

**B. TECH FIRST SEMESTER
(CE, CSE, ECE & EE)
ENGINEERING PHYSICS-I**

Course Title	Engineering Physics-I	
Course code		Total credits: 5 Total hours:

Course Outcomes (CO):

CO1. Apply vector calculus concepts such as gradient, divergence, curl, and vector integration theorems to solve problems in electromagnetism and explain Maxwell's equations and electromagnetic wave concepts. (L3 – Apply, L4 – Analyze)

CO2. Explain and apply the principles of statics, dynamics, force systems, equilibrium conditions, momentum, and circular motion to solve engineering physics problems. (**L3-Apply**)

CO3. Analyze rotational motion of rigid bodies using concepts of torque, angular momentum, moment of inertia, gyroscope, and conservation laws. (**L4-Analyze**)

CO4. Analyze sound characteristics, reverberation, acoustics of buildings, and the production and applications of ultrasonic waves in engineering fields. (L3 – Apply, L4 – Analyze)

CO5. Explain the laws of thermodynamics, entropy, nanomaterials, shape memory alloys, and biomaterials, and relate their properties to modern technological applications. (L2 – Understand, L3 – Apply)

MODULE I: VECTOR CALCULUS & ELECTROMAGNETISM (6 HOURS)

UNIT 1: Gradient, Divergence and Curl, Line, Surface, and Volume integrals, Gauss's divergence theorem and Stokes' theorem in Cartesian (Derivation not needed), Spherical polar and cylindrical polar coordinates, Dirac Delta function.

UNIT 2: Gauss's law and Biot savart law in differential form, Ampere's Law, Inconsistency in Ampere's Law, Continuity equation, Displacement current, Maxwell's equation in differential form with significance.

MODULE II: STATICS & DYNAMICS (6 HOURS)

UNIT 3: Force, Free-body diagram – Concept – Important Steps for Drawing FBD, System of forces – Classification, Analytical method for Concurrent Force System, Lami's theorem, Moment of a force, Varignon's Principle or Principle of Moments, Analytical Method for Parallel Force System, Analytical Method for Non-Concurrent Force System - Conditions of equilibrium.

UNIT 4: Force and momentum, Kinetics of Particles – D'Alembert Principle, Impulse and its applications, Circular motion - Definition of angular quantities, Linear and Angular velocity, Centripetal and centrifugal force, Banking of roads.

MODULE III: ROTATIONAL MOTION OF RIGID BODIES (4 HOURS)

UNIT 5: Translational and rotational motion with examples, Definition of torque and angular momentum, Mass moments – Area moments, Moment of Inertia, Theorem of parallel and perpendicular axes – Axis of Reference – Axis of Symmetry, Conservation of angular momentum and its applications - Radius of gyration, Gyroscope.

MODULE IV: ACOUSTICS & ULTRASONIC (5 HOURS)

UNIT 6: Decibel level of sound, Weber-Fechner law, Reverberation & Reverberation time, Sabine's formula for reverberation time (Derivation not required), Absorption co-efficient, Factors affecting acoustics of buildings and their remedies, Acoustic design of a hall.

UNIT 7: Production and properties of ultrasonic waves, Applications of Ultrasonic.

MODULE V: THERMAL PHYSICS (4 HOURS)

UNIT 8: Thermal equilibrium, zeroth law and concept of temperature. First law and its consequences, reversible, irreversible and quasi-static processes. Second law: heat engines, concept of entropy and its statistical interpretation.

MODULE VI: NANOMATERIALS AND ADVANCED MATERIAL (5 HOURS)

UNIT 9: Introduction to Nanomaterials, Properties of Nanomaterials, Potential Well and Quantum Confinement (qualitative), Types of Nanomaterials and their application.

UNIT 10: Advanced materials: Shape memory alloys and Biomaterials and their application.

References:

1. **Introduction to Electrodynamics by David J. Griffiths.**
2. **Mechanics by D. S. Mathur.**
3. **Applied Physics for Engineers by Neeraj Mehta.**
4. **Thermal Physics by S. C. Garg, R. M. Bansal & C. K. Ghosh.**
5. **An Introduction to Nanoscience and Nanotechnology by A. Nouliahat.**

Practical Components:

Experiment 1: a. To compute a. the gradient of a scalar function using computational tools.
b. the divergence of a vector field using computational tools. **[Module I]**

Experiment 2: To verify Gauss's/Stokes' theorem for a given vector field. **[Module I]**

Experiment 3: To find the horizontal component of earth's magnetic field by using deflection and vibration magnetometer. **[Module I]**

Experiment 4: To verify Lami's theorem for system of three concurrent and coplanar forces. **[Module II]**

Experiment 5: To verify principle of moments by using moment of force apparatus. **[Module II]**

Experiment 6: To find the moment of inertia of an unknown body using M-I table. **[Module III]**

Experiment 7: To find the acceleration due to gravity using Bar Pendulum. **[Module III]**

Experiment 8: To verify Law's of transverse vibration using sonometer. **[Module IV]**

Experiment 9: To measure the mechanical equivalent of heat by Joule's Calorimeter. **[Module V]**

Experiment 10: To measure the specific heat of a liquid by newton's law of cooling. **[Module V]**

Experiment 11: To study properties and applications of nanomaterials. **[Module VI].**

Assam Skill University

B.Tech. Engineering Mathematics Syllabus (Semesters I, II, and III)

1 Semester I: Engineering Mathematics-I (Linear Algebra, ODE, PDE, Single & Multivariable Calculus)

Computational Software Co-requisites: MATLAB / Wolfram Mathematica

1.1 Course Objectives

To deliver a comprehensive analytical baseline common to all engineering disciplines by tightly unifying matrix linear structures, ordinary and partial differential physical models, and multivariable calculus spaces.

1.2 Course Outcomes (COs)

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

- **CO1:** Solve systems of linear equations and extract structural eigenvalues using matrix spectrum transformations.
- **CO2:** Compute analytical solutions for classic first and high-order ordinary differential equations.
- **CO3:** Formulate partial differential equations using separation of variables to model basic boundary value problems.
- **CO4:** Analyze vector spaces, track curves via curvature metrics, and resolve constrained multi-variable fields via Lagrange multipliers.
- **CO5:** Develop modular programs in MATLAB/Mathematica to compute, map, and visualize basic calculus geometries and system equilibria.

1.3 Course Content and Unit-wise Practicals

Unit I: Linear Algebra

Symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal, and unitary matrices. Matrix rank evaluations via echelon forms. Consistency of linear systems; Gauss Elimination and Gauss-Jordan Elimination. Linear Independence, Eigenvalues, Eigenvectors, Diagonalization of matrices, and Cayley-Hamilton Theorem.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
1	Study of Special Types of Matrices	Identify and verify symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal and unitary matrices.
2	Rank of a Matrix using Echelon Form	Determine the rank of matrices using row echelon and normal forms.

3	Solution of Linear Systems	Solve systems of linear equations using Cramer's Rule, Gauss Elimination and Gauss-Jordan methods.
4	Eigenvalues, Eigenvectors and Diagonalization	Find eigenvalues, eigenvectors and diagonalize square matrices.
5	Verification of Linear Independence	Test linear independence and dependence of vectors in vector spaces.

Unit II: Single and Multivariable Calculus

Curvature parameters, evolutes, and involutes; Indeterminate forms, L'Hospital rule. Applications of improper integrals (Beta and Gamma functions). Functions of several variables: Limit, continuity, partial derivatives, and directional derivatives; Tangent plane and normal lines; Maxima, minima, and saddle points; Method of Lagrange multipliers.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
6	3D Surface Visualization and Topological Mapping	Render and analyze three-dimensional surfaces symbolically and graphically to study surface behavior and topology
7	Determination of Critical Points and Coordinate Extrema	Compute and classify local maxima, minima, and stationary points of multivariable functions
8	Identification and Visualization of Saddle Points	Determine saddle points using second derivative tests and visualize their geometric behavior on surfaces
9	Optimization of Multivariable Functions using Lagrange Multipliers	Apply Lagrange multiplier techniques to optimize functions subject to equality constraints
10	Symbolic and Numerical Topographical Optimization Toolkit	Develop computational scripts for symbolic differentiation, extrema detection, saddle point analysis, and constrained optimization

Unit III: Ordinary Differential Equations

First-order linear and non-linear ordinary differential equations: Exact, linear, and Bernoulli equations. Special first-degree variants: equations solvable for p , equations solvable for y , and Clairaut's form. Second-order linear differential equations with constant coefficients, method of variation of parameters, and Cauchy-Euler equations, Linear ODEs. Bernoulli Equation. Power Series Method for solution of ODEs: Legendre's Equation. Legendre Polynomials, Bessel's Equation, Bessels's functions $J_n(x)$ and $Y_n(x)$. Gamma Function.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
11	Solution of First-Order Differential Equations	Solve first-order linear and non-linear ordinary differential equations.
12	Second-Order Differential Equations with Constant Coefficients	Solve second-order linear differential equations with constant coefficients.
13	Differential Equations with Variable Coefficients	Solve ordinary differential equations involving variable coefficients.
14	Power Series Solutions of Differential Equations	Obtain power series solutions around ordinary points.
15	Graphical Interpretation of ODE Solutions	Plot and interpret solutions of ordinary differential equations graphically.

Unit IV: Partial Differential Equations

Introduction to partial differential equations, formulation of PDEs via elimination of constants and

arbitrary functions. First-order linear and quasi-linear equations (Lagrange's form). Method of separation of variables applied to physical boundaries: Modeling the one-dimensional wave equation and one-dimensional heat conduction grids.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
16	Formation of Partial Differential Equations	Form partial differential equations by eliminating arbitrary constants and functions.
17	Solution of PDEs using Separation of Variables	Solve boundary value problems using method of separation of variables.
18	Fourier Series Applications	Expand functions into Fourier series and apply them in engineering problems.
19	Laplace Transform and Inverse Laplace Transform	Compute Laplace transforms and inverse transforms of standard functions.
20	Applications of Laplace Transforms	Solve engineering differential equations using Laplace transform techniques.

1.4 Suggested Text/Reference Books

1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 10th Edition, John Wiley & Sons, 2018.
2. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 44th Edition, 2017.

SEMESTER – I						
Course Title	English for Technical Communication					
Course code		Total credits: 4	L	T	P	C
		Total hours: 13T+52P	1	0	4	3
Pre-requisite	NIL	Co-requisite	NIL			
Programme	Bachelor of Technology					
Semester	Odd semester of the first year of the programme					
Course Objectives	<ol style="list-style-type: none"> 1. Develop students' ability to distinguish technical communication from general writing and apply principles of clarity, conciseness, and audience awareness. 2. Enable students to construct well-structured technical descriptions, definitions, and manuals using formal writing principles. 3. Train students in producing formal workplace documents and summaries for real-world professional settings. 4. Equip students with skills to plan, draft, and present structured reports and persuasive proposals based on technical content. 5. Enhance students' oral communication abilities for technical presentations, discussions, and interviews. 					
CO1	Analyze various forms of written communication and apply technical writing conventions appropriately.					
CO2	Compose technical documents using appropriate structure, tone, and formatting tools.					
CO3	Draft and evaluate emails, résumés, summaries, and technical letters suited for industry communication.					
CO4	Organize and present information in the form of technical reports and proposals.					
CO5	Deliver structured presentations and respond effectively in interviews and group discussions.					
Unit-No.	Content	Contact Hour	Skill Outcome	BL		
I	Fundamentals of Technical Communication Nature and characteristics of technical communication, differences between technical and general writing, audience analysis, purpose-driven writing, principles of clarity, conciseness, and coherence. Practical components include comparing and revising technical vs. non-technical paragraphs, writing a brief technical description, peer-review exercises for clarity and readability.	3+10=13	Students will be able to classify types of writing, revise content for clarity, and improve coherence in technical documents.	3		
II	Technical Writing Essentials Writing technical definitions, descriptions, and instructions, maintaining formal tone and objectivity, using third-person voice, incorporating figures, charts, and tables with proper captions, formatting and structuring technical documents. Practical components include writing a user manual, defining and describing engineering terms, and	2+10=12	Students will be able to design a user manual and present technical descriptions effectively using visual and textual formats.	6		

SEMESTER – I				
Course Title	English for Technical Communication			
	delivering an oral walkthrough of a written process.			
III	<p>Professional Documentation Email etiquette, writing memos and technical letters, drafting minutes of meetings, notices, and circulars, preparing résumés and cover letters, writing abstracts and executive summaries.</p> <p>Practical components include composing formal emails and memos, preparing résumés and job applications, and writing and presenting project summaries or proposal abstracts.</p>	2+10=12	Students will be able to create a professional résumé and compose a job-specific cover letter with appropriate language and structure.	6
IV	<p>Report and Proposal Writing Types of reports including lab reports, feasibility reports, and project reports, structure and format of technical reports, principles of proposal writing, setting objectives, and incorporating persuasive elements.</p> <p>Practical components include writing a group project report, drafting a technical or research-based proposal, and presenting the proposal before a mock review panel.</p>	2+10=12	Students will be able to write a short project report and present a proposal using appropriate formatting, objectives, and visuals.	6
V	<p>Verbal Communication for Engineers Oral presentation techniques, effective use of visual aids such as PowerPoint and models, active listening strategies, public speaking skills, group discussion dynamics, and interview preparation.</p> <p>Practical components include conducting extempore sessions with peer feedback, delivering short technical presentations with visual support, and participating in mock interviews.</p>	2+12=14	Students will be able to conduct a technical extempore, present with visual aids, and participate in a mock interview with confidence.	3

TEXT BOOKS:

T1: Barun K. Mitra, *Effective Technical Communication – A Guide for Scientists and Engineers*, Oxford Higher Education, 2006 edition or later.

T2: T. M. Farhathullah, *Communication Skills for Technical Students*, Latest Edition, Orient Blackswan

T3: Meenakshi Raman, Sangeeta Sharma, *Technical Communication: Principles and Practice*, Latest Edition, Oxford University Press

REFERENCE BOOKS:

R1: Sharma S. D., Mishra B. K., *A Course in Technical English*, Latest Edition, PHI Learning

R2: R. C. Sharma, Krishna Mohan, *Business Correspondence and Report Writing*, Latest Edition, Tata McGraw Hill

2 Semester II: Engineering Mathematics-II (Complex Analysis, Sequences, Series & Numerical Calculus)

Computational Software Co-requisites: MATLAB / Wolfram Mathematica

2.1 Course Objectives

To master the mathematics of complex variables, contour integration theories, infinite sequences, and discrete numerical calculus loops required for frequency domain assessments and computational approximations.

2.2 Course Outcomes (COs)

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

- **CO1:** Establish the analyticity of complex functions and map spatial distortions using conformal transformations.
- **CO2:** Evaluate complex contour integrals and apply Cauchy's residue theorem to compute improper integrals.
- **CO3:** Assess convergence bounds for infinite series and construct exact Taylor, Maclaurin, and Fourier expansions.
- **CO4:** Execute numerical algorithms to isolate non-linear roots, interpolate scattered datasets, and perform high-precision computational integration.
- **CO5:** Program custom software algorithms to parse complex spatial variables and execute numerical differential solvers.

2.3 Course Content and Unit-wise Practicals

Unit I: Complex Variable Differentiation & Mappings

Complex number operations. Differentiation of complex functions, Cauchy-Riemann equations (Cartesian and Polar forms), analytic functions, harmonic functions, and extraction of harmonic conjugates. Elementary analytic functions (exponential, trigonometric, logarithmic) and their mapping properties. Conformal mappings and Mobius transformations.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
1	Complex Number Operations on the Argand Plane	Perform addition, subtraction, multiplication, division, modulus, and argument calculations geometrically and algebraically
2	Visualization of Polar and Exponential Forms of Complex Numbers	Convert complex numbers between Cartesian, polar, and exponential forms and visualize rotations
3	Differentiation of Complex Functions	Compute derivatives of complex-valued functions and analyze differentiability conditions
4	Verification of Cauchy-Riemann Equations in Cartesian Coordinates	Verify analyticity of functions using Cartesian form of Cauchy-Riemann equations
5	Verification of Cauchy-Riemann Equations in Polar Coordinates	Check analyticity conditions using polar form of Cauchy-Riemann equations
6	Identification of Analytic and Non-Analytic Functions	Determine whether given complex functions are analytic over specified domains
7	Construction and Verification of Harmonic Functions	Verify Laplace's equation for harmonic functions in two variables

8	Study of Complex Exponential Functions	Analyze mapping properties of the function $f(z) = e^z$ and visualize transformations
9	Mapping Properties of Complex Trigonometric Functions	Study transformations under $f(z) = \sin z, f(z) = \cos z$ and visualize image regions
10	Study of Complex Logarithmic Functions	Analyze branch cuts, principal values, and mappings associated with $f(z) = \log z$

Unit II: Complex Variable Integration & Residues

Complex integration: Line and contour integrals, Cauchy-Goursat theorem, Cauchy Integral formula. Taylor's series and Laurent's series expansions. Zeros of analytic functions, singularities, residues, Cauchy Residue theorem, and the calculation of improper real integrals using classic contour boundaries.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
11	Identification of Singularities and Pole Structures	Determine removable singularities, simple poles, higher-order poles, and essential singularities of complex functions
12	Residue Computation using Laurent Series and Residue Formula	Compute residues at simple and higher-order poles using Laurent expansions and residue formulas
13	Automated Residue Calculator using Symbolic Computation	Develop scripts to automatically identify poles, structural singularities, and residue terms of complex functions
14	Numerical Evaluation of Contour Integrals using Residue Theorem	Evaluate contour integrals numerically and analytically over circular and rectangular contours
15	Visualization of Contours, Singularities, and Residue Contributions	Visualize contour paths, poles, branch cuts, and residue contributions in the complex plane

Unit III: Sequences, Infinite Series & Fourier Expansions

Limits of sequence of numbers, infinite series; Tests for convergence (ratio, root, and comparison checks); Power series, Taylor and Maclaurin expansions with truncation error estimations. Fourier series definitions for periodic functions, Euler's formulae, and half-range sine and cosine expansions.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
16	Study of Convergence of Numerical Sequences	Investigate convergence/divergence of sequences numerically and graphically
17	Visualization of Limit of a Sequence	Approximate limits of sequences using tabulation and plotting techniques
18	Comparison of Different Types of Sequences	Compare arithmetic, geometric, harmonic, and recursive sequences
19	Numerical Investigation of Infinite Series	Compute partial sums and study convergence of infinite series

20	Verification of Ratio Test for Convergence	Apply Ratio Test on different infinite series
21	Verification of Root Test for Convergence	Analyze convergence using Cauchy Root Test
22	Application of Comparison and Limit Comparison Tests	Compare given series with standard benchmark series
23	Fourier Series Applications	Expand functions into Fourier series and apply them in engineering problems

Unit IV: Numerical Analysis, Root Extraction & Numerical Calculus

Numerical algorithms to isolate real roots of non-linear algebraic and transcendental equations (Bisection, Secant, and Newton-Raphson methods). Finite differences and data polynomial interpolation via Newton's expressions and Lagrange polynomials. Numerical integration frameworks (Trapezoidal and Simpson's rules). Euler's method and fourth-order Runge-Kutta (RK4) method.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
24	Finite Difference Tables	Construct forward, backward and central finite difference tables.
25	Newton's Forward and Backward Interpolation	Approximate values using Newton's forward and backward interpolation formulas.
26	Lagrange Interpolation Polynomial	Construct interpolation polynomials using Lagrange's method.
27	Numerical Differentiation	Approximate derivatives using finite difference methods.
28	Numerical Integration using Trapezoidal Rule	Evaluate definite integrals numerically using Trapezoidal Rule.
29	Numerical Integration using Simpson's Rules	Evaluate definite integrals using Simpson's $\frac{1}{3}$ Rule and Simpson's $\frac{3}{8}$ Rule.
30	Solution of Initial Value Problems using Euler's Method	Solve first-order differential equations numerically using Euler's method.
31	Modified Euler's Method	Improve numerical approximation of differential equations using Modified Euler's method.
32	Fourth-Order Runge-Kutta Method (RK4)	Solve ordinary differential equations using fourth-order Runge-Kutta method.
33	Comparative Study of Numerical ODE Solvers	Compare accuracy and convergence of Euler, Modified Euler and RK4 methods.
34	Graphical Interpretation of Numerical Solutions	Plot numerical solutions of differential equations and compare with exact solutions.

2.4 Suggested Text/Reference Books

1. J. W. Brown and R. V. Churchill, *Complex Variables and Applications*, 7th Edition, McGraw Hill, 2004.
2. S. S. Sastry, *Introductory Methods of Numerical Analysis*, 5th Edition, PHI Learning, 2012.

SEMESTER – II						
Course Title	Engineering Chemistry (BS-03)					
Course code		Total credits: 4	L	T	P	C
		Total hours: 26T+52P	2	0	4	4
Pre-requisite	NIL	Co-requisite	NIL			
Programme	Bachelor of Technology in Civil engineering /Electrical engineering/Electronics and communication Engineering					
Semester	Odd semester of the first year of the program me					
Course Objectives (Minimum 3)	<ol style="list-style-type: none"> 1. To acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. 2. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. 3. The student will be able to understand the new developments and breakthroughs efficiently in engineering and technology. 4. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the modern technologies. 					
CO1	To analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.					
CO2	To rationalise bulk properties and processes using thermodynamic considerations.					
CO3	To distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques					
CO4	To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.					
CO5	To list major chemical reactions that are used in the synthesis of molecules.					
Unit-No.	Content	Contact Hour	Skill Outcome		BL	
I	Atomic and Molecular Structure: Wave mechanical model of atom, Schrodinger equation. Particle in one dimension box and its application, energy and plotting of wavefunction and probability density. Particle in a box solution and their applications for conjugated molecules. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals Theory of diatomic molecules and its application. Energy level	5+6=11	<ul style="list-style-type: none"> • Apply the Schrödinger equation to solve quantum mechanical problems like particle in a box. • Interpret atomic and molecular orbital shapes and energy diagrams using orbital plots. • Analyze molecular orbital theory and aromaticity in conjugated systems like butadiene and benzene. • Evaluate crystal field splitting to predict 		2,3,4,5	

SEMESTER – II

SEMESTER – II				
Course Title	Engineering Chemistry (BS-03)			
	diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and concept of aromaticity. Crystal field theory and its application for transition metal ions and their magnetic properties. Isomerism in transitional metal compounds.		magnetic and electrical properties. <ul style="list-style-type: none"> • Analysis of coordination numbers, and geometries in coordination 	
II	Spectroscopic techniques and applications: Principles of spectroscopy and selection rules. Electronic spectroscopy. Vibrational and rotational spectroscopy of diatomic molecules. Applications of Nuclear magnetic resonance spectroscopy, characterization techniques Viz. Xray Diffraction: Principles and types, merits, demerits and applications of XRD.	6+6=12	<ul style="list-style-type: none"> • Understand the principles and selection rules of various spectroscopic techniques. • Apply electronic, vibrational, and rotational spectroscopy to analyze molecular structures. • Evaluate surface characterization methods using diffraction 	2,3,5
III	Intermolecular forces and potential energy surfaces: Types of Intermolecular force: Ionic, dipolar and van Der Waals, Hydrogen bonding interactions.	4+6=10	<ul style="list-style-type: none"> • Understand various intermolecular forces such as ionic, dipolar, Hydrogen bond and van der Waals interactions. 	2,3,4
IV	Use of free energy in chemical equilibria: Brief about system, surrounding, Type of systems, energy, First law, second law and zeroth law of thermodynamics, Concept of entropy and free energy. Estimations of entropy and free energies. Relationship between Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility	5+8=13	<ul style="list-style-type: none"> • Understand thermodynamic functions (energy, entropy, free energy) and their role in chemical equilibria. • Apply the Nernst equation to calculate cell potentials and analyze electrochemical systems. • Analyze acid-base, redox, and solubility equilibria using free energy principles. 	2,3,4,5

SEMESTER – II				
Course Title	Engineering Chemistry (BS-03)			
	equilibria. Water chemistry. Corrosion.			
V	<p>Periodic properties:</p> <p>Brief concept about orbitals, Types of Quantum numbers, Effective nuclear charge, penetration, shielding of orbitals, Calculation of Shielding parameter, electronic configurations and atomic or ionic radii, ionization energies, electron affinity and electronegativity. Trend in periodic properties and periodicity. polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.</p>	4+8=12	<ul style="list-style-type: none"> Understand periodic trends such as ionization energy, electron affinity, and electronegativity. Apply concepts like effective nuclear charge and orbital penetration/Shielding to explain atomic behaviour. Analyze electronic configurations and predict oxidation states, Evaluate acid-base interactions using HSAB (Hard and Soft Acids and Bases) theory. 	2,3,4,5
VI	<p>Stereochemistry:</p> <p>Representations of 3-dimensional structures, Isomerism, Type of isomerism: structural isomers and stereoisomers, configurations and chirality, enantiomers, diastereomers, optical activity, absolute configurations (R/S nomenclature and E/Z nomenclature) and conformational analysis in ethane, butane with energy level diagram.</p>	5+5=10	<ul style="list-style-type: none"> Understand 3D molecular representations and the concept of chirality and symmetry. Apply rules to distinguish structural isomers, stereoisomers, enantiomers, and diastereomers Analyse conformational isomerism and optical activity using absolute configurations. 	2,3,4
VII	<p>Organic reactions and synthesis of a drug molecule:</p> <p>Introduction to reactions involving substitution, addition, elimination, oxidation reduction transformations, Pericyclic reaction, Synthesis of a</p>	4+6=10	<ul style="list-style-type: none"> Understand fundamental organic reaction types such as substitution, addition, and elimination. Apply oxidation, reduction, cyclization, and ring-opening reactions in organic synthesis. 	2,3,4,6

SEMESTER – II			
Course Title	Engineering Chemistry (BS-03)		
	commonly used drug molecule.		<ul style="list-style-type: none"> Analyze reaction mechanisms to predict products and pathways in organic transformations. Design a synthetic route for a commonly used drug molecule using appropriate reactions.

TEXT BOOKS:

T1: AICTE's Prescribed Textbook: Chemistry – I with Lab Manual, Manisha Agrawal, Khanna Book Publishing, 2023.

T2: Engineering Chemistry, by Manisha Agrawal.

T3: University chemistry, by B. H. Mahan

T4: Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane

T5: Fundamentals of Molecular Spectroscopy, by C. N. Banwell

REFERENCE BOOKS:

R1: Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan

R2: Physical Chemistry, by P. W. Atkins 8. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition.

<http://bcs.whfreeman.com/vollhardtschore5e/default.asp>

Engineering Chemistry Lab (CE 201)

Learning Outcomes:

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

- 1) Prepare Standard Solution and determine the strength of Acid and Bases by volumetric titration.
- 2) Understand and differentiate various methods of qualitative and quantitative analysis.
- 3) Use various apparatus for precise measurements.

Course Outcome: After completion of the course, students will be able to

CO-1: Determination of strength of H₂SO₄ by titration against N/10 Na₂CO₃

CO-2: Determination of strength of NaOH by titration against N/10 HCl

CO-3: Determination of strength of NaOH by titration against Oxalic acid.

CO-3: Estimate the hardness of water by EDTA

CO-4: Identify the acidic radicals by Dry and Wet Test.

CO-5: Determine the pH of unknown sample by pH meter.

CO-6: To determine the conductivity of unknown sample by Conductivity meter

CO-7: To determine the concentration of unknown sample by Colorimeter.

- ☞ Discussion and demonstration on safety protocols in the laboratory.
- ☞ Hands on training on various laboratory equipment.

CO-8: Preparation of organic compound

CO-9: Preparation of inorganic double salt and coordination compound.

CO-10: Determination of total alkalinity of given water sample.

Experiment 01: Preparation of standard solution of KMnO_4 or Na_2CO_3 .

Experiment 02: Preparation of standard solution of Oxalic acid or to make different concentration of acid solution.

Experiment 03: Determination of strength of H_2SO_4 by titration against N/10 Na_2CO_3

Experiment 04: To prepare Ferrous ammonium sulphate or Mohr's salt (Double salt)

Experiment 05: To prepare Acetoxime.

Experiment 06: To prepare Iodoform.

Experiment 07: Preparation of Tetraamine copper (II) sulphate.

Experiment 08: Organic heteroatom (sulphur, nitrogen, halogen and phosphorous detection in given organic sample by Lassaign's test.

Experiment 09: Determination of strength of NaOH by titration against N/10 HCl

Experiment 10: Redox Titration- KMnO_4 Vs $\text{H}_2\text{C}_2\text{O}_4$

Experiment 11: Determine strength and concentration of unknown NaOH by titration against Oxalic acid.

Experiment 12: To estimate the hardness of water sample by EDTA method.

Experiment 13: To determine the concentration of unknown sample by Colorimeter

Experiment 14: Determine the pH of unknown sample by pH meter.

Experiment 15: To determine the conductivity of unknown sample by Conductivity meter.

Experiment 16: To determine the total alkalinity of given water sample.

Experiment 17: To identify the acidic radicals by Dry and Wet Test (CO_3^{2-} , Cl^- , Br^- , SO_4^{2-} , S^{2-} , NO_3^{-2})

Experiment 18: To identify the basic radicals by Dry and Wet Test — (Pb^{2+} , Cu^{2+} , Fe^{3+} , Al^{3+} , Zn^{2+} , Co^{2+} , Ni^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Mg^{2+} , K^+).

Books:

- 1) Experiments in Applied Chemistry, Sunita Rattan, S.K. Kataria and Sons Publications.
- 2) Elementary Practical Chemistry by G.D. Sharma and Arun Baht.
- 3) Elements of Practical chemistry by Sudarsan Barua, S. Chand & Co.

B. TECH SECOND SEMESTER (CSE, ECE & EE) ENGINEERING PHYSICS-II

Course Title	Engineering Physics-I					
Course code		Total credits: 5	L	T	P	C
		Total hours:	2	0	1	3

Course Outcomes (CO):

CO1. Describe and evaluate the mechanical properties of matter and oscillatory systems including elasticity, SHM, pendulums, damped and forced oscillations. **(L4-Analyze)**

CO2. Explain the principles and operation of lasers, optical fibers, and holography and identify their engineering and communication applications. (L2 – Understand, L3 – Apply)

CO3. Explain optical aberrations in lenses and apply methods for minimizing spherical and chromatic aberrations in optical systems. (L2 – Understand, L3 – Apply)

CO4. Interpret and solve problems related to wave optics including interference, diffraction, polarization, resolving power, and optical instruments. **(L3-Apply)**

CO5. Explain the fundamentals of solid-state physics, semiconductors, p-n junction devices, transistors, superconductors, and their engineering applications. **(L2-Understand)**

MODULE I: PROPERTIES OF MATTER & SHM (5 HOURS)

UNIT 1: Elasticity, Hooke's law, factors affecting elasticity, Poisson's ratio, Relations in elasticity, twisting couple on a wire, bending of beams with symmetric cross-section, Cantilever.

UNIT 2: Simple Harmonic Motion, Pendulum – simple, compound and torsion pendulums. forced oscillation and resonance.

MODULE II: LASERS, FIBER OPTICS AND HOLOGRAPHY (6 HOURS)

UNIT 3: Introduction, coherence, Einstein A and B coefficients, population inversion, basic principle and operation of a laser, the He-Ne laser, the Ruby laser & semiconductor laser.

UNIT 4: Optical fiber: Introduction, basic principle, structure and classification, acceptance angle and numerical aperture, application.

UNIT 5: Introduction to holography, principle and technique

MODULE III: OPTICS (3HOURS)

UNIT 6: Aberration in lenses, Spherical and Chromatic Aberration, Method of minimization of Spherical and Chromatic Aberration.

MODULE IV: WAVE OPTICS (8 HOURS)

UNIT 7: Coherence and coherent source, Interference: Interference by division of wavefront (Young's double slit experiment) interference by division of amplitude (thin films, Newton's rings)

UNIT 8: Diffraction; Fraunhofer and Fresnel diffraction; Fraunhofer diffraction for Single slit (Derivation needed), double slit & N-slit (diffraction grating) (derivation not needed), resolving power and dispersive power of a grating, Rayleigh criterion, resolving power of optical instruments

UNIT 9: Polarization: Introduction to polarization, optical activity, specific rotation, Laurent half shade polarimeter.

MODULE V: SOLID, SEMICONDUCTORS AND SUPERCONDUCTIVITY (8 HOURS)

UNIT 10: Free electron theory of metals, Density of States, Fermi level origin of energy bands: Metals, Semiconductors and Insulators, Solar Cell, LED, Hall effect.

P-N junctions: fabrication, static and dynamic behaviour of p-n junction diodes, Junction breakdown in p-n junctions, Transistor, Transistor as amplifier, Voltage gain, Current gain.

UNIT 11: Properties of Superconductors; Meissner effect, Critical Magnetic Field, Isotope effect, Persistent current, Magnetic levitation, Type-1 & Type-2 superconductors and their comparison, BCS theory of superconductivity (qualitative only).

References:

1. Properties of matter by D.S. Mathur
2. Laser Physics and Fiber Optics by Dr. Rajendra Kumar and Dr. Rajesh Kumar
3. Optics by Ajay Ghatak.
4. Optics by Brijlal and Subrahmanyam.
5. Solid State Physics by Gupta and Kumar.
6. Principles of Electronics by V. K. Mehta.

Practical Components

Experiment 1: To determine the Young's modulus of the material of a wire using Searl's apparatus. [Module I]

Experiment 2: To find the modulus of rigidity of the material of rod using Barton's Apparatus. [Module I]

Experiment 3: To measure the wavelength of He-Ne Laser using grating. [Module II]

Experiment 4: To determine the numerical aperture of an optical fiber. [Module II]

Experiment 5: To study spherical aberration in a convex lens. [Module III]

Experiment 6: To measure the focal length of a convex lens using a concave lens. [Module III]

Experiment 7: To verify Malus Law. [Module I V]

Experiment 8: To determine the wavelength of monochromatic light using YDSE. [Module IV]

Experiment 9: To measure the wavelength of light using millimetre scale as grating. [Module IV]

Experiment 10: To draw the characteristic curve of Zener diode. [Module V]

Experiment 11: To draw the characteristic of transistor. [Module V]

Experiment 12: To determine the Hall current. [Module V]

3 Semester III: Engineering Mathematics-III (Probability, Stochastic Processes, Group & Graph Theory)

Computational Software Co-requisites: MATLAB / Wolfram Mathematica

3.1 Course Objectives

To integrate advanced axiomatic probability distributions, stochastic chains, and signal filters alongside discrete mathematical structures, algebraic group properties, and network optimization routing graphs.

3.2 Course Outcomes (COs)

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

- **CO1:** Frame systemic engineering risks using axiomatic probability, conditional expectations, and Bayes' theorem.
- **CO2:** Process statistical correlation matrices, trace random sequences, and apply Central Limit Theorem bounds.
- **CO3:** Verify wide-sense stationarity across random signals, and compute Power Spectral Densities via the Wiener-Khinchin relationship.
- **CO4:** Model random processes passed through LTI systems, and configure basic Wiener or Kalman filter matrices.
- **CO5:** Validate discrete algebraic group compliance and map coset configurations.
- **CO6:** Apply matrix connectivity parameters to graphs and run Prim/Kruskal algorithms to resolve minimal spanning tree paths.

3.3 Course Content and Unit-wise Practicals

Unit I: Probability & Random Variables

Sample Spaces and Events, Probability spaces, conditional probability, Multiplication and Total Probability Rules and Bayes theorem. Discrete and continuous random variables, Probability Mass Function, Probability Density Function, and Cumulative Distribution Function. Standard distributions: Normal, Binomial, Poisson. Mathematical expectation, variance. Joint distributions, independence, and the Central Limit Theorem. Correlation and regression.

Hypothesis testing: Formulation of null hypothesis, alternative hypothesis, the critical region, Two types of errors, level of significance, and power of the test. Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
1	Verification of Probability Axioms	Verify axiomatic properties of probability using sample space and event models.
2	Conditional Probability and Bayes' Theorem	Solve problems involving conditional probability and verify Bayes' theorem numerically.
3	Discrete Probability Distributions	Construct and analyze probability mass functions for discrete random variables.
4	Continuous Probability Distributions	Study probability density functions and cumulative distribution functions of continuous random variables.
5	Expectation and Variance of Random Variables	Compute mean, variance and standard deviation of probability distributions.
6	Joint Probability Distributions	Determine joint probability distributions and marginal distributions of two random variables.

7	Measures of Central Tendency	Calculate mean, median and mode for grouped and ungrouped data.
8	Measures of Dispersion	Compute range, variance, standard deviation and coefficient of variation.
9	Correlation Analysis	Determine Karl Pearson's coefficient of correlation and interpret relationships between variables.
10	Linear Regression Analysis	Fit regression lines and analyze prediction models using linear regression.
11	Hypothesis Testing using Z-test and t-test	Perform large and small sample hypothesis tests using Z-test and t-test.
12	Chi-Square Test Applications	Apply Chi-square tests for goodness of fit and independence of attributes.

Unit II: Stochastic Processes

Random sequences and modes of convergence. Random processes: Definition, classification structures, wide-sense stationarity (WSS), and strict-sense stationarity. Autocorrelation and cross-correlation functions. Power Spectral Density (PSD) metrics and the verification mechanics of the Wiener-Khinchin theorem. Transmission of random processes through Linear Time-Invariant (LTI) systems. Output properties and introductory Kalman filtering state matrices.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
13	Stochastic Process Realization & Filter Analyzer	Generate multi-realization random paths to check for stationarity and ergodicity. Simulate white noise injection into an LTI system block, writing custom filter scripts to extract target signals.

Unit III: Group Theory

Definitions, closure, associativity, identity, Semigroups, Monoids, and Groups. Subgroup identities, cyclic groups, permutation groups, and Lagrange's theorem on finite groups. Structural mapping of left and right coset arrangements.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
14	Verification of Algebraic Structures	Verify whether given algebraic systems form semigroups, monoids or groups.
15	Study of Subgroups and Cosets	Determine subgroups, identity elements and cosets of finite groups.
16	Verification of Group Properties	Verify closure, associativity, identity and inverse properties for algebraic structures.

Unit IV: Graph Theory

Structural network terminology: Graph elements, Adjacency and Incidence matrix mappings, vertex degree sequences, paths, and cycles. Complete, regular, and bipartite graphs. Graph isomorphism. Spanning trees.

Recommended Computational Laboratory Framework:

Practical No.	Title of Practical	Objectives / Activities
17	Graph Representation using Matrices	Construct adjacency and incidence matrices of graphs.
18	Degree Sequences, Paths and Cycles	Determine degree sequences, connectivity, paths and cycles in graphs.

19	Graph Isomorphism	Verify graph isomorphism between different graph structures.
20	Binary Trees and Tree Traversal	Construct binary trees and perform preorder, inorder and postorder traversals.
21	Minimum Spanning Tree using Prim's Algorithm	Determine minimum spanning trees using Prim's algorithm.
22	Minimum Spanning Tree using Kruskal's Algorithm	Determine minimum spanning trees using Kruskal's algorithm and compare results.

3.4 Suggested Text/Reference Books

1. H. Stark and J. Woods, *Probability and Random Processes with Applications to Signal Processing*, 4th Edition, Pearson, 2012.
2. Kenneth H. Rosen, *Discrete Mathematics and Its Applications*, 8th Edition, McGraw Hill, 2019.
3. A. Papoulis and S. U. Pillai, *Probability, Random Variables and Stochastic Processes*, 4th Edition, McGraw Hill, 2002.

Signatures:

1. Faculty, Mathematics:
2. Head, Department of Basic Sciences and Humanities:
3. Head, Information Technology:
4. Head, Electronics and Communication Engineering:
5. Head, Electrical Engineering:
6. Head, Civil Engineering:
7. Dean-Academics: