B.Tech. (Biotechnology)

2026 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University – Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

SATHYAMANGALAM - 638401 ERODE DISTRICT TAMILNADU INDIA

Ph : 04295-226000/221289 Fax : 04295-226666 E-mail : stayahead@bitsathy.ac.in Web : www.bitsathy.ac.in

CONTENTS

VISION OF THE DEPARTMENT

To impart world-class Biotechnology education with academic excellence, innovation, and professional competency to meet technological and societal needs.

MISSION OF THE DEPARTMENT

- To provide state-of-the-art infrastructure and a conducive academic ecosystem through best pedagogical practices, complemented by co-curricular and extra-curricular activities aligned with national and global standards, enabling graduates to build strong foundational and applied competencies in biotechnology.
- To promote interdisciplinary research and innovation among students and faculty, focusing on sustainable and circular bioeconomy solutions addressing challenges in healthcare, agriculture, and environmental sectors.
- To establish effective collaborations with biotechnology industries, startups, and research organizations to foster professional skills, leadership qualities, ethical values, and lifelong learning for career advancement and societal contribution.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. To design and develop biotechnological solutions by applying core knowledge in biological sciences and engineering to address challenges in healthcare, agriculture, and environmental sectors.

II. To pursue higher studies, research, or professional careers, while continuously enhancing their knowledge, skills, and competencies in biotechnology and related fields.

III. To evolve as responsible professionals who contribute effectively to industry and society, with awareness of sustainability, ethics, and lifelong learning.

PROGRAMME OUTCOMES (POs)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of limitations.
6. Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues relevant to professional engineering practice.
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Apply advanced biotechnological tools and analytical techniques for the characterization of biological systems and the development of innovative biomolecules and bioprocesses for healthcare, agriculture, and allied sectors.
2. Design and implement sustainable, bioresource-based solutions and society-oriented projects for environmental protection, resource management, and sustainable development.

MAPPING OF PEOs AND POs

PEO(s)	Programme Outcomes(s)										
	1	2	3	4	5	6	7	8	9	10	11
I			X	X	X	X				X	
II	X	X	X	X	X	X		X	X	X	X
III						X	X	X	X	X	X

DEPARTMENT OF BIOTECHNOLOGY Minimum Credits to be Earned: 162										
I SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
26MA101	Linear Algebra and Calculus	3	1	0	4	4	40	60	100	BS
26PH102	Engineering Physics	3	0	0	3	3	40	60	100	BS
26CH103	Engineering Chemistry	2	0	0	2	2	40	60	100	BS
26GE002	Basics of Electrical and Electronics Engineering	3	0	0	3	3	40	60	100	ES
26GE005	Problem Solving using C	3	0	0	3	3	40	60	100	ES
26HS001	Communicative English	1	0	2	2	3	50	50	100	HSS
26HS002	தமிழர் மரபு / Heritage of Tamils	1	0	0	1	1	40	60	100	HSS
26PS108	Physical Science Laboratory	0	0	4	2	4	60	40	100	BS
26GE006	C Programming Laboratory	0	0	2	1	2	60	40	100	ES
26HS003	Induction Programme (AICTE, AU)	-	-	-	NC	-	-	-	100	HSS
Total					**21**	**25**				
II SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
26MA201	Differential Equations and Transforms	3	1	0	4	4	40	60	100	BS
26PH202	Materials Science	3	0	0	3	3	40	60	100	ES
26BT203	Principles of Biochemical Engineering	3	0	0	3	3	40	60	100	ES
26GE007	Python Programming	3	0	0	3	3	40	60	100	ES
26GE010	Biology for Engineers	2	0	0	2	2	40	60	100	BS
26HS004	Professional Communication	1	0	2	2	3	50	50	100	HSS
26HS005	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	1	0	0	1	1	40	60	100	HSS
26GE008	Python Programming Laboratory	0	0	2	1	2	60	40	100	ES
26GE009	Engineering Drawing	1	0	2	2	2	60	40	100	ES
26HS006	Co-curricular / Extracurricular Activities	-	-	-	NC	-	-	-	100	HSS
Total					**21**	**23**				

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
26BT301	Probability and Biostatistics	3	1	0	4	4	40	60	100	BS
26BT302	Biochemistry	3	0	0	3	3	40	60	100	ES
26BT303	Microbiology	3	0	0	3	3	40	60	100	PC
26BT304	Instrumental Methods of Analysis	3	0	0	3	3	40	60	100	PC
26BT305	Genetics and Molecular Biology	3	0	0	3	3	40	60	100	PC
26BT306	Bio thermodynamics	3	0	0	3	3	40	60	100	HSS
26BT307	Microbiology Laboratory	0	0	4	2	4	60	40	100	PC
26BT308	Biomolecular Analysis and Instrumentation Laboratory	0	0	4	2	4	60	40	100	PC
26BT309	Design Thinking and Innovation Laboratory	0	0	2	1	2	60	40	100	ES
Total					**24**	**32**				-
IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
26BT401	Bioprocess Engineering	3	0	0	3	3	40	60	100	BS
26BT402	Bioorganic Chemistry	3	0	0	3	3	40	60	100	PC
26BT403	Transport Phenomena for Biotechnology	3	0	0	3	3	40	60	100	PC
26BT404	Genetic Engineering	3	0	0	3	3	40	60	100	PC
26BT405	Immunology	3	0	0	3	3	40	60	100	PC
26BT406	Biosafety and Regulatory Affairs	3	0	0	3	3	40	60	100	PC
26HS007	Environmental Sciences and Sustainability	2	0	0	2	2	60	40	100	HSS
26BT408	Bioprocess Engineering Laboratory	0	0	2	1	2	60	40	100	PC
26BT409	Genetic Engineering Laboratory	0	0	2	1	2	60	40	100	PC
26BT410	Community Engagement Project	0	0	2	1	2	60	40	100	ES
Total					**23**	**26**				

V SEMESTER										
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
26BT501	Metabolic Engineering	3	0	0	3	3	40	60	100	PC
26BT502	Bioinformatics	3	0	0	3	3	40	60	100	PC
26BT503	Plant and Animal Tissue Culture	3	0	0	3	3	40	60	100	PC
26BT504	Sustainable Biotechnology and Entrepreneurship	3	0	0	3	3	40	60	100	PC
	Professional Elective I	3	0	0	3	3	40	60	100	PE
	Open Elective I	3	0	0	3	3	40	60	100	OE
26BT507	Standards in Biological Engineering	1	0	0	1	1	40	60	100	HSS
26BT508	Bioinformatics Laboratory	0	0	4	2	4	60	40	100	PC
26BT509	Tissue Culture Laboratory	0	0	4	2	4	60	40	100	PC
26HS008	Finance for Engineers	0	0	0	NC	-	100	0	100	HS
Total					**23**	**27**				**-**
FOR HONOURS DEGREE										
	Honours Elective I	3	0	0	3	3	40	60	100	-
	Honours Elective II	3	0	0	3	3	40	60	100	-
FOR MINOR DEGREE										
	Minor Elective I	3	0	0	3	3	40	60	100	-
	Minor Elective II	3	0	0	3	3	40	60	100	-

VI SEMESTER										
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
26BT601	Downstream Processing	3	0	0	3	3	40	60	100	PC
26BT602	Enzyme and Protein Engineering	3	0	0	3	3	40	60	100	PC
26BT603	Artificial Intelligence in Biotechnology	3	0	0	3	3	40	60	100	PC
	Professional Elective II	3	0	0	3	3	40	60	100	PE
	Professional Elective III	3	0	0	3	3	40	60	100	PE
	Open Elective II	3	0	0	3	3	40	60	100	OE
26BT607	Downstream Processing Laboratory	0	0	2	1	2	60	40	100	PC
26BT608	Enzyme and Protein Engineering Laboratory	0	0	4	2	4	60	40	100	PC
26BT610	Innovation and Product Development Project / Industry Oriented Course / Summer Internship	0	0	2	1	2	60	40	100	EEC
Total					**22**	**26**				-
FOR HONOURS DEGREE										
	Honours Elective III	3	0	0	3	3	40	60	100	-
	Honours Elective IV	3	0	0	3	3	40	60	100	-
FOR MINOR DEGREE										
	Minor Elective III	3	0	0	3	3	40	60	100	-
	Minor Elective IV	3	0	0	3	3	40	60	100	-

VII SEMESTER										
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22BT701	Omics Technology	3	0	0	3	3	40	60	100	PC
22BT702	Biopharmaceutical Technology	3	0	0	3	3	40	60	100	PC
	Professional Elective IV	3	0	0	3	3	40	60	100	PE
	Professional Elective V	3	0	0	3	3	40	60	100	PE
	Professional Elective VI	3	0	0	3	3	40	60	100	PE
26BT706	Biopharmaceutical Technology Laboratory	0	0	4	2	4	60	40	100	PC
26BT707	Project work I / Internship Project	0	0	6	3	6	60	40	100	EEC
Total					**20**	**25**				**-**
FOR HONOURS DEGREE										
	Honours Elective V	3	0	0	3	3	40	60	100	-
	Honours Elective VI	3	0	0	3	3	40	60	100	-
FOR MINOR DEGREE										
	Minor Elective V	3	0	0	3	3	40	60	100	-
	Minor Elective VI	3	0	0	3	3	40	60	100	-

VIII SEMESTER										
Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
26BT801	Project Work II / Internship Project / Startup Product	0	0	16	8	16	60	40	100	EEC
Total		0	0	16	8	**16**				

26MA101	Linear Algebra and Calculus	L	T	P	C
		3	1	0	4

Prerequisite	Assessment Pattern		
Basic Integration and Differentiation	CIA	SEE	Total
	40	60	100

Course Objectives:

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

- Develop mathematical models using linear algebra and systems of linear equations to address engineering applications and real-world problems.
- Apply single-variable and multivariable differential calculus to analyze and solve engineering problems involving real-world phenomena and data.
- Evaluate multiple integrals and apply multivariable integration techniques to model and solve problems arising in physical and dynamical systems.

Course Outcomes (COs)

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

1. Implement the concepts of systems of linear equations in engineering applications.
2. Formulate real-world problems as linear algebraic models.
3. Demonstrate real-world phenomena and data analysis using single-variable differential calculus.
4. Apply the concepts of multivariable calculus to solve engineering problems.
5. Develop the ability to identify and evaluate multiple integrals in physical and dynamical systems.

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	1	3											
CO 2	2	3											
CO 3	2	3											
CO 4	3	3											
CO 5	1	3											

Module 1

Linear Algebra **11 Hours**

Introduction to Vector Spaces- Examples- Subspaces - Linear Combinations- Span- Generating Sets- Linear Dependence and Independence- System of linear equations – Consistency of the system- Matrix representation of a linear transformation – Eigenvalues and Eigenvectors – Cayley- Hamilton theorem - Diagonalization - Reduction of quadratic form to canonical form- Nature of a Quadratic form.

Differential Calculus **11 Hours**

Functions and their graphs - Scaling and shifting graphs - Limits - Continuity-Derivatives- Maxima and Minima-Concavity - Curve sketching.

Functions of two variables-partial derivatives –Total derivative -Jacobian and its properties - Taylor's expansion for two variables–Maxima and minima– Constrained and Unconstrained maxima.

Module 2	
Integral calculus **11 Hours** Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions -Properties – Evaluation of integrals by using Beta and Gamma functions. **Multiple integral Calculus** **12 Hours** Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals.	
Term Work Activity	
GATE Questions, Quiz, Assignments.	
Self-Learning Activity	
NPTEL Course **Linear Algebra** **NPTEL link:** https://onlinecourses.nptel.ac.in/noc25_ma114/preview **NPTEL Course** **Differential Calculus** **NPTEL link:** https://onlinecourses.nptel.ac.in/noc19_ma18/preview **NPTEL Course** **Multiple integral Calculus** **NPTEL link:** https://onlinecourses.nptel.ac.in/noc23_ma27/preview	
Theory	**45 Hours**
Tutorial	**15 Hours**
Total	**60 Hours**

Text Books:

1. B.S Grewal, Higher Engineering Mathematics, Khanna Publisher, 45th Edition, 2024.
2. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017.

References:

1. Howard Anton, Chris Rorres, Elementary Linear Algebra with Supplementary Applications, Wiley, 11th edition, 2023.
2. Joel Hass, Christopher Heil, Przemyslaw Bogachi, Maurice D. Weir, Thomas' Calculus, 15th edition, Pearson, 2024.
3. Richard E., Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies Inc, 1997.
4. Michael Greenberg, Advanced Engineering Mathematics, 2/e,, Pearson, 2018
5. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley, 10th edition,2015.

26PH102	Engineering Physics	L	T	P	C
		3	0	0	3

Prerequisite	Assessment Pattern		
Understand the structure of atoms, bonding and its influence on material properties, kinetic and potential energy, periodic and oscillatory motion.	CIA	SEE	Total
	40	60	100

Course Objectives:

- Understand the fundamental concepts of atomic structure, material interactions, thermal physics, forces, energy, and gravitation.
- Apply the principles of mechanics, heat transfer, oscillations, waves, and electromagnetic phenomena to understand physical systems and their properties.
- Analyze the interaction of matter with mechanical, thermal, acoustic, and electromagnetic phenomena and relate these concepts to practical applications.

Course Outcomes (COs)

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

1. Apply the physical principles to describe the structure of matter from subatomic particles to atoms and elements.
2. Analyze the nature of ionic, covalent and metallic bonding and correlate the type of bonding with the mechanical, thermal and electrical properties of materials.
3. Interpret the relationship among heat, temperature and molecular motion to evaluate changes in physical states and material properties.
4. Apply and verify the fundamental laws of force, motion, and energy conservation to explain equilibrium, inertia, and gravitational effects in real-world systems.
5. Examine and model oscillations and wave phenomena including mechanical, sound and electromagnetic waves to interpret energy transmission and resonance behavior.
6. Integrate and relate atomic, thermal, and mechanical principles to justify the behavior of materials and their suitability for engineering applications.

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	3	2					1						
CO 2	3	3	2				1						
CO 3	3	3		2			1						
CO 4	3	2		3			1						
CO 5	3	2	3	2			1						
CO 6	2	-	3		2		1						

Module 1

Atomic Physics **8 Hours**

Origin of matter: Formation of atoms and elements (concept of nucleo synthesis). Sub-atomic particles and charge interactions: Coulomb's law. Atomic models: Thomson, Rutherford, Bohr, and QM concepts. Binding energy of an electron – ionization potential.

Atomic Interactions and Material Formation **8 Hours**

Origin and characteristics: Interactions of matter. Relationship of bond strength to mechanical, electrical, and thermal properties. Formation of molecules and compounds: representation and valency. Crystal parameters - defects and stability.

Heat, Temperature, and Phases of Matter **7 Hours**

Kinetic theory of gases: Ideal gas law and equation of state - Heat and temperature: thermal equilibrium – specific and latent heat capacity - temperature scales. Expansion of solids, liquids, and gases: Phase transitions. Modes of heat transfer: Conduction, convection and radiation.

Module 2

Forces, Energy and Gravity **7 Hours**

Concept of force-mass-weight-inertia. Newton's laws of motion: Linear and circular motion. Work-energy-power. Potential and kinetic energy- conservation of energy. Universal law of gravitation: gravitational field and potential energy. Density-mass-buoyancy-Archimedes' principle- stability in fluids.

Oscillations and Wave Mechanics **8 Hours**

Simple harmonic motion (SHM) – mathematical formulation-energy exchange. Damped and forced oscillations-resonance conditions. Mechanical waves: longitudinal and transverse wave-characteristics. Energy transport in waves: reflection-interference-diffraction. Sound waves: classification and application.

Introduction to Electromagnetic Waves and Matter Interaction **7 Hours**

Generation and propagation of electromagnetic waves-spectrum-dual nature of light-interaction of light with matter – absorption-transmission-reflection. Optical properties of materials: transparent-translucent-opaque. Luminescence: phosphorescence and fluorescence.

Term Work Activity	
GATE Questions, Quiz, Assignments, Presentations	
Self-Learning	
NPTEL Course https://nptel.ac.in/courses **NPTEL link:** https://nptel.ac.in/courses/122103011	
Theory	**45 Hours**
Total	**45 Hours**

Text Books:

1. Halliday, D. & Resnick, R. Fundamentals of Physics, 12th Edition, John Wiley & Sons, Inc., New Delhi (2021).

References:

1. Verma, H. C. Concepts of Physics Vol. I, Bharati Bhawan Publishers, New Delhi (2022 reprint).
2. Young, H. D. & Freedman, R. A. University Physics with Modern Physics, Global Edition, 15th Edition, Pearson, New Delhi (2024).
3. Tipler, P. A. & Mosca, G. Physics for Scientists and Engineers, 6th Edition, W. H. Freeman & Company / Macmillan, New Delhi (2020).
4. Serway, R. A. & Jewett, J. W. Principles of Physics: A Calculus-Based Text, 5th Edition, Brooks/Cole / Cengage Learning India Pvt. Ltd., New Delhi (2012).
5. Feynman, R. P., Leighton, R. B. & Sands, M. The Feynman Lectures on Physics (Vol. I), New Millennium Edition, Basic Books / Perseus Group, New Delhi (2011).

26CH103	**Engineering Chemistry**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

Prerequisite	**Assessment Pattern**		
Formation of elements	CIA	SEE	Total
Sub atomic particles	40	60	100

Course Objectives:

- Develop a strong foundation in atomic structure, periodicity, bonding, and their influence on material properties
- Examine energy conversion, electrochemical processes, corrosion, batteries, and fuel cells in engineering applications.
- Compare advanced materials, polymers, nanomaterials, and composites for sustainable engineering solutions.
- Correlate surface chemistry and computational modelling approaches with materials, reactions, and engineering applications.

Course Outcomes (COs)

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

1. Apply atomic structure, electronic configuration, periodic trends, bonding and intermolecular forces to interpret reactivity and properties of engineering materials
2. Apply concepts of energy conversion, corrosion, batteries, fuel cells, polymers, nanomaterials and adsorption to evaluate material performance
3. Analyze relationships among structure, bonding, surface interactions, electrochemical processes and advanced materials in sustainable engineering applications
4. Analyze chemical reactions, energy systems, materials behavior and corrosion processes using surface chemistry principles and computational modelling approaches

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	2	1									1		
CO 2	2	1							1		1		
CO 3	3	2				1			1		1		
CO 4	3	2				2			1		1		

Module 1

Atomic structure, periodicity and bonding **7 Hours**

Quantum shells and orbitals – electronic configuration and stability – periodic table, trends and their influence on reactivity – types of chemical bonds – intermolecular forces and their influence on material properties

Chemical Reactions and Energy Conversion **8 Hours**

Chemical reactions and stability – types of reactions – energy changes in reactions. Electrochemical cells – Electrode potential – corrosion as an electrochemical redox process: types, factors and prevention

Primary and secondary batteries – fuel cells – performance factors – solid-state and Na-ion trends – safety, recycling and environmental aspects

Module 2

Advanced materials for engineering **6 Hours**

Metals, ceramics and polymers – chemical perspective – Polymers: Thermoplastics – thermosets –

conducting and biodegradable polymers – polymer composites. Nanomaterials: CNTs – graphene and quantum dots. Future directions in sustainable material design

Surface Chemistry **5 Hours**

Adsorption: Physisorption and chemisorption, isotherms (Freundlich, Langmuir). Catalysis: homogeneous, heterogeneous and enzyme catalysis – Industrial examples

Computational Chemistry and Molecular Modelling **4 hours**

Need and scope in engineering. Basic quantum methods – molecular modelling software and visualization. Applications in chemical reactions, battery materials, corrosion and reaction pathways

Term Work Activity	
Quiz, Assignments, Student seminar, case studies and models (Experimental /Computational)	
Self-Learning Activity	
NPTEL Course Electrochemical Energy Systems (Prof. S. Mitra, IIT Madras) NPTEL link - https://nptel.ac.in/courses/113106028 Corrosion (Prof. Kallol Mondal, IIT Kanpur) NPTEL link - https://nptel.ac.in/courses/112104088 Composite Materials(Dr. P.C. Pandey, IISc Bangalore) NPTEL link - https://nptel.ac.in/courses/105108124 Foundations of Computational Materials Modelling (Narasimhan Swaminathan, Indian Institute of Technology Madras) NPTEL Link – https://nptel.ac.in/courses/112106296 Heterogeneous Catalysis and Catalytic Processes Indian Institute of Technology Delhi (NPTEL) NPTEL Link – https://nptel.ac.in/courses/103102012	
Total	**30 Hours**

Textbooks:

1. Thomas Engel, Maheswaramma and Chugh, Engineering Chemistry, First Edition, Pearson, 2026.
2. Jain, P. C. and Jain M, Engineering Chemistry, 17 th Edition, Dhanpat Rai Publishing Company (P) Ltd, 2015.
3. Puri, Sharma, and Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 48 th Edition, 2024.

References:

1. Frank Jensen, Introduction to Computational Chemistry, Wiley & sons, 3rd Edition, 2017.
2. S. Glasstone, An Introduction to Electrochemistry, 8 th Edition, East-West Press, Reprint, 2006.
3. Young and Lovell, Introduction to Polymers, 3rd Edition, CRC Press (Taylor & Francis imprint), 2011.
4. Michael F. Ashby, Hugh Shercliff and David Cebon, Materials: Engineering, Science, Processing and Design, 4th Edition, Butterworth-Heinemann -an imprint of Elsevier, 2018.
5. https://avogadro.cc
6. https://orcaforum.kofo.mpg.de

26GE002	Basics of Electrical and Electronics Engineering	L	T	P	C
		3	0	0	3

Prerequisite	Assessment Pattern		
Basic of Electric circuits	CIA	SEE	Total
	40	60	100

Course Objectives:

- To establish the fundamental concepts of electrical circuits, AC/DC networks, electromagnetic induction, electrical machines, transformers, and electrical drives.
- To strengthen the ability to apply semiconductor device principles, rectifier circuits, and operational amplifier concepts in basic electronic circuit applications.
- To familiarize learners with digital number systems, Boolean algebra, logic gates, adders, flip-flops, shift registers, and counters for developing basic digital systems.

Course Outcomes (COs)

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

1. Apply Ohm's law, Kirchhoff's laws, and voltage/current division techniques to analyze DC and AC electrical circuits and determine voltage, current, and power.
2. Analyze the construction, operating principles, and performance characteristics of DC machines, transformers, and induction motors for electrical applications.
3. Examine the fundamentals, construction, and working principles of DC stepper motors, DC servo motors, and BLDC motors for electrical drive applications.
4. Assess the characteristics and operation of semiconductor devices, including PN junction diodes, BJTs, and MOSFETs, in rectifier and basic electronic circuits.
5. Utilize operational amplifier principles to implement basic analog circuits such as summing amplifiers, differentiators, integrators, and voltage followers.
6. Design basic digital systems using number systems, Boolean algebra, logic gates, adders, flip-flops, shift registers, and counters.

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	3	2	2										
CO 2	3	3											
CO 3	2	2											
CO 4	3	3	2										
CO 5	3	2	3										
CO 6	3	3	3										

Module 1

ELECTRIC CIRCUITS **8 Hours**

Voltage, Current, Electromotive force, Resistance, Power & Energy, Ohms law and Kirchhoff's Law -Series and Parallel circuits - Voltage division and Current division techniques - Generation of alternating emf - RMS value, average value, peak factor and form factor- Real, reactive and apparent power.

DC AND AC MACHINES **8 Hours**

Law of Electromagnetic induction, Flemings Right & Left hand rule- Induced emf - Self and Mutual Inductance –DC Generator, DC Motor- Construction - Working Principle- Single Phase Transformer - Alternator – Capacitor start - Capacitor run Single phase induction motor, Three Phase Induction Motor - Construction - Working Principle.

ELECTRICAL DRIVES **7 Hours**

Fundamentals of Electrical Drives - DC stepper motor - DC servo motor - BLDC Motor - Construction - Working Principle

Module 2

SEMICONDUCTOR DEVICES **8 Hours**

Characteristics of PN Junction diode - Half wave and Full wave Rectifiers - Bipolar Junction Transistor - Operation of NPN and PNP transistors- Introduction to MOSFET, their structures operations, and I-V characteristics.

INTEGRATED CIRCUITS **7 Hours**

Introduction to ICs - Operational Amplifiers - Op-Amp characteristics - Summing Amplifier - Inverting and Non-inverting amplifier - Voltage follower - Differentiator and integrator.

DIGITAL ELECTRONICS **7 Hours**

Binary number system - Boolean algebra - Logic gates – Adders - One-bit memory - Flip-Flops (SR, JK) - Shift registers - Asynchronous counter.

Term Work Activity	
GATE Questions, Quiz, Assignments, Presentations, Seminars, Field Visit, Case study,	
Self-Learning Activity	
NPTEL Course https://nptel.ac.in/courses/108108076 NPTEL link: https://onlinecourses.nptel.ac.in/noc24_ee117/preview https://onlinecourses.nptel.ac.in/noc24_ee106/preview	
Theory	**45 Hours**
Total	**45 Hours**

Text Books:

1. S.K.Bhattacharya,"Basic Electrical and Electronics Engineering", Pearson India Education Pvt. Ltd, 2023.

References:

1. T. K. Nagsarkar and M. S. Sukhija, Basic of Electrical Engineering, Oxford University Press, 2017.
2. Smarjith Ghosh, Fundamentals of Electrical and Electronics Engineering, Prentice Hall (India) Pvt. Ltd., 2010.
3. A. Sudhakar, Shyammohan S Palli, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill, 2025.
4. Floyd T.L., Buchla D.L., "Electronics Fundamentals: Circuits, Devices and Applications", 8th Edition, 2024
5. R. S. Sedha, A Textbook of Applied Electronics, S.Chand& Company Ltd, 2013.

26GE005	Problem Solving Using C	L	T	P	C
		3	0	0	3

Prerequisite	Assessment Pattern		
Basic Mathematics	CIA	SEE	Total
	40	60	100

Course Objectives

- To understand the basics of algorithmic problem solving using flowcharts and pseudocode.
- To learn the structure of a C program, its data types, operators, and expressions.
- To solve problems using control structures, arrays, and string handling functions.
- To use functions, recursion, and pointers for modular and efficient programming.
- To do file operations in C using structures, unions, and streams.

Course Outcomes (COs)

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

1. Apply the principles of problem-solving and algorithm design to formulate computational solutions.
2. Develop simple programs using fundamental C syntax, operators, and control statements.
3. Use arrays, strings, and functions to create modular and reusable code for data processing tasks.
4. Implement pointers and dynamic memory management to optimize program flexibility and efficiency.
5. Construct programs using structures, unions, and file operations for practical engineering applications.
6. Design and debug real-world computational problems through modular, well-documented C programs.

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2										1	
CO2	2	2	1		2							1	
CO3	2	2			2		1		2			1	
CO4	2		2		2		1					1	
CO5	3	2	3	3	2		1		2			2	1
CO6	3	2	3	3	2		1				3	3	1

Module 1

Problem Solving and Algorithms **8 Hours**

Problem solving and algorithmic thinking- Algorithms-Definition, Characteristics and examples, flowcharts- symbols, conventions, and illustrations, Pseudocode and structured representation, Steps in program development, Overview of compilers and the C programming environment (edit → compile → execute).

C Programming Basics **7 Hours**

Structure of a C program, Tokens, keywords, identifiers, data types, variables, and constants, Operators and expressions, Input/output functions: printf(), scanf(), Type conversion and precedence rules, Debugging techniques and handling syntax errors.

Control Structures, Arrays and Strings **8 Hours** Decision making: if, if–else, nested if, switch – Looping: while, for, do–while – Loop control statements: break, continue – Nested loops and example programs – One-dimensional and two-dimensional arrays: declaration,

initialization, traversal – Concept of multi-dimensional arrays – Character arrays – Strings and string library functions – String processing applications.

Module 2

Functions and Modular Programming **8 Hours**

Concept of functions and modular programming, Function definition, declaration, prototypes, Parameter passing: call by value and call by reference, Recursion, Storage classes (auto, static, extern, register)

Pointers and Dynamic Memory **7 Hours**

Pointers and pointer arithmetic, Relationship between arrays and pointers, Pointers to functions, Pointers - function arguments, Dynamic memory allocation: malloc, calloc, free, realloc.

Structures, Unions and File Handling **7 Hours**

Structures: definition, initialization, arrays of structures, nested structures, Pointers to structures, Unions: definition, initialization, and difference from structures, Enumerated data types (enum), File handling: concept of files and streams, file operations, reading/writing text and binary files, error handling.

Term Work Activity	
Micro projects, PS Assessment and Programming Assignments	
Self-Learning Activity	
SWAYAM / NPTEL: Prof. AnupamBasu, Problem solving through Programming in C, IIT Kharagpur,2025, https://nptel.ac.in/courses/106105171. Prof. SatyadevNandakumar, Introduction to Programming in C, NPTEL Online Course, Indian Institute of Technology Khanpur, 2025, https://onlinecourses.nptel.ac.in/noc25_cs119/preview.	
Theory	**45 Hours**
Tutorial	**- Hours**
Total	**45 Hours**

Text Book:

1. Kernighan, B. W. and Ritchie, D. M., The C Programming Language, Prentice Hall, 2nd Edition, USA, 2023.
2. ReemaThareja, “Programming in C”, Oxford University Press, Second Edition, 2016.

References:

1. Schildt, H., C: The Complete Reference, McGraw Hill, Latest Edition, USA, 2018.
2. Kanetkar, Y. P., Let Us C, BPB Publications, Latest Edition, India, 2025.
3. Byron S. Gottfried, “Schaum’s Outline of Theory and Problems of Programming with C”, McGraw-Hill Education, 1996.
4. PradipDey, Manas Ghosh, “Computer Fundamentals and Programming in C”, Second Edition, Oxford University Press, 2013.
5. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, 1st Edition, Pearson Education, 2013.

26HS001	COMMUNICATIVE ENGLISH	L	T	P	C
		1	0	2	2

Prerequisite	Assessment Pattern		
Basic Communication & Writing skill	CIA	SEE	Total
	50	50	100

Course Objectives:

- Develop students' ability to communicate effectively and professionally using accurate and appropriate English.
- Enhance students' skills in descriptive and narrative forms of communication.
- Develop active reading and comprehension skills through exposure to authentic English texts.

Course Outcomes (COs)

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

1. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Understand and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text

Articulation Matrix

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

Module 1

Communication Process **5 Hours**

Listening –formal & informal conversations - Speaking –Self introduction– speaking on given topics & situations – recording speeches and strategies to improve - Reading - Reading comprehension – skimming/ scanning/ predicting – question & answers – objective and descriptive answers - Writing – paragraph writing, personal notes - Language Development- single word substitutes, compound words- conditionals

Language Mechanics **5 Hours**

Listening –Interviews – Extensive speech on current affairs - Speaking – Role plays- describing a simple process – asking and answering questions - Reading – critical reading – finding key information in a given text – ideation, mind mapping - Writing - dialogue, instructions, process description - Language Development – writing single sentence definitions, sequence words, synonyms & antonyms.

Module 2

Narration and Summation: **5 Hours**

Listening - TED talks - popular speeches and presentations, Motivational speeches - Speaking - impromptu speeches, Debates and discussion -Reading - articles – magazines - Writing – review writing, channel conversion – bar diagram/ table, poster/ picture interpretation- Language Development – modal verbs, collocations, 21st century vocabulary

Practical **30 Hours**

Listening

Practice listening, speaking, pronunciation, and non-verbal communication in lab activities.
Summarize interviews, news, or expert speeches.
Summarize TED Talks, speeches, or presentations, noting purpose, tone, and techniques.

Speaking

Deliver short talks, presentations, or speeches on current issues and professional communication.
Role-plays, process descriptions, and Q&A practice.
Impromptu speeches, debates, and group discussions on current or social issues.

Reading

Create podcasts, mind maps, infographics, or record speeches for micro-projects.
Identify main ideas and create mind maps.
Identify main ideas, supporting evidence, and author's viewpoint from articles or excerpts.

Writing

Complete written tasks like paragraphs, comprehension, process descriptions, and poster/picture interpretation.
Write dialogues, instructions, or process paragraphs.
Reviews, chart-to-paragraph conversions, and poster/image interpretations.

Language Development

Prepare group reports and reflections from industrial or field visits.
Practice definitions, connectors, synonyms, and antonyms.
Practice modal verbs, collocations, and 21st-century vocabulary.

Term Work Activity	
Technical Article Analysis, Mind Mapping, Interview Script, TED Talk review	
Self-Learning	
1. **MOOC**: NPTEL "Developing Soft Skills and Personality" or equivalent. **NPTEL link**: https://nptel.ac.in/courses/109104107 2. **Online Module**: Complete an NPTEL or Spoken Tutorial and submit the certificate or a 150–200 word summary. **NPTEL link**: https://onlinecourses.nptel.ac.in/noc26_hs74/preview 3. **MOOCs**: Complete an Nptel online module; submit certificate or summary. **NPTEL link:** https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_hs08 4. **Online Module:** Coursera / Swayam / FutureLearn on Communication Skills. **NPTEL link**: https://onlinecourses.swayam2.ac.in/e learning/preview/aic21_ 5. **Spoken Tutorial**: IIT Bombay English Communication. **TED Talk**: 200-word reflection on strategies learned. 6. **TED Talk: 200-word reflection on strategies learned.**	

Theory	**15 Hours**
Practical	**30 Hours**
Total	**45 Hours**

Textbooks:

1. A Course in Technical English, D. Praveen Sam and K.N. Shoba, Cambridge University Press, 2020
2. *Anderson, Paul V*. Technical Communication: A Reader – Centered Approach. Cengage, New Delhi, 2008.

References:

1. Smith-Worthington, Darlene & Sue Jefferson. Technical Writing for Success. Cengage, Mason, USA, 2007.
2. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford, 2007.
3. Chauhan, Gajendra Singh and et.al.Technical Communication (Latest Revised Edition). Cengage Learning India Pvt. Limited, 2018**.**

26HS002	தமிழர் மரபு	L	T	P	C
		1	0	0	1

Prerequisite	Assessment Pattern		
Understanding of Indian and Regional History/Culture	CIA	SEE	Total
	40	60	100

Course Objectives

- தமிழர்களின் வரலாறு, பண்பாடு மற்றும் மரபுகளை அறிதல்.
- தமிழர்களின் சாதனைகள் மற்றும் பங்களிப்புகளை அறிதல்.
- தமிழர் மரபின் மீது பெருமை கொண்டு அதைப் பாதுகாத்தல்.

Course Outcomes (COs)

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

1. இந்தியாவில் உள்ள மொழி பல்வகைத்தன்மையை விளக்கி, திராவிட மொழிகளையும் அவற்றின் சிறப்பம்சங்களையும் குறிப்பிடுவர்.
2. கலை வளர்ச்சியின் பரிணாமத்தை சுருக்கமாக -விளக்கி, பாறை ஓவியங்களிலிருந்து நவீன சிற்பங்கள்வரை ஏற்பட்ட முக்கிய மாற்றங்களை எடுத்துக்காட்டுவர்.
3. விளையாட்டுகள் மற்றும் பாரம்பரிய விளையாட்டுகள் பண்பாட்டு மதிப்புகளை வளர்த்தல் மற்றும் சமூக ஒற்றுமையை உருவாக்குவதில் கொண்டுள்ள பங்கினை ஆய்வு செய்வர்.
4. சங்க காலத்தில் இருந்த கல்வி மற்றும் எழுத்தறிவு முறைகள் மற்றும் அவற்றின் தாக்கத்தை விவாதிப்பர்.

Articulation Matrix

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

அலகு - I

மொழி மற்றும் இலக்கியம் **3 Hours**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் –தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச்சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மை கருத்துக்கள் –தமிழ் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களில் 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- சிற்பக்கலை **3 Hours**

ஐம்பொன் சிலைகள்- பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள் பொம்மைகள்- தேர் செய்யும் கலை-சுடுமண் சிற்பங்கள்- நாட்டுப்புற தெய்வங்கள்- குமரி முனையில் திருவள்ளுவர் சிலை- இசைக்கருவிகள்- மிருதங்கம்,

பறை, வீணை, யாழ், நாதஸ்வரம்- தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோயில்களின் பங்கு

நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் **3 Hours**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவை கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம்- தமிழர்களின் விளையாட்டுகள்.

அலகு - II

தமிழர்களின் திணைக் கோட்பாடுகள் **3 Hours**

தமிழகத்தின் தாவரங்களும் விலங்குகளும்- தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புற கோட்பாடுகள்- தமிழர்கள் போற்றிய அறக்கோட்பாடு சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும் கல்வியும்-சங்ககால நகரங்களும் துறைமுகங்களும்- சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி-கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி

இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்கு தமிழர்களின் பங்களிப்பு **3 Hours**

இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு -இந்தியாவின் பிற்பகுதிகளில் தமிழ் பண்பாட்டின் தாக்கம்- சுயமரியாதை இயக்கம்- இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு- கல்வெட்டுகள்- கையெழுத்து படிகள்- தமிழ் புத்தகங்களின் அச்சு வரலாறு

Term Work Activity	
Assignments, Case Study	
Theory	**15 Hours**
Total	**15 Hours**

பாடநூல்கள்:

1. தமிழர் மரபு - முனைவர் அ. பூபாலன் VRB பதிப்பகம் (VRB PUBLISHERS PVT LTD), 6/50, வெங்கடேசா நகர் 1-வது தெரு, விருகம்பாக்கம், சென்னை - 600 092.

பார்வை நூல்கள்:

1. தமிழர்களின் சமூக வாழ்க்கை (Social Life of Tamils) - முனைவர் க.க. பிள்ளை (TNTB, ESC மற்றும் RMRL ஆகியவற்றின் கூட்டு வெளியீடு) – (அச்சில் உள்ளது)
2. தமிழர்களின் சமூக வாழ்க்கை - செவ்வியல் காலம் (Social Life of the Tamils - The Classical Period) - முனைவர் ச. சிங்காரவேலு (வெளியீடு: உலகத் தமிழாராய்ச்சி நிறுவனம்)
3. தமிழர்களின் வரலாற்றுப் பாரம்பரியம் (Historical Heritage of the Tamils) - முனைவர் ச.வ. சுப்பிரமணியன், முனைவர் க.தி. திருநாவுக்கரசு (வெளியீடு: உலகத் தமிழாராய்ச்சி நிறுவனம்)
4. இந்தியப் பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்புகள் (The Contributions of the Tamils to Indian Culture) - முனைவர் ம. வளர்மதி (வெளியீடு: உலகத் தமிழாராய்ச்சி நிறுவனம்)
5. கீழடி - 'வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்' (Keeladi - 'Sangam City Civilization on the banks of river Vaigai') (கூட்டு வெளியீடு: தொல்லியல் துறை மற்றும் தமிழ்நாடு பாடநூல் மற்றும் கல்விச் சேவைகள் கழகம், தமிழ்நாடு) இந்திய

வரலாற்று ஆய்வுகள் - தமிழ்நாட்டிற்கான சிறப்புக்குறிப்புடன் (Studies in the History of India with Special Reference to Tamil Nadu) - முனைவர் க.க. பிள்ளை (வெளியீடு: நூலாசிரியர்)

6. பொருநை நாகரிகம் (Porunai Civilization) - (கூட்டு வெளியீடு: தொல்லியல் துறை மற்றும் தமிழ்நாடு பாடநூல் மற்றும் கல்விச் சேவைகள் கழகம், தமிழ்நாடு)
7. நாகரிகப் பயணம்: சிந்து முதல் வைகை வரை (Journey of Civilization: Indus to Vaigai) - இரா. பாலகிருஷ்ணன் (வெளியீடு: RMRL) – பார்வை நூல்..

26PS108	PHYSICAL SCIENCE LABORATORY - PHYSICS	L	T	P	C
		0	0	2	1

Prerequisite	Assessment Pattern		
Principles of interference and diffraction of light. Characteristics of laser light. Skills in data observation, measurement, and error calculation.	CIA	SEE	Total
	60	40	100

Course Objectives:

- Develop proficiency in using precision instruments to accurately measure dimensions of engineering materials.
- Determine mechanical and optical properties of materials through systematic experimental methods and analysis.
- Characterize semiconductor and solar cell performance using electrical measurements and graphical analysis techniques.

Course Outcomes (COs)

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

1. Demonstrate the ability to measure and record physical parameters such as radius, diameter, thickness, and refractive index.
2. Determine and analyze mechanical properties like Young's modulus, rigidity modulus, and moment of inertia.
3. Investigate optical phenomena to measure thickness, wavelength, and particle size using interference and diffraction methods
4. Analyze I–V characteristics and energy band gap to evaluate performance parameters of solar cells and PN junction diodes.
5. Interpret and apply experimental data to understand material behavior and solve engineering problems.

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	2	1					1		1		1		
CO 2	2	1					1		1		1		
CO 3	2	1					1		1		1		
CO 4	2	1					1		1		1		
CO 5	2	1					1		1		1		

Module 1 (Any three experiments)

9 Hours

Experiment 1

Assess the physical parameters (radius, diameter, and thickness) of various engineering materials using precision instruments like the screw gauge, vernier caliper, and travelling microscope

Experiment 2

Determine the moment of inertia of a given disc by torsional oscillations and evaluate the rigidity modulus of the material of the suspension wire

Experiment 3

Apply the non-uniform bending method to determine the Young's modulus of a uniform bar and analyze its mechanical properties for engineering applications.	
Experiment 4	
Analyze the thickness of a thin sheet or wire by observing the interference pattern in an air-wedge arrangement	
Module 2 (Any two experiments)	
6 Hours	
Experiment 5	
Evaluate the wavelength of a laser source and assess the size of the given micro-particles (Lycopodium powder) using appropriate experimental techniques	
Experiment 6	
Determine the efficiency of a solar cell by experimentally plotting its current-voltage (I–V) characteristics curve.	
Experiment 7	
Measure the characteristics of a PN junction diode to determine the energy band gap of the semiconductor material.	
Experiment 8	
Investigate the refractive indices of a glass slab and water by measuring their apparent thickness using a travelling microscope.	
Self-Learning Activity	
NPTEL Course: NOC: Experimental Physics I, Prof. Amal Kumar Das NPTEL link https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_ph16 **NPTEL Course: NOC:** Experimental Physics II, Prof. Amal Kumar Das NPTEL link: https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ph06	
Practical	**15 Hours**
Total	**15 Hours**

Text Book:

1. Knight, R. D., "Physics for Scientists and Engineers: A Strategic Approach with Modern Physics," 4th Edition, Pearson, 2017.

Reference:

1. Prakash, I., Ramakrishna, "A Textbook of Practical Physics," 11th Edition, Kitab Mahal, 2011.

26PS108	**Physical Science Laboratory - Chemistry**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Prerequisite	**Assessment Pattern**		
Atomic structure	CIA	SEE	Total
Redox reactions	60	40	100

Course Objectives

- Apply suitable instruments and techniques to determine chemical properties of water, metals, and effluents.
- Analyze experimental data to determine concentrations, hardness, acidity, corrosion, adsorption, and electrochemical properties.
- Analyze experimental results using calculations and software to identify chemical behavior and stable structures.

Course Outcomes (COs)

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

1. Apply electrochemical techniques to determine cell EMF, conductivity and concentration of iron present in the given water samples
2. Apply analytical technique to identify the chromium concentration in industrial and environmental samples
3. Apply the principles of surface chemistry and adsorption to assess the adsorption ability of activated charcoal in the removal of heavy metals (such as chromium or nickel) from aqueous solutions
4. Analyze the quality of given water sample by measuring hardness/pH and interpret their suitability for domestic use.
5. Analyze the corrosion in concrete TMT bars and determine Fe^{2+} content in mild steel alloys to evaluate material degradation

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	2	1				2			1		1		
CO 2	2	1				1			1		1		
CO 3	1	2				2					1		
CO 4	2	2				1			1		1		
CO 5	2	1				1					1		

Module 1 (Any three experiments) **9 Hours**

Experiment 1
Construction of a simple electrochemical cell (Cu–Zn) and measurement of its potential.

Experiment 2
Assess the adsorption ability of activated charcoal in heavy metal (chromium/nickel) removal

Experiment 3
Determine the amount of electrolyte present in the industrial effluent by conductometric titration

Experiment 4

Redox titration: Potentiometric Analysis of iron (Fe^{2+}) present in the given water sample using $KMnO_4$

Module 2 (Any two experiments)

6 Hours

Experiment 5
Estimation of Hardness in water sample by EDTA method.

Experiment 6
Determination of acid content by measuring pH (Use pH Meter)

Experiment 7
Evaluate the corrosion percentage in concrete TMT bars.

Experiment 8
Investigate the amount of Iron (Fe^{2+}) in a mild steel alloy sample using a spectrophotometer.

Experiment 9
Visualize the geometry of the given molecule and identify the stable structure using software tools.

Self-Learning

NPTEL Course: NOC: Water Quality Management Practices, Prof. Gourav Dhar Bhowmick IIT Kharagpur NPTEL link: https://nptel.ac.in/courses/126105335 NPTEL Course: Elementary Electrochemistry, Prof. Angshuman Roy Choudhur, IISER Mohali NPTEL link: https://onlinecourses.nptel.ac.in/noc23_cy19/preview	
Practical	**15 Hours**
Total	**15 Hours**

Textbook:

1. Vogel, A. I., Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson,2009

References:

1. Skoog, West and Holler, Fundamentals of Analytical Chemistry, 10th Edition, 2022

Fontana, M. G., Corrosion Engineering, 4th Edition, 2017.

26GE006	C Programming Laboratory	L	T	P	C
		0	0	2	1

Prerequisite	Assessment Pattern		
Fundamental mathematics	CIA	SEE	Total
	60	40	100

Course Objectives

- To understand problem solving through flowcharts, pseudocode, and the C compilation process.
- To learn to write programs using operators, decision-making, and looping constructs.
- To implement programs using arrays, matrices, and string library functions.
- To use functions, recursion, pointers, and dynamic memory allocation in programs.
- To do file operations in C using structures and unions for real-world applications.

Course Outcomes (COs)

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

1. Apply algorithmic problem-solving techniques and fundamental C programming constructs to develop programs using operators, decision-making and looping constructs.
2. Develop C programs using arrays, matrices and string processing techniques to manipulate and process data.
3. Implement modular C programs using functions, recursion, pointers and dynamic memory allocation techniques.
4. Construct C programs using structures, unions and file handling techniques to manage structured and persistent data.

Articulation Matrix

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

Module 1	
Experiment 1	**3 Hours**
Problem-solving using flowcharts and pseudocode	
Experiment 2	**3 Hours**
Simple programs using arithmetic, logical, and relational operators.	
Experiment 3	**3 Hours**
Programs using decision-making and looping constructs.	
Experiment 4	**3 Hours**
Programs using arrays and matrices	
Experiment 5	**3 Hours**
String manipulation programs using library functions	
Module 2	
Experiment 6	**3 Hours**
Programs with user-defined functions and recursion	
Experiment 7	**3 Hours**
Implementation of pointer-based programs (arrays and functions).	

Experiment 8	**3 Hours**
Dynamic memory allocation programs	
Experiment 9	**3 Hours**
Programs using structures and unions.	
Experiment 10	**3 Hours**
File handling – reading, writing, and updating text/binary files.	
Practical	**30 Hours**
Total	**30 Hours**

References:

1. Kernighan, B. W. and Ritchie, D. M., The C Programming Language, Prentice Hall, 2nd Edition, USA, 2023.
2. Schildt, H., C: The Complete Reference, McGraw Hill, Latest Edition, USA, 2018.
3. Kanetkar, Y. P., Let Us C, BPB Publications, Latest Edition, India, 2025.
4. Thareja, R., Programming in C, Oxford University Press, Latest Edition, India, 2024.

26MA201	Differential Equations and Transforms (For B. Tech- Agri and Biotech)	L	T	P	C
		3	1	0	4

Prerequisite	Assessment Pattern		
Linear Algebra and Vectors, Complex Numbers and Basic Algebra, Calculus	CIA	SEE	Total
	40	60	100

Course Objectives:

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

- Develop proficiency in solving higher-order linear differential equations and applying Fourier and Laplace transforms to engineering problems.
- Understand the fundamental concepts and properties of Fourier, Laplace, and Z-transforms for analyzing continuous and discrete systems.
- Apply transform techniques, particularly Laplace and Z-transforms, to solve ordinary differential equations, initial value problems, and difference equations in practical applications.

Course Outcomes (COs)

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

1. Analyze and solve higher-order linear differential equations with constant coefficients in engineering applications.
2. Apply Fourier Transforms to analyze non-periodic functions in practical applications.
3. Use Laplace Transforms to solve ordinary differential equations and initial value problems.
4. Explain the concept of Z–Transform and its fundamental properties.
5. Determine the solutions of difference equations through Z transforms.

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	1	3											
CO 2	2	3											
CO 3	2	3											
CO 4	3	3											
CO 5	1	3											

Module 1

Linear Differential Equations **12 Hours**

Homogeneous linear ordinary differential equations of second order, linearity principle, general solution- Particular integral – Operator method – Solution by variation of parameters – Method of undetermined coefficients – Homogenous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

Fourier Transforms **11 Hours**

Fourier integral theorem- Fourier transform and inverse Fourier transform- Sine and cosine transforms - Properties - Transforms of simple functions - Convolution theorem – Parseval's identity

Module 2	
Laplace Transforms **12 Hours** Laplace transform: Existence of Laplace transform- Properties of Laplace transform-Laplace transform of periodic function. Inverse Laplace transform: Properties of inverse Laplace transform-Partial fraction method – Initial and final value theorems- Convolution- Application of Laplace transform to solve ordinary differential equations with constant coefficients- Solutions of simultaneous differential equations by Laplace transforms techniques. **Z- Transforms** **10 Hours** Z-Transform - Properties - Inverse Z-transform - Convolution method- Partial fraction method - Initial and final value theorems - Solution of difference equations using Z-transform.	
Term Work Activity	
GATE Questions, Quiz, Assignments.	
Self-Learning Activity	
NPTEL Course **Linear Differential Equations** **NPTEL link:** https://onlinecourses.nptel.ac.in/noc22_ma72/preview **NPTEL Course** **Transforms** **NPTEL link:** https://nptel.ac.in/courses/111106111	
Theory	**45 Hours**
Tutorial	**15 Hours**
Total	**60 Hours**

Text Books:

1. B.S Grewal, Higher Engineering Mathematics, Khanna Publisher, 45th Edition, 2024.
2. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017.

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th edition ,2015.
2. Richard E., Williamson Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies Inc, 1997.
3. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
4. George B.Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013.

26PH202	Materials Science	L	T	P	C
		3	0	0	3

Prerequisite	Assessment Pattern		
Understand the concepts of electric charge, current, magnetism, radiation-matter interaction, charged particle behavior and atomic structure of materials.	CIA	SEE	Total
	40	60	100

Course Objectives:

- Understand the principles of electrostatics, electricity, magnetism, optics, quantum mechanics and solid-state physics.
- Apply the laws of electromagnetism, optics and quantum mechanics to solve basic engineering problems.
- Analyze the electrical, optical, magnetic, and quantum properties of materials and their applications in modern technology.

Course Outcomes (COs)

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

1. Apply electrostatic principles to determine electric field, potential, and energy in simple charge configurations.
2. Explain the behavior of magnetic materials and apply laws of electromagnetic induction to real-world systems.
3. Analyze and interpret optical phenomena including interference, diffraction and polarization for engineering applications.
4. Interpret and apply quantum principles to explain the microscopic behavior of particles and energy quantization.
5. Relate the electronic and structural properties of semiconductors and modern materials to their technological applications.

Articulation Matrix

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

Module 1

Electrostatics **8 Hours**

Electric charge-field-potential. Gauss's law and its applications. Electric flux-field due to charge distributions-line, plane, and sphere. Capacitance and energy storage: parallel plate and spherical capacitors. Dielectric constant-polarization-displacement current.

Current Electricity **8 Hours**

Electric current-drift velocity-mobility-current density. Ohm's law-resistivity temperature dependence of resistance. Kirchhoff's laws and applications in resistive networks. RC circuit – charging and discharging of capacitors-time constant.

Magnetism and Electromagnetic Induction **7 Hours**

Magnetic field: Biot–Savart law-Ampere's circuital law. Classification of magnetic materials-magnetic domains: B–H curve and hysteresis. Faraday's and Lenz's law: Eddy currents and applications. Inductance – self and mutual-transformers and energy in magnetic fields

Module 2

Optics **7 Hours**

Interference: Air wedge-Newton's ring-Michelson interferometer. Diffraction: Single slit- diffraction grating-resolving power. Polarization: Plane-circular-elliptical-applications. Optical fibers: Principle-numerical aperture-applications in communication.

Quantum Mechanics **8 Hours**

Blackbody radiation-photoelectric effect-Compton effect. De-Broglie hypothesis-Davisson–Germer experiment. Schrödinger wave equation – physical interpretation-particle in a one dimensional-box. Quantum tunneling-application in electronic devices.

Solid State and Modern Materials **7 Hours**

Band theory of solids: Conductors-semiconductors-insulators. Semiconductor: Types-Fermi level and conductivity. Superconductor: Types-properties-applications. Nanomaterials – properties and applications.

Term Work Activity	
GATE Questions, Quiz, Assignments, Presentations	
Self-Learning	
NPTEL Course https://nptel.ac.in/courses **NPTEL link:** https://nptel.ac.in/courses/113107078	
Theory	**45 Hours**
Total	**45 Hours**

Text Books:

1. William D. Callister Materials Science and Engineering: An Introduction, 6th Edition, John Wiley & Sons, 2003.

References:

1. Halliday, D. & Resnick, R. Fundamentals of Physics, 12th Edition, John Wiley & Sons, Inc., New Delhi (2021).
2. Verma, H. C. Concepts of Physics Vol. I, Bharati Bhawan Publishers, New Delhi (2022 reprint).
3. Young, H. D. & Freedman, R. A. University Physics with Modern Physics, Global Edition, 15th Edition, Pearson, New Delhi (2024).
4. Tipler, P. A. &Mosca, G. Physics for Scientists and Engineers, 6th Edition, W. H. Freeman & Company / Macmillan, New Delhi (2020).
5. Serway, R. A. & Jewett, J. W. Principles of Physics: A Calculus-Based Text, 5th Edition, Brooks/Cole / Cengage Learning India Pvt. Ltd., New Delhi (2012).
6. Feynman, R. P., Leighton, R. B. & Sands, M. The Feynman Lectures on Physics (Vol. I), New Millennium Edition, Basic Books / Perseus Group, New Delhi (2011).

26BT203	Principles of Biochemical Engineering	L	T	P	C
		3	0	0	3

Prerequisite	Assessment Pattern		
Basic Concepts of Chemistry, physics, mathematics and Biology for Engineers	CIA	SEE	Total
	40	60	100

Course Outcomes (COs)

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

1. Apply the principles of stoichiometry, material, and energy balances to analyze and solve problems in biochemical and chemical process operations such as distillation, evaporation, drying, and recycle systems.
2. Apply thermodynamic variables, phase diagrams, and heat effects to evaluate energy transformations and thermal behavior in biochemical processes.
3. Analyze reaction kinetics, temperature dependence, and fundamental heat and mass transfer mechanisms to understand and model biochemical reaction systems.
4. Analyse mixing and agitation processes by comparing flow patterns, power requirements, and mixing–reaction interactions in different bioreactor configurations.
5. Evaluate bioprocess operations by assessing rate laws, filtration and sedimentation performance, and selecting suitable equipment for efficient and sustainable biochemical production

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO 1	3	3	2	2	1								
CO 2	3	3	3	3	2								
CO 3	3	2	3	3	2	1							
CO 4	2	2	3	3	2	1						2	
CO 5	2	3	3	3	3	2						2	

Module 1

Stoichiometry and Thermodynamics **5 Hours**

Scope of biochemical engineering; Stoichiometry of reactions, yields, and conversions; Basic chemical calculations - mole, weight & volume percentage; Basic thermodynamic variables and phase diagrams.

Material and Energy Balance **5 Hours**

Material Balance without Chemical reaction - distillation, evaporation, drying; recycle, bypass and purging operations; Energy balance - Sensible heat, latent heat; Heat capacity, heat effects, and simple biochemical process examples.

Reaction in Biological Systems **5 Hours**

Reaction orders; rate laws; temperature laws; Heat and mass transfer fundamentals in biochemical systems

Module 2

Mechanical Operations in Biochemical Systems **5 Hours**

Properties of particulate solids, Screening; Screen analysis; Surface area measurements; Size reduction of solids - laws, stages of reduction; Power-driven machines - Crushers, ball mills, conveyors.

Mixing and Agitation **5 Hours**

Introduction to agitation and mixing of liquids; Mixing - types of mixers - ribbon and muller mixer; Basics of fluid flow, pumps, and flow measurement; Mixing and bio-reaction interactions - with and without baffles; Agitation equipment, flow patterns in agitator; Power number.

Bioprocess Systems **5 Hours**

Filtration - Principles of cake filtration; Constant rate filtration and constant pressure filtration; Filtration equipment; Sedimentation and Settling theory; Equipment for sedimentation.

Term Work Activity	
1. Material and Energy Balance Analysis of a Laboratory-Scale Fermentation Process. 2. Experimental Analysis of Particulate Handling, Mixing, and Filtration Processes	
Self-Learning	
Videos on biochemical thermodynamics and stoichiometry. - University of Colorado Boulder - https://learncheme.com/screencasts/mass-energy-balances R Mechanical Unit Operations - Prof. Nanda Kishore, IIT Guwahati - https://onlinecourses.nptel.ac.in/noc25_ch72/preview	
Total	**45 Hours**

Textbooks:

1. Rajiv Dutta, *Fundamentals of Biochemical Engineering*, Springer India, 2008.
2. Pauline M. Doran, *Bioprocess Engineering Principles*, Academic Press, London, 2012.

References:

1. Shukla J.P., Biochemical Engineering: Principles and Concepts, Discovery Publishing House, New Delhi, 2013.
2. M.L. Shuler and F. Kargi, Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, 2002.
3. J.E. Bailey and D.F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill, New York, 1986.
4. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press, London, 2012.
5. Online resources: https://nptel.ac.in/courses/103105054; https://www.sciencedirect.com

26GE007	Python Programming	L	T	P	C
		3	0	0	3

Prerequisite	Assessment Pattern		
Basic understanding of programming paradigms Basic mathematical concepts	CIA	SEE	Total
	40	60	100

Course Objectives

- To understand Python syntax, data types, operators, and control structures for problem solving.
- To learn to use strings and built-in data structures — lists, tuples, sets, dictionaries.
- To define Python functions and apply recursion and modular programming principles.
- To use modules, file operations, exception handling, and object-oriented programming.
- To do data analysis and visualization using NumPy, Pandas, and Matplotlib.

Course Outcomes (COs)

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

1. Apply Python syntax, data types and control structures to develop programs for problem solving.
2. Develop modular Python programs using strings, built-in data structures, functions, and recursion to process and manipulate data.
3. Implement Python programs using modules, file operations, and exception handling to manage data and handle program execution errors.
4. Construct object-oriented Python programs using classes, objects, inheritance, polymorphism, encapsulation, and abstraction to model application entities.
5. Apply NumPy, Pandas, and Matplotlib to perform data processing, analysis, and visualization.

Articulation Matrix

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

Module 1

Python Fundamentals **8 Hours**

Introduction to Python: features, versions, IDEs, interpreter and script mode – Syntax, indentation, identifiers and comments – Variables, constants and basic data types – Type conversions – Expressions and operators – Evaluation order – Input and output operations.

Control Structures and Strings **6 Hours**

Conditional statements: if, if–else, elif, nested conditions – Looping constructs: for, while, nested loops – Loop control statements: break, continue, pass – String creation, indexing, slicing and formatting – Common string methods.

Data Structures and Functions **9 Hours**

Lists, tuples, sets, and dictionaries – creation, indexing, slicing, and operations - Built-in methods and comprehensions (list, set, dictionary) Functions: Function definition, parameters, return values- Function Arguments: Default and keyword arguments Scope and Lifetime of Variables- Recursion and Modular Programming Principles.

Module 2

File Handling and Exception Management **7 Hours**

Modules and packages – creation and import of built-in and user-defined modules – File operations (open, read, write, append) – Working with text and CSV files – Context managers (with statement) – Exception handling using try, except, else, finally, raise – User-defined exceptions.

Object-Oriented Programming **7 Hours**

Classes and objects – attributes and methods – Constructors (__init__) and destructors – Instance and class variables – Basics of inheritance and polymorphism – Encapsulation and abstraction – Simple OOP applications.

Numerical and Data Analysis with Visualization **8 Hours**

Introduction to NumPy arrays and operations – Introduction to Pandas (Series and DataFrame) – Data import/export (CSV, Excel) – Data selection, filtering, cleaning, and aggregation – Data visualization using Matplotlib (line, bar, scatter plots) with chart customization – Integration of NumPy and Pandas for analysis and visualization.

Term Work Activity	
Micro projects, PS Assessment, Programming Assignments.	
Self-Learning Activity	
SWAYAM / NPTEL: Dr. RizwanRehman, Programming in Python, Dibrugarh University, https://onlinecourses.swayam2.ac.in/cec22_cs20/preview	
Theory	**45 Hours**
Total	**45 Hours**

Text Book:

1. 1. Thareja, R., Python Programming using Problem Solving Approach, Oxford University Press, 2nd Edition, New Delhi, 2019.

References:

1. McKinney, W., Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter, O'Reilly Media, 3rd Edition, Sebastopol, 2022.
2. Lutz, M., Learning Python, O'Reilly Media, 5th Edition, Sebastopol, 2013.
3. Matthes, E., Python Crash Course: A Hands-On, Project-Based Introduction to Programming, No Starch Press, 2nd Edition, San Francisco, 2019.
4. Vasiliev, Y., Python for Data Science: A Hands-On Introduction, No Starch Press, 1st Edition, San Francisco, 2022.
5. VanderPlas, J., Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Media, 1st Edition, Sebastopol, 2016. Severance, C., Python for Everybody: Exploring Data Using Python 3, CreateSpace Independent Publishing, 1st Edition, Michigan, 2016.
6. Chen, D.Y., Pandas for Everyone: Python Data Analysis, Addison-Wesley Professional, 1st Edition, Boston, 2018.
7. Arora, S. and Deore, P., Hands-On Data Analysis with NumPy and Pandas, Packt Publishing, 1st Edition, Birmingham, 2019.

26GE010	**Biology for Engineers**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

Prerequisite	**Assessment Pattern**		
Basics of Biology, Chemistry and Mathematical calculations	CIA	SEE	Total
	40	60	100

Course Outcomes (COs)

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

1. Apply fundamental principles of biology to explain the diversity of life, classification of organisms, and the structure and function of biomolecules and cells.
2. Analyze cellular structures, membrane transport, and signaling mechanisms to understand cell function and communication
3. Analyze processes of cell division, cell cycle regulation, and differentiation to interpret growth and development in biological systems.
4. Analyze principles of genetics, molecular mechanisms, gene expression, and mutations to understand heredity and biotechnological applications.
5. Evaluate genetic engineering techniques, GM crops, and biotechnology applications with consideration of ethical and biosafety issues.

Articulation Matrix

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

Module 1

Introduction to Biology **5 Hours**

Biology -Scope, diversity of life, prokaryotes vs. eukaryotes, classification of organisms.

Fundamentals of Cellular components **5 Hours**

Structure and function of carbohydrates, proteins, lipids; nucleic acids; Cell Structure and Function - organelles, organization of plasma membrane; Cytoskeleton, Plant Cell Features - cell wall, chloroplasts, vacuoles, and plasmodesmata.

Concepts of Cell Communication and Division **5 Hours**

Membrane Transport and Communication - diffusion, osmosis, active transport, Cell signaling basics. Cell Division - mitosis, meiosis, Cell Cycle and regulation of cell growth, Cell differentiation, stem cells.

Module 2

Principles of Genetics **5 Hours**

Molecular Basis of Heredity - Mendelian inheritance, laws of dominance, segregation, independent assortment, linkage, chromosomal theory.

Genetic Materials & Mutations **5 Hours**

DNA and RNA structure, replication, transcription, translation, genetic code. Mutations - types and significance in biology and agriculture.

Genetic Engineering and Applications **5 Hours** GM crops, CRISPR basics, PCR, role of microbes in agriculture. Ethical and Biosafety Issues- responsible use of genetic technologies, safety in biotechnology applications.	
Term Work Activity	
1. Integrated Study of Cellular Structures, Biomolecules, and Functions 2. Analysis and Application of Genetic Principles and Biotechnological Tools.	
Self-Learning	
1. Introduction to Cell Biology- Prof. Nagaraj Balasubramanian, Prof. Girish Ratnaparkhi - IISER Pune **NPTEL link** - https://onlinecourses.nptel.ac.in/noc25_bt69 2. Cell and Molecular Biology - Prof. Vishal Trivedi - IIT Guwahati **NPTEL link -** https://onlinecourses.nptel.ac.in/noc25_bt57	
Total	**30 Hours**

Textbooks:

1. V. Rajesh, *Biology for Engineers*, 1st ed., New Delhi, India: Cengage India, 2025. ISBN: 9789360536268.
2. S. Chakraborty and S. Akhtar, *Biology for Engineers*, New Delhi, India: PHI Learning, 2020.
3. A. Nag, *Textbook of Agricultural Biotechnology*, New Delhi, India: PHI Learning, 2021.
4. G. N. Waite and L. R. Waite, *Applied Cell and Molecular Biology for Engineers*, New York, NY: McGraw-Hill, 2016.

References:

1. A. T. Johnson, *Biology for Engineers*, 2nd ed., Boca Raton, FL: CRC Press, 2018.
2. Wiley Editorial, *Biology for Engineers: As per Latest AICTE Curriculum*, New Delhi, India: Wiley Publishers, 2018. ISBN: 9788126576340.
3. A. H. Scragg, *Biotechnology for Engineers: Biological Systems in Technological Processes*, Chichester, UK: Ellis Horwood Publishers, 1988.

26HS004	PROFESSIONAL COMMUNICATION	L	T	P	C
		1	0	2	2

Prerequisite	Assessment Pattern		
Basic Communication & Writing skill	CIA	SEE	Total
	50	50	100

Course Objectives

- Develop students' professional communication skills using clear, accurate, and error-free English.
- Enhance students' ability to communicate effectively through descriptive and narrative forms.
- Develop students' ability to use English appropriately in business and professional contexts.

Course Outcomes (COs)

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

1. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Understand and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text

Articulation Matrix

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

Module 1

Effective Communication **5 Hours**

Listening – conversations, advertisements, expert talks – Speaking – real-life conversations, greetings, telephonic communication – Reading – short stories, articles, autobiographies – Writing – autobiographical writing, blogs, summaries, checklists – Language Development – subject-verb agreement, commonly confused words, reported speech, idiomatic expressions.

Module 2

Formal and Technical Expression **5 Hours**

Listening – podcasts, documentaries – Speaking – oral presentation with visuals, expressing opinions, debates, group discussions – Reading – biographies, travelogues, innovations – Writing – reports, agenda and minutes, formal letters, proposals, job application and resume – Language Development – cause & effect expressions, degrees of comparison, acronyms and abbreviations.

Career Competencies **5 Hours**

Listening – expert and technical talks, recommendations and solutions – Speaking – debates, GDs, professional presentations – Reading – analytical reading of reports and articles – Writing – proposals.

Practical **30 Hours**

Listening

Listen to real-life talks, ads, or expert speeches and summarize key ideas, tone, and purpose. Summarize podcasts or documentaries on innovation and social issues, focusing on theme and tone. Summarize expert talks, webinars, or panel discussions highlighting key insights and practical takeaways.

Speaking

Practice greetings, introductions, and telephonic role plays using correct etiquette and clarity. Deliver presentations and join debates or discussions using formal communication. Deliver professional presentations and participate in debates or GDs on industry or ethical topics.

Reading

Read short stories or articles to identify main ideas, tone, and writer's perspective. Analyze biographies or articles for key ideas, tone, and cause–effect links. Analyze technical reports or journal articles for key arguments, data, and recommendations.

Writing

Compose short autobiographies, blog posts, summaries, or checklists based on given topics. Draft reports, proposals, and job applications with clarity and structure. Prepare proposals, technical reports, formal emails, resumes, and cover letters.

Language Development

Reinforce grammar, vocabulary and idiomatic usage through quizzes and practice exercises. Practice grammar, connectors, comparisons, and workplace vocabulary
Practice verbal analogies, phrasal verbs, and vocabulary through quizzes and games

Term Work Activity	
Role Play, Mind Maping, Data Conversion, Poster Interpretation, JAM (Just a Minute)	
Self-Learning Activity	
1. **MOOCs**: Online NPTEL English or communication course. **NPTEL link**: https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed67 2. **MOOC**: NPTEL course on Business Communication or English; submit certificate or 150-word summary. **NPTEL link:** https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg128 3. **MOOC**: NPTELcourse on Professional Communication or Workplace English; submit certificate or 150-word reflection. **NPTEL link: https://onlinecourses.nptel.ac.in/noc26_hs25/preview**	

4. **TED Talk Analysis:** Summarize key lessons from a biography or travelogue. 5. **Review:** Draft a report or business letter with proper tone and format. 6. **Review**: Summarize a career-related article or success story (150 words). 7. **Writing**: Draft a formal email, proposal, or report using workplace tone. 8. **Career Task**: Update your LinkedIn profile with skills and certifications; share reflections in class.	
Theory	**15 Hours**
Practical	**30 Hours**
Total	**45 Hours**

Textbooks:

1. Raman, Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford University Press.
2. Bailey, Stephen. Academic Writing: A Practical Guide for Students. Routledge, New York,2011.

References:

1. Raman, Meenakshi, Sharma, Sangeeta. Technical Communication. Principles and Practice. Oxford University Press, New Delhi, 2014.
2. Muralikrishnan & Mishra Sunitha, Communication skills for Engineers 2nd ed. Pearson, Tamil Nadu, India 2011. P. Kiranmai and Rajeevan, Geetha. Basic Communication Skills, Foundation Books, New Delhi, 2013.
3. Vesilind Aarne P., Public Speaking and Writing Skills for Engineering Students (2nd Ed), Lakeshore press, 2007
4. Richards, Jack C. Interchange Students' Book – 2. Cambridge University Press, New Delhi, 2015.

26HS005	தமிழரும் ததொழில்நுட்பமும்	L	T	P	C
		1	0	0	1

Prerequisite	Assessment Pattern		
இந்திய மற்றும் பிராந்திய வரலாறு/ கலாச்சாரம் பற்றிய புரிதல்	CIA	SEE	Total
	40	60	100

Course Objectives

- **டிஜிட்டல் பாதுகாப்பை ஆய்வு செய்தல்:** தமிழ் கணினி, டிஜிட்டல் ஆவணக்காப்பகம் மற்றும் மொழி கருவிகள் ஆகியவை எவ்வாறு கலாச்சார மரபுகளைப் பாதுகாக்கின்றன என்பதை மதிப்பீடு செய்தல்.
- **நவீன தொழில்நுட்ப பயன்பாட்டை ஆராய்தல்:** உலகெங்கிலும் உள்ள தமிழ் சமூகங்கள் தங்களுக்குள் தொடர்புகொள்ள சமூக ஊடகங்கள், மென்பொருள்கள் மற்றும் செயற்கை நுண்ணறிவை (AI) எவ்வாறு பயன்படுத்துகின்றன என்பதை ஆராய்தல்.

Course Outcomes (COs)

பாடநெறி முடிவில், மாணவர்கள் பின்வருவனவற்றை செய்யக்கூடியவர்களாக இருப்பார்கள்:

1. சங்க கால நெசவு மற்றும் மண்பாண்டத் தொழில்நுட்பங்களின் (கருப்பு மற்றும் சிவப்பு மட்பாண்டங்கள் போன்றவை) நுட்பங்களையும் அவற்றின் முக்கியத்துவத்தையும் பகுப்பாய்வு செய்தல்; மட்பாண்டங்களில் உள்ள கீறல் குறியீடுகளின் (Graffiti) விளக்கங்களையும் இதனுள் உள்ளடக்குதல்.
2. சங்க கால வீடுகள் மற்றும் நடுகற்கள் முதல் கோவில்களின் (எ.கா., மாமல்லபுரம், சோழர், நாயக்கர்) கட்டடக் கலை விவரங்கள் வரை, பண்டைய தமிழ்நாட்டில் பயன்படுத்தப்பட்ட வடிவமைப்பு மற்றும் கட்டுமானத் தொழில்நுட்பங்களை விவரித்தல் மற்றும் வேறுபடுத்துதல்; மேலும் பல்வேறு காலகட்டங்களில் (செட்டிநாடு மற்றும் இந்தோ-சாராசனிக் கட்டடக்கலை உட்பட) அவற்றின் பரிணாம வளர்ச்சியை ஆராய்தல்.
3. முக்கியத் தொழில்கள் சார்ந்த உற்பத்திச் செயல்முறைகளை விளக்குதல்; குறிப்பாகக் கப்பல் கட்டும் கலை, பல்வேறு உலோகவியல் நடைமுறைகள் (இரும்பு உருக்குதல், எஃகு, செம்பு/தங்க நாணயங்கள் தயாரிப்பு) மற்றும் மணி செய்யும் கலையில் (கல், கண்ணாடி, சுடுமண், சங்கு) பயன்படுத்தப்பட்ட பல்வேறு தொழில்நுட்பங்களை விளக்குதல்.
4. பண்டைய மற்றும் இடைக்காலத் தமிழ்ச் சமூகத்தின் தொழில்நுட்ப, வர்த்தக மற்றும் பொருளாதார நிலப்பரப்பை மறுகட்டமைப்பு செய்வதற்கும் புரிந்துகொள்வதற்கும், தொல்லியல் மற்றும் இலக்கியச்

சான்றுகளை (சிலப்பதிகாரம் போன்றவை) முதன்மை ஆதாரங்களாகக் கொண்டு மதிப்பிடுதல்.

Articulation Matrix

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

Module 1

நெசவு மற்றும் மட்பாண்டத் தொழில்நுட்பம் **3 Hours**

சங்ககாலத்தில் நெசவுத்தொழில்- பானை தொழில் நுட்பம்- கருப்பு சிவப்பு பாண்டங்கள்- பாண்டங்களில் கீறல் குறியீடுகள்

வடிவமைப்பு மற்றும் கட்டிட தொழில்நுட்பம் **3 Hours**

சங்ககாலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் -சங்க காலத்தில் வீட்டுப் பொருட்களின் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருள்களும் நடுகல்லும்- சிலப்பதிகாரத்தில் மேடை வடிவமைப்பு பற்றிய விவரங்கள் -மாமல்லபுர சிற்பங்களும் கோவில்களும் -சோழர் காலத்து பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத்தலங்கள்- நாயக்கர் கால கோயில்கள் மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மீனாட்சியம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால்- செட்டிநாட்டு வீடுகள் -பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ சாரா செனிக் கட்டிடக்கலை

உற்பத்தித் தொழில்நுட்பம் **3 Hours**

கப்பல் கட்டும் கலை -உலோகவியல் -இரும்பு தொழிற்சாலை- இரும்பு உருக்குதல் ,எஃகு- வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் -நாணயங்கள் அச்சடித்தல்- மணி உருவாக்கும் தொழிற்சாலைகள்- கல்மனைகள், கண்ணாடி மணிகள்- சுடுமண் மணிகள் -சங்கு மணிகள்-எலும்புத் துண்டுகள்- தொல்லியல் சான்றுகள் -சிலப்பதிகாரத்தில் மணிகளின் வகைகள்

Module 2

வேளாண்மை மற்றும் நீர் பாசனத் தொழில்நுட்பம் **3 Hours**

அணை- ஏரி, குளங்கள், மதகு- சோழர்காலக் குமிழித்தோம்பின் முக்கியத்துவம்- கால்நடை பராமரிப்பு -கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள்- கடல்சார அறிவு - மீன்வளம் -முத்து மற்றும் முத்து குளித்தல் -பெருங் கடல் குறித்த பண்டைய அறிவு- அறிவுசார் சமூகம்

அறிவியல் தமிழ் மற்றும் கணித்தமிழ் **3 Hours**

அறிவியல் தமிழின் வளர்ச்சி -கணித்தமிழ் வளர்ச்சி -தமிழ் நூல்களை மின் பதிப்பு செய்தல்- தமிழ் மென்பொருட்கள் உருவாக்கம் -தமிழ் இணைய கல்விக்கழகம் - தமிழ் மின் நூலகம்- இணையத்தில் தமிழ் அகராதிகள் - சொற் குவைத் திட்டம்

Term Work Activity	
Assignments, Case Study	
Theory	**15 Hours**
Total	**15 Hours**

பாடநூல்கள்:

1. தமிழரும் தொழில்நுட்பமும் - டாக்டர் அ. பூபாலன் VRB பதிப்பகம் பிரைவேட் லிமிடெட், 6/50, வெங்கடேசா நகர் 1-வது தெரு, விருகம்பாக்கம், சென்னை - 600 092.

துணைநூல்கள்:

1. Social Life of Tamils (தமிழர்களின் சமூக வாழ்க்கை) - டாக்டர் கே.கே. பிள்ளை (TNTB & ESC மற்றும் RMRL ஆகியவற்றின் கூட்டு வெளியீடு) – (அச்சில் உள்ளது)
2. Social Life of the Tamils - The Classical Period (தமிழர்களின் சமூக வாழ்க்கை - செவ்வியல் காலம்) - டாக்டர் ச. சிங்காரவேலு (வெளியீடு: உலகத் தமிழாராய்ச்சி நிறுவனம்)
3. Historical Heritage of the Tamils (தமிழர்களின் வரலாற்றுப் பாரம்பரியம்) - டாக்டர் ச.வ. சுப்பிரமணியன், டாக்டர் கே.டி. திருநாவுக்கரசு (வெளியீடு: உலகத் தமிழாராய்ச்சி நிறுவனம்)
4. The Contributions of the Tamils to Indian Culture (இந்தியப் பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்புகள்) - டாக்டர் ம. வளர்மதி (வெளியீடு: உலகத் தமிழாராய்ச்சி நிறுவனம்)
5. கீழடி - 'வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்' (கூட்டு வெளியீடு: தொல்லியல் துறை மற்றும் தமிழ்நாடு பாடநூல் மற்றும் கல்விச் சேவைகள் கழகம், தமிழ்நாடு)
6. Studies in the History of India with Special Reference to Tamil Nadu (இந்திய வரலாற்றாய்வுகள் - தமிழ்நாட்டைச் சிறப்புக்குறிப்பாகக் கொண்டு) - டாக்டர் கே.கே. பிள்ளை (வெளியீடு: நூலாசிரியர்)
7. பொருநை நாகரிகம் (கூட்டு வெளியீடு: தொல்லியல் துறை மற்றும் தமிழ்நாடு பாடநூல் மற்றும் கல்விச் சேவைகள் கழகம், தமிழ்நாடு)
8. Journey of Civilization: Indus to Vaigai (நாகரிகப் பயணம்: சிந்து முதல் வைகை வரை) - இரா. பாலகிருஷ்ணன் (வெளியீடு: RMRL) – துணைநூல். (வெளியீடு: நூலாசிரியர்)

26GE008	Python Programming Laboratory	L	T	P	C
		0	0	2	1

Prerequisite	Assessment Pattern		
Fundamental mathematics	CIA	SEE	Total
	60	40	100

Course Objectives:

- To understand Python syntax, operators, and control statements for problem solving.
- To learn to use strings, lists, tuples, sets, and dictionaries to represent data.
- To define Python functions and build modular programs using classes and inheritance.
- To use file handling and exception handling for structured program development.
- To do numerical analysis and visualization using NumPy, Pandas, and Matplotlib.

Course Outcomes (COs)

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

1. Apply Python syntax, operators, control structures, and input/output constructs to develop programs for solving computational problems.
2. Develop Python programs using strings and built-in data structures such as lists, tuples, sets, and dictionaries to store and manipulate data.
3. Implement modular and robust Python programs using functions, recursion, file handling, and exception handling techniques.
4. Construct Python programs using classes, objects, and inheritance to implement object-oriented solutions.
5. Apply NumPy, Pandas, and Matplotlib to perform numerical computation, data processing, and visualization.

Articulation Matrix

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

Module 1

Experiment 1	**3 Hours**
Writing and executing Python programs using expressions, operators, and control statements.	
Experiment 2	**3 Hours**
Programs involving loops, conditional statements, and user input.	
Experiment 3	**3 Hours**
String operations and formatted output programs.	
Experiment 4	**3 Hours**
Programs using lists, tuples, sets, and dictionaries.	
Experiment 5	**3 Hours**

Function-based programs – recursion, modular code, and argument passing.	
Module 2	
Experiment 6	**3 Hours**
File operations – reading, writing, and processing text and CSV files.	
Experiment 7	**3 Hours**
Exception handling programs with user-defined exceptions.	
Experiment 8	**3 Hours**
Programs using classes, objects, and inheritance.	
Experiment 9	**3 Hours**
Numerical computation and data analysis using NumPy and Pandas.	
Experiment 10	**3 Hours**
Visualization of data using Matplotlib (line, bar, scatter plots).	
Practical	**30 Hours**
Total	**30 Hours**

References:

1. McKinney, W., Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter, O'Reilly Media, 3rd Edition, Sebastopol, 2022.
2. Thareja, R., Python Programming using Problem Solving Approach, Oxford University Press, 2nd Edition, New Delhi, 2021.
3. Lutz, M., *Learning Python*, O'Reilly Media, 5th Edition, Sebastopol, 2013.
4. Matthes, E., *Python Crash Course: A Hands-On, Project-Based Introduction to Programming*, No Starch Press, 2nd Edition, San Francisco, 2019.
5. Vasiliev, Y., Python for Data Science: A Hands-On Introduction, No Starch Press, 1st Edition, San Francisco, 2022.
6. VanderPlas, J., Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly Media, 1st Edition, Sebastopol, 2016. Severance, C., Python for Everybody: Exploring Data Using Python 3, CreateSpace Independent Publishing, 1st Edition, Michigan, 2016.
7. Chen, D.Y., Pandas for Everyone: Python Data Analysis, Addison-Wesley Professional, 1st Edition, Boston, 2018.
8. Arora, S. and Deore, P., Hands-On Data Analysis with NumPy and Pandas, Packt Publishing, 1st Edition, Birmingham, 2019

26GE009	Engineering Drawing	L	T	P	C
		1	0	2	2

Prerequisite	Assessment Pattern		
Algebra; Geometry Construction	CIA	SEE	Total
	60	40	100

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

Course Outcomes (COs)

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

1. Understand the standards and conventions used in Engineering drawing
2. Apply the concepts of projections in formulating various solid parts in engineering systems.
3. Analyze the various view and interpret the engineering drawings.
4. Demonstrate lifelong learning and adaptability by utilizing modern techniques and digital tools to improve engineering drawing skills

Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO 1												2		
CO 2	3											2		
CO 3		3										2		
CO 4					2						2	2		

Module 1

Fundamentals **6 Hours**

Engineering Drawing standards (SP 46), usage of drawing instruments, drawing sheets, scales, line and its types. Practices on lettering, numbering, dimension of drawings

Construction of Curves **8 Hours**

Regular Polygons. Conic curves with their tangent and normal – ellipse, parabola, and hyperbola by eccentricity method.

Projections of Points, Lines and Solids **8 Hours**

Principles and conventions of Orthographic Projections. Projections of Points and lines inclined to both planes. Projections of Regular Solids - Parallel, perpendicular, inclined to one plane using change of position method and inclined to both the planes.

Module 2

Section of Solids **8 Hours**

Simple and hollow solids with true shape of section – Prisms, Pyramids and Axisymmetric solids. Cutting plane parallel, perpendicular and inclined to one plane

Development of Surfaces **8 Hours**

Regular and Truncated Solids - Prism, Pyramid, Cylinder and Cone

Orthographic and Isometric Projections **7 Hours**

Orthographic projections and isometric view of components used in engineering applications.

Term Work Activity

Quiz on Drawing Standards, Drawing Assignments, Product Drawing Recreation, Assembly Drawing.	
Self-Learning	
Virtual Labs - https://eg-nitk.vlabs.ac.in/ and https://eg-dei.vlabs.ac.in/	
Theory	**15 Hours**
Practical	**30 Hours**
Total	**45 Hours**

Text Books:

1. N.D. Bhatt and V.M. Panchal, Engineering Drawing, 55th Edition, Charotar Publishing house Pvt. Ltd, Gujarat, 2024
2. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2023.

References:

1. Frederick E. Giesecke et al., Technical Drawing with Engineering Graphics, 16th Edition, Peachpit Press, 2023.
2. K. Venugopal, Engineering Drawing and Graphics, 5th Edition, New Age International Pvt Ltd, 2024.
3. Virtual Labs - https://eg-nitk.vlabs.ac.in/ and https://eg-dei.vlabs.ac.in/
4. NPTEL Course - Engineering Drawing and Engineering Graphics and Design