B.Tech in
Chemical Engineering

Faculty of Engineering

AMRITA
VISHWA VIDYAPEETHAM

Revised in June 2015
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Vision of the Institute

To be a global leader in the delivery of engineering education, transforming individuals to become creative, innovative, and socially responsible contributors in their professions.

Mission of the Institute:

1. To provide best-in-class infrastructure and resources to achieve excellence in technical education,

2. To promote knowledge development in thematic research areas that have a positive impact on society, both nationally and globally,

3. To design and maintain the highest quality education through active engagement with all stakeholders – students, faculty, industry, alumni and reputed academic institutions,

4. To contribute to the quality enhancement of the local and global education ecosystem,

5. To promote a culture of collaboration that allows creativity, innovation, and entrepreneurship to flourish, and

6. To practice and promote high standards of professional ethics, transparency, and accountability.
Vision of the Department

To be recognized nationally and internationally for excellence in teaching and research in chemical engineering & materials science, integrated with, and practicing, social responsibility and value systems.

Mission of the Department

The department strives for a passionate and committed drive towards continuous improvement in

- the delivery, standards, and currency of education,
- administration efficiency,
- socially beneficial scientific research to create new processes, products, methods, materials, or systems that impact and are beneficial to society, and
- Meeting and exceeding the needs of the stakeholders and Amrita Vishwa Vidyapeetham.

Program Educational Objectives (PEOs)

To produce graduates in chemical engineering, who, immediately after graduation or within five years of it:

- can apply the knowledge for engineering practice, research, and management in the chemical and allied industries such as bulk chemicals, specialty chemicals, petroleum & petrochemicals, energy, advanced materials, microelectronics, healthcare, biotechnology, consumer products, and other industries, while adhering to values in the context of ethical, health, environmental, social, safety and economic issues,
• can make worthy progress towards the acquisition of advanced degrees, are motivated to pursue additional training and certifications, and use their knowledge and skills to participate in the activities of local/national/international professional societies,
• have good written and oral communication skills, and communicate their ideas and knowledge via scholarly articles, patents, delivery of effective presentations, and/or training of co-workers and associates,
• strive for continuous self-development and life-long learning, and engage in their daily work with awareness of the global or social implications.

Program Specific Outcomes (PSOs)

The undergraduate chemical engineering graduates will be able to:

• obtain, apply, and demonstrate knowledge of core concepts and principles associated with chemical engineering unit operations and unit processes, along with the associated ethics, economics, safety, and sustainability aspects required to work in manufacturing, service, and R&D sectors,
• formulate chemical engineering problems, and then apply computational and simulation tools to solve them for effective, efficient, and sustainable design, operation, and optimization of chemical processes, while being socially and environmentally responsible, and
• plan, design and conduct scientific experiments, analyse the data, apply critical thinking to make valid inferences, and prepare technical and scholarly reports that include management and economics.
**Program Outcomes (POs)**

The Program Outcomes are defined by National Board of Accreditation. Engineering graduates will be able to:

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

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

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

- **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

- **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

- **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

- **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

- **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

- **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
• **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

• **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

• **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
**Evaluation Pattern**

### 50:50 (Internal: External) (All Theory Courses)

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### 80:20 (Internal: External) (Lab courses and Lab based Courses having 1 Theory hour)

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### 70:30 (Internal: External) (Lab based courses having 2 Theory hours/ Theory and Tutorial)

**Theory- 60 Marks; Lab- 40 Marks**

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65:35 (Internal: External) (Lab based courses having 3 Theory hours/ Theory and Tutorial)

Theory- 70 Marks; Lab- 30 Marks

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*CA – Can be Quizzes, Assignment, Projects, and Reports.

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Grades O to P indicate successful completion of the course

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CGPA = \frac{\sum (C_i \times Gr_i)}{\sum C_i}
\]

Where

- \( C_i \) = Credit for the \( i^{th} \) course in any semester
- \( Gr_i \) = Grade point for the \( i^{th} \) course
- Cr. = Credits for the Course
- Gr. = Grade Obtained
OBJECTIVES: To make the students communicate their thoughts, opinions, and ideas freely and naturally; to make them understand the different styles in communication; to make the students understand the aesthetics of reading and writing; to bring in a spirit of enquiry; to motivate critical thinking and analysis; to help them ruminate on human values.

Unit 1

Reading: Different styles of communication – Reading Comprehension - critical thinking and analysis – Note-making – Any two pieces from the text.

Unit 2

Writing: Prewriting techniques - Kinds of paragraphs - basics of continuous writing.

Grammar & Usage: Parts of Speech, Tenses, Concord, Phrasal Verbs, Modal Auxiliaries, Modifiers (Workbook) - Any two pieces from the text.

Unit 3

Practical sessions (Listening & Speaking): Introduction to English pronunciation including minimal pairs and word stress – differences between British and American English – Listening comprehension and Note-taking - Any two pieces from the text.

Activities: Short speeches, seminars, quizzes, language games, debates, and discussions, Book Reviews, etc.

Text: Language through Reading: Compilation by Amrita University for internal circulation

Poems:

i. The Poplar Field by William Cowper
ii. Telephone Conversation by Wole Soyinka

Prose:
i. Higher Mathematics by R. K. Narayan
ii. Wings of Fire by Abdul Kalam (Part III.11)

Short Stories:

i. Best Investment I Ever Made by A. J. Cronin
ii. Death of an Indian by Krishna Charan Das

Language through Practice: Compilation by Amrita University for internal circulation

**Outcomes:**

CO 1: Demonstrate competency in all the four linguistic skills viz, listening, speaking, reading and writing.

CO 2: Apply different styles of communication in professional context.

CO 3: Take part in different planned & extempore communicative activities.

CO 4: Interpret and Discuss facts and information in a given context.

CO 5: Develop an appreciation for human values.

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15MAT111  CALCULUS AND MATRIX ALGEBRA  2 1 0 3

Unit 1
Calculus

Limit and Continuity: Limit (One-Sided and Two-Sided) of Functions. Continuous Functions, Discontinuities, Monotonic Functions, Infinite Limits and Limit at Infinity.

Unit 2

Unit 3
Matrix Algebra
Review: System of linear Equations, linear independence

Outcomes:

CO1: Understand the basic concepts of functions, limits, continuity, derivatives and analyze them.

CO2: Apply the concept of differentiability to find the extreme values of the given function and analyze the derivatives to sketch the graph of the given function.

CO3: Recall the terms, facts and basic concepts of definite integrals and the techniques of obtaining antiderivatives.

CO4: Understand the notion of eigenvalues and eigenvectors, analyze the possibility of diagonalization and hence compute a diagonal matrix, if possible.

CO5: Apply the knowledge of diagonalization to transform the given quadratic form into the
principal axes form and analyze the given conic section.

CO6: Understand the advantages of the iterative techniques and apply it to solve the system of equations and finding eigenvectors.

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**TEXTBOOKS:**

**REFERENCE BOOKS:**

**15CSE100 COMPUTATIONAL THINKING AND PROBLEM SOLVING**

**Unit 1**
Unit 2

Unit 3
Problem Solving Techniques: Factoring and Recursion Techniques, Search and Sort techniques, Text processing and Pattern matching.

Outcomes:

- **CO1:** Apply computational thinking principles and algorithmic building blocks to understand, define, and solve problems
- **CO2:** Design algorithms and implement solutions for problems
- **CO3:** Represent, organize, manipulate and interpret data
- **CO4:** Trace computational states and analyse techniques/ strategies for given solutions

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**TEXTBOOKS:**

1. **David Riley and Kenny Hunt, Computational Thinking for Modern Solver, Chapman & Hall / CRC, 2014**
2. **R. G. Dromey, “How to solve it by Computer”, PHI, 2008**
Unit 1
Chemical Bonding
Review of orbital concept and electronic configuration, electrovalency and ionic bond formation, ionic compounds and their properties, lattice energy, solvation enthalpy and solubility of ionic compounds, covalent bond, covalency, orbital theory of covalency - sigma and pi bonds - formation of covalent compounds and their properties. Hybridization and geometry of covalent molecules - VSEPR theory - polar and non-polar covalent bonds, polarization of covalent bond - polarizing power, polarisability of ions and Fajan’s rule, dipole moment, percentage ionic character from dipole moment, dipole moment and structure of molecules - co-ordinate covalent compounds and their characteristics, molecular orbital theory for H2, N2, O2 and CO, metallic bond - free electron, valence bond and band theories, weak chemical bonds – inter and intra molecular hydrogen bond - van der Waals forces.

Unit 2
Thermodynamic Parameters
Stoichiometry - mole concept, significance of balanced chemical equation - simple calculations - Conditions for occurrence of chemical reactions - enthalpy, entropy and free changes - spontaneity – Thermochemistry - heats of reactions - (formation, combustion, neutralization) - specific heats - variation of enthalpy change with temperature - Kirchhoff’ relation (integrated form) - bond enthalpy and bond order - Problems based on the above.

Kinetics
Review of molecularity and order of a reaction, rate law expression and rate constant - first, second, third and zero order reactions, pseudo-first order reactions (pseudo-unimolecular reactions) - complex reactions - equilibrium and steady state approximations - mechanism of these reactions - effect of temperature on reaction rates - Arrhenius equation and its significance, Michaelis Menden kinetics-enzyme catalysis.

Unit 3
Electrochemistry
Electrolytes - strong and weak, dilution law, Debye-Huckel theory, faraday’s laws, origin of potential, single electrode potential, electrochemical series, electrochemical cells, Nernst equation and its application, reference electrodes - SHE, Ag/AgCl, Calomel.

Photochemistry
Photochemistry, laws of photochemistry - Stark-Einstein law, Beer-Lamberts law, quantum efficiency-determination, photochemical processes - Jablonsky diagram, internal conversion, inter-system crossing, fluorescence, phosphorescence, chemiluminescence and photo sensitization, photo polymerization.

Outcomes:

CO 1: Understand the fundamental concepts of chemistry to predict the structure and properties of engineering materials
CO 2: Develop analytical skills to evaluate the cause, feasibility and course of chemical reactions
CO 3: Design and apply the idea of cutting edge area of chemistry to solve engineering related problems

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REFERENCE BOOKS

_Physical chemistry, Puri and Sharma Inorganic chemistry_,
_Puri and Sharma_

15PHY100 PHYSICS 3 0 0 3

Unit 1


**Unit 2**

**Atomic Structure and Quantum Mechanics**

Quantum Mechanics: Introduction - wave equation - Schrodinger’s equation (time dependent and independent) - expectation values, operators, Eigen value (momentum and energy) – 1D potential box (finite and infinite) - tunnel effect - harmonic oscillator.

**Unit 3**

**Statistical Mechanics and Solid State Physics**


**Outcomes:**

CO1: Understand, Comprehend and acquaint with concepts of Modern Physics
CO2: Analyze and solve (idealized and quasi practical) physics problems pertaining to various concepts of Modern Physics
CO3: Apply concepts of Modern Physics to solve engineering problems that needs ideas from Modern Physics

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**TEXTBOOK:**
15CHY181 CHEMISTRY LAB. 0021

1. Acid base titration (double titration)
2. Complexometric titration (double titration)
3. Redox (permanganimetry) titration (double titration)
4. Conductometric titration
5. Potentiometric titration
6. Ester hydrolysis

Outcomes:

CO1: Develop analytical skills for the determination of water quality parameter

CO2: Understand the electrochemical principles of conductance and electrode potentials and its application in analytical science

CO3: Develop analytical skills in the determination of rates of chemical reactions and its application

CO4: Learn the basics of redox reaction and applying it for quantitative determination.

CO5: Create skills to convert basic chemical reactions to analytical application.

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Young’s Modulus – Non Uniform Bending Newton’s Rings
Laser - Determination of Wavelength and Particle Size Determination Spectrometer
Carey Foster’s Bridge Rigidity Modulus - Tensional Pendulum Viscosity of Liquid by Stokes’s method
Ultrasonic Interferometer Hysteresis – B H curve

Outcomes:

CO1: Prepare for the lab experiment and perform individually a wide spectrum of experiments.

CO2: Present experimental data in various appropriate forms like tabulation, and plots.

CO3: Analyze, Interpret and Summarize experimental results.

CO4: Communicate clearly understanding of various experimental principles, instruments/setup, and procedure.

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15MEC180 WORKSHOP A 0021

1. Product Detailing Workshop
Disassemble the product of sub assembly - Measure various dimensions using measuring instruments - Free hand rough sketch of the assembly and components - Name of the components and indicate the various materials used - Study the functioning of the
assembly and parts - Study the assembly and components design for compactness, processing, ease of assembly and disassembly - Assemble the product or subassembly.

2. Pneumatics and PLC Workshop
Study of pneumatic elements - Design and assembly of simple circuits using basic pneumatic elements - Design and Assembly of simple circuits using Electro-pneumatics.

Study of PLC and its applications - Simple programming using ladder diagrams.

3. Sheet Metal Workshop
Study of tools and equipments - Draw development drawing of simple objects on sheet metal (cone, cylinder, pyramid, prism, tray etc.) Fabrication of components using small shearing and bending machines - Riveting and painting practice.

4. (a) Welding Workshop
Study of tools and equipments - Study of various welding methods - Arc welding practice and demonstration of gas welding and cutting.

(b) Demo and practice Workshop
Fitting: Study of tools, practice in chipping, filing and making joints. Carpentry: Study of tools, planning practice and making joints

Outcomes:

CO1: Dismantle and assemble various products.

CO2: Design and simulate pneumatic and electro-pneumatic circuits.

CO3: Fabricate sheet metal objects.

CO4: Perform arc welding and soldering.

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Part A – Electronics

Identification of electronic components (Passive and Active)
Study of measuring instruments (Voltmeter, Ammeter and Multimeter) Measurement and theoretical Verification of series and parallel combination of resistors and capacitors
Calibration of CRO and measurements of signal parameters (RMS, maximum value, peak value, time and frequency)
Calibration of function generator using CRO Soldering practice

Part B – Electrical

1. Study on power supply and protective devices
2. Study on tools and electrical accessories
3. Study on sources of light
4. Study on energy efficiency
5. Study on water pump
6. Study on house hold appliances:
   7. Iron box
   8. Fan
   9. Refrigerator
10. Air conditioner
11. House wiring I – Glow an incandescent lamp using SPST switch
12. House wiring II – Glow a fluorescent lamp using SPST switch
13. House wiring III – Operate a fan and an incandescent lamp using two independent SPST switch
14. House wiring IV – Operate a fluorescent lamp and a 3 pin socket using two independent SPST switch
15. House wiring V – Staircase wiring
16. House wiring VI – Godown wiring

Outcomes:

CO1: Understand electrical safety measures and identify electrical tools, electronic components and their symbols.

CO2: Understand electric laws using simulation studies and detect failures in electrical and electronic circuits.

CO3: Build/Solder and test, residential wiring/Electronic circuits and measure electrical parameters.

CO4: Estimate the materials required for wiring a building.

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15MEC100 Engineering Drawing CAD I 2023
(Pre-Requisite: Nil)

Objectives:

1. To develop drawings using Bureau of Indian Standards (BIS)
2. To communicate effectively through drawings
3. To enhance visualization skills, which will facilitate the understanding of engineering systems.

Keywords:
Coordinate system, Orthographic projections, Isometric projections

Contents:


Outcomes:

CO1: Understand the fundamental principles of first angle and third angle projections.

CO2: Dimension and label the drawings as per standards.

CO3: Construct the drawings by choosing appropriate line type.

CO4: Visualize and construct projections of line and lamina when inclined to one reference plane and both reference planes.

CO5: Visualize and construct solid entities in its simple position and when inclined to one reference plane. CO6: Construct the drawings using computer aided design and drafting software package

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TEXTBOOK:


REFERENCES:

15CUL101 CULTURAL EDUCATION I 2002

Unit 1
Introduction to Indian Culture; Introduction to Amma’s Life and Teachings; Symbols of Indian Culture.

Unit 2
Science and Technology in ancient India; Education in Ancient India; Goals of Life
- Purusharthas; Introduction to Vendanta and Bhagavat Gita.

Unit 3
Introduction to Yoga; Nature and Indian Culture; Values from Indian History; Life and work of Great Seers of India.

Outcomes:

CO1: Be introduced to the foundational concepts of Indian culture and heritage, will be able to understand the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma’s life

CO2: Understand the foundational concepts of Indian civilization like purusharthas, law of karma, etc, which contributes towards personality growth.

CO3: Gain a positive appreciation of Indian culture, traditions, customs and practices

CO4: Imbibe spirit of living in harmony with nature, and principles and practices of Yoga

CO5: Get guidelines for healthy and happy living from the great spiritual masters
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**TEXTBOOKS:**
1. *The Glory of India* (in-house publication)
2. *The Mother of Sweet Bliss* (Amma’s Life & Teachings)

**15MAT121 VECTOR CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS**

**Unit 1**
Vector Differentiation: Vector and Scalar Functions, Derivatives, Curves, Tangents, Arc Length, Curves in Mechanics, Velocity and Acceleration, Gradient of a Scalar Field, Directional
Derivative, Divergence of a Vector Field, Curl of a Vector Field. (Sections: 9.4, 9.5, 9.6, 9.9, 9.10, 9.11)

Vector Integration: Line Integral, Line Integrals Independent of Path. Green’s Theorem in the Plane (Sections: 10.1, 10.2, 10.3, 10.4).

**Unit 2**
Surface Integral: Surfaces for Surface Integrals, Surface Integrals, Triple Integrals – Gauss Divergence Theorem, Stoke’s Theorem. (Sections: 10.5, 10.6, 10.7, 10.9)

First Order Differential Equations: First Order ODE, Exact Differential Equations and Integrating Factors (Sections 1.1 and 1.4).

**Unit 3**
Second Order Differential Equations: Homogeneous and non-homogeneous linear differential equations of second order (Review), Modelling: Free Oscillations, Euler-Cauchy Equations, Solution by Undetermined Coefficients, Solution by the Method of Variation of Parameters (Sections 2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 2.10).


**Outcomes:**

CO 1: Able to understand, and interpret the concepts.
CO 2: Able to apply the concept and understand them
CO 3: Able to understand and implement the concepts in application oriented problems.
CO 4: Able to understand and analyze the and apply the knowledge of diagonalization of matrices to transform the given quadratic form.
CO 5: Able to understand the basic concepts and apply them in modeling the first order ODEs.
CO 6: Able to understand and apply methods of undetermined coefficients and variation of parameters to solve second order ODEs.

**CO –PO Mapping:**
15CSE102 Computer Programming 3 0 0 3

Objectives:

1. The course intends to familiarize the students with the structured programming paradigm.
2. The course aims to provide necessary skills to students to apply the structured programming principles to solve problems

Contents:

Unit 1:
Introduction to C language: Structure of a C program, comments, Data types, variables, constants, data input and output statements, input assertions; expressions and evaluation. Functions: inter function communication, standard functions, scope. Selection: two way selection, multi-way selection. Repetition: concept of loop, loop invariant, pretest and posttest loops, initialization and updating, event and counter controlled loops. Recursion: recursive definition, recursive solution, designing recursive functions, limitations of recursion.

Unit 2:

Files and streams, file input output, Arrays –1D numeric, searching and sorting, 2D numeric arrays, problems with matrices. Pointers: introduction, compatibility, arrays and pointers, Dynamic memory allocation, arrays of pointers, pointer arithmetic.

Unit 3:

Strings: fixed length and variable length strings, strings and characters, string input, output, array of strings, string manipulation functions, sorting of strings. Enumerated types, Structures: structure vs array comparison, complex structures, structures and functions, Union, binary input output, command line arguments.

Outcomes:

CO1: Understand the structured programming constructs: data types (primitive and compound), control and recursion thereby to understand a given program

CO2: Understand and analyze a given program by tracing, identify coding errors and debug them

CO3: Apply structural programming constructs appropriately for given problem scenarios

CO4: Develop computer programs that implement suitable algorithms for problem scenarios and applications

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**TEXTBOOK:**

**REFERENCES:**

**15CHE111 INTRODUCTION TO CHEMICAL ENGINEERING  3 0 0 3**

**Unit 1**

Historical evolution of chemical engineering; what is chemical Engineering; the impact & role of chemical engineering; representing chemical processes using process diagrams and flow sheets (introduction to unit operations and unit processes; batch vs. continuous operation); understanding prevalent symbols; chemical process industries: evolution, broad classification, characteristics, origin, growth, present scenario, & projections; opportunities and challenges; roles of the modern chemical engineer.

Physical quantities: units & dimensions, conversion & conversion factors; important process variables, making the connection between the variables and their measurements; conventions in methods of analysis
and measurement, basis, chemical equations and stoichiometry, conversion, and yield; industrially important physical and chemical properties.

**Unit 2**

Introduction to fluid flow (pressure-flow interaction, non-flowing fluids, pumps & turbines), heat transfer (applications of heat exchange in the industry), mass transfer (molecular vs. bulk transport), reaction engineering (important of describing reaction rate and design of reaction vessel), materials (important properties and their influence on selection of materials), and control (need for control and strategies); mathematical representation of process; types of chemical engineering problems (mainly rate, equilibrium and design).

**Unit 3**

Computer aided calculations & spreadsheets; graphing (basic plots, interpreting trends, curve fitting, log-log & semi-log representation); relation between chemical engineering and physico – chemical sciences and other engineering disciplines; modern view of chemical engineering; economics (costs in industry, profitability considerations, analytical view of process and reporting of performance); safety-health-environment; ethics; case studies.

**Course Outcomes**

CHE111.1 Understand various fields to which chemical engineers have been contributed and Identify the role of a modern Chemical Engineer.
CHE111.2 Convert the batch process of a chemical production into a continuous process
CHE111.3 Convert units of physical quantities from one system to another
CHE111.4 Understand the skeleton of Chemical Engineering curriculum
CHE111.5 Develop simple mathematical equations of a process using conservation principles and solve them using suitable mathematical techniques
CHE111.6 Develop a process flow diagram for a given process based on the requirements and analyze the equipment required
CHE111.7 Follow ethics in Chemical Engineering discipline
CHE111.8 Perform profitability and safety analysis of a given process
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**TEXTBOOKS & REFERENCES:**


15CHE112 MATERIAL BALANCES 3 1 0 4

**Unit 1**
Chemical engineer vs. Chemist, Careers in chemical engineering, Chemical engineering industries; Chemical engineering approach – Streams, Units and Processes; Unit operations and processes: Fluid and solid operations, Heat transfer operations, Mass transfer and separation operations, Chemical reactors, Control of processes, Costing and economics, Process flowsheets and components; Case studies.

Representing streams: Dimensions and unit conversions, Conversion factors, Dimensional consistency, Dimensionless numbers in chemical engineering; Representing compositions of mixtures and solutions: Binary and tertiary mixtures, Graphical representation, Compound stoichiometry; Representing gas phases: Ideal gas law, P-V-T calculations, Partial pressures and pure component volumes in mixtures; Representing reactions: Reaction stoichiometry, Conversion, Yield, Selectivity, Limiting and excess reactants; Dissociating gases; Representing moist gases: Humidity, Wet and dry bulb temperatures, Humidity chart.

**Unit 2**
Material balance – Control volume, Conservation of mass and species in a unit; Steady and unsteady state processes, Batch and continuous processes; Basis for calculation; Degrees of freedom; Steady and unsteady material balance in unit operations: Evaporation; Crystallization; Leaching; Adsorption; Drying; Liquid-Liquid Extraction; Absorption; Distillation; Recycle, Bypass, and Purge
Unit 3
Combustion: Orsat analysis, Proximate and ultimate analyses of coal; Single-pass and overall conversions; Oxidation of sulphur compounds; Reactions involving phosphorus; Reactions involving nitrogen; Reactions involving chlorine; Extraction of metals from ores; Hydrogenation, hydration, and oxidation; Electrochemical reactions; Recycle, Bypass, and Purge involving reactions

Representing processes: Creating Flowsheets; Degree of freedom analysis of flowsheets; Material balance involving multiple unit operations; Modular and overall equation-solving approaches; Case studies involving industrial flowsheets.

Course Outcomes
CHE112.1 Understand the fundamental concepts of stoichiometry and identifying process variables and properties and develop systematic problem solving skills
CHE112.2 Ability to make and solve material balance equations on unit operations and processes
CHE112.3 Ability to perform material balances with chemical reactions
CHE112.4 Ability to perform material balances involving multiple unit operations

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TEXTBOOKS:
REFERENCES:

15CSE180 Computer Programming Lab. 0021

Objectives:

- The laboratory intends to provide hands-on experience on the structured programming paradigm.
- This laboratory facilitates students to apply the structured programming principles to solve problems

Contents:

Solving simple problems with operators, programs on conditional control constructs, programs on loops (while, do-while and for), programs using user-defined functions and library functions, programs on files, arrays (single and multi-dimensional), programs using DMA, programs on strings, structures.

Outcomes:

CO1: Develop solutions for problems systematically using structured logic approach.

CO2: Develop computer programs for a given problem scenario.

CO3: Make use of the programming constructs effectively while developing computer programs.
CO4: Develop modular solutions for a given scenario.

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TEXT BOOKS/REFERENCES:


15CUL111 CULTURAL EDUCATION II 2002

Unit 1
1. Relevance of Sri Rama and Sri Krishna in this Scientific Age
2. Lessons from the Epics of India
3. Ramayana & Mahabharata

Unit 2
4. Who is a Wise Man?
5. A Ruler’s Dharma
6. The Story of King Shibi

Unit 3
7. Introduction to the Bhagavad Gita
8. Bhagavad Gita – Action without Desire

Unit 4
9. Role and Position of Women in India
10. The Awakening of Universal Motherhood

Unit 5

Patanjali’s Astanga - Yoga System for Personality Refinement
11. Examples of Heroism and Patriotism in Modern India

Outcomes:

CO1: Get an overview of India and her contribution to the world in the field of science and literature
CO2: Understand the foundational concepts of ancient Indian education system and practices associated with them
CO3: Learn the important concepts of Vedas, Bhagavad-Gita and Yogasutras and their relevance to daily life
CO4: Familiarize themselves with the inspirational characters and anecdotes from the epics and Indian history
CO5: Gain a rational understanding of the underlying principles of Indian spirituality

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TEXTBOOKS:

Common Resource Material II (in-house publication)
Sanatana Dharma - The Eternal Truth (A compilation of Amma’s teachings on Indian Culture)


15CHE201 ENERGY BALANCE AND THERMODYNAMICS 3 0 2 4

Unit 1
Systems, Properties, Processes, Cycles; State of a system and state postulate; State and path functions; Temperature and zeroth law of thermodynamics; Pressure and pressure measurement; Energy and its forms: Potential and Kinetic energy, Internal energy; Energy sources; Energy transfer – Heat, Work, Electricity; Mechanisms of heat transfer; Work: Moving boundary work, Flow work, Shaft, spring, elasticity, surface tension, and electrical work; Energy balance – First law for open and closed systems, steady and unsteady state processes.

Phases and phase diagrams of a pure substance, Saturation, Superheating, T-v, P-v, P-T diagrams and the P-v-T surface; Enthalpy; Property tables; Ideal and non-ideal gases: van der Waals, Soave-Redlich-Kwong, Peng-Robinson equations of state; Virial equation and its physical meaning; Compressibility factor.

Unit 2
Estimation of heat capacities: Solids, Liquids, Gases, Mixtures, Temperature dependence; Enthalpy changes: Mixing, Fusion, Vaporization – Clayperon equation, Clausius-Clayperon equation, Watson equation, Trouton’s rule, Kistyakowsky equation; Energy analysis of gas cycles; Energy analysis using property tables.

Mechanical energy balance – Bernoulli equation; Energy transfer by mechanical work: Nozzles and diffusers, Turbines, compressors and pumps, Throttling valves, Pipe and duct flow; Energy transfer by heat: Heat exchangers, Boilers and Furnaces; Energy balance in unit operations: Mixers and splitters; Drying; Evaporation; Crystallization; Leaching; Adsorption; Liquid-Liquid Extraction; Absorption; Distillation; Recycle, Bypass, Purge.

Unit 3
Standard heat of reactions – Combustion and Formation; Hess’s law; Effect of temperature and pressure; Adiabatic reaction temperature; Recycle in reactors; Combined material and energy balance in flowsheets – Degree of freedom analysis; Modular and overall equation-solving approaches.
Entropy and thermodynamic temperature; Combined first and second law for closed systems and cycles: Carnot cycle; Refrigerators, Heat pumps; Thermodynamic efficiency and coefficient of performance; Second law for open systems – Entropy balance; Statistical meaning of entropy.

Course Outcomes

CHE201.1 Understand the basic thermodynamic definitions, laws and P-v-T behaviour of fluids
CHE201.2 Ability to apply fundamental concepts of thermodynamics to engineering applications and energy analysis using property tables
CHE201.3 Understand the energy transfer by mechanical work, by heat and energy balance in unit operations
CHE201.4 Understand the energy analysis of gas cycles, thermodynamic efficiencies and the concept of entropy

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TEXTBOOKS:


REFERENCES:


Unit 1

Elementary concepts – density, specific weight, specific gravity, viscosity – dynamic and kinematic viscosity – surface tension, capillarity, vapour pressure, compressibility – Compressible and incompressible fluids; Concept of gauge and absolute pressure, measurement of pressure using manometers of different types. Hydrostatic force on plane and curved surfaces, center of pressure; buoyancy and stability of submerged and floating bodies;

Flow types - Unsteady, Steady and non-uniform, laminar and turbulent flows – Reynolds number; Ideal flow – rotational and irrotational, stream function, potential function – Velocity vectors; Path line, streak line and stream line; Derivation of continuity and momentum equation for steady three dimensional flows - Application of one dimensional steady flow; circulation and vorticity; Laminar flow between parallel plates – Taylor-Coutte flow and Poiseulle flow; Flow in closed conduits Laminar flow through circular pipe – Shear stress and velocity profiles; pressure gradient, Hagen-Poiseulle’s equation; Power required to overcome pressure drop; Velocity profile in turbulent flows;

Two dimensional flows - Boundary layer; Boundary layer equation; Blasius solution for boundary layer flow; boundary layer separation and its control.

Unit 2

Bernoulli’s and Euler’s equations; Application of Bernoulli’s equations to flow meters - Pitot tube, Nozzle, Venturi meter and Orifice meter; Coefficient of discharge for flow meters and velocity measurement;

Concept of friction and friction factor from drag on a flat plate; Friction loss in laminar and turbulent flows, Darcy-Weisbach equation, Moody chart; Minor losses

– Pipe fittings and pipe networks, equivalent length for pipe in pipe fittings;

Flow past immersed bodies – drag and lift, drag and lift coefficients, flow though beds of solids, one dimensional motion of particle through fluid, terminal velocity, indered settling, Fluidization – Conditions for onset of fluidization, Hydraulic radius of porous medium, Porous medium Reynolds number, minimum fluidization velocity; Pressure drop through porous media for spherical and non-spherical particles – Ergun equation; Types of fluidization;

Unit 3

Applications Transportation of fluids – pipes, fittings, valves; Pump terminology – Suction and Delivery heads, Suction lift, Cavitation, Net positive suction head and Power requirement; Positive displacement
pumps – Reciprocating pump and gear pump; Rotary pumps - Centrifugal Volute pump, Pressure raise in centrifugal pump; Pump characteristics;

Significance of dimensionless numbers; Dimensional analysis and model testing – Bucking ham pi-theorem; Application of dimensionless analysis - Flow through pipe, Settling of particles in a fluid, Centrifugal pump, Reynolds and Froude numbers and their use in model testing;

**Course Outcomes**

**CHE202.1** Understand basic properties of fluids, stress-strain relationship in fluids, classify their behavior and establish force balance in static systems

**CHE202.2** Analyze fluid flow problems in different configurations with the application of the momentum and energy equations. Understand principles and functioning of flow metering devices and apply Bernoulli equation to determine the performance of flow-metering devices.

**CHE202.3** Analyse fluid behaviour in fixed bed systems, compute power requirement in fixed bed system and determine minimum fluidization velocity in fluidized bed.

**CHE202.4** Determine and analyze the performance aspects of fluid machinery specifically for centrifugal pump and reciprocating pump. Develop dimensionless groups that help in scale-up and scale-down of fluid flow systems.

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**TEXTBOOK AND REFERENCE BOOKS:**

15CHE203 MECHANICAL OPERATIONS

Unit 1

Properties and handling of particulate solids- characteristics of solid particles, standard screen series, mixed particle size and screen analysis; Screening: Theory of screening, Effectiveness and Capacity of screens, Screening equipment: stationary screens and grizzlies, gyrating screens, vibrating screens and other industrial screens like trammels, etc. Transportation and storage of solids: bins, hoppers and silos, flow out of bins; conveyor selection, different types of conveyers and their performance characteristics.


Unit 2

Separation of solids: gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, bowl classifier, super centrifuges, design of basket centrifuges; Industrial dust removing equipment - cyclones and hydro cyclones, with special reference to electrostatic and magnetic separators; Heavy media separations, flotation.

Mixing and Agitation: Mixing of liquids (with or without solids), mixing of liquids (with solids), mixing of liquids (with solids), mixing of powders, selection of suitable mixers, power requirement for mixing.

Unit 3

Filtration: Principle of Cake filtration, Pressure drop through filter media, compressible and incompressible filter cakes, Constant pressure and rate filtration, Continuous filtration, washing of filter
cakes; Filtration – Theory, Filtration considerations, Batch and continuous filtration equipment (Pressure and Vacuum) – selection, operation and design of filters and optimum cycle of operation.

Course Outcomes

CHE203.1 To develop basic knowledge on particle technology and analyze particle size and shape with deeper understanding on different particle diameters

CHE203.2 To develop understanding on various size reduction operations and mechanical separations with basic understanding on size reduction laws and principles

CHE203.3 To understand various ways of storing, handling solids and agitation of solids in chemical industries

CHE203.4 To apply and analyze appropriate unit operations for separation of solids from solids and separation of solids from liquids

CO-PO Mapping

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TEXTBOOKS:


REFERENCE:
15CHY245  INSTRUMENTAL METHODS OF ANALYSIS  3 0 0 3

Unit 1

Separation Techniques: Brief out line of column, paper and thin layer chromatography - Ion exchange methods - principle and application – HPLC.

Unit 2
Gas chromatography - principle and applications – gel chromatography.


Unit 3

Thermal and Diffraction techniques: Principles and applications of DTG - DTA - DSC - X-ray - Electron Diffraction Studies - SEM, TEM.

Course Outcome
CO01: To develop an understanding of principle and working of the range of instrumental methods in analytical chemistry
CO02: To provide an understanding and skills in contemporary methods of separation and appropriate selection of instruments for the successful analysis of chemical compounds
CO03: To impart skills in the scientific method of planning, conducting, reviewing, reporting experiments and problem solving in chemical analysis.
TEXTBOOKS:


REFERENCES:


15MAT204 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

Unit 1


Unit 2

Convolution, Integral Equations, Partial Fractions, Differential Equations, Systems of Differential Equations. (Sections: 6.1 to 6.7)


Unit 3


Partial Differential Equations: Basic Concepts, Modeling; Vibrating String, Wave Equation, Separation of Variables, Use of Fourier Series, Heat Equation; Solution by Fourier Series. (Sections: 12.1-12.5)
Course Outcomes

15MAT204.CO1  Understand the concepts of Laplace and Fourier transforms and its properties to transform a function from time domain to the frequency domain.

15MAT204.CO2  Obtain the Laplace and Fourier transform and its inverse transform of impulsive, discontinuous and some complicated periodic signals.

15MAT204.CO3  Solve the initial value problems’ using Laplace and Fourier transforms on signals arising by changing over to frequency domain.

15MAT204.CO4  Define the Fourier series for periodic functions and determine the Fourier coefficients

15MAT204.CO5  Understand the formation of partial differential equations and apply some standard methods to obtain its solutions.

15MAT204.CO6  Apply Fourier series technique to solve the heat, wave and Laplace equations.

TEXTBOOK:


REFERENCE BOOKS:


15CHE281  FLUID MECHANICS LAB.  0 0 2 1

Bernoulli’s equation for steady flow - verification of energy conservation principle; Determination of coefficient of discharge of flow measuring devices like venturimeter, orificometer, rotameter; Pipe friction studies- losses in fittings - friction factor; Flow through annular and helical coil pipes - coefficient of friction; Performance characteristics of centrifugal and reciprocating pumps; Flow through packed columns – fluidization - pressure drop in the column; Terminal settling velocity.
Course Outcomes

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<td>15CHE281.2</td>
<td>To handle and operate reciprocating and centrifugal pumps</td>
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<td>15CHE281.3</td>
<td>To develop ability to conduct experiments in packed column, helical coil and annular flow pipe</td>
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<td>To perform experiments to calculate friction loss in pipe flow and drag coefficients</td>
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CO-PO Mapping

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15CHE282   MECHANICAL OPERATIONS LAB. 0 0 2 1

Calculating Specific Surface Area and Particle Size using Sieve Analysis, Screen Effectiveness, Verifying crushing laws and energy consumption in Jaw Crusher, Ball mill and Drop weight Crusher, Determining reduction ratio in Roll Crusher, and Drop Weight Crusher, Solid Separation in Cyclone Separator, Calculation thickener area using batch sedimentation experiment, Determining Specific Cake resistance and filter medium Resistance in Filter Press, and Leaf Filter.

Course Outcomes

| CHE282.1   | To learn particle analysis of complex heterogeneous mixtures using sieve analysis and familiarise on the different ways of calculating particle diameters and specific surface area |
| CHE282.2   | To understand screen analysis and effectiveness of screen |
| CHE282.3   | To familiarise on the various size reduction mechanisms and equipment and investigating the energy consumption using empirical laws |
| CHE282.4   | To understand separation of solids from liquids and gases |
## CO-PO Mapping

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### 15AVP201 / AMRITA VALUES PROGRAMME I / 1 0 0 1

### 15AVP211 AMRITA VALUES PROGRAMME II 1 0 0 1

Amrita University's Amrita Values Programme (AVP) is a new initiative to give exposure to students about richness and beauty of Indian way of life. India is a country where history, culture, art, aesthetics, cuisine and nature exhibit more diversity than nearly anywhere else in the world.

Amrita Values Programmes emphasize on making students familiar with the rich tapestry of Indian life, culture, arts, science and heritage which has historically drawn people from all over the world.

Students shall have to register for any two of the following courses, one each in the third and the fourth semesters, which may be offered by the respective school during the concerned semester.

**Courses offered under the framework of Amrita Values Programmes I and II**

**Message from Amma’s Life for the Modern World**

Amma’s messages can be put to action in our life through pragmatism and attuning of our thought process in a positive and creative manner. Every single word Amma speaks and the guidance received in on matters which we consider as trivial are rich in content and touches the very inner being of our personality. Life gets enriched by Amma’s guidance and She teaches us...
the art of exemplary life skills where we become witness to all the happenings around us still keeping the balance of the mind.

Lessons from the Ramayana
Introduction to Ramayana, the first Epic in the world – Influence of Ramayana on Indian values and culture – Storyline of Ramayana – Study of leading characters in Ramayana – Influence of Ramayana outside India – Relevance of Ramayana for modern times.

Lessons from the Mahabharata
Introduction to Mahabharata, the largest Epic in the world – Influence of Mahabharata on Indian values and culture – Storyline of Mahabharata – Study of leading characters in Mahabharata – Kurukshetra War and its significance - Relevance of Mahabharata for modern times.

Lessons from the Upanishads
Introduction to the Upanishads: Sruti versus Smrti - Overview of the four Vedas and the ten Principal Upanishads - The central problems of the Upanishads – The Upanishads and Indian Culture – Relevance of Upanishads for modern times – A few Upanishad Personalities: Nachiketas, Satyakama Jabala, Aruni, Shvetaketu.

Message of the Bhagavad Gita

Life and Message of Swami Vivekananda
Brief Sketch of Swami Vivekananda’s Life – Meeting with Guru – Disciplining of Narendra - Travel across India - Inspiring Life incidents – Address at the Parliament of Religions – Travel in United States and Europe – Return and reception India – Message from Swamiji’s life.

Life and Teachings of Spiritual Masters India
Sri Rama, Sri Krishna, Sri Buddha, Adi Shankaracharya, Sri Ramakrishna Paramahamsa, Swami Vivekananda, Sri Ramana Maharshi, Mata Amritanandamayi Devi.

Insights into Indian Arts and Literature
The aim of this course is to present the rich literature and culture of Ancient India and help students appreciate their deep influence on Indian Life - Vedic culture, primary source of Indian Culture – Brief introduction and appreciation of a few of the art forms of India - Arts,
Music, Dance, Theatre.

**Yoga and Meditation**
The objective of the course is to provide practical training in YOGA ASANAS with a sound theoretical base and theory classes on selected verses of Patanjali’s Yoga Sutra and Ashtanga Yoga. The coverage also includes the effect of yoga on integrated personality development.

**Kerala Mural Art and Painting**
Mural painting is an offshoot of the devotional tradition of Kerala. A mural is any piece of artwork painted or applied directly on a wall, ceiling or other large permanent surface. In the contemporary scenario Mural painting is not restricted to the permanent structures and are being done even on canvas. Kerala mural paintings are the frescos depicting mythology and legends, which are drawn on the walls of temples and churches in South India, principally in Kerala. Ancient temples, churches and places in Kerala, South India, display an abounding tradition of mural paintings mostly dating back between the 9th to 12th centuries when this form of art enjoyed Royal patronage. Learning Mural painting through the theory and practice workshop is the objective of this course.

**Course on Organic Farming and Sustainability**
Organic farming is emerging as an important segment of human sustainability and healthy life. Haritamritam’ is an attempt to empower the youth with basic skills in tradition of organic farming and to revive the culture of growing vegetables that one consumes, without using chemicals and pesticides. Growth of Agriculture through such positive initiatives will go a long way in nation development. In Amma’s words “it is a big step in restoring the lost harmony of nature”.

**Benefits of Indian Medicinal Systems**
Indian medicinal systems are one of the most ancient in the world. Even today society continues to derive enormous benefits from the wealth of knowledge in Ayurveda of which is recognised as a viable and sustainable medicinal tradition. This course will expose students to the fundamental principles and philosophy of Ayurveda and other Indian medicinal traditions.

**Traditional Fine Arts of India**
India is home to one of the most diverse Art forms world over. The underlying philosophy of Indian life is ‘Unity in Diversity’ and it has led to the most diverse expressions of culture in India. Most art forms of India are an expression of devotion by the devotee towards the Lord and its influence in Indian life is very pervasive. This course will introduce students to the deeper philosophical basis of Indian Art forms and attempt to provide a practical demonstration of the continuing relevance of the Art.
Science of Worship in India

Indian mode of worship is unique among the world civilisations. Nowhere in the world has the philosophical idea of reverence and worshipfulness for everything in this universe found universal acceptance as it in India. Indian religious life even today is a practical demonstration of the potential for realisation of this profound truth. To see the all-pervading consciousness in everything, including animate and inanimate, and constituting society to realise this truth can be seen as the epitome of civilizational excellence. This course will discuss the principles and rationale behind different modes of worship prevalent in India.

Outcomes:

CO1: Appreciate the significance of Rāmāyaṇa as an itihāsa, and important aspects of Bālakāṇḍa.

CO2: Understand the family values and ideal human relationships portrayed in the Ayodhyākāṇḍa and Aranyākāṇḍa of Rāmāyaṇa.

CO3: Understand dharma and its nuances, emphasizing its applicability in an individual’s life through Kishkindhaṅga and Sundarakāṇḍa of Ramayana.

CO4: Appreciate the triumph of dharma over adharma through Yuddhaṅga of Rāmāyaṇa

CO5: Appreciate the spiritual values from Rāmāyaṇa in resolving personal and social conflicts through varied effective presentations of important episodes of the Rāmāyaṇa

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Unit 1
Pure gaseous substances – P-v-T behavior of pure substances, Calculation of work done, heat transferred, change in enthalpy in different processes – Ideal and Non-ideal gases; Equation of State, Compressibility factor.

Gas Mixtures – P-v-T behavior of gas mixtures, ideal and non-ideal mixtures, Mixture rules, Compressibility factors for mixtures.
Excess properties of mixtures – Temperature and Pressure dependence, Gibbs-Duhem equation;

Unit 2
Ideal and non-ideal solutions; vapor pressure of solutions; fugacity and activity coefficients and their estimation; Criterion for vapor liquid equilibrium (VLE); Binary VLE – Bubble and dew point calculations – Equation of State and Activity Co-efficient models; Multi-component VLE – K-factor approach; Thermodynamic consistency of VLE data.

Criterion for liquid-liquid equilibrium; Estimation of distribution co-efficient from activity models;
Composition estimation in problems related to extraction.

Unit 3
Criterion for chemical reaction equilibrium – feasibility of chemical processes, Equilibrium constant;

Conversion calculations in a reaction – Homogeneous gas phase reactions, Gas-Liquid reactions, effect of temperature and pressure on conversion.

Course Outcomes
CHE211.1 Students will understand thermodynamic definitions, ideal, non ideal gases, equations of state, gas mixtures and mixture rules
CHE211.2 Understand ideal and non ideal solutions, criterion for vapor liquid equilibrium(VLE),binary and multi-component VLE and criterion for liquid-liquid equilibrium
CHE211.3 Ability to estimate the feasibility of chemical processes and predict the criterion for chemical reaction equilibria
CHE211.4 Analyze homogeneous gas phase reactions, gas-liquid reactions and conversion calculations in chemical reactions

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**TEXTBOOK AND REFERENCE BOOKS:**


**15CHE212 CHEMICAL TECHNOLOGY 4004**

**Unit 1**

Chemical processing, the role of a chemical engineers in process industries, importance of block diagrams and flow charts, unit operations, unit processes, process utilities and economics, industrial safety and pollution, outline of plant and equipment design, process control and instrumentation; Chlor-Alkali: Definition of electrochemistry, manufacture of soda ash by solvay process, manufacture of chlorine & caustic soda by diaphragm cell, advantages & disadvantages of diaphragm & comparison with mercury cell. Cement: Definition of cement & portland cement, process description, raw material, flow sheet & major engineering problems associated with the dry processes for manufacturing of portland cement; Glass & Ceramics: Definition and general composition of glass, raw material, methods of manufacture, special glasses - fused silica and high silica glass; Ceramics – properties, classification, manufacturing process; Types of refractories and manufacturing processes; kilns. Inorganic Acids: Flow sheet, raw materials, industrial applications, and engineering problems for Sulfuric acid (includes production of Sulfur) and Hydrochloric acid. Soap & Detergent industry: Continuous hydrolysis & saponification process, flow sheet for continuous process, for fatty acids, soap & glycerine; types of surface active agents, different constituents of detergent, manufacturing process of detergent (sulfonation and sulfation and compounding of detergent). Vegetable Oils: Extraction methods, hydrogenation of vegetable oils,
general methods of production; Pulp & Paper Industry: Kraft process for pulp manufacture, Fourdrinier and Cylinder Machine processes for paper manufacture, and paper finishing;

**Unit 2**

Fertilizer Industry: mixed and direct-application fertilizers, NPK value, granulation, Haber process for Ammonia synthesis; Petroleum Refining Industry: Constituents of petroleum, products of refining, processing or refining; Petrochemicals Industry: Unit operations, chemical conversions, manufacture of petrochemicals, reactions producing petrochemicals; Paints & Varnishes: Brief description of requirements for surface coatings, simple flow sheet of paint coatings, simple flow sheets of paint manufacturing process, varnishes & their applications; Dyes and Intermediates: Raw materials, important cyclic intermediates, chemical conversions, structure and classification of dyes.

**Unit 3**

Polymers & Plastics Industries: Definitions, types of polymers, classifications, polymerization reactions, manufacture of PE, PP, PVC; Phenolic and epoxy resin. Rubber Industries: Natural and synthetic rubber, rubber compounding, rubber fabrication, latex compounds, and rubber derivatives; Pharmaceutical: Classification, alkylation, condensation and cyclization, dehydration, halogenations, oxidation, sulfonation, amination. Fermentation process; Manufacture of antibiotic - Penicillin, Streptomycin and Erythromycin; Biologicals. Food industry: Types of processing (refining & milling, canning, concentration, freezing, drying, pasteurization); Sugar: Manufacture and refining of cane sugar, decolorization, bagasse, beet sugar.

**Course Outcomes**

CHE212.1 Understand the role of Chemical Engineers in chemical processing, plant location considerations and manufacture of various chemical products

CHE212.2 Analyze and understand the significance of unit processes and equipment involved in manufacture of organic and inorganic chemical products.

CHE212.3 Understand the production sequences and manufacturing processes involved in selected chemical process industries

CHE212.4 Develop knowledge to propose a process flow diagram with enhanced process parameters for improved performance in chemical process industries

**CO-PO Mapping**
TEXTBOOKS:


REFERENCES:


15CHE213 PROCESS HEAT TRANSFER 3 1 0 4

Unit 1
Modes of heat transfer – Fourier’s law of heat conduction and applications; Thermal conductivity measurement; Steady state conduction with variable area; Heat transfer coefficient & film theory; Heat transfer in extended surfaces; Heat Transfer to Fluids without phase change: Concepts of heat transfer by convection – Natural and forced convection; Correlations for the calculation of heat transfer coefficients.

Unit 2
Analogies between transfer of momentum and heat – Reynold’s analogy, Prandtl and Colburn analogies; Heat Transfer to Fluids with Phase Change – heat transfer from condensing vapors, drop wise film wise condensation, film condensation on vertical surface and horizontal tube bank; Heat transfer to boiling liquids – mechanism of boiling of saturated liquids; Heat exchangers – shell & tube, double pipe, flow
patterns, construction and operational features, theory & calculations, energy balances and effectiveness.

Unit 3
Heat exchanger design procedure – Effectiveness - NTU Method – Chart for different configurations; Theory of Evaporation; evaporator types; single effect and multiple effect evaporation; evaporator design considerations; Radiation heat transfer – Emissive power, Black body radiation, Emissivity, Stefan–Boltzman law, Planck’s law, radiation between surfaces.

Course Outcomes

CHE213.1 Ability to understand conduction, convection, and radiation heat transfer modes
CHE213.2 Ability to estimate value of heat transfer coefficient for systems with and without phase change
CHE213.3 Ability to understand and solve the coupled heat transfer and fluid dynamics problems
CHE213.4 Design and analyze the performance of heat exchangers
CHE213.5 Design and analyze the performance of evaporators

CO-PO Mapping

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TEXTBOOKS:
REFERENCES:

15CHE285 CHEMICAL ENGINEERING INSTRUMENTATION LAB

Measurements – Units and Dimensions, Unit Conversions, Significant Figures, Uncertainty in Measurements: Standard Error, Standard Deviation, Sampling and Confidence Intervals; Rating an Instrument – Interval, Range, Resolution, Sensitivity, Detection Limit, Repeatability, Reproducibility, Accuracy and Precision; Graphical Representation of Data – Scatter Plots, Linear, Log-Linear and Log-Log Plots, 3D and Contour Plots, Bar Charts

Pressure Measurement (Two Experiments) – Atmospheric, Gauge, Differential, Vacuum, Barometric Pressure, Static vs. Dynamic Pressure; U-tube Manometer, Capsule Gauge, Thermal Gauge, Capacitive Gauge, Ion Gauge; Safety: Pressure Regulator, Relief Valves, Rupture Disks, Pressure Test and Leak Test;

Temperature Measurement (Two Experiments) – Wet Bulb, Dry Bulb Temperatures and Dew Point; Thermometers, Thermistors, Resistance Temperature Devices (RTD), Thermocouples, Thermopiles, Pyrometers;


Analysis of Solids and Powders (One Experiment) – Bulk and Particle Density; Particle Size and Size Distribution – Sieve Analysis, Diffraction, Microscopy;

Concentration and pH in Gases and Liquids (One Experiment) – pH Meters, Introduction to Chromatography, Mass Spectrometry, Refractometry, Spectroscopy

Course Outcomes

CHE285.1 Understand the principles behind the process instrumentation for measurement of temperature, pressure, density, concentration etc.,
CHE285.2 Perform Gauge R&R Analysis and test the suitability of an instrument for a given process.
CHE285.3 Develop a working model of an instrument for measuring temperature and pressure separately.
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</table>

TEXTBOOKS / REFERENCES:

3. AlokBarua, “Fundamentals of Industrial Instrumentation”, Wiley India, 2011

15CHE286 CHEMICAL TECHNOLOGY LAB. 0 0 2 1

1. Estimation of the percentage of nitrogen in urea by Kjeldahl’s method
2. Determination of the percentage of available chlorine in the given sample of bleaching powder.
3. Determination of acid value and iodine value of different oils (any two)
4. Estimation of saponification value of different oils (any two)
5. Determination of alkalinity and Total fatty matter by Soap analysis (any two)
6. Analysis of Flash point of a given oil (any two)
7. Determination of viscosity by red wood viscometer
8. Estimation of silica and moisture content in cement analysis.
9. Determination of sucrose content in the given sample of sugar
10. Analysis of the percentage of ash and lactose content in the given milk sample.

Course Outcomes
CHE286.1 Understanding the theoretical concepts by way of doing lab experiments
CHE286.2 Exposure for how the factors are affecting the experiments
CHE286.3 Able to understand the evaluation of material/product performance
CHE286.4 Work in a team to perform laboratory experiments and exposure for team work

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15SSK221      SOFT SKILLS I      1 0 2 2

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<td>1.</td>
<td>Soft Skills: At the end of the course, the students would have developed self-confidence and positive attitude necessary to compete and challenge themselves. They would also be able to analyse and manage their emotions to face real life situations.</td>
<td>PO8, PO9, PO10, PO12</td>
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<td>2.</td>
<td>Soft Skills: At the end of the course, the students would hone their presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.</td>
<td>PO9, PO10, PO12</td>
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<td>3.</td>
<td>Aptitude: At the end of the course, the student will have acquired the ability to analyze, understand and classify questions under arithmetic, algebra and logical reasoning and solve them employing the most suitable methods. They will be able to analyze, compare and arrive at conclusions for data analysis questions.</td>
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<td>4.</td>
<td>Verbal: At the end of the course, the students will have the ability to dissect polysyllabic words, infer the meaning, inspect, classify, contextualise and use them effectively</td>
<td>PO10, PO12</td>
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5. Verbal: At the end of the course, the students will have the ability to understand the nuances of English grammar and apply them effectively.  

6. Verbal: At the end of the course, the students will have the ability to identify, analyse and interpret relationship between words and use the process of elimination to arrive at the answer. They will also have the ability to judge, evaluate, summarise, criticise, present and defend their perceptions convincingly.

**CO-PO Mapping:**

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Soft skills and its importance: Pleasure and pains of transition from an academic environment to work-environment. Need for change. Fears, stress and competition in the professional world. Importance of positive attitude, self motivation and continuous knowledge upgradation.

Self-confidence: Characteristics of the person perceived, characteristics of the situation, characteristics of the perceiver. Attitude, values, motivation, emotion management, steps to like yourself, positive mental attitude, assertiveness.

Presentations: Preparations, outlining, hints for efficient practice, last minute tasks, means of effective presentation, language, gestures, posture, facial expressions, professional attire.

Vocabulary building: A brief introduction into the methods and practices of learning vocabulary. Learning how to face questions on antonyms, synonyms, spelling error, analogy, etc. Faulty comparison, wrong form of words and confused words like understanding the nuances of spelling changes and wrong use of words.

Listening skills: The importance of listening in communication and how to listen actively.
Prepositions, articles and punctuation: A experiential method of learning the uses of articles and prepositions in sentences is provided.

Problem solving level I: Number system; LCM & HCF; Divisibility test; Surds and indices; Logarithms; Ratio, proportions and variations; Partnership;

Problem solving level II: Time speed and distance; work time problems;

Data interpretation: Numerical data tables; Line graphs; Bar charts and Pie charts; Caselet forms; Mix diagrams; Geometrical diagrams and other forms of data representation.

Logical reasoning: Family tree; Deductions; Logical connectives; Binary logic; Linear arrangements; Circular and complex arrangement; Conditionalities and grouping; Sequencing and scheduling; Selections; Networks; Codes; Cubes; Venn diagram in logical reasoning; Quant based reasoning; Flaw detection; Puzzles; Cryptographs.

**TEXTBOOKS:**

5. Quantitative Aptitude by R. S. Aggarwal, S. Chand
6. Quantitative Aptitude – Abijith Guha, TMH.
7. Quantitative Aptitude for Cat - Arun Sharma. TMH.

**REFERENCES:**

3. The BBC and British Council online resources
4. Owl Purdue University online teaching resources www.the grammarbook.com - online teaching resources
   www.englishpage.com - online teaching resources and other useful websites.

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15CHE301 CHEMICAL REACTION ENGINEERING I 3 0 0 3

Unit 1
Elementary reactions - Rate equation and rate law, temperature dependency of rate of reaction (rate
Non-elementary reactions, mechanisms of non-elementary reactions – the pseudo steady state hypothesis (PSSH).

Analysis of Batch Reactor Data – Integral and Differential analysis of data, rate parameter estimation using least square analysis and curve fitting.

**Unit 2**
Design / performance equations for homogeneous and Isothermal systems – Batch, mixed flow and tubular reactors; size comparison of different reactors for single reactions; Rate parameter estimation using experimental data from various reactors.

Combination of reactors for a single reaction; Mixed Flow Reactors in Series; Combined Reactors in Series – Plug flow followed by mixed flow and vice versa. Parallel reactors – feed distribution in parallel reactor configuration; Auto catalytic reactions - Recycle reactors, Optimization of recycle ratio.

**Unit 3**
Multiple reactions – series, parallel and series-parallel reactions; Conversion and Selectivity; Reactor design for series reactions; Reactor design for parallel reactions; Reactor design for Series-parallel reactions;

Adiabatic reactions; heat of reaction as a function of temperature; Temperature as a function of Conversion and vice versa; Cooling / heating requirements in near-isothermal operation; Effect of temperature on conversion and selectivity in multiple reactions;

**Course Outcomes**

CHE301.1 Estimate rate parameters rate constant, order, pre-exponential factor and activation energy from experimental data obtained from batch, mixed flow and plug flow reactors.

CHE301.2 Analyze the effect of parameters such as temperature, pressure etc., on reaction and reactor performance.

CHE301.3 Develop reaction mechanisms for non-elementary reactions based on experimentally determined rate

CHE301.4 Design and optimize reactors for single and multiple homogeneous reactions for required conversion, productivity and selectivity.

CHE301.5 Optimize recycle ratio for autocatalytic reactions

CHE301.6 Develop the relation between temperature and conversion for adiabatic reactions to operate them near isothermal.
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TEXTBOOK AND REFERENCE BOOKS:


15CHE302 DIFFUSIONAL MASS TRANSFER OPERATIONS 3 1 0 4

Unit 1

Molecular diffusion in fluids, Fick’s Law of diffusion, steady state diffusion under stagnant and laminar flow conditions. Diffusivity measurement and estimation, multi-component diffusion, diffusion in solids and its applications, eddy diffusion, mass transfer coefficients, theories of mass transfer, analogy equations, application of empirical correlations to known geometry such as flat plates, wetted wall columns. Concept of mass transfer coefficients, inter phase mass transfer, two film theory, relationship between individual and overall mass transfer coefficients. Mass transfer in fluidized bed, flow past solids and boundary layers. Equipments for countercurrent and concurrent mass transfer operations.

Unit 2

Absorption and stripping – Gas liquid equilibria, Raoult’s and Henry’s laws, Solubility of gases in liquid, choice of solvent; Material balance in countercurrent and concurrent absorption and stripping, L/G ratio, absorption factor; Equipment for absorption, Graphical and analytical methods for tray column,

Unit 3


Course Outcomes

CHE302.1 Understand fundamental concepts in mass transfer
CHE302.2 Ability to solve systems consisting of diffusion and convection
CHE302.3 Ability to estimate value of mass transfer coefficient for different systems involving fluid flow
CHE302.4 Design and analyze the performance of absorbers, humidifier, and crystallizer

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TEXTBOOKS:

2. Binay K. Dutta, Principles of Mass Transfer and Separation Processes, PHI Learning Private Ltd,
REFERENCES:


15CHE303  STATICS AND STRENGTH OF MATERIALS  3 1 0 4

Unit 1

Principles of statics: Introduction to vector approach - free body diagram - forces in plane and space - concurrent forces - resolution of forces - equilibrium of particle. Statics of rigid bodies in two and three dimensions - moment of force - rigid body equilibrium - support reactions. Centroid and centre of gravity; Centroids of lines, areas, volumes and composite bodies - Second moment of area - polar moment of inertia - mass moment of inertia.

Unit 2

Simple Stresses and Strains: Hooke’s law - Elastic limit linear strain - lateral strain - Analysis of varying sections - bars of composite sections – Thermal stresses. Shear force and bending moment; Different types of support conditions and loads - Cantilever – simply supported – Over hanging beams, point loads, uniformly distributed loads - Theory of Simple bending; flexural formula.

Unit 3

Course Outcomes

CHE303.1 To understand the vectorial and scalar representation of forces and moments and to develop simple mathematical model for engineering problems and carry out static analysis.

CHE303.2 To analyse & solve rigid body equilibrium problems using free-body diagrams and accurate equilibrium equations

CHE303.3 To gain a fundamental understanding of the concepts of stress, strain and moduli by applying it to solids subjected to elastic deformation

CHE303.4 To analyze statically determinate axial members, torsional members, and beams to determine axial forces, torque, shear forces, and bending moments.

CO-PO Mapping

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TEXTBOOKS:

REFERENCES:

15ENV300 ENVIRONMENTAL SCIENCE AND SUSTAINABILITY 3003

Unit 1

State of Environment and Unsustainability, Need for Sustainable Development, Traditional conservation systems in India, People in Environment, Need for an attitudinal change and ethics, Need for Environmental Education, Overview of International Treaties and Conventions, Overview of Legal and Regulatory Frameworks.

Environment: Abiotic and biotic factors, Segments of the Environment, Biogeochemical Cycles, Ecosystems (associations, community adaptations, ecological succession, Food webs, Food chain, ecological pyramids), Types of Ecosystems – Terrestrial ecosystems, Ecosystem Services, Economic value of ecosystem services, Threats to ecosystems and conservation strategies.

Biodiversity: Species, Genetic & Ecosystem Diversity, Origin of life and significance of biodiversity, Value of Biodiversity, Biodiversity at Global, National and Local Levels, India as a Mega-Diversity Nation (Hotspots) & Protected Area Network, Community Biodiversity Registers. Threats to Biodiversity, Red Data book, Rare, Endangered and Endemic Species of India. Conservation of Biodiversity. People’s action.

Impacts, causes, effects, control measures, international, legal and regulatory frameworks of: Climate Change, Ozone depletion, Air pollution, Water pollution, Noise pollution, Soil / land degradation / pollution

Unit 2

Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste management.

Discuss the interrelation of environmental issues with social issues such as: Population, Illiteracy, Poverty, Gender equality, Class discrimination, Social impacts of development on the poor and tribal communities, Conservation movements: people’s movements and activism, Indigenous knowledge systems and traditions of conservation.
Unit 3


Global and national state of housing and shelter, Urbanization, Effects of unplanned development case studies, Impacts of the building and road construction industry on the environment, Eco-homes / Green buildings, Sustainable communities, Sustainable Cities.

Ethical issues related to resource consumption, Intergenerational ethics, Need for investigation and resolution of the root cause of unsustainability, Traditional value systems of India, Significance of holistic value-based education for true sustainability.

Outcomes:

ENV300.1 CO1: Integrate facts and concepts from ecological, physical and social sciences to characterize some common socio-environmental problems.

ENV300.2 CO2: Develop simple integrated systems and frameworks for solving common interconnected socio-environmental problems.

ENV300.3 CO3: Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.

ENV300.4 CO4: Identify the ethical underpinnings of socio-environmental issues in general.

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Unit 1
Random Variable and Distributions: Introduction to random variable – discrete and continuous
distribution functions - mathematical expectations – moment generating functions and characteristic
functions. Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions (MGF,
mean, variance and simple problems) – Chebyshev’s theorem

Unit 2
Sampling Distributions: Distributions of Sampling Statistics, Chi-square, t and F distributions (only
definitions and use). Central Limit Theorem.
Theory of estimation: Point Estimation, Unbiased estimator - Maximum Likelihood Estimator - Interval
Estimation.

Unit 3
Testing of Hypothesis: Large and small sample tests for mean and variance – Tests based on Chi-square
distribution.

Course Outcomes
15MAT214.1 Understand the basic concepts of probability and probability modeling.
15MAT214.2 Gain knowledge about statistical distributions and their properties
15MAT214.3 Get in-depth knowledge about statistical distributions and their real time applications.
15MAT214.4 Understand some approximation theorems on probability and distributions.
15MAT214.5 Know the importance of estimating the parameters of probability models.
15MAT214.6 Ability to make decisions under uncertainties using statistical testing of hypotheses

TEXTBOOK:
John Wiley and Sons Inc.

REFERENCE BOOKS:
15CHE381 HEAT TRANSFER LAB. 0 0 2 1

Thermal conductivity of solid materials, transient heat conduction, electrical analogies, natural convection, forced convection, heat transfer in pool boiling, condensation heat transfer, steady and unsteady state heat transfer through submerged coils in agitated vessels. Radiation heat transfer, characteristics and efficiency of heat transfer equipments such as heat exchangers, jacketed pans and evaporators.

Course Outcomes

CHE381.1 Design of experiment based on theoretical concepts studied in classroom.

CHE381.2 Understanding of concept of heat transfer coefficient and its determination for various systems under different convection conditions.

CHE381.3 Understanding of operation and design concepts of heat exchangers

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Tensile test on metals and wires - determination of tensile strength, modulus of elasticity, percentage elongation; Hardness tests - Rockwell, Brinell hardness number; Impact test - Izod and Charpy - impact strength, energy and modulus estimation; Compression test; Torsion test on shafts - determination of shear stress and modulus of rigidity; Static bending test – fibre stress at limit of proportionality, resilience, modulus of elasticity; Fatigue test - S-N curves; Deflection test on beams; Double shear test.

Course Outcomes

CHE382.1 To gain fundamental knowledge on the mechanical behaviour of materials when subjected to tensile, impact and bending loads.

CHE382.2 Familiarization of the experimental methods to determine the mechanical properties like strength, modulus, hardness, toughness and stiffness of materials.

CHE382.3 Develop ability to work in groups and document results as reports.

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<td>Soft Skills: At the end of the course, the students will have the ability to communicate convincingly and negotiate diplomatically while working in a team to arrive at a win-win situation. They would further develop their inter-personal and leadership skills.</td>
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<td>Soft Skills: At the end of the course, the students shall learn to examine the context of a Group Discussion topic and develop new perspectives and ideas through brainstorming and arrive at a consensus.</td>
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<td>Aptitude: At the end of the course, students will be able to identify, recall and arrive at appropriate strategies to solve questions on geometry. They will be able to investigate, interpret and select suitable methods to solve questions on arithmetic, probability and combinatorics.</td>
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<td>Verbal: At the end of the course, the students will have the ability to relate, choose, conclude and determine the usage of right vocabulary.</td>
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<td>Verbal: At the end of the course, the students will have the ability to utilise prior knowledge of grammar to recognise structural instabilities and modify them.</td>
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<td>Verbal: At the end of the course, the students will have the ability to comprehend, interpret, deduce and logically categorise words, phrases and sentences. They will also have the ability to theorise, discuss, elaborate, criticise and defend their ideas.</td>
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Professional grooming and practices: Basics of corporate culture, key pillars of business etiquette. Basics of etiquette: Etiquette – socially acceptable ways of behaviour, personal

Group discussions: Advantages of group discussions, structured GD – roles, negative roles to be avoided, personality traits to do well in a GD, initiation techniques, how to perform in a group discussion, summarization techniques.

Listening comprehension advanced: Exercise on improving listening skills, grammar basics: Topics like clauses, punctuation, capitalization, number agreement, pronouns, tenses etc.

Reading comprehension advanced: A course on how to approach middle level reading comprehension passages.

Problem solving level III: Money related problems; Mixtures; Symbol based problems; Clocks and calendars; Simple, linear, quadratic and polynomial equations; special equations; Inequalities; Functions and graphs; Sequence and series; Set theory; Permutations and combinations; Probability; Statistics.

Data sufficiency: Concepts and problem solving.

Non-verbal reasoning and simple engineering aptitude: Mirror image; Water image; Paper folding; Paper cutting; Grouping of figures; Figure formation and analysis; Completion of incomplete pattern; Figure matrix; Miscellaneous.

Spacial aptitude: Cloth, leather, 2D and 3D objects, coin, match sticks, stubs, chalk, chess board, land and geodesic problems etc., related problems.

**TEXTBOOKS:**

5. Quick Maths – Tyra.
6. Quicker Arithmetic – Ashish Aggarwal
7. Test of reasoning for competitive examinations by Thorpe.E. TMH
8. Non-verbal reasoning by R. S. Aggarwal, S. Chand

**REFERENCES:**

15CHE390 / 15CHE490  
LIVE-IN-LAB.  
3 cr

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after fourth semester or sixth semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth or seventh semester. The objectives and projected outcome of the project should be reviewed and approved by the Dept. chairperson and a faculty assigned as the project guide. On completion of the project, the student shall submit a detailed project report. The report shall be evaluated and the students shall appear for a viva-voce test on the project.

15CHE311  
CHEMICAL REACTION ENGINEERING II  
3 0 0 3

Unit 1

Steps in heterogeneous reactions – bulk diffusion, internal diffusion, adsorption, desorption and surface reaction; Rate expressions for different steps in heterogeneous systems; Thiele modulus and effectiveness factor.

Flow regimes in Gas-Solid and Liquid-Solid systems; Estimation of overall mass transfer coefficient in heterogeneous systems; Design of packed-bed, fluidized bed, slurry and trickle bed reactors;

Unit 2

Relative rates of reaction and mass transfer in non-catalytic reactions in Gas-liquid reactions – Hatta number; Effect of gas solubility on rate of reaction;

Models for fluid-solid reactions: Progressive conversion model and Shrinking core model; Rate controlling steps in fluid-solid non-catalytic systems; Reactor design for non-catalytic reactions.
Unit 3

Non-ideal mixing in reactors; Estimation of mean residence time distribution and dispersion in mixing vessels using tracer studies; Dispersion model and Tanks-in Series model.

Course Outcomes

CHE311.1 Develop rate expressions for different steps in heterogeneous catalytic and non-catalytic reactions
CHE311.2 Identify the rate limiting step in heterogeneous reactions
CHE311.3 Design catalysts for pore diffusion control / elimination
CHE311.4 Analyze the effect of parameters on heat and mass transfer in heterogeneous systems
CHE311.5 Design reactors for Gas-Solid & Liquid-Solid catalytic and non-catalytic reactions
CHE311.6 Analyze the effect of non-ideal mixing in reactors on mean residence time and reactor performance
CHE311.7 Estimate kinetic rate parameters using experimental data from multi-phase reactors

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TEXTBOOK AND REFERENCE BOOKS:
15CHE312 EQUILIBRIUM STAGED OPERATIONS 3104

Unit 1
Design of mass transfer equipment based on the concept of equilibrium stage;

Distillation: vapor-liquid equilibria, Raoult’s law and deviations from ideality, methods of distillation; Equilibrium and operating line concepts; Design calculations by McCabe-Thiele and Ponchon-Savarit methods; Continuous contact distillation (packed tower) design; Extractive and azeotropic distillation, low pressure distillation; Steam distillation; Tray tower equipment.

Unit 2
Absorption: Design of tray tower absorbers; Operating characteristics of stagewise and differential contactors; Design calculations for single stage, multistage concurrent and countercurrent absorbers.

Liquid-liquid extraction: Equilibrium in ternary systems; Design calculations for batch and continuous extractors, equipment – spray, packed and mechanically agitated contactors; Pulsed extractors, centrifugal extractors.

Unit 3
Leaching: Solid-liquid equilibria; Equipment – batch and continuous types; Calculation of number of stages.

Adsorption and Ion exchange: Theories of adsorption of gases and liquids; Principle of ion exchange; Equipment for batch and continuous operation; Design calculations for adsorption and for ion exchange resins.

Miscellaneous separation processes: Introduction to membrane separation process; Solid and liquid membranes; Reverse osmosis; Electrodialysis.
Course Outcomes

15CHE312.1 Develop a strong conceptual understanding of various mass transfer processes

15CHE312.2 Understand general design and operations of mass transfer equipments

15CHE312.3 Analyze chemical engineering operations involving mass transfer equipments

15CHE312.4 Ability to solve problems involving staged mass transfer processes such as distillation, extraction, adsorption, absorption and leaching.

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TEXTBOOKS:


REFERENCES:

15CHE313 MATERIALS TECHNOLOGY 3 0 0 3

Unit 1


Unit 2


Unit 3


Course Outcomes

CHE313.1 To understand the structure, directions, planes and directions in polycrystalline materials
CHE313.2 To understand the different types of deformation and mechanical behavior of materials
CHE313.3 To create awareness on the various test methods for the selection of materials for specific applications
CHE313.4 To gain fundamental knowledge on the construction of phase diagrams for alloy systems
CHE 313.5 To analyze the various heat treatment processes and the corresponding changes in the structure and properties of metals and alloys
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TEXTBOOKS:

REFERENCES:
1. L H Van Vlack, Elements of Materials Science and Engineering, Pearson India 2008

15CHE314 PROCESS DYNAMICS AND CONTROL 3 1 0 4

Unit 1

Laplace transformation, transform of standard functions, derivatives and integrals; Open–Loop systems, first order systems: concept of transfer functions, transient response for standard input functions, physical examples of first order systems, first order systems in series, linearization and its application in process control, second order systems and their dynamics, transportation lag.

Unit 2

Closed loop control systems, development of block diagram for feedback control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers; transient response of closed – loop control systems; stability of control systems: Routh-Hurwitz criterion, root locus diagrams.
Unit 3

Frequency response of closed – loop systems, control system design by frequency response techniques, bode diagram and stability criterion, tuning of controller settings. Introduction to advanced control systems - cascade control, Feed-forward control; Control of chemical processes.

Course Outcomes

CHE314.1 Understand the necessity for process control in chemical process plants and apply basic principles to dynamic modelling, developing transfer functions and system behaviour study to various input functions.

CHE314.2 Develop block diagram and utilize control algorithms to design and analyse transient response of control schemes for various configurations.

CHE314.3 Analyse stability of control Systems and tuning of process controllers.

CHE314.4 Application of control systems in chemical processes.

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TEXTBOOKS:

REFERENCE BOOKS:
2. *Peter Harriot, Process Control, Tata McGraw Hill, 2008*

**15MAT302 NUMERICAL METHODS 2023**

**Unit 1**
Review of Errors: Accuracy and Precision, round-off error and truncation error. (Sec. 2.2-2.4)

Roots of Transcendental and Polynomial Equations: Bisection method, Iteration methods based on first degree equation, Rate of convergence, System of nonlinear equations. (Sec. 4.2, 4.3, 5.1-5.3, 5.5)


**Unit 2**
Interpolation and Approximation: Lagrange and Newton interpolation for unequal intervals, Finite difference operators, Interpolating polynomials using finite differences. (Sec. 13.1 – 13.4, 13.6)

**Unit 3**
Review of Ordinary Differential Equations:


Lab. - Implementation of these methods: MATLAB or EXCEL or Free and Open Source Software (FOSS) tools like R-programming and Scilab.

**Course Outcomes**

15MAT302.1 Understand and apply different numerical methods to solve algebraic, transcendental equations and system of nonlinear equations

15MAT302.2 Understand and apply power method, Jacobi method to find eigenvalues and eigenvectors

15MAT302.3 Understand and apply concept of interpolation and inverse interpolation

15MAT302.4 Understand and implementation of methods Taylors series, Euler method, modified Euler method and RK methods to solve ODE

15MAT302.5 Implementation of numerical methods using MATLAB and writing efficient well documented MATLAB codes and present numerical methods in an informative way.
**TEXTBOOK:**

**REFERENCE BOOKS:**

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**15CHE385 CHEMICAL REACTION ENGINEERING LAB. 0 0 2 1**

Lecture on RTD studies; Study of kinetic expressions for first and second order reactions, kinetic studies in batch reactor, Semi batch reactor, Sono batch reactor, CSTR, PFR, Combined reactor in series, RTD study in CSTR in series, RTD study in a PFR.

**Course Outcomes**

**CHE385.1** Evaluate the kinetic parameters for a given reaction from the experimental data obtained from different reactors

**CHE385.2** Design reactors using experimentally obtained kinetic parameters and performance equation for a specified conversion

**CHE385.3** Determine conversion in various reactors and compare it with the theoretical value

**CHE385.4** Estimate the mean residence time and mixing behavior based on RTD studies

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15CHE386  
MASS TRANSFER LAB.  
0 0 2 1


Course Outcomes

CHE386.1  To understand the molecular diffusion in fluids and to determine the diffusion coefficient for given organic fluid into air and mass transfer coefficient for the evaporation of liquid into air under natural and forced convection conditions.

CHE386.2  Understand the basic principles of distillation and conduct simple, steam and packed bed distillation experiments.

CHE386.3  Understand the basic principles of leaching and conduct co-current single stage, multistage leaching and counter current leaching.

CHE386.4  Understand the principles of adsorption and determine the amount of adsorbate on the surface of adsorbent and interpret through adsorption isotherms.

CO-PO Mapping
### Course Outcomes

**CO#** | **Course Outcomes** | **Programme Outcomes**
--- | --- | ---
1. | Soft Skills: At the end of the course, the students will have the ability to prepare a suitable resume (including video resume). They would also have acquired the necessary skills, abilities and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews. | PO9, PO10, PO12
2. | Soft Skills: At the end of the course, the students will have the ability to analyse every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one’s right case positive attitude and courteous communication. | PO8, PO9, PO10, PO12
3. | Aptitude: At the end of the course, students will be able to interpret, critically analyze and solve logical reasoning questions. They will have acquired the skills to manage time while applying methods to solve questions on arithmetic, algebra, logical reasoning, and statistics and data analysis and arrive at appropriate conclusions. | PO2, PO4
4. | Verbal: At the end of the course, the students will have the ability to understand and use words, idioms and phrases, interpret the meaning of standard expressions and compose sentences using the same. | PO10, PO12
5. | Verbal: At the end of the course, the students will have the ability to decide, conclude, identify and choose the right grammatical construction. | PO10, PO12

### Programme Outcomes

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Verbal: At the end of the course, the students will have the ability to examine, interpret and investigate arguments, use inductive and deductive reasoning to support, defend, prove or disprove them. They will also have the ability to create, generate and relate facts/ideas/opinions and share/express the same convincingly to the audience/recipient using their communication skills in English.

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Team work: Value of team work in organisations, definition of a team, why team, elements of leadership, disadvantages of a team, stages of team formation. Group development activities: Orientation, internal problem solving, growth and productivity, evaluation and control. Effective team building: basics of team building, teamwork parameters, roles, empowerment, communication, effective team working, team effectiveness criteria, common characteristics of effective teams, factors affecting team effectiveness, personal characteristics of members, team structure, team process, team outcomes.

Facing an interview: Foundation in core subject, industry orientation/knowledge about the company professional personality, communication skills, activities before interview, upon entering interview room, during the interview and at the end. Mock interviews.

Advanced grammar: Topics like parallel construction, dangling modifiers, active and passive voices, etc.

Syllogisms, critical reasoning: A course on verbal reasoning. Listening comprehension
advanced: An exercise on improving listening skills.

Reading comprehension advanced: A course on how to approach advanced level of reading, comprehension passages. Exercises on competitive exam questions.

Problem solving level IV: Geometry; Trigonometry; Heights and distances; Co-ordinate geometry; Mensuration.

Specific training: Solving campus recruitment papers, national level and state level competitive examination papers; Speed mathematics; Tackling aptitude problems asked in interview; Techniques to remember (In mathematics). Lateral thinking problems. Quick checking of answers techniques; Techniques on elimination of options, estimating and predicting correct answer; Time management in aptitude tests; Test taking strategies.

TEXTBOOKS:

5. Data Interpretation by R. S. Aggarwal, S. Chand
6. Logical Reasoning and Data Interpretation – Niskit K Sinkha
7. Puzzles – Shakuntala Devi

REFERENCES:

3. The BBC and British Council online resources
4. Owl Purdue University online teaching resources www.the grammarbook.com - online teaching resources
   www.englishpage.com- online teaching resources and other useful websites.
Students will apply the concepts that they have studied in Project Based Learning - I, and proceed with executing the project as per plan. The instructor provides guidance through tutorial classes to help the students to master problem solving and analytical aspects. There will be requirement of literature review report, two mid-project reports and a final report, each of which will be used towards course evaluation.

**Course Outcomes**

CHE396.1 Ability to construct detailed process flow chart

CHE396.2 Understand aspects of equipment, process, and plant design & economics

CHE396.3 Ability to prepare a detailed project report for set up of a chemical plant

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15CHE401 PROCESS DESIGN AND INTEGRATION

**Unit 1**


Reactor Network Synthesis - Reactor type and conditions for reaction systems, geometric techniques for synthesis of reactor networks.

**Unit 2**

Separation system Synthesis – Distillation column sequencing for ideal liquid mixtures, Separation system structure for non-ideal mixtures using distillation / residue curves. Reaction, Separation and
recycle systems for batch and continuous processes.

Unit 3


Course Outcomes

CHE401.1 Understand the concepts and hierarchy of chemical of process design. Apply heuristics to process design. Synthesize flow sheets.
CHE401.2 Use knowledge of reaction type and kinetics to identify performance criterion, optimum reactor configurations, conditions and reactor networks.
CHE401.3 Apply heuristics and thermodynamic principles to separation system synthesis - distillation columns sequencing for ideal and non-ideal mixtures.
CHE401.4 Appreciate the pinch concept and able to identify minimum energy targets, identification of different choices and constraint during heat exchange networking, heat integration of process equipment.

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15CHE402 PROCESS EQUIPMENT DESIGN AND DRAWING

Design and drawing of chemical engineering equipments – hydrodynamic design, process design, mechanical design and drawing of the following equipments:

Unit 1
Pressure Vessels, Storage Tanks, Heat exchangers, Condensers.

Unit 2
Evaporators, Dryers, Cooling towers, Crystallizers.

Unit 3
Absorption columns, Distillation columns, Extraction columns, Reactors.

Course Outcomes

CHE402.1 Knowledge of basics of process equipment and important parameters of process equipment design
CHE402.2 Able to process design of pressure vessels, shell and tube heat exchanger and condenser
CHE402.3 Able to process design of storage vessels, evaporator, packed bed absorption column and crystallizer.
CHE402.4 Able to process design of sieve tray distillation column, reactor, dryer and cooling tower

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15CHE403 TRANSPORT PHENOMENA 3 1 0 4

Unit 1

Review of basic vector algebra and introduction to tensors, Macroscopic – Microscopic-Molecular views of phenomena; Momentum Transport: viscosity, pressure and temperature effect on viscosity of gases and liquids, Newton’s law of viscosity, mechanisms of momentum transport, non-Newtonian fluids & power-law models, derivation of velocity profile using shell balance method, velocity distributions in falling film and circular tube; equations of continuity, motion, and mechanical energy; use of equations of change to solve flow problems; unsteady viscous flow.

Unit 2

Energy Transport: Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier’s law, mechanisms of energy transport, derivation of temperature profile using shell energy balance (with electrical, nuclear, viscous and chemical heat source); temperature distribution in solids and laminar flow, heat conduction through composite walls, and cylinders; Combined energy flux vector; equation of energy (alternate forms) - applications to specific systems (forced convection laminar flow in tube, tangential flow in annulus, transpiration cooling); unsteady heat conduction in
solids.

Unit 3

Mass Transport: Diffusivity, mechanisms of mass transport, concentration distribution in solids and in laminar flow, Fick’s law, temperature and pressure effect, theory of diffusion in gases and liquids, types of diffusion (ordinary, thermal, pressure, and forced), mass and moles transport, mass & molar average velocities; shell mass balances; concentration distribution through stagnant gas, diffusion in heterogeneous and homogeneous chemical reaction, falling film; Equations of change for multicomponent systems and concentration distribution in turbulent flows: derivation of equation of continuity for binary mixture.

Course Outcomes

15CHE403.1 Understanding of mechanism of various transport processes like momentum, heat and mass transport

15CHE403.2 Develop shell balances for steady flow through various geometries in momentum, heat and mass transport problems

15CHE403.3 Analyze chemical engineering industrial problems along with their appropriate boundary conditions for momentum, heat and mass transport problems

15CHE403.4 Ability to develop steady and time dependent solutions with their limitations for momentum, heat and mass transport problems.

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REFERENCES:

15CHE481 CHEMICAL PROCESS CONTOL LAB. 0021

Calibration of temperature, pressure and flow measuring instruments, Dynamics of first order, second order, interacting and non-interacting systems, Control valve characteristics, Study of control systems involving temperature, pressure, flow and level, Study advanced control strategies and Controller tuning.

Course Outcomes

CHE481.1 Understand the dynamic response of first and second order systems, first order systems in series in interacting and non-interacting manner different input functions and evaluate system parameters
CHE481.2 Understand the types of control valves, temperature measuring devices and their characteristics
CHE481.3 Analyse the response of control systems (level, flow, pressure etc) in different control configurations and control parameter settings, perform tuning of control configurations
CHE481.4 Understand and analyse the dynamic response of advanced control configurations

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Introduction to Aspen PLUS/ HYSYS; Thermodynamic property methods; Solution strategies; Simulation of pressure changing devices (Pumps, Compressors and Turbine); Simulation of two-phase and three phase separation units, Simulation of heat exchangers, Simulation of reactors (Plug Flow, Mixed Flow, Conversion, Gibbs, Equilibrium reactors and their combinations); Simulation of Distillation, Absorption and Extraction columns;

Case study set up and Sensitivity analysis.

Course Outcomes

CHE482.1 Understand the basic structure of a process simulation software
CHE482.2 Formulate governing equations for a process based on conservation principles and analyze degrees of freedom for a stream, equipment and process
CHE482.3 Develop and simulate a process flow sheet based on given problem statement
CHE482.4 Perform case studies for a chemical process

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15CHE495 PROJECT PHASE I 2 cr

Identification of the problem based on the current need gaps of the industry / knowledge / other academic / theoretical aspects; literature survey, identification of the project deliverables, identification of materials
/ equipment requirements, preparation of the methodology for the experimentation, and procurement of
the materials. Presentation of project progress report to the department for evaluation at the end of the
semester.

Course Outcomes

15CHE495.1 Create a set up through proper design and investigate the system using the engineering
knowledge acquired
15CHE495.2 Estimate and manage the cost and time of the project
15CHE495.3 Present the project with clarity and ethics in both oral and written mode
15CHE495.4 Develop a team and effectively participate in the team to execute the project
15CHE495.5 Support the environmental, social and engineering discipline through the project

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15CHE499 PROJECT PHASE II 10 cr

Setting up of the experimental work (hardware/software), carrying out the experimental work, carrying
out material characterization if required, analysis of the results, discussion and interpretation of the
results, validation of the hypothesis, and reporting project outcome in the approved format.

Presentation of the work / findings to the faculty for review and feedback three times during the semester.
The final project will be evaluated by expert panel consisting of internal and external examiners.

Course Outcomes

15CHE499.1 Create a set up through proper design and investigate the system using the engineering knowledge acquired

15CHE499.2 Estimate and manage the cost and time of the project

15CHE499.3 Present the project with clarity and ethics in both oral and written mode

15CHE499.4 Develop a team and effectively participate in the team to execute the project

15CHE499.5 Support the environmental, social and engineering discipline through the project

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ELECTIVES

15CHE431 BIOCHEMICAL ENGINEERING 3 0 0 3

Unit 1
Introduction: History and need for biochemical Engineering; Essential life sciences: Biomolecules; Microbial world; Metabolism and Bioenergetics; Cell and their function; Enzymes and enzyme kinetics: Enzymes fundamental concepts, Classification of enzymes; Industrial application of enzymes; Industrially important enzymes; Mechanism of enzymatic reactions; Kinetics: Michaelis-Menten and Briggs Haldane equation; Evaluation of kinetic parameters; Enzymes inhibition; Factors affecting the reaction rates;
Unit 2
Immobilized enzyme: Medical and analytical application of immobilized enzyme; Techniques; Immobilized Enzyme kinetics: Effect of mass transfer resistance. Microbial kinetics: Typical growth characteristics of microbial cells, factors affecting growth; Monod’s equation; Transport in microbial system: Newtonian and Non-Newtonian behaviour of broths; Agitation and Mixing; Power consumption; Gas– Liquid transport in cells; Transfer resistances; Mass transfer coefficients and their role in scale-up of equipments.

Unit 3
Bioreactors: Batch and continuous types; High performance bioreactors; Downstream processes and effluent treatment: Recovery and purification of products, different unit operations in down streaming with special reference to membrane separations; Extractive fermentation; Anaerobic treatment of effluents; Typical industrial examples for downstream processing and effluent disposal.

Course Outcomes

CHE431.1 Understand the basics of biomolecules and microbes to study different biochemical reactions.
CHE431.2 Study the basic concepts and kinetics of enzyme and immobilized enzyme
CHE431.3 Design and analyze the bioreactors
CHE431.4 Understand the downstream processing and industrial bioreactors

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REFERENCE BOOKS:
15CHE432 CHEMICAL PROCESS MODELING AND SIMULATION 3003

Unit 1

Chemical engineering problems; Modeling – Steps involved; Variables – Stream, Unit, and Process variables; Constraints – Conservation relations, Sources and sinks, Material, Energy, Momentum balances; Equilibrium relations, Constitutive models; Common assumptions in modeling; Types of models – Lumped, Distributed, and Staged parameter models; Design variables – Characteristic length, time, velocity, temperature, mass, force; Change of variables; Dimensionless groups in modelling.

Filling and draining tanks: Steady and unsteady states, Varying inlets and outlets, Level and flow control; Mixing tanks: Two and multiple streams, Composition control; Heated tank: Jacketed kettle with steam condensation, Electrical heating, Phase change; Isothermal CSTR: 1st and 2nd order reactions, Enzyme kinetics; Non-isothermal CSTR; Centrifugal separation.

Unit 2

Shell balances: Flow through a pipe, Continuity equation; Compressible fluid flow, Shock waves; Double-pipe heat exchanger: Steam condensing in shell/tube, Parallel vs counter flow; Pipeline flashing; Isothermal PFR: Component continuity equation, 1st and 2nd order reactions; Non-isothermal PFR: 1st and 2nd order reaction.

Triple effect evaporator; Binary distillation: continuous and batch columns; Multicomponent distillation: Underwood-Gilliland model; Gas absorption into a laminar liquid jet; Tray tower absorption: Kremser-Brown-Sauders equation, rigorous models; Reactive absorption in a wetted wall column; Multistagecountercurrent liquid-liquid extraction.

Unit 3

Selected Systems from the following: Multiple steady states and Stability: Isothermal and Non-isothermal CSTR; Temperature control in a non-isothermal PFR; Packed bed reactor; Polymerization: Bulk and Suspension polymerization; Membrane separation – Cross flow and reverse osmosis; Activated sludge
process – secondary bioreactor; Pyrolysis of plastic; Chemical vapor deposition; Continuous, multicomponent distillation column; Dry flue gas desulfurization; Ball mill; Rotary kiln.

Course Outcomes

CHE432.1 For a given chemical system, recognize the various processes taking place whose relative rates will influence system performance. Identify the characteristic scales appropriate to the system and processes and derive dimensionless groups.

CHE432.2 For a given chemical system, write the appropriate conservation and constitutive equations that determine the rates of the processes or specify the equilibrium conditions for reversible processes taking place.

CHE432.3 Determine appropriate specifications of model parameters for a chemical system - lumped, distributed, or staged system, to solve simple design and rating problems involving the system.

CHE432.4 Derive mathematical models for basic chemical engineering unit - lumped, distributed, and staged - operations and processes. Solve the models either by analytical techniques or set up a solution by numerical techniques.

CHE432.5 For a complex chemical system, construct a mathematical model in general terms, perform a dimensional analysis to understand interactions between competing phenomena, identify controlling physics, and reduce the model to simpler cases.

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TEXTBOOK / REFERENCE:

105


15CHE433 ENVIRONMENTAL ENGINEERING FOR PROCESS INDUSTRIES

Unit 1


Unit 2

Solid Wastes Management: Characterization of wastes-hazardous and non-hazardous wastes. Waste disposal and management laws and guidelines; Problems of collection and handling; various processing techniques used in solid waste management - treatment, disposal, utilization and management; value extraction from the wastes;

Industrial waste management and Pollution Prevention: Process modification, alternative raw material, recovery of by co-product, recycle and reuse of waste, energy recovery and waste utilization.

Unit 3

Air Pollution Control: Sources and effects of air pollutants on physical environment and living systems,
Methods of measuring and sampling of gaseous and particulate pollutants, meteorological aspects of air pollution, effects, Selection and Design of particulate and gaseous pollution control equipment; mechanical separation, Bag filter, cyclone separator, electrostatic precipitation, wet gas scrubbing, adsorption and absorption.

**Course Outcomes**

**CHE433.1** To develop basic knowledge on water pollutants and wastewater characteristics

**CHE433.2** To understand various unit operations and unit processes involved in wastewater treatment

**CHE433.3** To design and apply specific treatment methods for effluents of various chemical process industries

**CHE433.4** To design and apply specific treatment methods for air pollutants of various chemical process industries

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**TEXTBOOKS / REFERENCES:**


1995.


15CHE434 INTERFACIAL SCIENCE AND ENGINEERING 3003

Unit 1

Introduction – colloids, surfaces and interfaces, Colloids - classifications and characterizations. Colloids - preparation and purification methods - Surfaces and interfaces – definitions, description of different surface and interfaces, applications of interfacial engineering - Surface, interfacial tensions and measurement of interfacial tension using different methods - Surface properties.

Attractive forces and van der Waals interactions - Columbic forces and ionic, dipole interactions. Van der Waals forces in polar and non-polar media - Electrostatic and Electrokinetic theories.

Source of interfacial formation and electrical double layer (EDL) - Helmholtz model, Gouy-Chapman model, Debye–Hückel theory on EDL, EDL thickness - Surface potential, Zeta potential, pH effects, calculations - Electroosmosis and Electrophoresis, types, applications.

Unit 2


Adsorption – Gibbs surface excess, adsorption equation for Solid-Fluid interfaces, Gibbs adsorption isotherm – Physisorption vs Chemisorption, Thermodynamic considerations, heterogeneous catalysis.

Catalytic poisons, promoters and adsorption isotherms at S-V interfaces, Langmuir, Freundlich, BET adsorption isotherms and surface area calculations, adsorption at S-L interfaces - Adsorption isotherms in solid–liquid systems, nature of the adsorbent surface, environmental effects - Colloidal stability –
Coagulation, flocculation, mechanism for colloidal formation.

Unit 3

Colloidal behaviour, Lennard–Jones 6–12 potential, attractive forces, sources of colloidal stability, critical coagulation concentration -Coagulation kinetics - fast and slow, Smoluchowski equation, DLVO theory, reversible flocculation.

Emulsions - formation, emulsification methods-Emulsifiers and Stabilizing agents, types, functions.

HLB number, PIT and Application of HLB and PIT in Emulsion Formulation - Association colloids - vesicles, micelles and membranes -Surfactant solubility, krafft temperature, and cloud point - Surfactant liquid crystals, micelles, micelle formation – Critical micelle concentrations (CMC) - factors affecting CMC, additives - Vesicles and bilayer membranes – definitions, applications.

Optical properties - Light scattering, turbidity, light scattering theories - Scattering by small particles, large particles, Rayleigh, Debye and Mie scattering of particles - Foams, Aerosols, Foam stability and microfoams - Rheological properties of colloidal dispersions - viscosity, newtonian and non-newtonian fluids, Electroviscous effects.

Course Outcomes

CHE434.1 Understand the fundamental theories associated with the surface and interface properties
CHE434.2 Understand the surface and interfacial phenomena of thin film coatings and colloids
CHE434.3 Analyze the role of surface and interface properties in the processings of different industrial products, intermediates and raw materials
CHE434.4 Design of new product formulations with superior surface and interface properties

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REFERENCE / TEXTBOOKS:

15CHE435 MATERIAL CHARACTERIZATION AND SPECTROSCOPIC METHODS

Unit 1


Unit 2

X-ray-diffraction, properties of x-rays, review of crystal systems and miller indices, stereographic projections, Laue conditions, braggs conditions, diffraction methods, phase identifications, electron diffraction methods.

Unit 3

EDAX, XPS, scattering methods, Thermal and Thermomechanical analysis: differential scanning calorimetry and Differential thermal analysis. Thermogravimetric analysis, Dynamic mechanical analysis and TMA.

Course Outcomes

15CHE435.1 Understand the fundamental principles behind the individual characterization methods which are included in the curriculum.
15CHE435.2 Analyze, interpret and present observations from the different characterization methods.
15CHE435.3 Assess which methods of characterization are appropriate for different material / requirement/ condition/ problems.
15CHE435.4 Able to evaluate the uncertainty of observations and results from the different characterization methods.

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**REFERENCE / TEXTBOOKS:**


**15CHE436 MODERN SEPARATION METHODS 3 0 0 3**

**Unit 1**

Introduction to binary distillation – The concept of K-factor; Multi-component distillation – Design, Models for multi-component design; Design of distillation columns for more than one feed stream; Pressure drop and tray-efficiency calculations.

**Unit 2**


Unit 3


Course Outcomes

CHE436.1 Ability to design multi component distillation columns with multiple feed streams
CHE436.2 Describe the the structure, characteristics and operational features of different types of synthetic membranes and membrane modules
CHE436.3 Explain the characteristic features, applications, limitations and advantages of separation operations like filtration, reverse osmosis, electrodialysis, pervaporation, gas separation and chromatographic separations
CHE436.4 Describe the governing principles and characteristic features of combined reaction and separation techniques, ionic separations, supercritical fluid extractions, industrial effluent treatment, reactive extraction and reactive distillation

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REFERENCES:
- Relevant journal publications.

15CHE437  NANOSCIENCE AND NANOTECHNOLOGY

Unit 1
Nanotechnology Fundamentals - Atomic structure, molecules and phases, surfaces, biosystems, metals, and other materials.

Molecular recognition, nanostructure preparation techniques, top-down and bottom up approach, self-assembly, nano manipulations – overview.

Familiar Nanostructures – SAMs, monolayer protected nanoparticles, quantum dots and core-shell nanoparticles, preparations, characterizations and applications.

Unit 2
Nano fabrication methods: Top-down approach – nanolithography techniques – dip pen, projection optical, e-beam, Extreme UV, proximity x-ray and MBE.

Bottom-up approach: self-assemblies – hydrogen bonded, biomimetic and dimensional nanoparticle arrays.

Carbon nanomaterials - Carbon nanotubes and fullerenes: Formation and properties of nanotubes, fullerenes, characterizations and their applications in electronics and energy storage.

Molecular switches – monomolecular in solutions, on surfaces (electron, pH and light driven switches).

Unit 3
Micro/ Nanoelectronics (Nanowires: transistors, LEDs, Lasers, photodetectors).

Nano-Bio Technology (Lipid and lipid templates, self-assembled monolayers, biological computing, Protein Engineering, biosensors, drug delivery, PDT), Social implications of nanotechnology.

Course Outcomes
15CHE437.1 Understanding of length scale concepts, top-down and bottom-up preparation methods of nanomaterials and nanostructures

15CHE437.2 Demonstrate the principles of processing and characterization methods of nanomaterials and nanoensembles

15CHE437.3 Apply the electron and scanning probe microscopes to characterize and to manipulate different nanostructures and nanodevices.

15CHE437.4 Evaluate and analyze the electrical, mechanical and thermal properties of nanostructured metals and semiconductors, quantum dots and carbon nanotubes

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**REFERENCE / TEXTBOOKS:**

Unit 1


Unit 2

Petrochemical technology: Petrochemical industry overview, primary raw materials for petrochemicals, first generation petrochemicals – hydrocarbon intermediates and their production, non-hydrocarbon intermediates, olefin production, processing of olefins C4& C5 cut from steam cracking and fluid cracking.

Unit 3


Course Outcomes

15CHE438.1 Understand the concepts of various physical and chemical processes in modern refinery
15CHE438.2 Ability to understand the overview and block diagrams of various operations involved in fractionation of crude oil
15CHE438.3 Analyze the design, operations and flow sheet of various units in fractionation of crude oil
15CHE438.4 Develop and analyze the flow sheets of various petrochemicals processes

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**TEXTBOOKS:**


**REFERENCES:**


**15CHE439 POLYMER COMPOSITES 3 0 0 3**

**Unit 1**

General introduction to composite materials: Concept and definition, classification of composites (CMC, MMC, PMC). Functional roles of reinforcement and matrix and importance of interface. Polymer matrix

**Unit 2**


**Unit 3**

Composite precursors: SMCs, DMCs, BMCs prepreg materials and their choice in specific applications. Fabrication processes for FRP Composites: hand layup, spray up, vacuum bag moulding, compression moulding, filament winding, braiding, pultrusion, RTM, RIM, RRIM, RFI, autoclave moulding, injection moulding etc. Room temperature and hot curing of composites, Joining composite elements and repairs, Recycling of polymer composites.

**Course Outcomes**

CHE439.1 Able to explain how common fibers are produced and how the properties of the fibers are related to the internal structure

CHE439.2 Able to explain how interfacial bonding may be achieved between matrices and reinforcement and parameters affecting composite properties

CHE439.3 Able to select suitable matrices and reinforcement of composites for suitable application including biodegradable green composites

CHE439.4 Able to analyze the mechanics of the composite materials including theoretical calculation based on mathematical models

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**TEXTBOOKS:**


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**15CHE440 POLYMER MATERIALS - STRUCTURE PROPERTY RELATIONS**

**Unit 1**

Structure of polymers – thermoplastic – thermoset, rubber - Linear, branched, crosslinked, and network polymers - Homochain and hetero atomic chain polymers - Copolymers - Linear and cyclic arrangement - Prediction of polymer properties, group contribution techniques, topological techniques - Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

Mechanical properties - Stress-strain properties of polymers - Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness - Crazing in glassy polymers - Ductile brittle transition. Effect of additives on mechanical properties of polymers - Creep, stress relaxation, and fatigue.

**Unit 2**

Thermodynamic and transition properties - Transition temperature in polymers, glass transition (Tg), melt transition (Tm), relationship between Tg and Tm - other transitions like β-transitions, upper and lower glass transition temperatures - Prediction of Tg and Tm of polymers by group contributions. Calorimetric properties - Heat capacity, specific heat, latent heat of crystallization and fusion, enthalpy and entropy -
Calculation of heat capacities of polymers.

Electrical and optical properties - Effect of polymer structure on dielectric constant, power factor, dissipation factor, and loss factor - effect of frequency of voltage and temperature on dielectric properties - Prediction of molar polarization and effective dipole moment. Effect of additives on electrical properties of polymers.

Unit 3
Optical properties - Effect of polymer structure on optical properties - clarity, transparency, haze, transmittance, reflectance, and gloss - Prediction of refractive indices of polymers by group contributions.
Chemical Properties - Cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers - Prediction of solubility parameter - Effect of polymer structure on solubility in solvents and oils - Influence of structure in prediction of flame retardancy, water repellency - Chemical resistance of polymers - Polymer toxicity.

Course Outcomes

15CHE440.1  Given the chemical structure of a monomer(s) and a polymerization mechanism, be able to predict other properties

15CHE440.2  Understand differences in terms of polymerization mechanism and product of a) free radical versus coordination addition polymerization and b) bulk, solution, suspension and emulsion addition polymerization.

15CHE440.3  Knowledge of chemical structure, properties and selection of material for end use applications

15CHE440.4  Ability to "cost" plastics products, including life cycle analysis with the appropriate design of a "plastics part"

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TEXTBOOKS:


REFERENCE BOOKS


15CHE441 POLYMER PROCESSING 3 0 0 3

Unit 1


Unit 2


Unit 3

Course Outcomes

15CHE441.1 Understand the fundamental background to the processing of polymeric materials like flow behaviour and mixing of additives

15CHE441.2 Comprehend the practical and theoretical basis of injection moulding and extrusion and their offshoot processes.

15CHE441.3 Familiarize a wide range of polymer processing operations like compression and transfer moulding, rotational moulding, blow moulding, thermoforming and assembling techniques.

15CHE441.4 Develop capability for selecting an appropriate processing method for the conversion of polymer feed to products.

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**TEXTBOOKS:**


**REFERENCES:**

Unit 1

Introduction, general principles of measurement, classification of instruments, elements of an instrument, direct and inferential measurement; Static and dynamic characteristics of instruments, errors in measurements & error Analysis; Classification of sensors and transducers, amplifier signal conditioner, signal isolation, transmission, display, data acquisition modules, interfaces, recording. Control centre, instrumentation diagram.

Temperature measurement: Expansion thermometers - constant-volume gas thermometer, pressure spring thermometer, volumetric and pressure thermometers; Thermoelectric temperature measurement - Thermoelectricity, industrial thermocouples; Resistance thermometers - industrial resistance thermometers, null-bridge resistance thermometers, deflectional resistance thermometers; Radiation temperature measurement - radiation pyrometers, photoelectric pyrometers and optical pyrometers.

Unit 2

Measurement of pressure and vacuum: Pressure, vacuum and head; liquid column manometers - U-tube type, well type and inclined type, micromanometers; Low pressure measurement - kenometer, McLeod gage, thermal conductivity gauge; Barometer method for atmospheric pressure measurement; pressure measurement using bourdon tube, flat and corrugated diaphragms, and capsules; Measurement of pressure in corrosive fluids using liquid seal and diaphragm seal.
Hydrostatic type, Elastic Element type, Electrical Type and other type of instruments like Neleod Gauge, Thermocouple gauge, Knudson Gauge, Ionization Gauge.

Flow measurement: Variable area and variable head flow meters, volumetric and mass flow rate meters, linear velocity measurement systems, anemometers; Measurement of Head and Level: Density and specific gravity - constant volume hydrometer, air pressure balance method, gas density detector and gas specific gravity measuring system; Level measurement: pressure type, resistance & capacitance type, sonic & ultrasonic, thermal type level meters, level measurement in open vessels and in pressure vessels, solid level detectors.

Unit 3

Viscometers: Redwood, Saybolt, Engler, Cup and Cone type, Rheo & other types of viscometers; Composition analysis - Gas analysis by thermal conductivity, analysis of moisture in gases (humidity), psychrometer method, hygrometer method, dew-point method for moisture analysis in gases, measurement of moisture solids; pH measurement; Gas analysis by thermal conductivity, polarography & chromatography; Composition analysis using spectroscopic methods; On line instrumentation in modern
plants.

**Course Outcomes**

15CHE442.1 Gain knowledge about general principles of measurement, measurement methods employed in industrial processing and manufacturing and various elements of instrumentation

15CHE442.2 Understand the static and dynamic characteristics of instruments, gain knowledge of calibration methods of instruments and processes and perform error analysis.

15CHE442.3 Acquire knowledge of the operating principles, construction & working of temperature measuring devices and gain ability to select the most suitable measuring device based on its performance characteristics

15CHE442.4 Understand the operating principles, construction & working of pressure, flow and level measuring devices.

15CHE442.5 Acquaint with the various latest analytical instruments and online instrumentation and gain knowledge of the working principles of instruments for measuring viscosity, pH, moisture, composition analysis etc

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**TEXTBOOK:**

1. Jain R. K., Mechanical and Industrial Measurements, Khanna
REFERENCES:


15CHE443 PROCESS INTENSIFICATION

Unit 1


Unit 2

Intensified Reactors: Spinning Disk Reactors; Oscillatory Baffled Reactors; Taylor-Couette Flow Reactor Microreactors: Basics & Applications; HEX Reactors; Induction Heating, Sonochemistry, Microwave Enhancement, Plasma Enhancement, Laser-Induced Reactions; Choice of reactors based on reaction type; Operating regimes of reactors - Dimensionless Analysis.

Supercritical Operation; Intensified Separation: Distillation Columns – Divided Wall Columns, Compact Heat Exchangers; HiGee; Centrifuges; Membrane-based Separation; Intensified Mixing: In-line Mixers: Static Mixer, Mixing on a Spinning Disk, Induction-Heated Mixer;

Unit 3

Reactive Separations: Reactive Distillation and Reactive Extraction; Membrane Reactors - Applications to dehydrogenation; Steam-methane reformation;

Case studies: Reaction separation of Plastic/Biomass pyrolysis; Petrochemicals and Fine Chemicals,
Refineries, Bulk Chemicals, & Nuclear Industry.

**Course Outcomes**

15CHE443.1 Identify inefficiencies, and economic pressures and environmental impacts of a process or operation

15CHE443.2 Understand the principles of process intensification

15CHE443.3 Assess the developmental stage or a process of an intensification technology based on evaluation of scientific and engineering literature (e.g. journals and patents), and industrial benchmarking.

15CHE443.4 Choose a variety of process technologies that can be used to intensify reaction kinetics, separations and/or transport phenomena, or that reduce processing cost.

15CHE443.5 Evaluate different process options based on qualitative and quantitative measures to arrive at an optimal process design choice

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**TEXTBOOK / REFERENCES:**

Unit 1

 Hazard identification: General hazards of plant operation toxic hazards, fire and explosions – hazards. Transport of chemicals with safety unforeseen deviations, emergency management, planning for safety, selecting a basics of safety – preventive and protective measures, safety based on emergency, relief systems, safety based on containment operational safety procedural instructions – routine checks, process and product changes, safety checks, checklist for safety, leaks and detection.

Unit 2

 Hazards of plant operation: Toxic hazards, fire and explosion hazards, reaction hazards, literature calculations & explosions screening, normal reaction, gas evolution, characterizing runaway, control and mitigation of gas emanations, absorption with chemical reaction, health and environmental effects. Special problem of developing countries, safety gadgets, dispersions, degree of hazards, disposals, hierarchy of options, threshold limits, laws of safety, accident reporting.

Unit 3

 Storage, central handling safety, unintentional spills, runoff emits, containment economics, waste disposal and environmental protection, incineration, alternatives. Risk analysis, evaluation, mitigation, Hazop, Hazan, definition, probability quantification – risk, engineering, clean technology, initiatives, standards, emergency handling, accident investigation, legislation, nil-risk quantification methods. Case histories of accidents, examples of hazards assessment, examples of use of Hazan, explosion hazards in batch units, technical process, documentation for hazardous chemicals, format and methods.

Course Outcomes

15CHE444.1 Identifying the typical sources of risks in a process plants by hazard identification and examination of case studies
15CHE444.2 Evaluate the workplace to determine occupational safety and health hazards
15CHE444.3 Select appropriate control methodologies to prevent hazards in industries
15CHE444.4 Undertake a Hazard and Operability Studies (HAZOP)

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TEXTBOOKS:


REFERENCES:


15CHE445    SOLAR ENERGY    3 0 0 3

Unit 1

Solar energy

Solar radiation, its measurements and analysis. Solar angles, day length, angle of incidence on tilted surface, Sunpath diagrams, Shadow determination. Extraterrestrial characteristics, Effect of earth atmosphere, measurement & estimation on horizontal and tilted surfaces.
Solar cell physics

p-n junction, homo and hetero junctions, Metal-semiconductor interface, Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, efficiency measurements, high efficiency cells, Tandem structure.

Unit 2

Solar cell fabrication technology

Preparation of metallurgical, Electronic and Solar grade Silicon, Production of Single Crystal ‘Si’, Chocharlski (CZ) and Float Zone (FZ) method for preparation of silicon, procedure of masking, photolithography and etching, Design of a complete silicon, GaAs, InP solar cell. High efficiency III-V, II-VI multijunction solar cell, a-Si-H based solar cells, Quantum well solar cell, Thermophotovoltaics. Nanosolar cells. Thin film technologies.

Solar Cell Characterization

Characterization of solar cells: IV characteristics, impedance, incident photon-to-current conversion efficiency (IPCE), intensity modulated photovoltage spectroscopy (IMPV), lifetime measurements.

Solar photovoltaic system design

Solar cell arrays, system analysis and performance prediction, shadow analysis, reliability, solar cell array design concepts, PV system design, Design process and optimization, Detailed array design, storage autonomy, Voltage regulation, maximum tracking, Power electronic converters for interfacing with load and grid, use of computers in array design, Quick sizing method, Array protection and troubleshooting.

Unit 3

Emerging Photovoltaic Technologies

Working principle, characterization and applications of: organic solar cells, dye sensitized solar cells, quantum dot solar cells, bulk heterojunction solar cells

SPV applications

Centralized and decentralized SPV systems, stand alone, hybrid and grid connected systems, system installation, operation and maintenances, case studies and field experience, PV market analysis and Economics of SPV systems.

Course Outcomes

127
15CHE445.1 Determine the placement of solar panels based on the daily and yearly movement of the sun in the sky.
15CHE445.2 Explain the basic functioning of photovoltaic cell along with its efficiency, figures of merit and main sources of losses.
15CHE445.3 Describe the main solar cell fabrication methods.
15CHE445.4 Design a simple solar photovoltaic system.

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**TEXTBOOKS:**

1. John W Twidell and A D Weir, Renewable Energy Resources, ELBS

**REFERENCE BOOKS:**

Unit 1

Introduction - Managers and Management. The historical roots of contemporary management practices - the pre-modern era, classical contributions, human resources approach, the quantitative approach. The Management Environment - A global market place, emphasis on technology, society and managers, entrepreneurship.

Foundations of Planning - Planning in uncertain environments, types of plans, management by objectives. The importance of organizational strategy, strategic framework, quality as a Strategic weapon. Foundations of Decision Making - The decision-making process, making decisions - the rational model, modifications of the rational model. Decision making - a contingency approach, decision-making styles, making decisions in groups.

Unit 2

Basic Organization Designs - The elements of structure, contingency variables affecting structure, organization design applications, learning organization, organization culture.

Managers and the Human resource management process - Employment planning, recruitment and selection, orientation, training, and development, performance management, compensation and benefits, managing change, stress and innovation, change process, organizational change and member resistance, making changes in the organization. Stress - the aftermath of organizational change, stimulating innovation.

Unit 3

Foundations of Individual and Group behaviour - Explaining and predicting behaviour, personality, perception, learning, foundations of group behaviour. Understanding work teams - types of work teams, characteristics of high-performance work teams. Motivating and rewarding employees - motivation and individual needs, early theories of motivation, contemporary theories of motivation. Leadership and Trust - Managers versus leaders, trait theories of leadership, behavioral theories of leadership, contingency theories of leadership, emerging approaches to leadership, contemporary leadership issues, building trust. Communication and Interpersonal skills - understanding communication, communication and Information Technology, developing interpersonal skills.

Foundations of Control - the importance of control, types of control, control implications for managers, the dysfunctional side of control.
Course Outcomes

15CHE470.1 Understand the evolution of management principles and practices
Understand the importance of organizational strategy and principles of decision making processes.

15CHE470.2 Understand basic organization designs and principles of human resource management processes. Understand organizational change and member resistance.

15CHE470.3 Understand the principles of individual and group behavior. Understand theory and principles of motivation. Understand various theories of leadership. Understand the process of communication. Understand types and process of Control.

15CHE470.4 Understand, analyze and design suitable management solutions for a given problem through the Case Studies.

TEXTBOOK:


15CHE471 MANAGERIAL ECONOMICS AND ACCOUNTING 3 0 0 3

Unit 1

Introduction to Economics and managerial Decision Making, the Economics of a business, a brief review of important economic terms and concepts; Supply and Demand - market demand, market supply, determinants of supply and demand, short run market changes and long run market analysis, comparative statics analysis, Demand Elasticity - the economic concept of elasticity, the price elasticity of demand, the cross-elasticity of demand, income elasticity, other elasticity measures, elasticity and total revenue; Elasticity of Supply. Applications of elasticity. Marginal utility, the law of diminishing marginal utility.

The theory and estimation of production - the production function, a short-run analysis of total, average, and marginal product, the three stages of production in the short run, long run and the law of diminishing returns, derived demand and the optimal level of variable input usage. Forms of production function.

Unit 2
The Theory and Estimation of Cost - the importance of Cost in managerial decisions, the relationship between production and cost, the short-run cost function, the long-run cost function, economies of scale.

Pricing and output decisions - Competition and market types, pricing and output decisions in perfect competition, selecting optimum output level, competitive market in the long run; Pricing and output decisions in monopoly markets, implications for managerial decision making. Pricing and output decisions in monopolistic competition; oligopoly and market concentration, pricing in oligopolistic market.

Unit 3

Management accounting: Balance Sheet and Profit and Loss account – financial statements, assets, liabilities, and owner’s equity, relationship between assets, liabilities and owner’s equity, forms of the balance sheet, profit and loss account, relation between balance sheet and profit and loss account. Cost classifications and allocation - nature of cost, historical and future costs, cost classifications in a manufacturing firm, cost concepts for planning and control, cost allocation; cost-volume-profit analysis and operating leverage; Break-even analysis, break-even point, operative leverage.

Capital expenditure planning - nature of investment decisions, investment evaluation criteria, time value of money, net present value method, internal rate of return method, profitability index, payback period, accounting rate of return method, cash flows for investment analysis. Capital budgeting process.

Course Outcomes

15CHE471.1 Understand the economic concepts and principles of Supply and Demand and measures of elasticity and its applications to real world problems. Understand the theory and estimation of production during short run and long run and the law of diminishing returns.

15CHE471.2 Understand the theory and estimation of cost and its importance in managerial decisions. Understand the relationship between production and cost during short run and long run. Understand different types of competition and learn to determine pricing and output decisions as appropriate to the competition.

15CHE471.3 Understand financial statements of management accounting and tools for capital expenditure planning.

15CHE471.4 Apply the cost analysis methods for measuring enterprise financial performance.

REFERENCES:

15CHE472 PROJECT ENGINEERING OF PROCESS PLANTS  3 0 0 3

Unit 1

Scope of project engineering - the role of project engineer - R & D - TEFR - plant location and site selection - preliminary data for construction projects - process engineering – flow diagrams - plot plans - engineering design and drafting. Planning and scheduling of projects - bar chart and network techniques.

Unit 2

Business and legal procedures: Procurement operations, Organization and operation of procurement department, Procurement procedure, General purchaser-vendor practices, contracts and contractors, project financing, statutory sanctions.

Details of engineering design and equipment selection - design calculations excluded - Vessels, heat exchangers, process pumps, compressors and vacuum pumps, motors and Turbines, other process equipment.

Unit 3

Details of engineering design and equipment selection II - design calculations excluded - piping design, thermal insulation and buildings, safety in plant design, plant constructions, start up and commissioning.

Critical path method (CPM) and Programme evaluation and review technique (PERT) in project engineering.

Course Outcomes

15CHE472.1 Understand the role, duties, and scope of project engineering in a manufacturing plant
15CHE472.2 Understand the procurement process, inclusive of its logistics, business, and legal aspects
15CHE472.3 Understand the requirements for design of process equipment, plant facilities, and plant commissioning
15CHE472.4 Be able to assess the safety and effectiveness of the design
CO-PO Mapping

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REFERENCE BOOKS


15CHY239 COMPUTATIONAL CHEMISTRY AND MOLECULAR MODELLING

Unit 1
Introduction: Stability, symmetry, homogeneity and quantization as the requirements of natural changes - Born - Haber cycle – Energetic – kinetics - Principles of spectra.

Computational techniques: Introduction to molecular descriptors, computational chemistry problems involving iterative methods, matrix algebra, Curve fitting.

Introduction to Quantum mechanics - Schrodinger equation - Position and momentu - MO formation - Operators and the Hamiltonian operator - The quantum oscillator - Oscillator Eigen value problems - Quantum numbers - labeling of atomic electrons.

Unit 2
Molecular Symmetry: Elements of symmetry - Point groups - Determination of point groups of molecules.

Huckel’s MO theory: Approximate and exact solution of Schrodinger equation - Expectation value of energy - Huckel’s theory and the LCAO approximation - Homogeneous simultaneous equations - Secular matrix - Jacobi method - Eigen vectors: Matrix as operator - Huckel’s coefficient matrix - Wheeland’s method - Hoffmann’s EHT method - Chemical applications such as bond length, bond energy, charge density, dipole moment, Resonance energy.

Unit 3
Self consistent fields: Elements of secular matrix - Variational calculations - Semi empirical methods - PPP self consistent field calculation - Slater determinants - Hartree equation - Fock equation – Roothaan - Hall equation - Semi empirical models and approximations.

Ab-initio calculations: Gaussian implementations – Gamess - Thermodynamic functions - Koopman’s theorem - Isodesmic reactions, DFT for larger molecules - Computer aided assignments/mini projects with softwares - Introduction to HPC in Chemical calculations.

Molecular modelling software engineering - Modeling of molecules and processes - Signals and signal processing in Chemistry - QSAR studies and generation of molecular descriptors - Applications of chemical data mining - Familiarization with open source softwares useful for molecular modeling - Introduction to molecular simulation - M.D. simulation.

Course Outcome

CO01: Get to understand the structure of molecules using symmetry.

CO02: Understanding Quantum mechanical approach to calculate the energy of a system.

CO03: Applying mathematical knowledge and quantum mechanical approach in finding out the characteristics- reactivity, stability, etc., of the molecule.

CO04: To get a brief idea about molecular mechanics based chemical calculations.

CO05: To get an idea about general methodology of molecular modeling.
TEXTBOOKS:


REFERENCES:


15CHY241 ELECTROCHEMICAL ENERGY SYSTEMS AND PROCESSES

Unit 1
Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2
Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air, zinc-silver oxide batteries; lithium primary cells - liquid cathode, solid cathode and polymer electrolyte types and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: ARM (alkaline rechargeable manganese) cells, Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultra thin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles,
requirements of the battery - sodium-beta and redox batteries.

**Unit 3**

Electrochemical Processes: Principle, process description, operating conditions, process sequence and applications of Electroforming – production of waveguide and plated through hole (PTH) printed circuit boards by electrodeposition; Electroless plating of nickel, copper and gold; Electropolishing of metals; Anodizing of aluminium; Electrochemical machining of metals and alloys.

**Course Outcomes**
CO01: Understand the fundamental concepts of electrochemistry through electrode potential and reaction kinetics
CO02: Learn the application of the electrochemical principles for the functioning and fabrication of industrial batteries and fuel cells
CO03: Acquire knowledge in solving numerical problems on applied electrochemistry
CO04: Analysis and practical problem solving in fabrication of batteries and fuel cells
CO05: Application of concepts and principle in industrial electrochemical processes
CO06: Evaluation of comprehensive knowledge through problem solving

**TEXTBOOKS:**

**REFERENCES:**


15CHY243          FUELS AND COMBUSTION               3 0 0 3

Course Objectives:

To provide the basic knowledge about fuels, rocket propellants and explosives.

Unit 1
Fuels - Solid fuels - Classification, preparation, cleaning, analysis, ranking and properties - action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification.

Liquid fuels – Petroleum - origin, production, composition, classification, petroleum processing, properties, testing - flow test, smoke points, storage and handling.


Unit 2
Gaseous fuels - Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG - manufacture, cleaning, purification and analysis. Fuels for spark ignition engines, knocking and octane number, anti knock additives, fuels for compression engines, octane number, fuels for jet engines and rockets.

Flue gas analysis by chromatography and sensor techniques.

Unit 3
Rocket propellants and Explosives - classification, brief methods of preparation, characteristics; storage and handling.

Course Outcomes

CO01: Understand the types of fuels and variation in their properties

CO02: Able to analyze the fuel content

CO03: Obtain knowledge in identifying a proper fuel as per the requirement

CO04: Ability to know the preparation and working of propellants and explosives

TEXTBOOK:


REFERENCE:


15CHY244 GREEN CHEMISTRY AND TECHNOLOGY 3 0 0 3

Objectives

1. Understand the principles of green chemistry and its contribution to the development of sustainable products
2. Possess knowledge of the migration from a hydrocarbon-based economy to carbohydrate-based economy
3. Evaluate the deficiencies of traditional process and acknowledge the invention of new processes
4. Distinctly map the culmination of academic research to industrial chemistry

Unit 1
Our environment and its protection, chemical pollution and environmental regulations, environmental chemistry, pollution prevention strategies, challenges to the sustainability of chemical industry, Pollution Prevention Act 1990, USA, Green Chemistry and its 12 principles, toxicity of chemicals, material safety data sheet (MSDS), concept of zero pollution technologies, atom economy, functional toxicity vs non-functional toxicity, alternative solvents, energy minimization, microwave and sonochemical reactions, renewable feedstock, carbon dioxide as a feedstock.

Unit 2
Greener strategies of the synthesis of ibuprofen synthesis, terephthalic acid etc. phase behaviour and solvent attributes of supercritical CO2, use of supercritical carbon dioxide as a medium chemical industry, use of ionic liquids as a synthetic medium, gas expanded solvents, superheated water, etc. Synthesis of various chemicals from biomass, polycarbonate synthesis and CO2 fixation, green plastics, green oxidations, etc.

Unit 3
Processes involving solid catalysts – zeolites, ion exchange resins, Naion/silica nano composites and enhanced activity. Polymer supported reagents, green oxidations using TAML catalyst, membrane reactors. Green chemistry in material science, synthesis of porous polymers, green nanotechnology.

Course Outcomes

CO01: Understand the evolving concept of Green Chemistry and its application to the manufacture of sustainable products

CO02: Appreciate the need for Renewable energy and Feed stock along with carbon sequestration through the fundamentals of Green Chemistry Techniques

CO03: Develop a coherence to evaluate systematic deficiencies in traditional Chemical science process and products

CO04: Undertake a purposeful Journey through the microscopic domain of academic research to the macroscopic domain of Industrial chemistry

REFERENCES:

1. Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell Publishing.
15CHY331 BATTERIES AND FUEL CELLS 3 0 0 3

Course Objective:

To provide sound knowledge on the application of electrochemistry in energy storage systems.

Unit 1
Background Theory: Origin of potential - electrical double layer - reversible electrode potential - standard hydrogen electrode - emf series - measurement of potential - reference electrodes (calomel and silver/silver chloride) indicator and ion selective electrodes - Nernst equation - irreversible processes - kinetic treatment - Butler-Volmer equation - Overpotential, activation, concentration and IR overpotential - its practical significance - Tafel equation and Tafel plots - exchange current density and transfer coefficients.

Unit 2
Batteries: Primary batteries: The chemistry, fabrication and performance aspects, packing classification and rating of the following batteries: (The materials taken their function and significance, reactions with equations, their performance in terms of discharge, capacity, and energy density to be dealt with). Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air batteries; Lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cells (comparative account).

Secondary batteries: Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultrathin lithium polymer cells (comparative account). Advanced Batteries for electric vehicles, requirements of the battery - sodium-beta and redox batteries.

Unit 3
Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of

performance – recent developments.


**Course Outcome**

**CO01:** Understand the fundamental concepts of electrochemistry through electrode potential and reaction kinetics

**CO02:** Learn the application of the electrochemical principles for the functioning and fabrication industrial batteries and fuel cells

**CO03:** Analysis of practical problem solving in fabricating batteries and fuel cells

**CO04:** Evaluation of comprehensive knowledge through problem solving

**TEXTBOOKS:**


**REFERENCES:**

- Thermodynamic & Kinetic aspects of corrosion: The free energy criterion of corrosion possibility - Mechanism of Electrochemical corrosion - Galvanic and Electrochemical series and their significance.

Corrosion Control: Materials selection - metals and alloys - metal purification - non metallic - changing medium.

**Unit 2**

Anodic and cathodic protection methods - Coatings - metallic and other inorganic coatings - organic coatings - stray current corrosion - cost of corrosion control methods.

Corrosion protection by surface treatment: CVD and PVD processes - Arc spray - Plasma spray - Flame spray.

Corrosion Inhibitors: Passivators - Vapour phase inhibitor.

**Unit 3**

Stress and fatigue corrosion at the design and in service condition - control of bacterial corrosion.


**Course Outcome:**

**CO01**: Development of skill in identifying the nature and type of corrosion

**CO02**: Understanding the mechanism of various types of corrosion

**CO03**: Analysing the problem and find out a solution to combat corrosion in any sort of environment.

**CO-PO Mapping**

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**TEXTBOOKS:**

142
Unit 1

Introduction to Lagrangian dynamics
Survey of principles, mechanics of particles, mechanics of system of particles, constraints, D'Alembert's principle and Lagrange's equation, simple applications of the Lagrangian formulation, variational principles and Lagrange's equations, Hamilton's principles, derivation of Lagrange's equations from Hamilton's principle, conservation theorems and symmetry properties.

Unit 2

Central field problem
Two body central force problem, reduction to the equivalent one body problem, Kepler problem, inverse square law of force, motion in time in Kepler's problem, scattering in central force field, transformation of the scattering to laboratory system, Rutherford scattering, the three body problem.

Rotational kinematics and dynamics

Kinematics of rigid body motion, orthogonal transformation, Euler's theorem on the motion of a rigid body.

Unit 3

Angular momentum and kinetic energy of motion about a point, Euler equations of motion, force
free motion of rigid body.

Practical rigid body problems

Heavy symmetrical spinning top, satellite dynamics, torque-free motion, stability of torque-free motion - dual-spin spacecraft, satellite manoeuvring and attitude control - coning maneuver - Yo-yo despin mechanism - gyroscopic attitude control, gravity-gradient stabilization.

Course Outcomes

CO1 - Able to use the Lagrangian formalism to solve simple dynamical system
CO2- Able to understand Hamiltonian formalism and apply this in solving dynamical systems
CO3- Able to apply Lagrangian formalism in bound and scattered states with specific reference to Kepler’s laws and Scattering states
CO4- Able to solve problems in the Centre of Mass frame and connect it to Laboratory Frame of Reference
CO5- Understand and solve problems in rigid body rotations applying of Euler’s equations.

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TEXTBOOKS:


15PHY238  ELECTRICAL ENGINEERING MATERIALS  3003

Unit 1

Conducting materials: The nature of chemical bond, crystal structure Ohm’s law and the relaxation time, collision time, electron scattering and resistivity of metals, heat developed in a current carrying conductor, thermal conductivity of metals, superconductivity.

Semiconducting materials: Classifying materials as semiconductors, chemical bonds in Si and Ge and it’s consequences, density of carriers in intrinsic semiconductors, conductivity of intrinsic semiconductors, carrier densities in n type semiconductors, n type semiconductors, Hall effect and carrier density.

Unit 2

Magnetic materials: Classification of magnetic materials, diamagnetism, origin of permanent, magnetic dipoles in matter, paramagnetic spin systems, spontaneous magnetization and Curie Weiss law, ferromagnetic domains and coercive force, anti ferromagnetic materials, ferrites and it’s applications.

Unit 3

Dielectric materials: Static dielectric constant, polarization and dielectric constant, internal field in solids and liquids, spontaneous polarization, piezoelectricity.

PN junction: Drift currents and diffusion currents, continuity equation for minority carriers, quantitative treatment of the p-n junction rectifier, the n-p-n transistor.
Course Outcomes

CO1: To understand the nature of interaction between atoms in crystalline solid materials that determines their dielectric, magnetic and electrical properties.

CO2: Analyze the relation between the macroscopic dielectric constant and the atomic structure of an insulator.

CO3: Fundamental concepts of magnetic fields required to illustrate the magnetic dipoles. This forms the basis to understand the magnetic properties of dia, para, ferro, antiferro and ferri magnetic materials.

CO4: Fundamentals concerned with conduction mechanism in metals and superconductors.

CO5: Understand the basics for classification of materials based on its conductivity, nature of chemical bonds in Si and Ge, carrier density, energy band structure and conduction mechanism in intrinsic and extrinsic semiconductors.

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TEXTBOOK:


REFERENCES:


Unit 1

Review of some basic concepts and principle of laser.


Unit 2

Properties of LASERS

Gain mechanism, threshold condition for PI (derivation), emission broadening - line width, derivation of FWHM natural emission line width as deduced by quantum mechanics - additional broadening process: collision broadening, broadening due to dephasing collision, amorphous crystal broadening, Doppler broadening in laser and broadening in gases due to isotope shifts. Saturation intensity of laser, condition to attain saturation intensity.

Properties – coherency, intensity, directionality, monochromaticity and focussibility. LASER transition – role of electrons in LASER transition, levels of LASER action: 2 level, 3 level and 4 level laser system.

Unit 3

Types of LASERS


Liquid chemical and dye LASERS. Semiconductor LASER: Principle, characteristics,
semiconductor diode LASERS, homo-junction and hetero-junction LASERS, high power semiconductor diode LASERS.

Applications in Communication field:

LASER communications: Principle, construction, types, modes of propagation, degradation of signal, analogue communication system, digital transmission, fiber optic communication.

Applications of LASERS in other fields:


Course Outcomes

CO 1- Understand, Comprehend and acquaint with concepts of NanoPhysics
CO2- To familiarize the material’s property changes with respect to the dimensional confinements.
CO3- Acquire knowledge on the modern preparation process and analysis involved in the nanomaterial’s research
CO4- To learn about the technological advancements of the nano-structural materials and devices in the engineering applications

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REFERENCES:


15PHY532  ASTROPHYSICS  3 0 0 3

Unit 1
Practical astronomy - telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.
Celestial mechanics - Kepler’s laws - and derivations from Newton’s laws.
Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

Unit 2

Variable stars: Cepheid, RR Lyrae and Mira type variables - Novae and Super novae. Binary and multiple star system - measurement of relative masses and velocities. Interstellar clouds - Nebulae.

Unit 3
Galactic astronomy: Distance measurement - red shifts and Hubble’s law – age of the universe, galaxies – morphology - Hubble’s classification - gravitational lens, active galactic nuclei (AGNs), pulsars, quasars.
Cosmology: Comic principles, big bang and big crunch – cosmic background radiation - Nucleosynthesis - plank length and time, different cosmic models - inflationary, steady state. Variation of G. anthropic principle.

COURSE OUTCOMES (CO):

After completion of the course students should be able to

CO1: Get a broad knowledge of scientific and technical methods in astronomy and astrophysics.

CO2: Apply mathematical methods to solve problems in astrophysics.

CO3: Develop critical/logical thinking, scientific reasoning and skills in the area of modern astrophysics.

CO-PO Mapping:

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REFERENCES:


5. ‘Stellar Astronomy’ by K. D Abhayankar.

HUMANITIES ELECTIVES

15ENG230 BUSINESS COMMUNICATION 1022

Course Objectives

To introduce business vocabulary
To introduce business style in writing and speaking
To expose students to the cross-cultural aspects in a globalised world
To introduce the students to the art of persuasion and negotiation in business contexts

Syllabus

Unit 1:
Business Vocabulary - Writing: Drafting Notices, Agenda, and Minutes - Reading: Business news, Business articles

Unit 2:
Writing: Style and vocabulary - Business Memorandum, letters, Press Releases, reports – proposals – Speaking: Conversational practice, telephonic conversations, addressing a gathering, conducting meetings

Unit 3:
Active Listening: Pronunciation – information gathering and reporting - Speaking: Cross-Cultural Issues, Group Dynamics, negotiation & persuasion techniques

Activities
Case studies & role-plays

Course Outcomes

CO1 Familiarize and use appropriate business vocabulary and etiquettes in verbal communication in the professional context

CO2 Understand organizational structures, pay structures and performance assessments

CO3 Apply language skills in drafting various business documents and other necessary communications in the business context

CO4 Understand and address cross cultural differences in the corporate environment
CO5 participate in planned and extempore enactments of various business situations

CO-PO Mapping

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Books recommended:


15ENG233 TECHNICAL COMMUNICATION 1 0 2 2

Course Objectives:

To introduce the students to the elements of technical style
To introduce the basic elements of formal correspondence
To introduce technical paper writing skills and methods of documentation
To improve oral presentation skills in formal contexts

Syllabus:
Unit 1

Unit 2
Different kinds of written documents: Definitions - descriptions- instructions-recommendations- manuals - reports – proposals; Formal Correspondence: Letter Writing including job applications with Resume

Unit 3
Technical paper writing: Library research skills- documentation style - document editing – proof reading - formatting
Practice in oral communication: Practice in Oral communication and Technical presentations

Course Outcomes:

After the completion of the course the student will be able to:

CO1 Understand and use the basic elements of formal correspondence and methods of documentation
CO2 Learn to edit technical content for grammatical accuracy and appropriate tone and style
CO3 Use the library and internet recourses for research purposes
CO4 Demonstrate the ability to communicate effectively through group mock-technical presentations and other activities

Mapping of course outcomes with program outcomes:

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To teach Hindi for effective communication in different spheres of life: Social context, Education, Research & Media.

**Syllabus**

**Unit-1**


**Unit-2**

Common errors and error corrections in Parts of Speech with emphasis on use of pronouns, Adjective and verb in different tenses – Special usage of adverbs, changing voice and conjunctions in sentences, gender & number - General vocabulary for conversations in given context –understanding proper pronunciation – Conversations, Interviews, Short speeches.

**Unit-3**

Poems – Kabir Ist 8 Dohas, Surdas 1st 1 Pada; Tulsidas 1st 1 Pada; Meera 1st 1 Pada

**Unit-4**

Letter writing – personal and Formal –Translation from English to Hindi

**Unit-5**

Kahani –Premchand : Kafan, Abhilasha, Vidroh, Poos ki rath, Juloos

**Course Outcomes:**

After the completion of the course the student will be able to:
CO1 Gain knowledge about the nature and culture of Hindi language
CO2 Understand the structural aspects of Hindi language
CO3 Apply the knowledge of the grammatical structures to communicate in Hindi
CO4 Analyse the social significance of modern literature.
CO5 Develop the ability to translate a given text to Hindi

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Text Books :

1. Prem Chand Ki Srvaahrestha Kahaniyaam: Prem Chand ; Diamond Pub Ltd. New Delhi
2. Vyavaharik Hindi Vyakaran ,Anuvad thaha Rachana : Dr. H. Parameswaran, Radhakrishna publishing House,New Delhi

15HIN111 HINDI II 1022

Appreciation and assimilation of Hindi Literature - both *drishya* and *shravya* - using the best specimens provided as anthology.

Syllabus:

Unit -1

Kavya Tarang:-Dhumil ke Anthim Kavitha[Poet-Dhumil],Dhabba[Poet-Kedarnath Singh],Proxy[Poet-Venugopal],Vakth[Poet-Arun Kamal],Maachis[Poet-Suneeta Jain].

Unit -2

Communicative Hindi - Moukhik Abhivyakthi
Unit -3
Audio- Visual –Media in Hindi – Movies like Tare Zameen par , Paa, Black etc., appreciation and evaluation . News reading and presentations in Radio and TV channels in Hindi.

Unit -4
Gadya Manjusha – Budhapa , Kheesa, Sadachar ka Thavis

Unit -5

Course Outcomes:
After the completion of the course the student will be able to:

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Mapping of course outcomes with program outcomes:

Text Books:
2. Gadya Manjusha: Editor: Govind , Jawahar Pustakalay , Mathura
3. Prem Chand Ki Sravashrestha Kahaniyam: Prem Chand ; Diamond Pub Ltd. New Delhi
Course Objectives

1. To help students acquire the basic knowledge of behavior and effective living
2. To create an awareness of the hazards of health compromising behaviours
3. To develop and strengthen the tools required to handle the adversities of life

Syllabus

Unit 1

SELF AWARENESS & SELF MOTIVATION

Unit 2

THE NATURE AND COPING OF STRESS
Definition of stress, stressors, eustress, distress-PTSD-stress among college students- stress assessment-coping with stress-progressive muscle relaxation-RET-guided imagery-bio feedback-religious and spiritual way of coping with stress

Unit 3

APPLICATION OF HEALTH PSYCHOLOGY
Health compromising behaviors-smoking and alcoholism-biological and psychological effects of addiction-deaddiction-behavior modifications-CBT in handling problem behavior-cancer risks-AIDS.

Course Outcome

CO 1: Understand the basic concepts of Behavioral Psychology
CO 2: Demonstrate self reflective skills through activities
CO 3: Apply the knowledge of psychology to relieve stress
CO 4: Analyse the adverse effects of health compromising behaviours.
CO 5: Evaluate and use guided techniques to overcome and cope with stress related problems.

CO-PO Mapping

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Text Book(s)

V.D.Swaminathan & K.V.Kaliappan, Psychology for Effective living-An introduction to Health

Reference(s)


15HUM240 PSYCHOLOGY FOR ENGINEERS 2002

Course Objectives

1. To strengthen the fundamental knowledge of human behavior
2. To strengthen the ability to understand the basic nature and behavior of humans in organizations as a whole
3. To connect the concepts of psychology to personal and professional life
Syllabus

Unit 1

PSYCHOLOGY OF ADOLESCENTS
Psychology-definition-scope-adolescence-characteristics-developmental tasks-physical and psychological changes-interests-family relationships-emotions-peer pressure-positive and Negative effects of peer pressure-types of friends-choice of friends

Unit 2

LEARNING, MEMORY AND STUDY SKILLS
Definitions-Classical conditioning-Operant conditioning-Insight learning-reinforcement-its principles and its effects-role of reward and punishment in learning-forgetting-causes-techniques for improving study skills-Mnemonics-Intelligence-Emotional and social intelligence

Unit 3

ATTENTION & PERCEPTION
Definition-types of attention-span of attention-division of attention- factors determining attention-perception-difference between sensation and perception-laws of perception-errors in perception-illusion and hallucination

Course Outcome

CO 1: Understand the fundamental processes underlying human behavior such as learning, motivation, individual differences, intelligence and personality.
CO 2: Apply the principles of psychology in day-to-day life for a better understanding of oneself and others.
CO 3: Apply the knowledge of Psychology to improve study skills and learning methods
CO 4: Apply the concepts of defense mechanisms to safeguard against abusive relationships and to nurture healthy relationships.

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Text Book(s)
15HUM244 UNDERSTANDING SCIENCE OF FOOD AND NUTRITION 1022

Course Objectives:

- To introduce the significance of food, nutrients, locally available food resources, synergic food combinations, good cooking methods and importance of diversity in foods
- To understand nutritional imbalances and chronic diseases associated with the quality of food.
- To gain awareness about the quality of food - Organic food, genetically modified food, adulterated food, allergic food, food poisoning and food safety.
- To understand food preservation processing, packaging and the use of additives.

UNIT I:

FOOD AND FOOD GROUPS:

UNIT II:

NUTRIENTS AND NUTRITION:

UNIT III:

INTRODUCTION TO FOOD BIOTECHNOLOGY:
Future foods- Organic foods and genetically modified foods, Fortification of foods, bio fortification of foods, value addition of foods, functional foods, nutraceuticals, weaning foods/supplementary.
Processing and preservation of foods, applications of food technology in daily life, and your prospects associated with food industry – Nanoparticles, biosensors, advanced research.

Course Outcome:

**CO1**: Acquire knowledge about the various food and food groups  
**CO2**: Understand nutritional imbalances and chronic diseases prevailing among different age groups.  
**CO3**: Understand the significance of safe food and apply the food safety standards  
**CO4**: Demonstrate skills of food processing, preservation and packaging methods with or without additives  
**CO5**: Evaluate the quality of food based on the theoretical knowledge of Food and Nutrition

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Reference Books:

- B.SriLakhmi, **Dietetics**, New age international, 2015.  

15MAL101  
MALAYALAM I  
1 0 2 2

Course Objectives:

To teach Malayalam for effective communication in different spheres of life:- Social context , Education, Research & Media

Unit 1

Ancient poet trio:Adhyatmaramayanam,LakshmanaSwanthanam  
(Lines: valsasoumitre...
mungikidakayal), Ezhuthachan - Medieval period classics – Jnanappana(Lines: kalaminnu… vilasangalingane), Poonthanam.

Unit 2

Unit 3
Short stories from period 1/2/3: Poovanpazham-Vaikom Muhammed Basheer-Literary & Cultural figures of Kerala and about their literary contributions.

Unit 4
Literary Criticism: Bharatha Paryadanam-Vyasante Chiri–Ithihasa studies-Kuttikrishna Mararu-Outline of literary Criticism in Malayalam Literature-Introduction to Kuttikrishna Mararu & his outlook towards literature & life.

Unit 5

Course Outcome:

After the completion of the course the student will be able to:

| CO1 | Understand and inculcate philosophical thoughts and practices |
| CO2 | Understand and appreciate the post modern trends of literature. |
| CO3 | Analyse the literary texts and comprehend the cultural diversity of Kerala |
| CO4 | Distinguish the different genres in Malayalam literature |
| CO5 | Demonstrate the ability to effectively communicate in Malayalam |

CO-PO Mapping:

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REFERENCES:

6. Dr. M. Leelavathy, Kavitha Sahityacharitram, Kerala Sahitya Academy, 1996.
7. Thayattu Sankaran, Vallathol Navayugathinte Kavi, Vallathol Vidyapeetham

15MAL111 MALAYALAM II 1022

Course Objectives

➢ To appreciate the aesthetics and understand the cultural implications in Malayalam Literature
➢ To enhance creative thinking in Malayalam
➢ To equip the students to read and write effectively in Malayalam
➢ To acquire pronunciation skills

Unit 1
Ancient poet trio: Kalayanasougandhikam, (Lines: kallummarangalum... namukkennarikavrikodara), Kunjan Nambar - Critical analysis of his poetry - Ancient Drama: Kerala Sakunthalam (Act 1), Kalidasan (Translated by Attor Krishna Pisharody).

Unit 2

Unit 3

Unit 4
Part of an autobiography/travelogue: Kannerum Kinavum, Chapter: Valarnnuvarunnoratmavu, V.T. Bhattathirippadu - Socio-cultural literature-historical importance.

Unit 5
Error-free Malayalam- 1. Language; 2. Clarity of expression; 3. Punctuation- Thettillatha Malayalam-
Writing- a. Expansion of ideas; b. Précis Writing; c. Essay Writing; d. Letter writing; e. Radio Speech; f. Script/Feature/Script Writing; g. News Editing; h. Advertising; i. Editing; j. Editorial Writing; k. Critical appreciation of literary works (Any one or two as an assignment).

Course Outcome:

After the completion of the course the student will be able to:

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<th>Understand the different cultural influences in linguistic translation</th>
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<td>Identify and appreciate the Romantic elements of modern literature</td>
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<td>Analyze the genre of autobiographical writing</td>
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<td>CO4</td>
<td>Critically evaluate the significance of historical, political and socio cultural aspects in literature</td>
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<td>Demonstrate good writing skills in Malayalam</td>
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REFERENCES:

Course Objectives

- To introduce the students to different literature: Sangam literature, Epics, Bhakthi literature and modern literature.
- To improve their ability to communicate with creative concepts, and also to introduce them to the usefulness of basic grammatical components in Tamil.

Syllabus

Unit 1

The history of Tamil literature: Nāṭṭupapṭalkaḷ, kataikkaḷ, paḻamolikaḷ - ciṟukataikaḷ tōṟramum vaḷarcciyum.
ciṟilakkiyāṅkaḷ: Kāṅkattup paraṇi (pōrpāṭiyatu) - mukkūṭaṟ paḷḷu 35.
Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai nāṭaiyiyal āyvu māṟṟum aimperum – aiṅciuṅ kāppiyaṅkaḷ toṭarpāṇa ceyṭikal.

Unit 2

tinai ilakkiyamum nūṭiyilakkiyamum - paṭiṇekkīḷkaṇakku nūḷka toṭarpāṇa piṟa ceyṭikal - tirukkuṟṟaḷ (aṟpu, paṇpu, kalvi, oḷukkam, naṭpu, vāymai, kēḷvi, ceyṇāṇi, periyāraitṭuṇakkōṭal, vilippuṇarvu pēṇṟa atikārattil uḷḷa ceyṭikal.
Aṟanūlkaḷ: Ulakāṇiṭi (1-5) – ēḷāṭi (1,3,6). - Cittarkaḷ: Kaṭuveli cittar pāṭalkaḷ (āṅantak kalippu –1, 4, 6, 7, 8), māṟṟum akappēy cittar pāṭalkaḷ (1-5).

Unit 3
tamil ilakkaṇaṁ: Vākkīya vakaikaḷ – taṅviṇai piraviṇai – nērkkūṟṟu ayarkūṟṟu

Unit 4

Unit 5
tamil moli āyvil kaṇiṅi payaṇṟaṭu. - Karuttu parimāṟram - vilamparai moliyamaippū – pēccu - nāṭakam paṭṭaiippu - ciṟukatai, katai, putiṇăm paṭṭaiippu.
Course Outcomes

CO 1: To understand the Sangam literature  
CO 2: To understand the creative literature  
CO 3: To understand the literary work on religious scriptures  
CO 4: To improve the communication and memory skills  
CO 5: To understand the basic grammar components of Tamil language and their usage and applications  
CO 6: Understand creative writing aspects and apply them  

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Textbooks:

- http://Www.tunathamizh.tom/2013/07/blog0post_24.html
- Mu.Varatarācaṇ “tamiḻ ilakkiya varalāṇu” cāhitya akaṭemī pāṭikēṇaṇṇu, 2012
Course Objectives

- To learn the history of Tamil literature.
- To analyze different styles of Tamil Language.
- To strengthen the creativity in communication, Tamil basic grammar and use of computer on Tamil Language.

Syllabus

Unit 1

The history of Tamil literature: Nāṭṭupurap pāṭalkal, kataikkaḷ, paḷamolikai - cirukataikal tōṟramum vaḷarcciyum, ciririlakkiyanakal: Kaliṅkattup paraṇi (pōṟṭiyatu) - mukkūṭag paḻlu 35.
Kāppiyaṅkaḷ: Cilappatikāram – maṇimēkalai nāṭṭiyiyal āyvu marrum aimperum – ainçīruṅ kāppiyankal toṭarpāṇa ceytkal.

Unit 2

tīnai ilakkiyamum nīṭiyilakkiyamum - paṭineṅkikkaṅkaṅku nūlkai toṭarpāṇa piṅa ceytkal - tirukkuṟṟal (aNpu, paṇpu, kalvi, oḷukkam, nāṭpu, vāymai, kēḷvi, ceynaṟṟi, periyāraitumakkōṭal, vilippuṇarvum pēṅṟa atikārratil uḷḷa ceytkal.
Aṟanukkal: Ulakanīti (1-5) – ēḷati (1,3,6). - Cittarkal: Kaṭuveli cittar pāṭalkal (ānantak kalippu –1, 4, 6, 7, 8), marrum akappēy cittar pāṭalkal (1-5).

Unit 3

tamill ilakkaṇam: Vākkiya vakaikal – taṅvinai piṟvinai – nērkkūṟru ayaṟkūṟru

Unit 4


Unit 5

Course Outcomes

CO 1: Understand the history of Tamil literature.
CO 2: Apply practical and comparative analyses on literature.
CO 3: Understand thinai literature, literature on justice, Pathinenkeelkanaku literature.
CO 4: Understand the tamil scholars’ service to Tamil language and society.
CO 5: Understand components of Tamil grammar and its usage
CO 6: Understand creative writing aspects and apply them

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poṅ maṇimāṅaṅ “aṭṭoḥ tamiḻ ilakkāṇam “aṭṭoḥ papliśiñ kurūp, vaṅciyū