycle – Metabolism of fructose

Practicals:

1. Estimation of carbohydrate by the anthrone method
2. Estimation of reducing sugar by DNSA method

Activities: Assignment on various pathways of carbohydrate metabolism, Poster presentation on metabolic pathways of carbohydrate.

Metabolism of Lipids and Amino Acids: Biosynthesis of fatty acid – fatty acid oxidation – Ketogenesis - Synthesis of triacylglycerols – Metabolism of glycolipids – Metabolism of cholesterol – Lipoproteins – Metabolism of HDL – Metabolism of amino acids: Transamination, Deamination, Urea cycle

Practicals:

1. Quantification of amino acids using ninhydrin method

[

Activities: Assignment and Virtual Demonstration of lipids and amino acids } metabolism

Clinical Biochemistry: Clinical Enzymology: Lactate dehydrogenase (LDH), Aspartate amino transferase (AST), Alanine amino transferase (ALT), Alkaline phosphatase (ALP) – Regulation of glucose and diabetes mellitus: Overview of regulation of blood glucose, post-pirandial regulation, regulation in fasting state, diabetes mellitus – Cadiovascular diseases: Clinical significance of cholesterol, atherosclerosis and LDL, prevention of atherosclerosis

Practicals:

1. Determination of blood glucose levels using GOD-POD assay.
2. Determination of triglycerides levels in blood using coupled enzymatic assay.

Activities: Seminar and Reproduction of research paper/Case study on diabetes mellitus and cardiovascular diseases.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%.

Assessment Methodology: Assignments (20%), Seminar/Poster presentation (20%), Reproduction of research paper/Case Study (10%), Internal Examinations (50%).

References:

1. Satyanarayana, U. and U. Chakerapani, “Biochemistry” 6th Edition, Elsevier, 2021.
2. David L. Nelson, Michael M. Cox , Lehninger Principles of Biochemistry, W.H.Freeman and Company, 2017.
3. Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, “Harper’s Illustrated Biochemistry”, 31st Edition, McGraw-Hill, 2018.
4. Donald Voet, Judith G. Voet, “Biochemistry”, 4th Edition, Wiley, 2010
5. DM.Vasudevan, Sreekumari S.,Kannan Vaidyanathan, Text Book of Biochemistry For Medical Students,6th Edition, Jaypee Brothers Medical Publishers (p) Ltd.,2011

E-resources:

1. https://onlinecourses.nptel.ac.in/noc24_bt12/preview
   https://onlinecourses.swayam2.ac.in/cec20_ag01/preview

CO Mapping with PO & PSO

COs	CO Description	PO	PSO
CO1	Explain the structure, properties, and biological functions of carbohydrates.	-	-
CO2	Apply the knowledge of the structure and properties of lipids, proteins, and nucleic acids to biological systems.	PO1(3), PO2(3)	PSO1(2)
CO3	Analyze the metabolic pathways of carbohydrates and their regulatory mechanisms.	PO2(3)	PSO2(2)
CO4	Evaluate the metabolic interrelationships of lipids and amino acids in cellular functions and energy production.	PO2(3), PO4(3)	PSO2(1)
CO5	Design and interpret biochemical approaches for clinical enzymology, glucose regulation, and lipid profile assessment in biotechnology applications.	PO3(2), PO4(2), PO5(2)	PSO3(1)

BT25304	Microbiology	L	T	P	C
		3	0	4	5

Course Objectives:

- To impart fundamentals of microorganisms and develop essential microbiological laboratory skills for biotechnological applications.

Introduction to Microbiology: Scope and significance of microbiology; Classification of microorganisms: Whittaker and Woese's systems; Basic principles of Microscopy: Light and Electron; Sterilization and disinfection methods.

Practicals:

1. Introduction to aseptic techniques and biosafety practices
2. Preparation of culture media and sterilization techniques

Activities: Prepare a concept map illustrating the classification of microorganisms and integrate the examples of beneficial and harmful microbes.

Microbial Cell Structure and Staining Techniques: Structural organization and key structural components: Bacteria, fungi, algae, and viruses; Principles of staining techniques: Simple, Differential and Specialized staining techniques.

Practical:

1. Simple staining, Differential staining, Special staining

Activities: Draw and label comparative diagrams of prokaryotic and eukaryotic cells, including viruses, and write a brief explanation highlighting structural differences and their functional significance.

Microbial Growth and Nutrition: Nutritional types of microorganisms; Growth curve and influencing factors, Types of culture media (enriched, selective, differential; Basics of culture maintenance.

Practicals:

1. Inoculation and isolation techniques: streak plate, pour plate, spread plate
2. Determination of bacterial growth curve

Activities: Analyze and interpret a given microbial growth curve, identify different growth phases, and explain the effect of environmental factors on microbial growth behavior.

Microbial Control and Clinical Microbiology: Principles of microbial control: physical (heat, filtration, radiation) and chemical agents (disinfectants, antiseptics); Basic concepts of infection and transmission; Antimicrobial agents: classification, mechanisms of action, and resistance.

Practicals:

1. Antibiotic susceptibility testing (Kirby-Bauer method)

Activities: Analyze a short case scenario on infection spread and propose appropriate microbial control measures and preventive strategies based on theoretical concepts.

Microbial Ecology and Microbiome: Microbial interactions: mutualism, commensalism, parasitism, competition, syntrophy; Microbes in soil, water, and human body; Introduction to microbiome and its importance.

Practicals:

1. Isolation of microorganisms from soil and water samples.

Activities: will write a short reflection note explaining the role of the human microbiome in health and disease, supported by real-life examples or recent findings.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Assignments/module activities (20%), Laboratory performance and record (25%), Practical skill assessment (15%), Internal Examinations (40%).

References:

1. Prescott, Harley and Klein's Microbiology**.** By Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, 11th Edition, McGraw Hill Education, 2022.
2. Microbiology: A Laboratory Manual. By James G. Cappuccino and Chad T. Welsh, 12th Edition, Pearson Education, 2022.
3. Brock Biology of Microorganisms. By Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl, 16th Edition, Pearson Education, 2021.
4. Foundations in Microbiology. By Kathleen Park Talaro and Barry Chess, 11th Edition, McGraw Hill Education, 2021.
5. General Microbiology**.** By Hans G. Schlegel, Cambridge University Press, 2019.

E-Resources:

1. Microbiology – OpenStax
2. **NPTEL / MOOC Video Lectures: NPTEL Course: Microbiology by** Dr. Gurvinder Kaur Saini, IIT Guwahati

CO Mapping with PO & PSO

CO's	CO Description	PO Mapping	PSO Mapping
CO1	Understand the structure, properties, and biological functions of carbohydrates.	-	-
CO2	Apply the knowledge of the structure and properties of lipids, proteins, and nucleic acids to biological systems.	PO1 (3) PO2 (2) PO4 (2)	PSO1 (3) PSO2 (1)
CO3	Analyze the metabolic pathways of carbohydrates and their regulatory mechanisms under physiological conditions.	PO1 (3) PO2 (3) PO4 (2)	PSO1 (3) PSO2 (2)
CO4	Evaluate the metabolic interrelationships of lipids and amino acids in cellular metabolism and energy production.	PO2 (3) PO4 (3) PO5 (2)	PSO1 (2) PSO2 (3) PSO3 (2)
CO5	Create and interpret biochemical strategies for clinical enzymology, glucose regulation, and lipid profile assessment in biotechnology applications.	PO2 (3) PO4 (3) PO5 (3) PO11 (2)	PSO1 (2) PSO2 (3) PSO3 (3)

BT25305	Cell Biology	L	T	P	C
		3	0	2	4

Course Objectives:

- To develop a comprehensive understanding of cell structure, functions, fundamental cellular processes and to equip learners with competencies in modern techniques for cellular analysis.

Cell Structure and Function Of The Organelles: Discovery of cells – Basic properties of cell - Prokaryotic and Eukaryotic cells - Sub-cellular organelles and functions – Structure and function of the plasma membrane: Structure and functions of membrane proteins , membrane lipids and membrane fluidity dynamic nature of the plasma membrane - Extra cellular matrix: Interaction of cells with extracellular materials, interactions of cell with other cells, tight junctions, gap junctions, cell –cell junctions.

Practicals:

1. Identification of bacterial, plant and animal cell
2. Preparation of transverse sections of monocot and dicot roots and stems by staining and slide preparation for microscopic observation.

Activities: Create a model of a cellular structure.

Cell Division and Cytoskeleton Proteins: Cytoskeleton and cell motility: functions of cytoskeleton, study of the cytoskeleton, microtubules, intermediate filaments, microfilaments, muscle contractility – Mitosis: and Meiosis- Cell cycle: different phases of cell cycle - Regulation of cell cycle: cyclin and cyclin dependent kinases-Cancer: Basic properties of cancer cell, causes of cancer, genetics of cancer- Role of Ras and Raf in oncogenesis and apoptosis.

Practicals:

1. Cell viability using Trypan blue assay.
2. Staining for different stages of mitosis in Allium cepa (onion)
3. Meiotic cell division in Hibiscus flower buds

Activities: Construction of a three-dimensional model representing cytoskeletal components, including microtubules and actin filaments, to illustrate their structural organization.

Principles Of Membrane Transport: Overview on membrane transport - Passive and Active Transport - Bacterial Permeases - Ion channels - ATP pumps and ionic transport environment -Na+ / K+ /Ca+2 pumps – uniport - symport - antiporter system - Ligand gated / voltage gated channels and the propagation of action potentials in nerve cells; Acetylcholine-gated cation channels leads to muscle contraction - Agonists and Antagonists.

Practicals:

1. Study of Tonicity using red blood cells (Appropriate ethical guidelines).

2. Study of Osmosis across semi permeable membrane using dialysis tube.

Activities: Create a chart comparing all membrane transport mechanisms.

Cell Signaling and Signal Transduction: Receptors -– Extracellular signaling- Cell surface and cytosolic receptors - Different classes of receptors autocrine, paracrine, endocrine models – Secondary messengers molecules: calcium signaling.

Activities: Preparation of flowcharts illustrating major signaling pathways.

e.g. Receptor tyrosine kinase, Calcium signalling.

Techniques Used to Study Cells: Cell fractionation and flow cytometry, Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells – Immunostaining.

Practicals:

1.Cell fractionation using centrifugation techniques.

Activities: Comparative analysis of cellular images obtained from SEM, TEM, and confocal microscopy to evaluate differences in resolution, magnification, and ultrastructural details.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Assignments/module activities (10%), Laboratory performance and record (20%), Practical skill assessment (20%), Internal Examinations (50%).

References:

1. Harvey Lodish, Arnod Ber, Chris A. Kaiser, Monty Krieger, Anthongy Bretscher, Hidde Ploegh, Kelsey C Martin, Michael Yaffe, Angelika Amon (2020). The Molecular Biology of Cell, 8th (ed.), Garland Publisher.
2. Cooper, G.M. and R.E. Hansman (2018). The Cell: A Molecular Approach, 8th (ed.), Oxford University Press.
3. Karp Gerald (2021). Cell and Molecular Biology: Concepts and Experiments 8th (ed.), John Wiley Publication.
4. Bruce Alberts, Reccba Heald, Alexdaner Johnson,David Morgan, Martin Raff, Keith Roberts, Peter Walter, John Wilson, and Tim Hunt (2022).Molecular Biology of the Cell, 7th (ed.) W. W. Norton & Company.
   Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D, Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2025) Essential of Cell Biology" 4th (ed.) Garland Publishing.

E-Resources:

NPTEL: Introduction to Cell Biology by Prof.Nagraj Balasubramanin and Prof. Girish Ratnaparkhi; https://onlinecourses.nptel.ac.in/noc25_bt69/preview

MOOc-list.com/tags/ Cell Biology

CO Mapping with PO & PSO:

CO's	CO Description	PO Mapping	PSO Mapping
CO1	Understand the structure, organization, and functions of prokaryotic and eukaryotic cells.	PO1 (3), PO2 (2)	PSO1 (2)
CO2	Apply the principles of cell division, cell cycle regulation, and apoptosis to biological systems.	PO1 (3), PO2 (2), PO4 (1)	PSO1 (2), PSO2 (1)
CO3	Analyze membrane structure, function, and transport mechanisms in cellular processes.	PO1 (3), PO2 (3), PO4 (2)	PSO1 (2), PSO2 (2)
CO4	Evaluate the role of cell receptors and signaling pathways in cellular communication and regulation.	PO2 (3), PO4 (3), PO5 (2)	PSO2 (3), PSO3 (1)
CO5	Design and perform cell biology experiments using microscopy, cell fractionation, and flow cytometry techniques.	PO3 (3), PO4 (3), PO5 (3), PO11 (2)	PSO1 (2), PSO2 (3), PSO3 (3)

EN25C03	English Communication Skills Laboratory– I	L	T	P	C
		0	0	2	1

Course Objectives:

- The objectives of the course are to foster students' confidence and fluency in professional and social communication and to bridge the gap between academic English and industry expectations.

List of Activities

A. Elements of Effective Speaking and Listening

(i) Sharing life experience/ turning point in their life – SATORI

(ii) Situational Conversation – eg. Talking to a Senior about Internship Tips

(iii) Welcoming a Guest Speaker at a Seminar

(iv) Pictography to represent data using images or symbols

(v) B2-C1 Listening exercises include lectures, interviews, and discussions.

B. Mastering Presentations

(i) Presentation Skills – Non-verbal communication

(ii) Mini-Presentations: Topics like "My Dream Project," "Engineering in 2050," 3-minute technical pitches with logical flow

(iii) Technical Presentations with PPT

C. Group Discussion Strategies:

(i) Introduction to Group Discussions - Key skills for effective participation

(ii) Phases in a GD and Conversational Phrases in GD.

(iii) Group Discussions – Abstract and Factual topics

D. Resume & LinkedIn Optimization

(i) Building LinkedIn Profile – Drafting headlines and summaries

(ii) Social Media Optimisation

(iii) Preparing Video Resume

E. Podcast-Based Language Learning:

(i) Listening to podcast (motivational, career oriented, success stories)

(ii) Podcast Preparation – Purpose – Topic – Structure – Recording Tips - Publication of the Podcast

F. Mock Interviews and Communication Strategies:

(i) Listening – Job interview

(ii) Speaking – Mock interviews

Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%.

Internal Assessment: 1. Listening (20 marks)
2. Video Resume (20 marks)
3. Creating a Podcast (30 marks)
4. Mock interview (30 marks)

End Semester Assessment: 1. Presentation with PPT (50 marks)
2. Group Discussion (50 marks)

References:

1. Floyd Kory, “Interpersonal Communication”, McGraw Hill Publication, 2023.
2. Bharadwaj Apoorva, “Leadership Communication Skills for Intercultural Management: Strategies for Effective Intercultural Management (Contemporary Themes in Business and Management)”, Routledge India; 1st edition, 2024.
3. Helen Spencer-Oatey and DomnaLazidou**, “**Making Working Relationships Work: The TRIPS Toolkit for Handling Relationship Challenges and Promoting Rapport”,Castledown Publishers,2023.
4. Presentations - Cambridge
5. Speaking Extra
6. Listening Extra – Miles Craven by Cambridge University Press
7. CVs, Resumes, and LinkedIn: A Guide to Professional English – Springer International Publishing

E-resources:

1. Train your mind to perform under pressure- Simon Sinek
https://curiosity.com/videos/simon-sinek-on-training-your-mind-to-perform-under-pressure-capture-your-flag/
2. Brilliant way one CEO rallied his team in the middle of layoffs
https://www.inc.com/video/simon-sinek-explains-why-you-should-put-people-before-numbers.html
3. Will Smith's Top Ten rules for success
https://www.youtube.com/watch?v=bBsT9omTeh0

CO Mapping with PO & PSO:

	Description of CO	PO	PSO1
CO1	Communicate effectively in everyday professional situations with confidence		
CO2	Deliver well-organised and effective presentations.	PO9(3)	PSO1(1) PSO3(2)
CO3	Participate in group discussions and express ideas clearly and confidently.	PO8(2) PO9(3)	PSO3(2)
CO4	Create professional video resumes and participate in interviews effectively.	PO9(2)	PSO3(3)
CO5	Create, record and publish motivational podcasts.	PO9(2) PO11(1)	PSO2(2) PSO3(3)

SEMESTER IV

BT25401	Enzyme Technology	L	T	P	C
		2	1	0	3

Course Objectives:

- To provide the fundamentals of enzymes, enzyme kinetics and inhibition as well as knowledge about the production, immobilization methods and application of enzymes

Overview of Enzymes and Their Action: Nature of enzymes – Features of active site – Peptide bond formation – Properties of enzymes – Classification of enzymes - Factors affecting enzyme Activities – Enzyme specificity – Cofactors and Coenzymes – Mechanisms of enzyme action – Monomeric and oligomeric enzymes.

Activities: Preparation of concept maps illustrating enzyme structure and active site interactions.

Kinetics of Enzyme Catalysed Reactions: Kinetics of single-substrate enzyme catalysed reactions: Time course of enzymatic reactions - Relationship between initial velocity and substrate concentration – Derivation of Henri Michaelis-Menten equation – Derivation of Briggs-Haldane modification of Michaelis-Menten – Significance of Vmax, Km and Kcat – Linearized form of Michaelis-Menten equations (Lineweaver-Burk plot, Eadie- Hofstee plot, Hanes-Wolff plot and Eisenthal-Cornish-Bowden direct plot) – Kinetics of multi-substrate enzyme catalysed reactions: Ping-Pong bi-bi mechanism, Random order mechanism, Compulsory order mechanism.

Activities: Case study analysis on industrial relevance of enzyme kinetics.

Enzyme Inhibition: Overview of reversible and irreversible inhibition – Competitive inhibition – Uncompetitive inhibition – Non-competitive inhibition – Mixed inhibition – Partial inhibition – Substrate inhibition – Allosteric inhibition - Monod Changeux Wyman model.

Activities: Group discussion on the significance of enzyme inhibitors in therapeutics and drug design.

Production, Purification and Applications of Enzymes: Production, purification and characterization of enzymes from microbial, plant and animal sources - Enzymes in food industry – Enzymes in organic synthesis – Enzymes in therapeutic – Enzymes in pharmaceutical and textile industries.

Activities: Case Study on production and applications of enzymes.

Enzyme Immobilization and Biosensors: Overview of enzyme immobilization – Methods of reversible enzyme immobilization: Adsorption, Ionic binding, Affinity binding, Chelation or metal binding, Disulfide bonds - Methods of irreversible enzyme immobilization: Covalent binding, Entrapment (beads or fibres), Encapsulation, Cross linking – Multi-enzyme immobilization: Random co-immobilization, position co-immobilization and compartmentalization - Advantages and disadvantages of enzyme immobilization - Applications of immobilized enzymes in biosensor for healthcare (Biosensors for the detection of Glucose and Urea) and environment (Biosensors for the detection of Chromium and Arsenic).

Activities: Poster presentation on biosensors and Reproduction of research paper/Case Study

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Assignments (20%), Solution to application-oriented problems (20%), Seminar/Poster presentation (20%), Internal Examinations (40%).

References:

1. Trevor Palmer and Philip L. Bonner, Enzymes: Biochemistry, Biotechnology, Clinical Chemistry, 2nd Edition, Wood Head Publishing Ltd, 2011.
2. Klaus Buchholz, Volker Kasche, and Uwe T. Bornscheuer, Biocatalysts and Enzyme Technology, Wiley-Blackwell, 2012
3. Robert A.Copeland,“Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis”, 2nd Edition, Wiley Publishing, 2000.
4. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, 2015.
5. Wolfgang Aehle, Enzymes in Industry: Production and Applications, 3rd Edition, Wiley-VCH, 2007.

E-resources:

1. https://archive.nptel.ac.in/courses/102/102/102102033/
2. https://onlinecourses.swayam2.ac.in/cec24_bt15/preview

CO MAPPING WITH PO & PSO:

COs	CO Description	PO Mapping	PSO Mapping
CO1	Understand the structure, classification, and mechanisms of enzyme action in biological systems.	-	-
CO2	Apply enzyme kinetics principles to analyze catalytic reactions and determine enzyme activity.	PO1 (3) PO2 (3) PO5 (2)	PSO1 (2) PSO2 (2)
CO3	Analyze the different types of enzyme inhibition and their effects on biochemical reaction rates.	PO2 (3) PO4 (2) PO5 (3)	PSO1 (2) PSO2 (2) PSO3 (1)
CO4	Evaluate enzyme production methods and their industrial, medical, and biotechnological applications.	PO2 (3) PO3 (3) PO5 (2)	PSO1 (1) PSO2 (2)
CO5	Design enzyme immobilization systems and biosensor-based applications for solving biotechnology-related problems.	PO3 (3) PO4 (3) PO5 (3) PO11 (2)	PSO1 (1) PSO2 (2) PSO3 (1)

BT25402	Basic Industrial Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

- To provide fundamental knowledge of industrial biotechnology, focusing on microorganisms, enzymes, and bioprocesses for large-scale production.

Introduction To Industrial Biotechnology: Definition and scope of industrial biotechnology; historical developments; role of microorganisms in industry; classification of industrial products (primary and secondary metabolites); overview of fermentation technology; screening and selection of industrially important microorganisms; strain improvement methods (mutation and selection).

Activities: Prepare a comparative chart of different industrial products (e.g., citric acid, ethanol, and antibiotics), mentioning microorganism used, substrate, and applications.

Fermentation Technology: Types of fermentation processes (batch, fed-batch, continuous); components of fermentation media; sterilization methods; design and operation of bioreactors; parameters affecting fermentation (pH, temperature, aeration, agitation); scale-up of fermentation processes.

Activities: Group discussion/Assignment on the challenges involved in scaling up fermentation from laboratory to industrial level.

Microbial Production of Industrial Products: Production of organic acids (citric acid, lactic acid); production of alcohol (ethanol); production of antibiotics (penicillin); production of enzymes (amylase, protease); production of vitamins; concept of primary and secondary metabolites.

Activities: Design a basic experiment to screen microorganisms for enzyme production (e.g., amylase or protease) and predict the expected outcome.

Downstream Processing: Introduction to downstream processing; steps involved – separation, purification, and polishing; methods of cell disruption; filtration and centrifugation; extraction and precipitation; chromatography techniques; drying and formulation of final products.

Activities: Case study analysis of downstream processing in biofuel production, focusing on separation and purification strategies.

Applications of Industrial Biotechnology: Applications in food industry (fermented foods, dairy products); applications in pharmaceuticals; applications in agriculture (bio-fertilizers, bio-pesticides); environmental applications (bioremediation, waste treatment); basics of bio-refineries and biofuels.

Activities: Case study to select a suitable bio-fertilizer or bio-pesticide for a given crop problem.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Quiz (20%), Assignments (30%) and Internal Examinations (50%)

Reference Books:

1. Ilya Digel, Aida Kistaubayeva, Irina Savitskaya, Nuraly S. Akimbekov. Introduction to Industrial Biotechnology, Springer Cham, 2025.

2. Pradeep Verma (Ed.). Industrial Microbiology and Biotechnology: A New Horizon of the Microbial World, Springer Singapore, 2024.

3. Mark Anthony Benvenuto. Industrial Biotechnology, de Gruyter, 2024.

4. Pradeep Verma (Ed.). Industrial Microbiology and Biotechnology: An Insight into Current Trends, Springer, 2024.

5.Pradeep Verma (Ed.). Industrial Microbiology and Biotechnology: Emerging Concepts in Microbial Technology, Springer, 2023.

E-Resources:

1. **NPTEL : Industrial Biotechnology**
   https://onlinecourses.nptel.ac.in/noc23_bt61/preview

2**. Coursera:** Industrial Biotechnology (University of Manchester)
   https://www.coursera.org/learn/industrial-biotech

CO MAPPING WITH PO & PSO:

COs	CO Description	PO Mapping	PSO Mapping
CO1	Understand the characteristics and industrial significance of microorganisms used for the production of biotechnological products.	-	-
CO2	Apply fermentation techniques and bioprocess principles for the production of industrially important products.	PO1 (3) PO3 (2)	PSO1 (3) PSO2 (3)
CO3	Analyze the influence of microbial growth conditions and bioprocess parameters on product formation and yield.	PO2 (3) PO4 (2)	PSO1 (3) PSO2 (3) PSO3 (2)
CO4	Evaluate downstream processing methods for efficient recovery, purification, and quality assessment of bioproducts.	PO2 (3) PO4 (3) PO5 (2) PO6 (2)	PSO1 (2) PSO2 (1) PSO3 (2)
CO5	Design integrated and sustainable bioprocesses for the production of value-added products in healthcare, agriculture, food, and environmental sectors.	PO3 (3) PO4 (3) PO5 (3) PO11 (2)	PSO1 (2) PSO2 (1) PSO3 (2)

BT25403	Artificial Intelligence in Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce students to the basics of Artificial Intelligence and its applications in modern biological research and healthcare.

Basics of Artificial Intelligence: Introduction to Artificial Intelligence (AI), Difference between AI, Machine Learning, and Deep Learning, Importance of AI in biological sciences, Types of biological data, Overview of AI applications in biotechnology

Activities: Collection and presentation of recent AI applications in biotechnology from scientific articles, news, or online sources.

Gene and Genome Informatics Using AI: Introduction to AI-assisted bioinformatics tools -comparison and identification of DNA and protein sequences, Identification of genes and their functions in a genome; detection of promoters and important gene control regions using AI, designing primers for PCR and cloning using AI-based software

Activities: Identification of gene regions and protein sequences using online bioinformatics tools.

Applications of AI In Drug Discovery And Healthcare: AI in drug discovery and development - Identification of new drug targets using AI; AI in disease diagnosis - Detection of diseases from medical images and patient data; Applications of AI in medical biotechnology - AI-based analysis of biological and clinical data for healthcare applications.

Activities: Group discussion on AI applications in drug discovery and disease diagnosis

AI in Industrial and Agricultural Biotechnology: AI in fermentation and bioprocess optimization - Monitoring and control of fermentation conditions using AI; AI applications in food and agricultural biotechnology - AI-based prediction of crop diseases and yield improvement; Smart biosensors and diagnostics - Use of AI in rapid disease detection through biosensors

Activities: Group-based quiz competition on applications of AI in biotechnology.

Future Trends and Ethical Aspects Of AI: Ethical issues in AI and biotechnology- Data privacy and security in handling biological and medical information; Advantages and limitations of AI - Faster data analysis and automation in research, challenges related to data quality and limited human-like reasoning; future scope of AI in biotechnology

Activities: Preparation of a chart/poster showing AI applications in healthcare, or biotechnology research.

Course Outcomes:

After completing the course, students will be able to

1. Apply basic concepts of Artificial Intelligence in biological sciences and biotechnology.
2. Use AI-based bioinformatics tools for interpretation of gene and genome data.
3. Integrate AI approaches in identifying drug targets and biomedical applications.
4. Utilize AI concepts for industrial and agricultural applications.
5. Evaluate ethical issues, limitations, and future applications of AI in biotechnology research and industry.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Quiz (20%), Assignments (30%) and Internal Examinations (50%)

REFERENCES:

1. Preethi Kartan (Ed.). *Artificial Intelligence in Biotechnology*, Delve Publishing, 2021.
2. Baldi, S. Brunak. *Bioinformatics: The Machine Learning Approach*, MIT Press, 2024.
3. Shilpa Choudhary, Sandeep Kumar, Swathi Gowroju (Eds.). *Genomics at the Nexus of Artificial Intelligence, Computer Vision and Machine Learning*, Wiley-Scrivener, 2024.
4. Loveleen Gaur, Arun Solanki, Samuel Fosso Wamba (Eds.). *Advanced AI Techniques and Applications in Bioinformatics*, CRC Press, 2024.
5. Kevin Murphy (ed.). *Machine Learning for Bioinformatics and Computational Biology*, Springer Nature, 2025.

E-RESOURCES:

1. NPTEL: Bioinformatics – Algorithms and Applications (IIT Madras)
https://onlinecourses.nptel.ac.in/noc25_bt06/preview

2. FutureLearn: Artificial Intelligence in Bioinformatics
https://www.getyoureducation.net/course/artificial-intelligence-in-bioinformatics

CO Mapping with PO & PSO:

COs	CO Description	PO Mapping	PSO Mapping
CO1	Understand the fundamental concepts, principles, and applications of Artificial Intelligence in biological sciences and biotechnology.	-	-
CO2	Apply AI-based bioinformatics tools for the interpretation and analysis of gene, genome, and biological data.	PO1 (3), PO2 (3),	PSO1 (2), PSO2 (3), PSO3 (3)
CO3	Analyze the role of AI approaches in identifying drug targets and solving biomedical problems.	PO1 (2), PO2 (3), PO3 (3),	PSO1 (2), PSO2 (3), PSO3 (2)
CO4	Evaluate AI-driven solutions for industrial biotechnology, precision agriculture, and healthcare applications.	PO2 (3), PO3 (3), PO5 (3), PO6 (2), PO10 (2)	PSO1 (3), PSO2 (3), PSO3 (2)
CO5	Design AI-based models and innovative solutions to address emerging challenges in biotechnology, while considering ethical and societal implications.	PO3 (2), PO4 (3), PO5 (3), PO7 (3), PO11 (3)	PSO1 (2), PSO2 (3), PSO3 (3)

BT25404	Introduction to Standards in Biotechnology	L	T	P	C
		1	0	0	1

Course Objectives:

- To develop competency in regulatory affairs, GMP standards, and quality compliance essential for biotechnology product development and manufacturing.

Biotech Regulatory Frameworks and GMP: FDA biologics regulations (21 CFR 600-680), EMA ATMP guidelines, ICH Q7-Q12. WHO GMP for biologics, ISO 14644 cleanroom standards.

Activities: Demonstration of FDA regulations and guidelines

Bioprocess Validation and Quality Standards: QbD (ICH Q8), process validation (IQ/OQ/PQ) for fermenters, ISO 15378 sterile manufacturing. Risk management (ICH Q9 FMEA), deviation/CAPA systems, biotech-specific documentation (batch records).

Activities: Demonstration of ISO standards

Inspections, Approvals and Surveillance: BLA/IND/MAA submissions, GMP inspections (FDA Form 483, EMA GMP certificates). Post-approval changes (ICH Q12), change control (LMTD/CPV), biotech surveillance for cell/gene therapies.

Activities: Demonstration of GMP standards

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

Assessment Methodology: Quiz (20%), Assignments (30%) and Internal Examinations (50%)

References:

1. Srivastava, N. et al., Pharmaceutical Regulatory Affairs: Principles and Practices, 2nd ed. Boca Raton, FL, USA: Taylor & Francis, 2025.
2. Singh, A. et al., Quality Control and Regulatory Affairs for Biopharmaceuticals, 1st ed. New Delhi, India: NPH India, 2024.
3. Meena, K. P. and Kumar, A., Textbook on Regulatory Affairs for M. Pharm, 1st ed. New Delhi, India: Brillion Publishing, 2025.
4. O'Grady, J., Quality Assurance & Regulatory Affairs for the Biosciences, 1st ed. Minneapolis, MN, USA: Open Textbook Library, 2019.

CO Mapping with PO & PSO:

	CO Description	PO Mapping	PSO
CO1	Explain biotechnology industry standards and GMP requirements for biologics manufacturing.	-	-
CO2	Apply validation and quality compliance protocols specific to bioprocesses.	PO1(2) PO2(1) PO3(2)	PSO1(2) PSO2(3) PSO3(3)
Co3	Analyze regulatory inspection processes and product approval pathways in biotech.	PO1(2) PO2(1) PO3(2) PO4(1)	PSO1(2) PSO2(3) PSO3(3)

		3	0	4	5

Course Objectives:

- To familiarize the students with the basic cellular processes at molecular level and provide hands-on experience in performing basic molecular biology techniques.

Chemistry of Nucleic Acids: Historical overview of nucleic acids – Structure and physicochemical properties of DNA and RNA, Chargaff's rule, Conformational variants of double helical DNA – Hogsteen base pairing – DNA supercoiling – topoisomerase – Denaturation and hyperchromic effect – Genome complexity: DNA re-association kinetics, Cot curve, C-value paradox, repetitive and unique sequences.

Practicals:

1. Agarose gel electrophoresis.
2. Isolation of Genomic DNA (Bacteria, Plant & Blood)
3. Isolation of Plasmid DNA
4. Spectrophotometric analysis of DNA - Quantity and Purity

Activities: Construct a 3D model of DNA & RNA, identifying key features such as base pairing, double helix conformations, and differences between DNA and RNA.

DNA Replication & Repair: Overview of Central dogma – DNA replication: Meselson & Stahl experiment, bi–directional DNA replication, Okazaki fragments, Enzymes involves in DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication - Telomere replication in eukaryotes - D-loop and rolling circle mode of replication – Mutagens, DNA mutations and their mechanism – Various types of repair mechanisms.

Practicals:

1. AMES Test

Activities: DNA replication using diagrams or animations, create a flowchart showing enzymes involves in replication and compare the different repair mechanisms.

Transcription: Mechanism of RNA transcription in prokaryotes and eukaryotes; promoters, enhancers, repressors - RNA processing: processing of heterogeneous nuclear RNA: splicing, capping, polyadenylation – Ribozymes - Fidelity of RNA synthesis - Inhibitors of transcription.

Practicals:

1. Isolation and Quantification of Total RNA.

Activities: Construct a working model to illustrate the process of Transcription and Group activities about post-transcriptional modifications such as RNA splicing, capping, and polyadenylation.

Translation: Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, genetic code in mitochondria - Prokaryotic and eukaryotic translation process – Inhibitors of translation – Post-translational modifications and its importance.

Practicals:

1. Bacterial Conjugation
2. Bacterial Transduction

Activities: Decoding of mRNA sequences using the genetic code table and demonstrating the concept of codon degeneracy and wobble hypothesis. Prepare a detailed flowchart illustrating the process of protein translation in prokaryotes and eukaryotes.

Gene Regulation: Organization of genes in prokaryotic and eukaryotic chromosomes - Regulation of gene expression in prokaryotes - Operon concept, lac & trp operons - Regulation in eukaryotes, Control by promoter, enhancer and silencers, Cis-trans elements – Epigenetic regulation.

Practicals:

1. Transformation (Blue White Screening)
2. Transformation of yeast

Activities: A group discussion analyzing gene regulation mechanisms in prokaryotes and eukaryotes. Provide a simple model showing gene expression (lac and trp operons) under different conditions.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Assignments (20%), Flipped Class (5%), Practical (30%), Internal Examinations (40%).

References:

1. James D Watson, “Molecular Biology of the Gene” 8th Edition, East West Press, 2024.
2. Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts and Peter Walter. “Molecular Biology of the Cell” 7th Edition, WW Norton & Co., 2022.
3. Geoffrey Cooper and Kenneth Adams, “The Cell A Molecular Approach”, 9th Edition, Oxford University Press, 2022.
4. Gerald Karp, Janet Iwasa and Wallace Marshall, “Karp's Cell and Molecular Biology: Concepts and Experiments” 9th Edition, Wiley, 2020.
5. Jocelyn E Krebs, Elliott S Goldstein and Stephen T Kilpatrick, “Lewin’s Genes XII”, 12th Edition, Jones and Bartlett Publishers, 2017.
6. George M. Malacinski, “Friefelder’s Essentials of Molecular Biology” 4th Edition, Jones and Bartlett Publisher, 2015.

E-Resources:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc25_bt35/preview
2. Blackwell Publishing: Fundamental Molecular Biology by Lizabeth A. Allison
3. https://molbiomadeeasy.wordpress.com/wp-content/uploads/2013/09/fundamental_molecular_biology.pdf
4. McGraw Hill Companies: Molecular Biology by Robert F. Weaver
5. https://ttwrdcs.ac.in/Mahabubabad/pdf/1166781471molecular_biology_r-_f-_weaver_5th_ed.pdf
6. Genetics and Molecular Biology by Robert Schleif
7. https://pages.jh.edu/rschlei1/Random_stuff/publications/molbiogene.pdf

CO Mapping with PO & PSO:

COs	CO Description	PO Mapping	PSO Mapping
CO1	Understand the structure, organization, and functions of nucleic acids in biological systems.	-	-
CO2	Apply the principles of the central dogma to explain the flow of genetic information from DNA to proteins.	PO1 (3), PO2 (2), PO4 (2)	PSO1 (2), PSO3 (2)
CO3	Analyze the mechanisms of DNA replication, repair, and genome maintenance in prokaryotic and eukaryotic cells.	PO2 (3), PO3 (2), PO4 (2), PO11 (2)	PSO2 (2), PSO3 (1)
CO4	Evaluate the processes of transcription, translation, and gene regulation in prokaryotic and eukaryotic systems.	PO1 (3), PO2 (3), PO3 (2), PO11 (2)	PSO2 (2), PSO3 (2)
CO5	Design molecular biology strategies using recombinant DNA technology, PCR, electrophoresis, and other molecular techniques for biotechnology applications.	PO2 (3), PO3 (3), PO4 (3), PO8 (3), PO9 (3), PO11 (3)	PSO1 (3), PSO2 (2), PSO3 (3)

BT25406	Fluid Flow and Heat Transfer Operations	L	T	P	C
		3	0	4	5

Course Objectives:

- To introduce the students to the flow of fluids with applications and mode of transfer heat with principle and application of heat exchanger equipment's.

Fluid Properties & Fluid Mechanics: Fluid definition- compressible, incompressible fluids – coefficient of isothermal compressibility, Density, specific gravity, specific weight, surface tension, vapour pressure, viscosity. Newtonian and Non-Newtonian fluids. Gauge and absolute pressure – pressure measurement with Bourdon gauge & manometers.

Practicals: Flow measurements by using Venturimeter, Orificemeter and Rotameter.

Activities: Compilation of measurements of fluid properties

Industrial Pumps, Mixing and Agitation: Industrial pumps centrifugal, Reciprocating, Peristaltic, Diaphragm, Introduction to gas moving machinery-Fans, blowers, compressors, Mixing and Agitation: Types of agitators, mixing mechanisms, factors affecting mixing efficiency, and industrial applications in chemical and bioprocess industries. Power correlations.

Practicals: Comparative study of industrial pumps based on discharge and efficiency.

Activities: Preparation of flow diagrams illustrating industrial fluid transport systems.

Conduction Heat Transfer: Heat transfer phenomena. Heat conduction – Fourier's equation – steady state conduction in planar and radial systems – combined conduction and convection – overall heat transfer coefficients, unsteady state conduction – lumped capacity model.

Activities: Comparative analysis of steady-state and unsteady-state heat conduction processes.

Convection Heat Transfer: Forced and natural convection – Dimensional analysis, Dimensionless numbers, Convection heat transfer coefficient, Film and drop wise condensation over tubes. Heat transfer to boiling liquids –theory and mechanism of boiling.

Practical Determination of convection heat transfer coefficient.
Activities: Problem-solving exercises involving Reynolds, Nusselt, Prandtl, and Grashof numbers.

Radiation Heat Transfer and Heat Transfer Equipments: Electromagnetic waves, energy of radiation, Planck's equation-Blackbody, Kirchhoff's law, Stefen Boltemann equation of radiant energy – Wien's law, Radiation exchange between surfaces bodies, -sample problems, Heat exchangers, types, effectiveness, LMTD. NTU method. **Practicals:** Calculation of heat exchanger effectiveness using LMTD method. **Activities:** Virtual Demonstration of different modes of heat transfer.
References: 1. Geankoplis. C.J "Transport Process & separation Process Principles" IVth Edition Prentice Hall of India 2005. 2. P. K. Nag "Heat & Mass Transfer" Tata McGraw Hill – IIIrd Edition 2003. 3. Frank Kreith, Raj M. Manglik "Principles of Heat Transfer" VIIth edition Cenage Learning 4. Rajput "Heat and Mass Transfer" Edition 2008 5. Dr.R.K.Bansal "A Text book of Fluid mechanics and Hydraulic machines" Edition 11th edition
E Resources: NPTEL Video Lecture Prof Sunando Dasgupta IIT Karagpur

CO Mapping with PO & PSO

COs	CO Description	PO Mapping	PSO Mapping
CO1	Understand the principles and operating characteristics of pressure measurement devices used in engineering and bioprocess industries.	-	-
CO2	Apply the concepts of fluid transportation and pump operation for industrial and biotechnological applications.	PO1 (3), PO2 (2), PO3 (3), PO4 (2), PO5 (3), PO11 (3)	PSO1 (3), PSO2 (2)
CO3	Analyze heat transfer mechanisms including conduction, convection, and radiation in engineering and biological systems.	PO1 (2), PO2 (3), PO3 (3), PO4 (2), PO5 (3), PO11 (3)	PSO1 (3), PSO2 (3), PSO3 (2)
CO4	Evaluate the performance of heat transfer processes such as forced and natural convection, boiling, and condensation in industrial applications.	PO3 (2), PO5 (3), PO11 (2)	PSO1 (3), PSO2 (2), PSO3 (2)
CO5	Design suitable heat exchanger systems using LMTD and NTU methods for biotechnology and process engineering applications.	PO3 (3), PO4 (2), PO5 (3), PO11 (2)	PSO1 (2), PSO2 (2), PSO3 (3)

EN25C04	English Communication Skills Laboratory – II	L	T	P	C
		0	0	2	1

Course Objectives:

- The objectives of the course are to build students' advanced communication skills for workplace readiness and develop intercultural competence for effective collaboration in global and virtual teams. Prepare students for competitive exams with focused skill-building and test-oriented practice.

List of Activities

Stage Ready – Impactful Public Speaking .

(i) Simulate a formal event such as an academic conference, convocation, or awards ceremony, where students roles including Master of Ceremonies (MC), Role as a dignitary, and a Commentator

(ii) Visual Prompt Storytelling: Use random images to create spontaneous stories, focusing on plot, setting, and character,

(iii) Digital Presentation - Record a short video explaining a project or technical concept, using slides, voiceover, and visual aids (to be uploaded using google classroom or drive link)

Professional and Application-Oriented Writing

(i) Résumé Preparation: Design ATS-friendly résumés tailored to various job descriptions, using action verbs and quantifiable impact. ·

(ii) Design engaging content for poster presentation relevant to their domain.

Receptive Skills in Workplace Communication·

(i) Reading articles related to their domain and discuss in groups

(ii) Visit company websites, make inferences and present in the class

(iii) Listen to recorded mock interviews and take detailed notes. Summarise key points and action items in a professional format and make a presentation.

Intercultural Communication

(i) Assertive vs Aggressive communication

(ii) Role play activities – workplace communication in intercultural/crosscultural contexts

From Campus to Career: Industry Skills and Global Exam Preparation

(i) Participate in HR interviews using AI tools or peer interviewers, responding to behavioural questions using methods like STAR (Situation, Task, Action, Result)

(ii) Practice Verbal Ability in competitive exams like UPSC, SSC, CDS, TNPSC, etc.

Weightage: Continuous Assessment: 60%, End Semester Lab Examinations: 40%.

Internal Assessment Methodology: 1. Oral story telling using visual prompts (30 marks)
2. Poster presentation (40 marks)

3. ATS resume writing (30 marks)

End Semester Assessment:

1. Interview (50 marks)
2. Verbal Ability test (50 marks)
   (students must bring the resume but evaluation must be done based on the performance in the interview)

References:

1. Lucas, Stephen, and Paul Stob. The Art of Public Speaking. Thirteenth edition, McGraw- Hill Education, 2020.
2. Abrahams, Matt. Think Faster, Talk Smarter: How to Speak Successfully When You're Put on the Spot. Simon & Schuster, 2023.
3. Beshara, Tony. Powerful Phrases for Successful Interviews, Rev. ed., McGraw-Hill, 2023.
4. Papalia, Anna. Interviewology: The New Science of Interviewing. Harper Business, 2024.
5. Verbal Ability and Reading Comprehension by Ajay Singh McGraw Hill Education 2020

E-resources:

1. Purdue OWL – Online Writing Lab (Academic and professional writing help) https://owl.purdue.edu/
2. Canva Resume Builder (Creative, ATS-friendly resume design) https://www.canva.com/resumes/
3. BBC Learning English – Pronunciation https://www.bbc.co.uk/learningenglish/english/features/pronunciation
4. India Bix website

	Description of CO	**PO**	**PSO1**
CO1	Understand basic industry-related reading materials.	-	-
CO2	Design and present a domain specific poster	PO9(3)	PSO1(2) PSO3(3)
CO3	Deliver effective digital presentations	PO9(3)	PSO2(1)
CO4	Communicate appropriately in intercultural/cross cultural contexts	PO9(3)& PO11(1)	PSO3(3)
CO5	Perform in interviews and competitive exams successfully	PO9(3)	PSO3(1)