COURSE STRUCTURE and SYLLABUS

for

First Year B.Tech. Programmes

(To be implemented from session 2022 – 23 onwards)

Indian Institute of Petroleum and Energy

2^{nd} Floor, AU Engineering College Main Block
Andhra University, Visakhapatnam, Andhra Pradesh - 530003

Overview of Courses

1^{st} Semester

Sl. No.	Course Name	L	T	P	Credits	Remarks
1.	Engineering Mathematics – I (Calculus)	3	1	0	4	
2.	General Chemistry	3	1	0	4	
3.	Engineering Mechanics	3	1	0	4	
4.	Introduction to materials	3	0	0	3	
5.	Engineering Graphics	1	0	3	3	
6.	English for Communication	1	0	2	2	
7.	Electrical Technology	2	0	0	2	Modular
8.	Basic Electronics	2	0	0	2	
9.	Chemistry Lab	0	0	3	3	
10.	EAA I	0	0	0	P/F	
Total		18	3	8	27	

2^{nd} Semester

Sl. No.	Course Name	L	T	P	Credits	Remarks
1.	Engineering Mathematics – II	3	1	0	4	
2.	Strength of materials	3	1	0	4	
3.	Physics	3	1	0	4	
4.	Programming and Data Structure	3	0	3	5	
5.	Earth Energy and Environment	2	0	0	2	Modular
6.	Fundamentals of Biological System	2	0	0	2	
7.	Electrical and Electronics Lab	0	0	3	2	
8.	Workshop	0	0	3	2	
9.	EAA II	0	0	0	P/F	
Total		16	3	9	25	

1^{st} Semester

Engineering Mathematics - I (Calculus)						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1101	Engineering Mathematics – I (Calculus)	3	1	0	4

Objectives:

1. To introduce the notions of limits, continuity, differentiation and integration of real-valued functions of single variable and multivariable and the integration of vector-valued functions on curves and surfaces.
2. To learn the polynomial approximation of n-times differentiable functions and consequently to understand the behavior of the functions.

Learning Outcomes:

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

1. Analyze the properties such as continuity, differentiability, and Integration of single and multivariable functions.
2. Evaluate the maxima and minima of a function by various methods such as Lagrange's multiplier method.
3. Understand polynomial approximation of a single and multivariable function by Taylor series.
4. Know the convergent properties of sequence, series and Beta and Gamma functions.
5. Evaluate the area, volume, surface area, double and triple integrals.
6. Know the connection between single, double, and triple integrals by Green's, Gauss, and Stoke's theorem.

S.No	Topics to be Covered	Learning Outcome
1.	**Functions of single variable:** Sequences in real numbers, limits and continuity of real-valued functions on intervals, extreme values of functions in interval, Intermediate value property and differentiation, Mean Value Theorems, Indeterminate forms, Taylor's formula, convergence of series, root test, ratio test, Cauchy condensation test, alternating series, Leibnitz's test, absolute and conditional convergence, power series, radius of convergence, Taylor series.	The student will be able to, analyze the properties such as continuity, differentiability, maxima, minima, polynomial approximation, the convergence of sequence and series, and integration of single-variable functions
2.	Riemann integration, Riemann integrable functions, Mean value theorems of Integrals, Improper integrals, Beta and Gamma functions and their convergence, comparison test, absolute convergence.	The student will be able to, evaluate and study the convergent properties of definite integrals and indefinite integrals such as Beta and Gamma functions.

3.	**Functions of several variables:** Continuity, partial derivatives, directional derivatives and gradient, differentiability, chain rule, tangent plane and normal line, Euler's theorem on homogeneous functions, Taylor's theorem, extreme values, Lagrange multipliers.	The student will be able to, analyze the properties such as continuity, differentiability, maxima, minima, polynomial approximation and Integration of multivariable functions.
4.	Double and triple integrals, volume and area, change of variables, surface area, surface integrals, line integrals, Green's theorem, vector fields, divergence and curl of a vector field, Stoke's theorem, Divergence theorem.	The student will be able to, evaluate the area, volume, surface area, double and triple integrals, relations among lines, surface and volume integrals

Text Books:

1. G. B. Thomas Jr, M. D. Weir, and J. R. Hass, Calculus, Pearson Education (2009).
2. Hughes-Hallett et al., Calculus - Single and Multivariable (3rd Edition), John-Wiley and Sons (2003).
3. James Stewart, Calculus, Thomson (2003).
4. N. Piskunov, Differential and Integral Calculus Vol.1-2, Mir publishers, (1974).
5. Tom M. Apostol, Calculus Vol. 1-2, Wiley, (2007).

References:

1. S.R. Ghorpade, B.V.Limaye, A course in Calculus and Real Analysis, Springer (2017)
2. S.R. Ghorpade, B.V.Limaye, A course in Multivariable Calculus and Analysis, Springer (2017)

General Chemistry						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1102	General Chemistry	3	1	0	4

Objectives:

1. This course is designed to provide good foundation on the fundamental concepts of Physical and Inorganic chemistry, viz: Thermodynamics, Chemical Equilibrium, Kinetics, Physical properties of matter, Electrochemistry, Basic spectroscopy, Alkane-alkene chemistry.

Learning Outcomes:

At the end of the course completion, the student will be able to:

1. Identify directionality and/or the tendency of physical/chemical change through thermodynamic properties/laws.
2. Identify the directionality of chemical equilibrium after perturbation in the system.
3. Identify and determine the rate constant and related properties of a chemical reaction.
4. Utilize the basic spectroscopic concept to identify basic organic/inorganic molecules.
5. Measure and determine EMF of a cell and thereby solubility product (in water) of sparingly soluble salt.
6. Understand and improvise the concept of primary and secondary battery.
7. Utilize the concept of hydrocarbon chemistry in the synthesis and characterization of Alkane/Alkene/Alkyne.

S.No	Topics to be Covered	Learning Outcome
1.	Concept of entropy, Chemical potential, Equilibrium conditions for closed systems, Phase and reaction equilibria, Maxwell relations, Real gas and real solution. Electrochemical Systems: Electrochemical cells and EMF, Applications of EMF measurements: Thermodynamic data, activity coefficients, solubility product and pH, corrosion.	Identification of directionality and/or the tendency of physical/chemical change through thermodynamic properties/laws.
2.	Reversible, consecutive and parallel reactions, Steady state approximation, Chain reactions, Photochemical kinetics.	Identification and determination of rate constant and related properties of a chemical reaction.
3.	Alkane, Alkene, Alkyne: structure, stereochemistry, physical and chemical properties, chemical reactivity, separation.	Utilization of the concept of hydrocarbon chemistry in the synthesis and characterization of Alkane/Alkene/Alkyne.
4.	Basic concepts of spectroscopy, Selection rule, Determination of molecular structure.	Utilization of the basic spectroscopic concept to identify basic organic/inorganic molecules

Text Books:

1. Physical Chemistry by G.W. Castellan (Addison Wesley Publishing Company).
2. ATKINS' Physical Chemistry by Peter Atkins, Julio de Paula (Oxford press).
3. Organic Chemistry (Volume 1) by I. L. Finar (Richard Clay and Company Ltd.)

References:

1. Physical Chemistry by Robert J. Silbey, RobertA. Alberty, Moungi G.Bawendi (John Wiley&Sons, Inc.).
2. Principle of Physical Chemistry by Puri, Sharma, Pathania (Vishal Publication)

Engineering Mechanics						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1103	Engineering Mechanics	3	1	0	4

Objectives:

1. To provide students fundamental understanding of various principles of statics and Dynamics and to expand this knowledge into the vast area of "rigid body Mechanics".
2. To enhance students' ability to design by requiring the solution of open-ended problems.
3. To prepare the students for higher level courses such as courses in Mechanics of Solids, Fluid Mechanics and other Design and Structural Analysis subject.

Learning Outcomes:

Upon successful completion of this course student should be able to:

1. Use scalar and vector analytical techniques for analysing forces in statically determinate structures.
2. Apply fundamental concepts of statics to analyse stability of any structure.
3. Use principle of Kinematics and kinetics of particles to the analysis of simple, practical. problems.
4. Apply basic knowledge of mathematics and physics to solve real-world problems (LO4)

S.No	Topics to be Covered	Learning Outcome
1.	Introduction to Engineering Mechanics	Use scalar and vector analytical techniques for analyzing forces in statically determinate structures.
	Introduction to force system	
	Problems on Resolution of Forces	
	Review of Vectors	
	Problems on Vectors	
	Moment of force about a point and about an axis	
	Problem on Moment	
	Couple moment	
	Reduction of force system with a force and couple	
	Problems	
	Free body diagram	Apply fundamental concepts of statics to analyse stability of any structure.
	Equilibrium and its equation	
	Problems in two and three dimensions	
	Sample problems for practice	
	Trusses Introduction	
	Sample problems for practice	

2.	Laws of Coulomb friction, problems involving large and small contact surfaces	Learn about application of friction in designing screws, belt, Bearing.
	Square threaded screws	
	Belt friction	
	Friction in Bearing, Rolling resistance	
3.	Properties of area Introduction	Apply basic knowledge of mathematics and physics to find center of gravity and MOI of objects
	Moment of inertia and product of inertia	
	Polar moment of inertia and related problems	
	Principal moment of inertia	
	Sample problems for practice	
4.	Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables	Use the principle of Kinematics and kinetics of particles to the analysis of simple, practical problems.
	Central force motion	

Text Books:

1. Vector Mechanics for Engineers: Statics and Dynamics, 12th Edition By Ferdinand Beer and E. Johnston and David Mazurek and Phillip Cornwell and Brian Self.
2. Engineering mechanics. Volume 1, Statics : SI version, James L Meriam; L Glenn Kraige; Jeff N Bolton.
3. Engineering mechanics: statics and dynamics, Author:R C Hibbeler, Publisher:Upper Saddle River, NJ : Pearson Prentice Hall, ©2010.

References:

1. Engineering mechanics. Dynamics, Author:Irving Herman Shames; Ian Cole Publisher:Prentice Hall International, ©1998.

Introduction to Materials						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1104	Introduction to Materials	3	0	0	3

Objectives:

To familiarize the students with fundamentals of materials science such as crystallography, principles of alloy formation, plastic deformation, mechanical properties, various types of heat treatment processes, isothermal transformation and continuous cooling transformation diagrams. Further to introduce Ceramic, Composite and Polymeric Materials.

Learning Outcomes:

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

1. LO1: Understand classification of materials and crystal structures.
2. LO2: Understand imperfections and defects and mechanical properties of materials.
3. LO3: Understand phase rule and phase diagrams of engineering materials.
4. LO4: Understand various types of ceramics and composite.
5. LO5: Understand different types of polymers, characterization techniques.

S.No	Topics to be Covered	Learning Outcome
1.	Introduction, Classifications of materials, Atomic Structure & Interatomic Bonding, The Structure of Crystalline Solids, Imperfections (Defects) in Solids.	L01
2.	Mechanical Properties of Metals, Dislocations & Strengthening Mechanisms, Failure.	L02
3.	Phase Diagrams, Development of Microstructure and Control of Mechanical Properties in Metals, Applications of Metal Alloys.	L03
4.	Structures and Properties of Ceramics and Applications.	L04
5.	Polymer Structures, Characteristics, Applications of Polymers and Composites.	L05

Text Books:

1. W. D. Callister, Jr: Materials Science and Engineering- An Introduction, John Wiley and Sons, N.Y,
2. Callister W D, Materials Science and Engineering, 2nd Edition, Wiley India (P) Ltd. (2014).

References:

1. J. F. Shackelford: Introduction to Materials Science for Engineers, Mc-Millan Publishing Co., N.Y. 1992
2. Askeland D R, The Science and Engineering of Materials, 5th Edition, Thomson (2005).
3. Avner S H, Introduction to Physical Metallurgy, 2nd Edition, McGraw Hill Education (2017).
4. Kodgire V D, Material Science and Metallurgy for Engineers, 31st Edition, Everest Publishing House (2011).
5. Raghavan V, Materials Science and engineering - A first Course, 6th Edition, Prentice Hall India Learning (P) Ltd. (2015).

Engineering Graphics						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1105	Engineering Graphics	1	0	3	3

Objectives:

1. Enables students to learn the concepts of drawing as graphic communication, their role in engineering design.
2. Make familiar with different drawing equipment, technical standards, and procedures for the construction of different views.
3. Equipped with the skill that enables them to convert pictorial to orthogonal representations.
4. To enable the student to learn about computer graphics using solid-works tool.

Learning Outcomes:

Upon successful completion of this course student should be able to:

1. Use EG as a tool of communication between engineers.
2. To represent design data as per the BIS standards.
3. To visualize and represent the object in orthographic and isometric view.
4. To draw various engineering application devices using computer graphics techniques.

S.No	Topics to be Covered	Learning Outcome
1.	Engineering Drawing Introduction	Students will get to know about the uses of drawing and its importance.
2.	Projection of point	Students will get to know about the orthographic projection of points, lines, planes, and solids
3.	projection of line	
4.	Projection of planes	
5.	Projection of solid	
6.	Engineering Curve	Students will get to know about various profile generation
7.	Introduction to solid works	Students will get to know about modelling using solid works.
8.	Section of Solids	Students will get to know about generation of solids and its sections
9.	Isometric projection	Students will get to know about various views such as isometric, diametric and trimetric.
10.	EStudents will get to know about various views such as isometric, diametric and trimetric.	Students will get to draw various engineering application devices using computer graphics technique

Text Books:

1. Bhatt, N.D., Engineering Drawing,

References:

1. Shah, M.B. and Rana, B.C., 2009. Engineering Drawing. Pearson Education India.

English for Communication						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1106	English for Communication	1	0	2	2

Objectives:

1. This course has been designed to provide a foundation in effective communication in English.
2. The focus of the course is to improve the language proficiency of the students by emphasizing on the LSRW (Listening, Speaking, Reading, and Writing) skills.

Learning Outcomes:

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

1. Use the English Language effectively in spoken and written forms.
2. Comprehend the given texts and respond appropriately.
3. Communicate confidently in formal and informal contexts.

S.No	Topics to be Covered	Learning Outcome
1.	**English Grammar** A Revisiting Articles; Prepositions Modal verbs; Subject-verb agreement; Tense; Types of sentences Phrases and Clauses. **Exercises** On articles, prepositions (fill in the blanks) Correction of sentences (error analysis) Joining of sentences & Parsing of sentences On modal verbs.	To help students to refresh and revise the grammar
2.	**Importance of vocabulary building & Lexical aspects** Word- Form- Meaning Synonyms & Antonyms Word formation Idioms and phrases/ Phrasal verbs Collocations Words as metaphors and images. **Exercises:** Exercises on word formation & Word games: Hangman; building words with cards; memory game, etc. Reading of Maya Angelou's **"Caged Bird"** Robert Frost's **"After Apple-picking"**.	To help students to refresh and revise the grammar
3.	**Pronunciation/ Phonetics** Articulation of sounds (consonants & vowels) Syllable and consonant cluster Stress and Intonation Indian English pronunciation Received Pronunciation. **Exercises:** practice sessions on pronunciation (fricatives) Reading of Charles Dickens's Oliver Twist (Chapter 2: **Please Sir, I want more. . .)**; Julian Barnes's The Sense of an Ending (**Introduction**); Emma Donoghue's **"The Tale of the Rose"**.	To help the students to improve their pronunciation

4.	**Developing Listening Skills** Types of listening: active, passive, interpretive & critical Role of listening in communication. **Exercises:** Martin Luther King, Jr.'s I have a Dream... & Michelle Obama's New Hampshire Speech on Women Empowerment Snippets from movie: Troy (to re-narrate the Greek myth) &Games like Chinese whisper etc.	To develop students' listening comprehension skills
5.	**Reading Comprehension (literary texts)** Types of reading: close reading, reading between the lines, skimming & scanning Summarising & paraphrasing analysis and interpretation textual reading contextual reading (underpinning ideas on history/politics/economic condition/ knowledge/power structure etc. **Exercises:** Reading of short stories: - Ruskin Bond's **'Time Stops at Shamli'** - Mahasweta Devi's **Bitter Soil & Imaginary Maps** William Somerset Maugham's **"The Luncheon"**.	To develop students' reading comprehension of literary texts
6.	**Reading non-literary texts** Difference between scientific and literary discourses Objective vs. subjective; Fact vs fiction Brevity in expression& Linearity in discourse. **Exercises:** Cuttings from The Hindu's Science and Technology section Samples from science textbooks and journals.	To develop students' reading comprehension of non -literary and general texts
7.	**Oral Communication** Communication, the two way process Channels of communication Importance of listening in verbal discourses Importance of intonation in verbal discourses Sensitivity/ Aptness of words in articulating one's thought; Barriers to Communication. **Exercises:** On oral communication in the form of role plays; situational conversations for negotiation, persuasion, assertion etc. Making a Sales Presentation.	To develop students' speaking skills
8.	**Oral Presentation** India and the World with Shashi Tharoor, Conversations with History (youtube uploaded by univ of California, 2015). **Exercises:** Individual/ team presentations, impromptu presentations, chalk - talks, etc.	To develop students' oral presentation skills
9.	**Group Discussions** The Argumentation and Debate Process Body language. **Exercises:** GDs/ reporting of group activities.	To develop students' discussion skills
10.	**Developing Writing Skills** Different elements of the writing process (pre - writing, drafting, revising and editing) Types of writing (expository, descriptive & persuasive) Preparing an outline Sentence structure/ clusters, coherence & Sense of paragraph Use of Linking devices; grammatical device. **Exercises:** On paragraph writing Preparing an outline Summarizing a text Paraphrasing a text **Assignments:** letter Writing & Writing SoPs.	To develop students' Written Communication skills

11.	**Punctuation** Capitalization; apostrophe; colon; semi-colon; comma; hyphen; parentheses; Dash; Ellipses; quotation marks & inverted commas. **Exercises:** Short passages to punctuate Quizzes.	To help students develop their skills to use punctuation marks effectively
12.	**Rhetorical Functions in Academic Writing** Intro: For whom one is writing and the purpose for which one is writing to Argue, Inform, Persuade, Explain, Convince etc. Laboratory Reports, Book Reviews, Research Proposals, etc. Description; reporting; narration; comparison & contrast; explanation. **Exercises:** On description, reporting, narration, comparison and contrast, explanation Assignments: to prepare and present oral and visual laboratory reports.	To develop students' academic writing skills
13.	**Writing & Rhetoric** Writing about sports; food; fashion; film (in the form of review). **Exercises:** Related exercises on Writing: sports/ food/ fashion/ film review.	To develop students' writing skills for different purposes

Suggested reading:

1. Bailey, Stephen. Academic Writing: A Handbook for International Students. Routledge. 2011.
2. Doron, L. & Soffos,C. Teaching for Deep Comprehension. Portland, 2005.
3. Frey, N. & Fisher, D. Rigorous Reading: Five Access Points for Comprehending Complex Texts. Thousand Oaks, CA: Corwin. 2013.
4. Garner, Bryan A. Modern English Usage. OUP, 2016.
5. Gerson S J & Gerson S M (2002). Technical Writing, 3/e Pearson Education Asia.
6. Green, David. Contemporary English Grammar–Structures and Composition. MacMillan India. 2014.
7. Huckin T. N. & Olesan. Technical Writing and Professional Communication, McGraw-Hill, Inc.
8. Kortepeter, Paul. Writing & Rhetoric Series
9. Laminack, L. & Wadsworth, R. Learning under the influence of Language and Literature: Making the Most of Read-alouds Across the Day. Portsmouth, NH: Heinemann. 2006.
10. Lebauer, R. S. Learn to listen, listen to learn: Academic listening and note-taking. (2nd edn.). White Plains: NY: Pearson Education. 2000.
11. Lewis, Norman. Word Power Made Easy. Penguin India. 2015 (Print)
12. Pease, Allen & Barbara Pease. The Definitive Book of Body Language. Read Books, 2004.
13. Rost, M. Introducing Listening. London: Penguin books. 1994.
14. Solomon, Philip Sunil. Word Power: Vocabulary Builder. Oxford University Press. 2017 (Print)
15. Trimble, Louis. English for Science and Technology: A Discourse Approach. CUP. 1985.

Electrical Technology						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1107	Electrical Technology	2	0	0	2

Objectives:

1. To develop knowledge on electrical circuits analysis methods, understanding/calculation of various parameters in single phase and three phases alternating current (AC) circuits/distribution network.

Learning Outcomes:

1. Analysis of Direct Current (DC) circuits, Alternating Current circuits (both Single phase and Three phase) under steady state and calculate various parameters (like voltage, current, power etc).

S.No	Topics to be Covered	Learning Outcome
1.	**Electrical Technology** • DC Networks: Ohms Law, Voltage and Current Laws, Nodal and Mesh analysis Kirchhoff's laws, node voltage and mesh current methods, Superposition principle, Thevenin's, Norton's theorems. • Single phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, solution of R, L, C series circuits, the j operator, complex representation of impedances, phasor diagram, power factor, power in complex notation, solution of parallel and series – parallel circuits. • Three phase AC Circuits: Three phase EMF generation, delta and Y – connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits.	The student will be able to, analyze the properties such as continuity, differentiability, maxima, minima, polynomial approximation, the convergence of sequence and series, and integration of single-variable functions.

Text Books:

1. "Engineering Circuit Analysis" by William H. Hayt, Jack E. Kemmerly.
2. "Electronic Circuits, Analysis and Design" by Donald A. Neamen.

References:

1. "Electronic Devices and Circuits; An Introduction" by Allen Mottershead (Goodyear Publishing).
2. "Fundamentals of Electric Circuits" by Charles K. Alexander and Matthew N. O. Sadiku.
3. "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky.
4. "Digital Logic and Computer Design" by Morris Mano.

Basic Electronics						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1108	Basic Electronics	2	0	0	2

Objectives:

1. To develop knowledge on basic Operational amplifier circuits, semiconductor devices, digital logic gates and their application aspects in some electronic circuits.

Learning Outcomes:

1. Understanding operation/functioning of basic electronic devices (diode, bipolar junction transistor, operational amplifier) and their application in some electronic circuits.
2. Knowledge on Boolean function implementation using logic gates and their application in digital logic circuits.

S.No	Topics to be Covered	Learning Outcome
1.	**Basic Electronics** • Operational amplifier: Differential mode of operation, common mode rejection, typical op-amp specifications, inverting amplifier, non-inverting amplifier, integrator, differentiator, summing amplifier etc., concept of active filters; • Semiconductor devices: Diode, half wave and full wave rectification, filtering, regulation with zener diode, BJT, structure and principle of operation; Small-Signal Model of BJT and BJT Amplifier. • Digital electronics: Review of Boolean algebra and signed number representation schemes in binary, implementation of Boolean functions using various logic gates, concept of combinatorial and sequential circuits, registers and counters from functional viewpoint.	Understanding operation/functioning of basic electronic devices (diode, bipolar junction transistor, operational amplifier) and their application in some electronic circuits. Knowledge on Boolean function implementation using logic gates and their application in digital logic circuits.

Text Books:

1. "Engineering Circuit Analysis" by William H. Hayt, Jack E. Kemmerly.
2. "Electronic Circuits, Analysis and Design" by Donald A. Neamen.

References:

1. "Electronic Devices and Circuits; An Introduction" by Allen Mottershead (Goodyear Publishing).
2. "Fundamentals of Electric Circuits" by Charles K. Alexander and Matthew N. O. Sadiku.
3. "Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky.
4. "Digital Logic and Computer Design" by Morris Mano.

Chemistry Lab						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1109	Chemistry Lab	0	0	3	3

Objectives:

1. This course is designed to provide the foundation on the lab experience of Physical Chemistry concepts.

Learning Outcomes:

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

1. Experience in measuring several physical quantities.
2. Learn how conductivity measurements help in the determination of the end-points of titrations.
3. Measure various kinetic parameters of the chemical reactions.
4. Perform volumetric titrations for quantitative analysis.

S.No	Topics to be Covered	Learning Outcome
1.	Measurement of surface tension, CMC of a surfactant	Surface tension measurement with stalagmometer
2.	Molecular weight of a polymer by viscometric method	Viscosity measurement with Ostwald viscometer
3.	Conductometric titration	Strength of an acid can be determined using conductometer
4.	pH-metric titration	Determination of strength/pKa of a weak acid
5.	Acid-Base Volumetric titration	Determination of strength of a given acid.
6.	Redox titration	Determination of amount of Fe(II) in Mohr's salt.
7.	Determination of vander-Waals gas constant by using the P-V data.	Plotting using Excel package.
8.	Kinetics of Ester hydrolysis	Determination of rate constant.
9.	Phase diagram of a Binary system (Phenol-water)	Determination of critical solution temperature from phase diagram
10.	Determination of heat of a solution	Application of the concepts of specific heat and temperature change in the determination of heat of solution of a water-soluble salt
11.	Determination of concentration and molar extinction coefficient using UV-Visible spectroscopy	Handling of UV-Visible spectroscopy, validation of Lambert Beer's Law.
12.	Identification of functional groups of a given polymer by FTIR spectroscopy	Handling of FTIR spectroscopy and characteristic vibrational frequency identification

Text Books:

1. Advanced Physical Chemistry Experiments by Dr. J. N. Gurtu and Amit Gurtu
2. Laboratory manual for instructions.

2^{nd} Semester

Engineering Mathematics - II						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1201	Engineering Mathematics – II	3	1	0	4

Objectives:

1. To introduce the fundamental concepts such as vector spaces, subspaces, basis, linear transformations and their matrix representation of linear algebra. To study various methods to find the solution of a system of equations and the consistency conditions of it. To study the conditions for a square matrix to be similar to a diagonal matrix.
2. To expose students to understand the ordinary differential equations and their solvability in a variety of applications, behavior of complex valued functions and its singularities.

Learning Outcomes:

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

1. Generate the new vector spaces from existing ones and find the basis for a vector space.
2. Understand the relationship between linear transformations and matrices.
3. Solve the linear system of equations by using various methods and understand their consistency conditions.
4. Understanding the variety of techniques to solve the ordinary differential equations arises in engineering applications.
5. Analyze the properties like continuity, differentiability and analyticity of complex functions. Evaluate the complex integrals, analytic functions and to classify the singularities of complex-valued functions.

S.No	Topics to be Covered	Learning Outcome
1.	**Linear Algebra:** Algebra of matrices, Vector spaces, subspaces, linear dependence of vectors, basis and dimensions, linear transforms, matrix representation of a linear transform, rank-nullity theorem, rank and inverse of a matrix, solution of algebraic equations-consistency conditions, Gaussian elimination and Gauss-Jordon methods, Hermitian, skew Hermitian and unitary matrices, eigenvalues and eigenvectors, Cayley-Hamilton theorem, diagonalizability, bilinear forms.	The student will be able to: Understand the relationship between linear transformations and matrices. Generate the new vector spaces from existing ones and find the basis for a vector space. Solve the linear system of equations by using various methods and understand their consistent conditions.

2.	**Differential equations:** First order differential equations: Exact Equations, integrating factors, Reducible to exact differential equations, linear and Bernoulli's form, Orthogonal trajectories, Lipschitz condition, Picard's theorem, Examples of non-uniqueness. Homogeneous and non-homogeneous second order ODE's with constant coefficients, Characteristic equation, Linear dependence and Independence, Existence of solutions, Wronskian, method of variation of parameters, general linear differential equations with constant coefficients, Method of undetermined coefficients, Cauchy-Euler equations, System of differential equations.	The student will be able to, understanding the variety of techniques to solve the ordinary differential equations arises in engineering applications.
3.	**Complex Variables:** Limit, continuity, differentiability and analyticity of functions, Cauchy-Riemann equations, line integrals in complex plane, Cauchy's integral theorem, independence of path, existence of indefinite integral, Cauchy's integral formula, derivatives of analytic functions, Taylor s series, Laurent s series, Zeros and singularities, Residue theorem, evaluation of real integrals.	The student will be able to: Analyze the properties like continuity, differentiability, and analyticity of complex functions. Evaluate the complex integrals, analytic functions, and to classify the singularities of complex valued functions.

Text Books:

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson publisher
2. E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).
3. S.L. Ross, Differential Equations, Third Edition, Wiley-India (2004).
4. R. V. Churchill, J. W. Brown, Complex Variables and Applications, Mc-GrawHill, (1990).

References:

1. G. Strang, Linear Algebra and its applications.
2. S. Ponnusamy, H. Silverman, Complex Variables with Applications, Birkhauser, (2006).

Strength of Materials						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1202	Strength of Materials	3	1	0	4

Objectives:

1. To understand fundamental concepts of stress and strain under various types of loading conditions.
2. To understand various concepts tension, compression, shear, bending and torsion.
3. To learn about location of maximum stress and strain under loading and calculate shear force, bending moment and deflection of beams.

Learning Outcomes:

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

1. Understand concept of stress and strain.
2. Predict deformation under axial loading, compressive loading, bending, shear and torsion Understand and solve statically determinate and indeterminate problems on members subjected to torsion.
3. Understand the concept of principal stresses and Mohr's circle, stress estimation in pressure vessels.
4. Understand the failure loads for columns for various end conditions

S.No	Topics to be Covered	Learning Outcome
1.	External vs. Internal loadings, Axial loading vs. transverse loading – Theory + Problems Normal stress and Shear Stress– Theory + Problems Bearing stress – Theory + Problems Stresses in axially loaded members– Theory + Problems Normal strain, Hooke's law Stress-strain diagram and strain energy concept Poisson's ratio– Theory + Problems Generalized Hooke's law– Theory + Problems Homogeneous and Composite members under axial loading– Theory + Problems	Students will get to know the concept of stress and strain
2.	Shear stress, strain and angle of twist concept in solid and hollow circular shaft subjected to torque– Theory + Problems	Learn to predict deformation under axial loading, compressive loading, bending, shear and torsion Understand and solve statically determinate and indeterminate problems on members subjected to torsion.
	Shear stress, strain and angle of twist concept in circular composite shaft subjected to torque – Theory + Problems	
	Shear stress, strain and angle of twist in both ends fixed circular shaft subjected to torque – Theory + Problems	
	Shear stress, strain and angle of twist geared circular shaft subjected to torque – Theory + Problems	

3.	Concept of bending, neutral axis, pure flexural stress derivation, radius of curvature estimation	Students will learn to draw shear force and bending moment diagram for beams
	Stresses in homogeneous beam subjected to pure bending – Theory + Problems	
	Stresses in composite beam subjected to pure bending– Theory + Problems	
	Concept of shear force, Bending moment and shear force diagram for beams subjected to various loads– Theory + Problems	
4.	General state of stress	Understand the concept of principal stresses and Mohr's circle, stress estimation in pressure vessels
	Stress estimation in members subjected to eccentric loading (axial + bending) – Theory + Problems	
	Stress estimation in members subjected to loading (axial + torsion) – Theory + Problems	
	Stress estimation in members subjected to loading (axial + torsion + bending) – Theory + Problems	
5.	Principal stress and strain	
	Estimation of principal stress, maximum shear stress from Mohr's circle– Theory + Problems	
	Stresses in pressure vessels – cylindrical and spherical – Theory + Problems	
6.	Buckling of slender column – Theory + Problems	Understand the failure loads for columns for various end conditions
	Euler's buckling load for different end conditions – Theory + Problems	

Text Books:

1. Mechanics of Materials by Beer Johnson et al. McGraw-Hill Education; 7th edition.

References:

1. Elements of Strength of Material by Timoshenko and Young (East West Press).
2. Mechanics of Materials by R.C. Hibbler. Pearson; 10th edition (5 January 2016).

Physics						
Course Type	Course Code	Name of Course	L	T	P	Credit
	IC1203	Physics	3	1	0	4

Objectives:

1. This course is prepared to understand the basic principles and fundamentals of Physics for macroscopic, microscopic, and systems of particles.
2. The 1st part of the course is devoted to the understanding of different systems, coordinates, and reference frames.
3. The second part of the syllabus is devoted to thermal physics based on the connection of microscopic motion to macroscopic observation and basic concepts of heat transfer.
4. The concept of electromagnetic waves -particle duality and electromagnetic theory forms the basis for conceptualizing the signal communication techniques and also forms the basis of electric signal theory.

Learning Outcomes:

1. This course is designed in such a way that the students learn the fundamentals of Classical Physics, which will build the base for the study of Engineering and Technology. Upon completion of this course, the students will be able to have a basic understanding of the motion of a system of particles, the statistical behavior of molecules, and their correlation with gross properties such as temperature, heat conduction, and convections, Radiation.
2. The course will also help students in understanding wave motion, and the propagation characteristics of electromagnetic waves in a vacuum as well as in materials systems.

S.No	Topics to be Covered	Learning Outcome
1.	Co-ordinate systems, plane polar, cylindrical and spherical polar coordinate systems, frame of reference, rotational frame, Coriolis forces. The motion of a system of particles, Conservation laws, Constraints and degrees of freedom, Generalized coordinates, Lagrange's and Hamilton's formulations.	
2.	Concepts of distribution of molecular velocities; distribution laws and statistics-MB, FD and BE; mean free path; Transport phenomena – viscosity, diffusion; thermal conductivity, measurement of thermal conductivity; the periodic and aperiodic flow of heat, Wiedemann-Franz law. Heat radiation, black body and black body radiation, Planck's distribution law and its application to classical distribution (Rayleigh-Jeans and Wiens) and total radiation (Stefan-Boltzmann) laws, Basic concept of conduction, and convection.	

3.	Overview of vibrations with emphasis on damped and forced oscillations, resonance, coupled oscillations, and normal modes. Wave Motion: longitudinal and transverse waves, wave equation, plane waves, phase velocity, superposition wave packets and group velocity, two and three-dimensional waves, polarization. Electromagnetic Waves: Maxwell's equations, wave equation, plane electromagnetic waves, energy-momentum, Poynting's theorem, electromagnetic boundary conditions, reflection and refraction, interference, Young's experiment, interferometers, diffraction, Fraunhofer diffraction (single slit), dispersion, radiation. Wave Mechanics: failure of classical physics, qualitative review of relevant experiments, de Broglie waves, uncertainty principle, wave function and Schrodinger equation.	

Text Books:

1. Classical Mechanics, H Goldstein, Reading Mass Adison-Wesley Press, Inc.
2. Physics for Scientists and Engineers Raymond A. Serway and John W. Jewett.
3. Concepts of Modern Physics, A. Beiser .
4. Introduction to Electrodynamics, Griffiths D.J. (2012) PHI Learning Pvt. Ltd. 4.2

References:

1. An Introduction to Mechanics, D. Kleppner and R. J. Kolenkow, Tata McGraw-Hill.
2. Classical Dynamics, D T Greenwood, Prentice Hall of India, Pvt. Ltd., New Delhi.
3. Physics: Principles with Applications Douglas C. Giancoli .
4. Introduction to special relativity, Robert Resnick.
5. Introduction to Electricity & Magnetism Liao, Dourmashkin, and Belcher.
6. Introduction to Electromagnetics, Griffith D.J. PHI Learning, 4th edition.

Programming and Data Structure						
Course Type	Course Code	Name of Course	L	T	P	Credit
	IC1204	Programming and Data Structure	3	0	3	5

Objectives:

Introduce students to digital computers, basics of programming, different constructs in C-programming language. Introduce fundamental data structures: arrays, linked list, stack, queue, trees and graphs and standard algorithms (Sorting and Searching).

Learning Outcomes:

At the end of the course, the student will be able to improve his/her problem-solving skills and will be able to use: C-Programming constructs, standard data structures, and sorting and searching algorithms.

S.No	Topics to be Covered	Learning Outcome
1.	Introduction to digital computers; Introduction to programming variables, assignments; expressions; input/output; Conditionals and branching; Iteration; Functions; Recursion; Arrays.	Able to use the basic C-constructs like conditional statements, loops, functions, and arrays.
2.	Introduction to pointers; Character strings; Structures; Introduction to data-procedure encapsulation; Dynamic allocation.	Able to use advanced C-constructs like Structures, pointers, dynamic allocation
3.	Time and space requirements; Searching and sorting algorithms.	Able to understand search and sorting methods and their complexity
4.	Introduction to data structures Linked structures. stacks and queues, Trees and Graphs.	Able to select and use right data structures for a given problem.

Text Books:

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (MIT Press).
2. The C Programming Language, Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall of India.

References:

1. Schaum's Outline of Programming with C, Byron Gottfried, Tata McGraw-Hill.
2. Data Structures, Schaum's Outline Series, Seymour Lipschutz, Tata McGraw-Hill.
3. Fundamentals of Data Strcutures in C , Ellis Horowitz, Satraj Sahni and Susan Anderson-Freed, W. H. Freemn and Company.
4. Classic Data Structures, Debasis. Samanta, Prentice Hall of India.

Earth Energy and Environment						
Course Type	Course Code	Name of Course	L	T	P	Credit
	IC1205	Earth Energy and Environment	2	0	0	2

Objectives:

1. This course aims to train students to understand environmental issues, policies and regulations.
2. It imparts understanding on the linkages between the human-environment-economy.

Learning Outcomes:

1. Students will understand the major environmental problems and it will create awareness on their role as an individual.
2. Students will understand the role of conservation of natural resources and biodiversity to achieve sustainable development.

S.No	Topics to be Covered	Learning Outcome
Unit 1.	• Introduction • Geological Timescale and Geological Processes • Global Environmental crisis • UN conferences on Environment and Sustainable Development • Sustainable Development Goals	• Students will be acquainted with the Environmental crisis and the importance of its management. • Sustainable energy goals will be introduced.
Unit 2.	• Ecosystems: Basic concepts • Cycles in Ecosystem • Changes in various Ecosystems • Renewable natural resources • Non-renewable natural resources	• Anthropogenic and natural changes in ecosystem, non-renewable and natural resources will be discussed.
Unit 3.	• Greenhouse gases and climate change • Species extinction • Human population growth and resource usage. • Water and Soil Pollution • Air pollution • Solid Waste Management	• The role of various pollutants and greenhouse gases in breaking down the ecological harmony will be discussed.

Unit 4.	• Environmental Policies • UNFCC, Kyoto Protocol and Paris Agreement • Human-environment relationship • DPSIR model • Biodiversity • Biodiversity conservation • MINAS Standards • Changes in fuel quality specification	• The relationship of human-environment, the importance of biodiversity conservation will be discussed.

Text Books:

1. Environmental Studies: From Crisis to Cure, R. Rajagopalan, OUP India, 3rd Edition.
2. Textbook of Environmental Studies for Undergraduate Courses of all branches of higher education By Erach Bharucha.

References:

1. Environmental Science: A Study of Interrelationships, 12th Edition, Eldon D. Enger and Bradley F. Smith, McGraw-Hill.

Fundamentals of Biological Systems						
Course Type	Course Code	Name of Course	L	T	P	Credit
	IC1206	Fundamentals of Biological Systems	2	0	0	2

Objectives:

1. This course aims to provide thorough understanding of the basic concepts in biochemistry, cell and molecular biology.
2. It imparts understanding of the structure and functional roles of biological macromolecules.

Learning Outcomes:

1. Students will understand how the biological processes are interconnected and regulated.
2. It will introduce all the fundamentals and prepare students for advanced courses in biology.

S.No	Topics to be Covered	Learning Outcome
1.	• Introduction • Prokaryotic cell • Eukaryotic cell • Cell cycle and Division • Cellular Respiration and ATP synthesis • Photosynthesis	• Students will gain knowledge on the basic fundamentals of cell biology and different biochemical processes.
2.	• Proteins: structure and sequencing • Enzymes: mechanism, kinetics and inhibition • DNA: structure • DNA: replication and recombination • RNA synthesis • Genetic code and protein biosynthesis • Recombinant DNA technology	• Students will gain knowledge on the important macromolecules, their structure and synthesis

3.	• Noncovalent interactions • Free energy changes in biological processes • Transport Phenomena in biological systems • Blood Rheology • Fluid mechanical aspects of some diseases and organs • Bio-Micro devices • Crop management and Disease control • Biological Hazards and safety • Unsolved Problems in Biology	• Students will be familiarized to the mechanistic insights of biological processes. • Students can understand Implication Biosafety & Ethical protocols in biology.

Text Books:

1. Lehninger Principles of Biochemistry, David L. Nelson and Michael Cox, WH Freeman publishers.
2. Molecular Cell Biology by Lodish et al., WH Freeman publishers.

References:

1. Biochemistry by Donald Voet & Judith Voet, John Wiley & Sons.

Electrical and Electronics Lab						
Course Type	Course Code	Name of Course	L	T	P	Credit
	IC1207	Electrical and Electronics Lab	0	0	3	2

Objectives:

1. To familiarize on operation or function of various electrical and electronic measuring instruments or meters (voltmeter, ammeter, wattmeter, CSO, multimeter, Function generator etc).
2. Aims to develop the experimental setup for verifying/understanding the theoretical concepts related to some electrical and electronics circuits or theorems in the laboratory.

Learning Outcomes:

1. Knowledge of the functioning or uses of various electrical and electronics measuring instruments (volt meter, ammeter, wattmeter, CSO, multimeter, Function generator etc) and ability to connect them in the circuit for measuring various parameters.
2. Ability to build the laboratory experimental setup consisting of electrical source, measuring instruments, load as per the theoretical concept or schematic diagram and verifying the same in laboratory.

S.No	Topics to be Covered	Learning Outcome
1.	Verification of Kirchhoff's Laws	1. Knowledge on the functioning or uses of various electrical and electronics measuring instruments (volt meter, ammeter, wattmeter, CSO, multimeter, Function generator etc) and ability to connect them in the circuit for measuring various parameters. 2. Ability to build the laboratory experimental setup consisting of electrical source, measuring instruments, load as per the theoretical concept or schematic diagram and verifying the same in laboratory.
2.	Verification of Ohm's Law and Measurement of Filament Lamp Resistance	
3.	Verification of Superposition Theorem	
4.	To measure the single phase power by using three voltmeter method.	
5.	Measurement of Power in 3-ϕ Circuit by Two Wattmeter Method	
6.	Familiarization with electronic components, Oscilloscope, Signal Generator and usage of Multimeters	
7.	Frequency response and Square wave testing of R-C, and C-R Networks.	
8.	Voltage Rectifiers-Half Wave, Full Wave Rectifier with and without Filters.	
9.	Characteristics of P-N Diode and Bipolar Junction Transistor.	
10.	Studies on Logic Gates-Verification of Logic Gates, Adders and Flip-flops.	

Text Books:

1. "Engineering Circuit Analysis" by William H. Hayt, Jack E. Kemmerly.
2. "Electronic Circuits, Analysis and Design" by Donald A. Neamen.

References:

1. "Electronic Devices and Circuits; An Introduction" by Allen Mottershead (Goodyear Publishing).
2. "Fundamentals of Electric Circuits" by Charles K. Alexander and Matthew N. O. Sadiku.

3. “Electronic Devices and Circuit Theory” by Robert L. Boylestad and Louis Nashelsky.

4. “Digital Logic and Computer Design” by Morris Mano.

Workshop						
Course Type	Course Code	Name of Course	L	T	P	Credit
Core	IC1208	Workshop	0	0	3	2

Objectives:

1. To study the basics of workshop engineering practice
2. To identify the hand tools and instruments and acquire measuring skills.
3. To acquire practical skills by performing the experiments in different shops of workshop.

Learning Outcomes:

1. The student will be able to use different manufacturing (machining, welding, foundry, sheet-metal working, etc) processes required to manufacture a product from the raw materials.
2. Learn to use different measuring, marking, cutting tools used in workshop.
3. Get to know about various safety precautions while working in workshop.

S.No	Topics to be Covered	Learning Outcome
1.	Safety Precautions in workshop Welding Shop 1. To study about various welding processes and the tools and equipment's use in welding shop. 2. To prepare a joint (lap butt T) using gas welding.	Students will get to know about various safety precautions while working in workshop. Students will learn about welding methodology and metal joining processing by using welding.
2.	**Foundry Shop** 1. To study about tools and equipments use in foundry shop and how to make a mould. 2. To prepare an aluminium sand casting using the mould prepared by the students.	Students will get to know about mould making and foundry process.
3.	**Machine Shop** 1. To study about various machine tools (lathe, milling, shaper, drilling, grinding and EDM drill) available in machine shop. 2. To study about various machining process performed on lathe machine tool in detail and to study the cutting tools used for various machining processes in lathe. 3. To perform facing, step turning, taper turning and knurling on a given work-piece material.	Students will get to know about using various machine such as Lathe, milling, grinding. In lathe machine they will perform various turning operations.
4.	**To study about the carpentry, fitting and sheet-metal shop.** 1. To study about the job holding devices, machine tools 2. To study about the measuring, marking, cutting and plain tools	Learn to use different measuring, marking, cutting tools used in workshop.

Text Books:

1. Hajra S. K. and Chaudhary, Workshop Technology I & II, Khanna Publisher.
2. Raghuvansi B. S., Workshop Technology I & II.

References:

1. Chapman W. A. J., Workshop Technology Vol. 1, 2, 3 & 4, Butterworth-Heinemann.
2. Gupta I. C., Engineering Metrology, Dhanpat Rai & Sons.
3. Beckwith Thomas G., Mechanical Measurements, Narosa Publishing House.
4. Gupta K. M., Material Science and Engineering, Umesh Publication.
5. Callister W. D., Material Science & Engineering, John Wiley & Sons.