B.TECH. FOUR YEAR DEGREE COURSE (CHEMICAL ENGINEERING)

COURSE STRUCTURE & SYLLABUS (R-22)

(w.e.f. 2022-2023 batch onwards)



DEPARTMENT OF CHEMICAL ENGINEEERING

JNTUH UNIVERSITY COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY, HYDERABAD

(Autonomous)

Kukapally, Hyderabad-085

JNTUH UNIVERSITY COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY, HYDERABAD

VISION

To be recognized as one of the top 10 institutes in the country offering technical education, sustaining and improving its repute of UG programmes, expanding need based PG and research programmes with global outlook, synergising teaching and research for societal relevance

MISSION

- 1. To identify technological advancements and build the right level of skills at the right time contributing to the industrial and national growth.
- 2. To identify and keep abreast with the state of the art technology maintaining its legacy of striving for excellence in higher education.
- 3. To promote world class research of local relevance to society.
- 4. With a research community of professors, research fellows and research centres, expand the scale and multidisciplinary character of its research activities.
- 5. With a global outlook strive for collaborations to network with International Universities and National Institutes of Research and Higher Learning

CHEMICAL ENGINEERING DEPARTMENT

VISION:

To be a premier chemical engineering department meeting the needs of academia, industry and society through quality education and innovative research.

MISSION:

- 1. Provide a comprehensive learning ambience in sciences, chemical and allied engineering.
- 2. Impart principles of sustainability and stimulate the evolution of environment friendly techniques and processes for the benefit of society.
- 3. Promote leadership qualities and team work through collaborations.

JNTUH UNIVERSITY COLLEGE OF ENGINEERING HYDERABAD (Autonomous) Kukatpally, Hyderabad – 500085

DEPARTMENT OF CHEMICAL ENGINEERING

	PROGRAM EDUCATIONAL OBJECTIVES (PEOs)
PEO-1	Achieve innovation in research, education and administration in multi-discipline environment.
PEO-2	Obtain leadership positions in prestigious organizations.
PEO-3	Exhibit high ethical standards, team work with continuous learning to cater the ever changing
	professional needs.
PEO-4	Pursue personal development through acquiring knowledge, skills and attitude.
	PROGRAM OUTCOMES (POs)
1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering
	fundamentals, and an engineering specialization to the solution of complex engineering
	problems.
2	Problem analysis: Identify, formulate, research literature, and analyze complex engineering
	problems reaching substantiated conclusions using first principles of mathematics, natural
	science, and engineering sciences.
3	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.
4	Conduct investigations of complex problems: Use research-based knowledge and research
	methods including design of experiments, analysis and interpretation of data, and synthesis of
5	Ine information to provide valid conclusions.
5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern angingering and IT tools including prediction and modelling to complex engineering activities
	with an understanding of the limitations
6	The angineer and society: Apply reasoning informed by the contextual knowledge to assess
0	societal health safety legal and cultural issues and the consequent responsibilities relevant to
	the professional engineering practice.
7	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.
8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and
	norms of the engineering practice.
9	Individual and in team: Function effectively as an individual, and as a member or leader in
	diverse teams, and in multidisciplinary settings.
10	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, give and receive clear
	instructions.
11	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.
12	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.
	PROGRAM SPECIFIC OUTCOMES (PSOs)
PSO-1	Interdisciplinary Approach: The Students will be able to apply chemical engineering
	principles to interdisciplinary areas like nanotechnology, environmental & energy engineering,
	Process safety
PSO-2	Modeling & Simulation: The Students will be able to work on modeling, simulation &
	optimization of chemical processes using MATLAB & PRO-II software

JNTUH UNIVERSITY COLLEGE OF ENGINEERING HYDERABAD (AUTONOMOUS) B.TECH. FOUR YEAR DEGREE COURSE (CHEMICAL ENGINEEERING) COURSE STRUCTURE (R-22)

I YEAR I SEMESTER

S. No.	Course Code	Course Title	L	Т	Р	Credits
1	BSC	Matrices and Calculus	3	1	0	4
2	BSC	Applied Physics	3	1	0	4
3	ESC	C Programming and Data Structures	3	0	0	3
4	ESC	Engineering Workshop	0	1	3	2.5
5	HSMC	English for Skill Enhancement	2	0	0	2
6		Elements of Chemical Engineering	0	0	2	1
7	BSC-LC	Applied Physics Laboratory	0	0	3	1.5
8	HSMC-LC	English Language and Communication Skills Laboratory	0	0	2	1
9	ESC-LC	C Programming and Data Structures Laboratory	0	0	2	1
10		Environmental Science	3	0	0	0
11	MC	Induction Programme				
		Total	14	3	12	20

I YEAR II SEMESTER

S. No.	Course Code	Course Title	L	Т	Р	Credits
		Ordinary Differential Equations and Vector	2	1	0	1
1		Calculus	3	1	0	4
2	BSC	Engineering Chemistry	3	1	0	4
3	ESC	Computer Aided Engineering Graphics	1	0	4	3
4	ESC	Engineering Mechanics	3	0	0	3
5		Material Science for Chemical Engineering	2	0	0	2
6	ESC-LC	Python Programming Laboratory	0	1	2	2
7	BSC - LC	Engineering Chemistry Laboratory	0	0	2	1
8		Engineering Materials Laboratory	0	0	2	1
		Total	12	3	10	20

JNTUH UNIVERSITY COLLEGE OF ENGINEERING HYDERABAD (AUTONOMOUS) B.TECH. CHEMICAL ENGINEEERING COURSE STRUCTURE & SYLLABUS (R-22 Regulations)

II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	Т	Р	Credits
1	BSC	Probability, Statistics and Complex Variables	3	1	0	4
2		Material and Energy Balance Computations	3	0	0	3
3		Chemical Engineering Fluid Mechanics	3	1	0	4
4		Inorganic & Physical Chemistry	3	0	0	3
5		Basic Electrical and Electronics Engineering	3	0	0	3
6		Fluid Mechanics Lab	0	0	2	1
7		Inorganic & Physical Chemistry Lab	0	0	2	1
Q		Basic Electrical and Electronics Engineering	0	0	2	1
0		Lab	0	0	2	1
9	MC*	Constitution of India	3	0	0	0
		Total	18	2	6	20

II YEAR II SEMESTER

S. No.	Course Code	Course Title	L	Т	Р	Credits
1		Chemical Engineering Thermodynamics-I	3	0	0	3
2		Mechanical Operations	3	0	0	3
3		Process Heat Transfer	3	0	0	3
4		Fundamentals of Management for Engineers	3	0	0	3
5		Organic & Analytical Chemistry	3	0	0	3
6		Mechanical Operations Lab	0	0	2	1
7		Process Heat Transfer Lab	0	0	2	1
8		Organic & Analytical Chemistry Lab	0	0	2	1
9		Real-time Research Project/Field-Based Project	0	0	4	2
10		Gender Sensitization Lab	0	0	2	0
		Total	15	0	12	20

JNTUH UNIVERSITY COLLEGE OF ENGINEERING HYDERABAD (AUTONOMOUS) B. TECH CHEMICAL ENGINEEERING COURSE STRUCTURE & SYLLABUS (R-22 Regulations)

III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	Т	Р	Credits
1		Mass Transfer Operations-I	3	0	0	3
2		Chemical Reaction Engineering-I	3	0	0	3
3		Instrumentation and Process Control	3	0	0	3
4		Chemical Engineering Thermodynamics-II	3	0	0	3
5		Process Modelling & Simulation	3	0	0	3
6		Chemical Technology	2	0	0	2
7		Instrumentation and Process Control Lab	0	0	2	1
8		Process Simulation Lab	0	0	2	1
9		Advanced English Communications Skills Lab	0	0	2	1
10	MC*	Intellectual Property Rights	3	0	0	0
		Total	20	0	6	20

III YEAR II SEMESTER

S. No.	Course Code	Course Title	L	Т	Р	Credits
1		Mass Transfer Operations-II	3	0	0	3
2		Chemical Reaction Engineering-II	3	0	0	3
3		Process Equipment Design	2	0	0	2
4		Professional Elective – I	3	0	0	3
5		Open Elective – I	3	0	0	3
6		Mass Transfer Operations Lab	0	0	3	1.5
7		Chemical Reaction Engineering Lab	0	0	3	1.5
8		Process Equipment Design & Drawing lab	0	0	2	1
9		Industry Oriented Mini Project/ Internship	0	0	4	2
10	MC*	Environmental Science	3	0	0	0
		Total	17	0	12	20

Environmental Science in III yr II Semester should be registered by Lateral Entry Students Only.

JNTUH UNIVERSITY COLLEGE OF ENGINEERING HYDERABAD (AUTONOMOUS) B.TECH. CHEMICAL ENGINEEERING COURSE STRUCTURE & SYLLABUS (R-22 Regulations)

IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	Т	Р	Credits
1		Transport Phenomena	3	0	0	3
2		Chemical Engineering Plant Design and	2	0	0	2
		Economics	-	Ŭ	0	
3		Professional Elective – II	3	0	0	3
4		Professional Elective – III	3	0	0	3
5		Professional Elective – IV	3	0	0	3
6		Open Elective – II	3	0	0	3
7		Project Stage - I	0	0	6	3
		Total	17	0	6	20

IV YEAR II SEMESTER

S. No.	Course Code	Course Title	L	Т	Р	Credits
1		Professional Elective – V	3	0	0	3
2		Professional Elective – VI	3	0	0	3
3		Open Elective – III	3	0	0	3
4		Project Stage – II including seminar	0	0	22	9+2
		Total	9	0	22	20

*MC- Satisfactory/Unsatisfactory

PROFESSIONAL ELECTIVE OFFERED IN R22

Professional Elective – I

Petroleum Refining and Petrochemicals
Sustainable Energy Technology
Basics of Nanotechnology

Professional Elective – II

Interfacial and Colloidal Science
Polymer Science and Engineering
Optimization of Chemical Processes

Professional Elective – III

Biochemical Engineering
Industrial Pollution Control Engineering
Bio-fuels & Bio-refinery

Professional Elective – IV

Computational Fluid Dynamics
Nuclear Engineering
Process Intensification

Professional Elective – V

AI & ML in Chemical Engineering
Pharmaceutical Technology
Food Processing Technology

Professional Elective – VI

Membrane Technology
Industrial Safety Hazard Management
Fuel Cell Technology

Open Elective-I:

1. Solid Waste Management

Open Elective-II:

1. Industrial Pollution Prevention & Control

Open Elective-III:

1. Safety in Industries

MATRICES AND CALCULUS

B.Tech. I Year I Sem.

L T P C 3 1 0 4

Pre-requisites: Mathematical Knowledge at pre-university level

Course Objectives: To learn

- Types of matrices and their properties.
- Concept of a rank of the matrix and applying this concept to know the consistency and solving the system of linear equations.
- Concept of eigenvalues and eigenvectors and to reduce the quadratic form to canonical form
- Geometrical approach to the mean value theorems and their application to the mathematical problems
- Evaluation of surface areas and volumes of revolutions of curves.
- Evaluation of improper integrals using Beta and Gamma functions.
- Partial differentiation, concept of total derivative
- Finding maxima and minima of function of two and three variables.
- Evaluation of multiple integrals and their applications

Course outcomes: After learning the contents of this paper the student must be able to

- Write the matrix representation of a set of linear equations and to analyse the solution of the system of equations
- Find the Eigenvalues and Eigen vectors
- Reduce the quadratic form to canonical form using orthogonal transformations.
- Solve the applications on the mean value theorems.
- Evaluate the improper integrals using Beta and Gamma functions
- Find the extreme values of functions of two variables with/ without constraints.
- Evaluate the multiple integrals and apply the concept to find areas, volumes

UNIT-I: Matrices

Rank of a matrix by Echelon form and Normal form, Inverse of Non-singular matrices by Gauss-Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations equations by Gauss elimination method, Gauss Seidel Iteration Method.

UNIT-II: Eigen values and Eigen vectors

Linear Transformation and Orthogonal Transformation: Eigenvalues, Eigenvectors and their properties properties, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation.

UNIT-III: Calculus

Mean value theorems: Rolle's theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean Value Theorem, Taylor's Series.

Applications of definite integrals to evaluate surface areas and volumes of revolutions of curves Only in Cartesian coordinates), Definition of Improper Integral: Beta and Gamma functions and their applications.

10 L

10 L

10 L

UNIT-IV: Multivariable Calculus (Partial Differentiation and applications) 10 L

Definitions of Limit and continuity.

Partial Differentiation: Euler's Theorem, Total derivative, Jacobian, Functional dependence & independence. Applications: Maxima and minima of functions of two variables and three variables using method of Lagrange multipliers.

UNIT-V: Multivariable Calculus (Integration)

Evaluation of Double Integrals (Cartesian and polar coordinates), change of order of integration (only Cartesian form), Evaluation of Triple Integrals: Change of variables (Cartesian to polar) for double and (Cartesian to Spherical and Cylindrical polar coordinates) for triple integrals.

Applications: Areas (by double integrals) and volumes (by double integrals and triple integrals).

TEXT BOOKS:

- 1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
- 2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5th Editon, 2016.

REFERENCE BOOKS:

- 1. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
- 2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
- 3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
- 4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S Chand and Company Limited, New Delhi.

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APPLIED PHYSICS

B.Tech. I Year I Sem.

L T P C 3 10 4

Pre-requisites: 10 + 2 Physics

Course Objectives: The objectives of this course for the student are to:

- 1. Understand the basic principles of quantum physics and band theory of solids.
- 2. Understand the underlying mechanism involved in construction and working principles of various semiconductor devices.
- 3. Study the fundamental concepts related to the dielectric, magnetic and energy materials.
- 4. Identify the importance of nanoscale, quantum confinement and various fabrications techniques.
- 5. Study the characteristics of lasers and optical fibres.

Course Outcomes: At the end of the course the student will be able to:

- 1. Understand physical world from fundamental point of view by the concepts of Quantum mechanics and visualize the difference between conductor, semiconductor, and an insulator by classification of solids.
- 2. Identify the role of semiconductor devices in science and engineering Applications.
- 3. Explore the fundamental properties of dielectric, magnetic materials and energy for their pplications
- 4. Appreciate the features and applications of Nanomaterials.
- 5. Understand various aspects of Lasers and Optical fiber and their applications in diverse fields.

UNIT - I: QUANTUM PHYSICS AND SOLIDS

Quantum Mechanics: Introduction to quantum physics, blackbody radiation – Stefan-Boltzmann's law, Wein's and Rayleigh-Jean's law, Planck's radiation law - photoelectric effect - Davisson and Germer experiment –Heisenberg uncertainty principle - Born interpretation of the wave function – time independent Schrodinger wave equation - particle in one dimensional potential box. Solids: Symmetry in solids, free electron theory (Drude & Lorentz, Sommerfeld) - Fermi-Dirac

distribution - Bloch's theorem -Kronig-Penney model – E-K diagram- effective mass of electron-origin of energy bands- classification of solids.

UNIT - II: SEMICONDUCTORS AND DEVICES

Intrinsic and extrinsic semiconductors – Hall effect - direct and indirect band gap semiconductors - construction, principle of operation and characteristics of P-N Junction diode, Zener diode and bipolar junction transistor (BJT)–LED, PIN diode, avalanche photo diode (APD) and solar cells, their structure, materials, working principle and characteristics.

UNIT - III: DIELECTRIC, MAGNETIC AND ENERGY MATERIALS

Dielectric Materials: Basic definitions- types of polarizations (qualitative) - ferroelectric, piezoelectric, and pyroelectric materials – applications – liquid crystal displays (LCD) and crystal oscillators. Magnetic Materials: Hysteresis - soft and hard magnetic materials - magnetostriction, magnetoresistance - applications - bubble memory devices, magnetic field sensors and multiferroics. Energy Materials: Conductivity of liquid and solid electrolytes- superionic conductors - materials and electrolytes for super capacitors - rechargeable ion batteries, solid fuel cells.

UNIT - IV: NANOTECHNOLOGY

Nanoscale, quantum confinement, surface to volume ratio, bottom-up fabrication: sol-gel, precipitation, combustion methods – top-down fabrication: ball milling - physical vapor deposition (PVD) - chemical vapor deposition (CVD) - characterization techniques - XRD, SEM &TEM-applications of nanomaterials.

UNIT - V: LASER AND FIBER OPTICS

Lasers: Laser beam characteristics-three quantum processes-Einstein coefficients and their relationslasing action - pumping methods- ruby laser, He-Ne laser, CO2 laser, Argon ion Laser, Nd:YAG lasersemiconductor laser-applications of laser.

Fiber Optics: Introduction to optical fiber- advantages of optical Fibers - total internal reflection construction of optical fiber - acceptance angle - numerical aperture- classification of optical fibers losses in optical fiber - optical fiber for communication system - applications.

TEXT BOOKS:

- 1. M. N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy" A Text book of Engineering Physics"-S. Chand Publications, 11th Edition 2019.
- 2. Engineering Physics by Shatendra Sharma and Jyotsna Sharma, Pearson Publication, 2019.
- 3. Semiconductor Physics and Devices- Basic Principle Donald A, Neamen, Mc Graw Hill, 4th Edition,2021.
- 4. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Learning, 2nd Edition, 2022.
- 5. Essentials of Nanoscience & Nanotechnology by Narasimha Reddy Katta, Typical Creatives NANO DIGEST, 1st Edition, 2021.

- 1. Quantum Physics, H.C. Verma, TBS Publication, 2nd Edition 2012.
- 2. Fundamentals of Physics Halliday, Resnick and Walker, John Wiley & Sons, 11th Edition, 2018.
- 3. Introduction to Solid State Physics, Charles Kittel, Wiley Eastern, 2019.
- 4. Elementary Solid State Physics, S.L. Gupta and V. Kumar, Pragathi Prakashan, 2019.
- 5. A.K. Bhandhopadhya Nano Materials, New Age International, 1st Edition, 2007.
- Energy Materials a Short Introduction to Functional Materials for Energy Conversion and Storage Aliaksandr S. Bandarenka, CRC Press Taylor & Francis Group Energy Materials, Taylor & Francis Group, 1st Edition, 2022.

C PROGRAMMING AND DATA STRUCTURES

B.Tech. I Year I Sem.

L T P C 3 0 0 3

Course Objectives: Introduce the importance of programming, C language constructs, program development, data structures, searching and sorting.

Course Outcomes:

- 1. Understand the various steps in Program development.
- 2. Explore the basic concepts in C Programming Language.
- 3. Develop modular and readable C Programs
- 4. Understand the basic concepts such as Abstract Data Types, Linear and Non-Linear Data structures.
- 5. Apply data structures such as stacks, queues in problem solving
- 6. To understand and analyze various searching and sorting algorithms.

UNIT - I

Introduction to Computers – Computer Systems, Computing Environments, Computer Languages, Creating and running programs, Software Development

Introduction to C Language – Background, Simple C programs, Identifiers, Basic data types, Variables, Constants, Input / Output

Structure of a C Program – Operators, Bit-wise operators, Expressions, Precedence and Associatively, Expression Evaluation, Type conversions, Statements.

UNIT - II

Statements – if and switch statements, Repetition statements – while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Recursion.

Designing Structured Programs- Functions, basics, user defined functions, inter function communication, standard functions.

Arrays – Concepts, using arrays in C, inter function communication, array applications, twodimensional arrays, multidimensional arrays.

UNIT - III

Pointers – Introduction, Pointers for inter function communication, pointers to pointers, compatibility, **Pointer Applications** – Passing an array to a function, Memory allocation functions, array of pointers **Strings** – Concepts, C Strings, String Input / Output functions, arrays of strings, string manipulation functions, string / data conversion.

UNIT - IV

Derived types – The Typedef, enumerated types, Structures – Declaration, definition and initialization of structures, accessing structures, operations on structures, complex structures. Unions-Referencing unions, initializers, unions and structures.

Input and Output – Text vs Binary streams, standard library functions for files, converting file types, File programs – copy, merge files.

UNIT – V

Sorting- selection sort, bubble sort, insertion sort,

Searching-linear and binary search methods.

Data Structures – Introduction to Data Structures, abstract data types, Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, Stacks-Operations, array and linked representations of stacks, stack applications, Queues-operations, array and linked reoresentations.

TEXT BOOKS:

- 1. C Programming & Data Structures, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
- 2. Problem Solving and Program Design in C, J.R. Hanly and E.B. Koffman, Fifth Edition, Person Education.
- 3. The C Programming Language, B.W. Kernighan and Dennis M.Ritchie, PHI/Pearson Education.

- 1. C & Data structures P. Padmanabham, 3rd Edition, B.S. Publications.
- 2. C Programming with problem solving, J.A. Jones & K. Harrow, Dreamtech Press.
- 3. Programming in C Stephen G. Kochan, III Edition, Pearson Education.
- 4. C for Engineers and Scientists, H. Cheng, McGraw-Hill International Edition.
- 5. Data Structures using C A. M. Tanenbaum, Y. Langsam, and M.J. Augenstein, Pearson Education / PHI.
- 6. C Programming & Data Structures, E. Balagurusamy, TMH.
- 7. C Programming & Data Structures, P. Dey, M Ghosh R Thereja, Oxford University Press.
- 8. C & Data structures E V Prasad and N B Venkateswarlu, S. Chand & Co.

ENGINEERING WORKSHOP

B.Tech. I Year I Sem.

L T P C 0 1 3 2.5

Pre-requisites: Practical skill

Course Objectives:

- To Study of different hand operated power tools, uses and their demonstration.
- To gain a good basic working knowledge required for the production of various engineering products.
- To provide hands on experience about use of different engineering materials, tools, equipments and processes those are common in the engineering field.
- To develop a right attitude, team working, precision and safety at work place.
- It explains the construction, function, use and application of different working tools, equipment and machines.
- To study commonly used carpentry joints.
- To have practical exposure to various welding and joining processes.
- Identify and use marking out tools, hand tools, measuring equipment and to work to prescribed to lerances.

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

- CO 1: Study and practice on machine tools and their operations
- CO 2: Practice on manufacturing of components using workshop trades including pluming,
- fitting, carpentry, foundry, house wiring and welding.
- CO 3: Identify and apply suitable tools for different trades of Engineering processes including drilling, material removing, measuring, chiseling.
- CO 4: Apply basic electrical engineering knowledge for house wiring practice.

1. TRADES FOR EXERCISES:

At least two exercises from each trade:

I. Carpentry – (T-Lap Joint, Dovetail Joint, Mortise & Tenon Joint)

II. Fitting – (V-Fit, Dovetail Fit & Semi-circular fit)

III. Tin-Smithy – (Square Tin, Rectangular Tray & Conical Funnel)

IV. Foundry – (Preparation of Green Sand Mould using Single Piece and Split Pattern)

V. Welding Practice – (Arc Welding & Gas Welding)

VI. House-wiring – (Parallel & Series, Two-way Switch and Tube Light)

VII. Black Smithy – (Round to Square, Fan Hook and S-Hook)

2. TRADES FOR DEMONSTRATION & EXPOSURE:

Plumbing, Machine Shop, Metal Cutting (Water Plasma), Power tools in construction and Wood Working

TEXT BOOKS:

- 1. Workshop Practice /B. L. Juneja / Cengage
- 2. Workshop Manual / K. Venugopal / Anuradha.

- 1. Work shop Manual P. Kannaiah/ K.L. Narayana/ Scitech
- 2. Workshop Manual / Venkat Reddy/ BSP

ENGLISH FOR SKILL ENHANCEMENT

B.Tech. I Year I Sem.

L T P C 2 0 0 2

Course Objectives: This course will enable the students to:

- 1. Improve the language proficiency of students in English with an emphasis on Vocabulary, Grammar, Reading and Writing skills.
- 2. Develop study skills and communication skills in various professional situations.
- 3. Equip students to study engineering subjects more effectively and critically using the theoretical and practical components of the syllabus.

Course Outcomes: Students will be able to:

- 1. Understand the importance of vocabulary and sentence structures.
- 2. Choose appropriate vocabulary and sentence structures for their oral and written communication.
- 3. Demonstrate their understanding of the rules of functional grammar.
- 4. Develop comprehension skills from the known and unknown passages.
- 5. Take an active part in drafting paragraphs, letters, essays, abstracts, précis and reports in various contexts.
- 6. Acquire basic proficiency in reading and writing modules of English.

UNIT - I

Chapter entitled '*Toasted English*' by R.K.Narayan from "*English: Language, Context and Culture*" published by Orient BlackSwan, Hyderabad.

Vocabulary: The Concept of Word Formation -The Use of Prefixes and Suffixes – Acquaintance with Prefixes and Suffixes from Foreign Languages to form Derivatives – Synonyms and Antonyms

Grammar: Identifying Common Errors in Writing with Reference to Articles and Prepositions. **Reading:** Reading and Its Importance- Techniques for Effective Reading.

Writing: Sentence Structures -Use of Phrases and Clauses in Sentences- Importance of Proper Punctuation- Techniques for Writing precisely – Paragraph Writing – Types, Structures and Features of a Paragraph - Creating Coherence-Organizing Principles of Paragraphs in documents.

UNIT - II

Chapter entitled 'Appro JRD' by Sudha Murthy from "English: Language, Context and Culture" *published* by Orient BlackSwan, Hyderabad.

Vocabulary: Words Often Misspelt - Homophones, Homonyms and Homographs

- **Grammar:** Identifying Common Errors in Writing with Reference to Noun-pronoun Agreement and Subject-verb Agreement.
- Reading: Sub-Skills of Reading Skimming and Scanning Exercises for Practice

Writing: Nature and Style of Writing- Defining /Describing People, Objects, Places and Events –

Classifying- Providing Examples or Evidence.

UNIT - III

Chapter entitled **'Lessons from Online Learning' by F.Haider Alvi, Deborah Hurst et al** from *"English: Language, Context and Culture"* published by Orient BlackSwan, Hyderabad. **Vocabulary**: Words Often Confused - Words from Foreign Languages and their Use in English.

Grammar: Identifying Common Errors in Writing with Reference to Misplaced Modifiers and Tenses.

Reading: Sub-Skills of Reading – Intensive Reading and Extensive Reading – Exercises for Practice. **Writing:** Format of a Formal Letter-Writing Formal Letters E.g., Letter of Complaint, Letter of

Requisition, Email Etiquette, Job Application with CV/Resume.

UNIT - IV

Chapter entitled 'Art and Literature' by Abdul Kalam from "English: Language, Context and Culture" published by Orient BlackSwan, Hyderabad.

Vocabulary: Standard Abbreviations in English

Grammar: Redundancies and Clichés in Oral and Written Communication.

Reading: Survey, Question, Read, Recite and Review (SQ3R Method) - Exercises for Practice

Writing: Writing Practices- Essay Writing-Writing Introduction and Conclusion -Précis Writing. UNIT - V

Chapter entitled 'Go, Kiss the World' by Subroto Bagchi from "*English: Language, Context and Culture*" published by Orient BlackSwan, Hyderabad.

Vocabulary: Technical Vocabulary and their Usage

Grammar: Common Errors in English (*Covering all the other aspects of grammar which were not covered in the previous units*)

Reading: Reading Comprehension-Exercises for Practice

Writing: Technical Reports- Introduction – Characteristics of a Report – Categories of Reports Formats- Structure of Reports (Manuscript Format) -Types of Reports - Writing a Report.

Note: Listening and Speaking Skills which are given under Unit-6 in AICTE Model Curriculum are covered in the syllabus of ELCS Lab Course.

- Note: 1. As the syllabus of English given in AICTE Model Curriculum-2018 for B.Tech First Year is Open-ended, besides following the prescribed textbook, it is required to prepare teaching/ learning materials by the teachers collectively in the form of handouts based on the needs of the students in their respective colleges for effective teaching/learning in the class.
- Note: 2. Based on the recommendations of NEP2020, teachers are requested to be flexible to adopt Blended Learning in dealing with the course contents. They are advised to teach 40 percent of each topic from the syllabus in blended mode.

TEXT BOOK:

1. "English: Language, Context and Culture" by Orient BlackSwan Pvt. Ltd, Hyderabad. 2022. Print.

- 1. Effective Academic Writing by Liss and Davis (OUP)
- 2. Richards, Jack C. (2022) Interchange Series. Introduction, 1,2,3. Cambridge University Press
- 3. Wood, F.T. (2007). Remedial English Grammar. Macmillan.
- 4. Chaudhuri, Santanu Sinha. (2018). Learn English: A Fun Book of Functional Language,
- Grammar and Vocabulary. (2nd ed.,). Sage Publications India Pvt. Ltd.
- 5. (2019). Technical Communication. Wiley India Pvt. Ltd.
- Vishwamohan, Aysha. (2013). English for Technical Communication for Engineering Students. Mc Graw-Hill Education India Pvt. Ltd.
- 7. Swan, Michael. (2016). Practical English Usage. Oxford University Press. Fourth Edition.

ELEMENTS OF CHEMICAL ENGINEERING

B.Tech. I Year I Sem.

L T P C 0 0 2 1

Course Objectives: To get primary understanding on chemical process equipment and instrumentation for the measurement of various process parameters such as discharge in rota meter, pH, conductivity, TDS, COD, air diffusion & rate of Drying

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

CO1: Understand the characteristics of water samples

CO2: Gain knowledge on different aspects of fluid mechanics & mechanical operations

CO3: Understand the basics principles of mass transfer & reaction engineering

LIST OF EXPERIMENTS

- 1. Determination of pH, conductivity, TDS & COD of given sample
- 2. Determination of viscosity of lubricating oil
- 3. Diffusion of CCl_{4 in} Air
- 4. Study of drying rate in tray dryer
- 5. Determination of activation energy of a reaction using batch reactor
- 6. Preparation of solid & liquid samples of different concentration
- 7. Measurement of coefficient of discharge of Rota Meter
- 8. Study of flow regimes using Reynold's apparatus
- 9. Study on Batch sedimentation
- 10. Determination of effectiveness of a vibrating screen

APPLIED PHYSICS LABORATORY

L T P C 0 0 3 1.5

Course Objectives: The objectives of this course for the student to

- 1. Capable of handling instruments related to the Hall effect and photoelectric effect experiments and their measurements.
- 2. Understand the characteristics of various devices such as PN junction diode, Zener diode, BJT, LED, solar cell, lasers and optical fiber and measurement of energy gap and resistivity of semiconductor materials.
- 3. Able to measure the characteristics of dielectric constant of a given material.
- 4. Study the behavior of B-H curve of ferromagnetic materials.
- 5. Understanding the method of least squares fitting.

Course Outcomes: The students will be able to:

- 1. Know the determination of the Planck's constant using Photo electric effect and identify the material whether it is n-type or p-type by Hall experiment.
- 2. Appreciate quantum physics in semiconductor devices and optoelectronics.
- 3. Gain the knowledge of applications of dielectric constant.
- 4. Understand the variation of magnetic field and behavior of hysteresis curve.
- 5. Carried out data analysis.

LIST OF EXPERIMENTS:

- 1. Determination of work function and Planck's constant using photoelectric effect.
- 2. Determination of Hall co-efficient and carrier concentration of a given semiconductor.
- 3. Characteristics of series and parallel LCR circuits.
- 4. V-I characteristics of a p-n junction diode and Zener diode
- 5. Input and output characteristics of BJT (CE, CB & CC configurations)
- 6. a) V-I and L-I characteristics of light emitting diode (LED)
- b) V-I Characteristics of solar cell
- 7. Determination of Energy gap of a semiconductor.
- 8. Determination of the resistivity of semiconductor by two probe method.
- 9. Study B-H curve of a magnetic material.
- 10. Determination of dielectric constant of a given material
- 11. a) Determination of the beam divergence of the given LASER beam
- b) Determination of Acceptance Angle and Numerical Apertureof an optical fiber.
- 12. Understanding the method of least squares torsional pendulum as an example.

Note: Any 8 experiments are to be performed.

REFERENCE BOOK:

1. S. Balasubramanian, M.N. Srinivasan "A Text book of Practical Physics"- S Chand Publishers, 2017.

ENGLISH LANGUAGE AND COMMUNICATION SKILLS LABORATORY

B.Tech. I Year I Sem.

LTPC

$0 \ 0 \ 2 \ 1$

The **English Language and Communication Skills (ELCS) Lab** focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations both in formal and informal contexts.

Course Objectives:

- ✓ To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
- ✓ To sensitize the students to the nuances of English speech sounds, word accent, intonation and rhythm
- ✓ To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
- ✓ To improve the fluency of students in spoken English and neutralize the impact of dialects.
- ✓ To train students to use language appropriately for public speaking, group discussions and interviews

Course Outcomes: Students will be able to:

- ✓ Understand the nuances of English language through audio- visual experience and group activities
- ✓ Neutralise their accent for intelligibility
- ✓ Speak with clarity and confidence which in turn enhances their employability skills

Syllabus: English Language and Communication Skills Lab (ELCS) shall have two parts: a. Computer Assisted Language Learning (CALL) Lab

b. Interactive Communication Skills (ICS) Lab

Listening Skills:

Objectives

- 1. To enable students develop their listening skills so that they may appreciate the role in the LSRW skills pproach to language and improve their pronunciation.
- 2. To equip students with necessary training in listening, so that they can comprehend the speech of people of different backgrounds and regions *Students should be given practice in listening to the sounds of the language, to be able to recognize them and find the distinction between different sounds, to be able to mark stress and recognize and use the right intonation in sentences.*
 - Listening for general content
 - Listening to fill up information
 - Intensive listening
 - Listening for specific information

Speaking Skills: Objectives

- 1. To involve students in speaking activities in various contexts
- 2. To enable students express themselves fluently and appropriately in social and professional contexts
 - Oral practice
 - Describing objects/situations/people
 - Role play Individual/Group activities
 - Just A Minute (JAM) Sessions

The following course content is prescribed for the English Language and Communication Skills Lab.

Exercise – I

CALL Lab:

Understand: Listening Skill- Its importance – Purpose- Process- Types- Barriers- Effective Listening. *Practice:* Introduction to Phonetics – Speech Sounds – Vowels and Consonants – Minimal Pairs-

Consonant Clusters- Past Tense Marker and Plural Marker- Testing Exercises

ICS Lab:

Understand: Spoken vs. Written language- Formal and Informal English.

Practice: Ice-Breaking Activity and JAM Session- Situational Dialogues – Greetings – Taking Leave – Introducing Oneself and Others.

Exercise – II

CALL Lab:

Understand: Structure of Syllables – Word Stress– Weak Forms and Strong Forms – Stress pattern in sentences – Intonation.

Practice: Basic Rules of Word Accent - Stress Shift - Weak Forms and Strong Forms- Stress pattern in sentences – Intonation - *Testing Exercises*

ICS Lab:

Understand: Features of Good Conversation - Strategies for Effective Communication.

Practice: Situational Dialogues – Role Play- Expressions in Various Situations – Making Requests and Seeking Permissions - Telephone Etiquette.

Exercise - III

CALL Lab:

Understand: Errors in Pronunciation-Neutralising Mother Tongue Interference (MTI).

Practice: Common Indian Variants in Pronunciation – Differences between British and American Pronunciation -*Testing Exercises*

ICS Lab:

Understand: Descriptions- Narrations- Giving Directions and Guidelines – Blog Writing *Practice:* Giving Instructions – Seeking Clarifications – Asking for and Giving Directions – Thanking and Responding – Agreeing and Disagreeing – Seeking and Giving Advice – Making Suggestions. **Exercise – IV**

CALL Lab:

Understand: Listening for General Details.

Practice: Listening Comprehension Tests - Testing Exercises

ICS Lab:

Understand: Public Speaking – Exposure to Structured Talks - Non-verbal Communication-Presentation Skills.

Practice: Making a Short Speech – Extempore- Making a Presentation.

Exercise – V

CALL Lab:

Understand: Listening for Specific Details.

Practice: Listening Comprehension Tests -Testing Exercises

ICS Lab:

Understand: Group Discussion

Practice: Group Discussion

Minimum Requirement of infrastructural facilities for ELCS Lab:

1. Computer Assisted Language Learning (CALL) Lab:

The Computer Assisted Language Learning Lab has to accommodate 40 students with 40 systems, with one Master Console, LAN facility and English language learning software for self- study by students.

System Requirement (Hardware component):

Computer network with LAN facility (minimum 40 systems with multimedia) with the following specifications:

i) Computers with Suitable Configuration

ii) High Fidelity Headphones

2. Interactive Communication Skills (ICS) Lab:

The Interactive Communication Skills Lab: A Spacious room with movable chairs and audiovisual aids with a Public Address System, a T. V. or LCD, a digital stereo –audio & video system and camcorder etc.

Source of Material (Master Copy):

- Exercises in Spoken English. Part 1,2,3. CIEFL and Oxford University Press
- **Note:** Teachers are requested to make use of the master copy and get it tailor-made to suit the contents of the syllabus.

Suggested Software:

- Oxford Advanced Learner's Compass, 10th Edition.
- Cambridge Advanced Learners' English Dictionary with CD.
- Grammar Made Easy by Darling Kindersley.
- Punctuation Made Easy by Darling Kindersley.
- English in Mind (Series 1-4), Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge.
- English Pronunciation in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
- English Vocabulary in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
- TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS).
- Digital All
- Orell Digital Language Lab (Licensed Version)

REFERENCE BOOKS:

- 1. (2022). English Language Communication Skills Lab Manual cum Workbook. Cengage Learning India Pvt. Ltd.
- 2. Shobha, KN & Rayen, J. Lourdes. (2019). *Communicative English A workbook*. Cambridge University Press.
- 3. Kumar, Sanjay & Lata, Pushp. (2019). Communication Skills: A Workbook. Oxford University Press.
- 4. Board of Editors. (2016). *ELCS Lab Manual: A Workbook for CALL and ICS Lab Activities*. Orient Black Swan Pvt. Ltd.
- 5. Mishra, Veerendra et al. (2020). *English Language Skills: A Practical Approach*. Cambridge University Press.

C PROGRAMMING AND DATA STRUCTURES LABORATORY

B.Tech. I Year I Sem.

L T P C 0 0 2 1

Course Objectives: Introduce the importance of programming, C language constructs, program development, data structures, searching and sorting.

Course Outcomes:

- 1. Develop modular and readable C Programs
- 2. Solve problems using strings, functions
- 3. Handle data in files
- 4. Implement stacks, queues using arrays, linked lists.
- 5. To understand and analyze various searching and sorting algorithms

List of Experiments:

- 1. Write a C program to find the sum of individual digits of a positive integer.
- 2. Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence. Write a C program to generate the first n terms of the sequence.
- 3. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.
- 4. Write a C program to find the roots of a quadratic equation.
- 5. Write a C program to find the factorial of a given integer.
- 6. Write a C program to find the GCD (greatest common divisor) of two given integers.
- 7. Write a C program to solve Towers of Hanoi problem.
- 8. Write a C program, which takes two integer operands and one operator from the user, performs the operation and then prints the result. (Consider the operators +,-,*, /, % and use Switch Statement)
- 9. Write a C program to find both the largest and smallest number in a list of integers.
- 10. Write a C program that uses functions to perform the following:
 - i) Addition of Two Matrices
 - ii) Multiplication of Two Matrices
- 11. Write a C program that uses functions to perform the following operations:
 - i) To insert a sub-string in to a given main string from a given position.
 - ii) To delete n Characters from a given position in a given string.
- 12. Write a C program to determine if the given string is a palindrome or not
- 13. Write a C program that displays the position or index in the string S where the string T begins, or 1 if S doesn't contain T.
- 14. Write a C program to count the lines, words and characters in a given text.
- 15. Write a C program to generate Pascal's triangle.
- 16. Write a C program to construct a pyramid of numbers.
- 17. Write a C program that uses functions to perform the following operations:
 - i) Reading a complex number
 - ii) Writing a complex number
 - iii) Addition of two complex numbers
 - iv) Multiplication of two complex numbers
- (Note: represent complex number using a structure.)

18.

- i. Write a C program which copies one file to another.
- ii. Write a C program to reverse the first n characters in a file.
- (Note: The file name and n are specified on the command line.)

19.

- i. Write a C program to display the contents of a file.
- ii. Write a C program to merge two files into a third file (i.e., the contents of the first file followed by those of the second are put in the third file)
- 20. Write a C program that uses functions to perform the following operations on singly linked list.:
 - i) Creation ii) Insertion iii) Deletion iv) Traversal
- 21. Write C programs that implement stack (its operations) using
 - i) Arrays ii) Pointers
- 22. Write C programs that implement Queue (its operations) using

i) Arrays ii) Pointers

- 23. Write a C program that implements the following sorting methods to sort a given list of integers in ascending order i) Bubble sort ii) Selection sort iii) Insertion sort
- 24. Write C programs that use both recursive and non-recursive functions to perform the following searching operations for a Key value in a given list of integers:

i) Linear search ii) Binary search

TEXT BOOKS:

- 1. C Programming & Data Structures, B.A. Forouzan and R. F. Gilberg, Third Edition, Cengage Learning.
- 2. Let us C, Yeswanth Kanitkar
- 3. C Programming, Balaguruswamy.

L T P C 3 0 0 0

B.Tech. I Year I Sem.

Course Objectives:

- Understanding the importance of ecological balance for sustainable development.
- Understanding the impacts of developmental activities and mitigation measures.
- Understanding the environmental policies and regulations

Course Outcomes:

• Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

UNIT - I

Ecosystems: Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

UNIT - II

Natural Resources: Classification of Resources: Living and Non-Living resources,

Water resources: use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems.

Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, Land resources: Forest resources,

Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

UNIT - III

Biodiversity and Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

UNIT - IV

Environmental Pollution and Control Technologies: Environmental Pollution: Classification of pollution, **Air Pollution:** Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil.

Noise Pollution: Sources and Health hazards, standards, **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.

Overview of air pollution control technologies, Concepts of bioremediation.

Global Environmental Issues and Global Efforts: Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol. NAPCC-GoI Initiatives.

UNIT - V

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act-1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules.

EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development Goals, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

TEXT BOOKS:

- 1 Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
- 2 Environmental Studies by R. Rajagopalan, Oxford University Press.

- 1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
- 2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
- 3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
- 4. Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.
- 5. Text book of Environmental Science and Technology Dr. M. Anji Reddy 2007, BS Publications.
- 6. Introduction to Environmental Science by Y. Anjaneyulu, BS. Publications.

ORDINARY DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

B.Tech. I Year II Sem.

L T P C 3 1 0 4

Pre-requisites: Mathematical Knowledge at pre-university level

Course Objectives: To learn

- Methods of solving the differential equations of first and higher order.
- Concept, properties of Laplace transforms
- Solving ordinary differential equations using Laplace transforms techniques.
- The physical quantities involved in engineering field related to vector valued functions
- The basic properties of vector valued functions and their applications to line, surface and volume integrals

Course outcomes: After learning the contents of this paper the student must be able to

- Identify whether the given differential equation of first order is exact or not
- Solve higher differential equation and apply the concept of differential equation to real world problems.
- Use the Laplace transforms techniques for solving ODE's.
- Evaluate the line, surface and volume integrals and converting them from one to another

UNIT-I: First Order ODE

Exact differential equations, Equations reducible to exact differential equations, linear and Bernoulli's equations, Orthogonal Trajectories (only in Cartesian Coordinates). Applications: Newton's law of cooling, Law of natural growth and decay.

UNIT-II: Ordinary Differential Equations of Higher Order

Second order linear differential equations with constant coefficients: Non-Homogeneous terms of the Type e^{ax} , sin ax, cos ax, polynomials in x, $e^{ax}V(x)$ and x V(x), method of variation of parameters, Equations reducible to linear ODE with constant coefficients: Legendre's equation, Cauchy-Euler equation. Applications: Electric Circuits.

UNIT-III: Laplace transforms

Laplace Transforms: Laplace Transform of standard functions, first shifting theorem, second shifting theorem, Unit step function, Dirac delta function, Laplace transforms of functions when they are multiplied and divided by 't', Laplace transforms of derivatives and integrals of function, Evaluation of integrals by Laplace transforms, Laplace transform of periodic functions, Inverse Laplace transform by different methods, convolution theorem (without proof). Applications: solving Initial value problems by Laplace Transform method.

8 L

10 L

10 L

Vector point functions and scalar point functions, Gradient, Divergence and Curl, Directional derivatives, Tangent plane and normal line, Vector Identities, Scalar potential functions, Solenoidal and Irrotational vectors.

UNIT-V: Vector Integration

10 L

Line, Surface and Volume Integrals, Theorems of Green, Gauss and Stokes (without proofs) and their applications.

TEXT BOOKS:

- 1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010
- 2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5th Edition, 2016.

- 1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
- 2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
- 3. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S Chand and Company Limited, New Delhi.
- 4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

ENGINEERING CHEMISTRY

B.Tech. I Year II Sem.

L T P C 3 1 0 4

Course Objectives:

- 1. To bring adaptability to new developments in Engineering Chemistry and to acquire the skills required to become a perfect engineer.
- 2. To include the importance of water in industrial usage, fundamental aspects of battery chemistry, significance of corrosion it's control to protect the structures.
- 3. To imbibe the basic concepts of petroleum and its products.
- 4. To acquire required knowledge about engineering materials like cement, smart materials and Lubricants.

Course Outcomes:

- 1. Students will acquire the basic knowledge of electrochemical procedures related to corrosion and its control.
- 2. The students are able to understand the basic properties of water and its usage in domestic and industrial purposes.
- 2. They can learn the fundamentals and general properties of polymers and other engineering materials.
- 3. They can predict potential applications of chemistry and practical utility in order to become good engineers and entrepreneurs.

UNIT - I: Water and its treatment: [8]

Introduction to hardness of water – Estimation of hardness of water by complexometric method and related numerical problems. Potable water and its specifications - Steps involved in the treatment of potable water - Disinfection of potable water by chlorination and break - point chlorination.

Defluoridation - Determination of F- ion by ion- selective electrode method.

Boiler troubles: Sludges, Scales and Caustic embrittlement. Internal treatment of Boiler feed water -Calgon conditioning - Phosphate conditioning - Colloidal conditioning, External treatment methods -Softening of water by ion- exchange processes. Desalination of water – Reverse osmosis.

UNIT – II Battery Chemistry & Corrosion [8]

Introduction - Classification of batteries- primary, secondary and reserve batteries with examples. Basic requirements for commercial batteries. Construction, working and applications of: Zn-air and Lithium ion battery, Applications of Li-ion battery to electrical vehicles. Fuel Cells- Differences between battery and a fuel cell, Construction and applications of Methanol Oxygen fuel cell and Solid oxide fuel cell. Solar cells - Introduction and applications of Solar cells.

Corrosion: Causes and effects of corrosion – theories of chemical and electrochemical corrosionmechanism of electrochemical corrosion, Types of corrosion: Galvanic, water-line and pitting corrosion. Factors affecting rate of corrosion, Corrosion control methods- Cathodic Protection-Sacrificial anode and impressed current methods. Definition – Classification of polymers with examples – Types of polymerization –addition (free radical addition) and condensation polymerization with examples – Nylon 6:6, Terylene

Plastics: Definition and characteristics- thermoplastic and thermosetting plastics, Preparation,

Properties and engineering applications of PVC and Bakelite, Teflon, Fiber reinforced plastics (FRP). **Rubbers:** Natural rubber and its vulcanization.

Elastomers: Characteristics – preparation – properties and applications of Buna-S, Butyl and Thiokol rubber.

Conducting polymers: Characteristics and Classification with examples-mechanism of conduction in trans-polyacetylene and applications of conducting polymers.

Biodegradable polymers: Concept and advantages - Polylactic acid and poly vinyl alcohol and their applications.

UNIT - IV: Energy Sources: [8]

Introduction, Calorific value of fuel – HCV, LCV- Dulongs formula. Classification- solid fuels: coalanalysis of coal – proximate and ultimate analysis and their significance. Liquid fuels – petroleum and its refining, cracking types – moving bed catalytic cracking. Knocking – octane and cetane rating, synthetic petrol - Fischer-Tropsch's process; Gaseous fuels – composition and uses of natural gas, LPG and CNG, Biodiesel – Transesterification, advantages.

UNIT - V: Engineering Materials: [8]

Cement: Portland cement, its composition, setting and hardening.

Smart materials and their engineering applications

Shape memory materials- Poly L- Lactic acid. Thermoresponse materials- Polyacryl amides, Poly vinyl amides

Lubricants: Classification of lubricants with examples-characteristics of a good lubricants -mechanism of lubrication (thick film, thin film and extreme pressure)- properties of lubricants: viscosity, cloud point, pour point, flash point and fire point.

TEXT BOOKS:

- 1. Engineering Chemistry by P.C. Jain and M. Jain, Dhanpatrai Publishing Company, 2010
- 2. Engineering Chemistry by Rama Devi, Venkata Ramana Reddy and Rath, Cengage learning, 2016
- 3. A text book of Engineering Chemistry by M. Thirumala Chary, E. Laxminarayana and K. Shashikala, Pearson Publications, 2021.
- 4. Textbook of Engineering Chemistry by Jaya Shree Anireddy, Wiley Publications.

- 1. Engineering Chemistry by Shikha Agarwal, Cambridge University Press, Delhi (2015)
- 2. Engineering Chemistry by Shashi Chawla, Dhanpatrai and Company (P) Ltd. Delhi (2011)

COMPUTER AIDED ENGINEERING GRAPHICS

B.Tech. I Year II Sem.

L T P C 1 0 4 3

Course Objectives:

- To develop the ability of visualization of different objects through technical drawings
- To acquire computer drafting skill for communication of concepts, ideas in the design of engineering products

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

- Apply computer aided drafting tools to create 2D and 3D objects
- sketch conics and different types of solids
- Appreciate the need of Sectional views of solids and Development of surfaces of solids
- Read and interpret engineering drawings
- Conversion of orthographic projection into isometric view and vice versa manually and by using computer aided drafting

UNIT – I:

Introduction to Engineering Graphics: Principles of Engineering Graphics and their Significance, Scales – Plain & Diagonal, Conic Sections including the Rectangular Hyperbola – General method only. Cycloid, Epicycloid and Hypocycloid, Introduction to Computer aided drafting – views, commands and conics

UNIT-II:

Orthographic Projections: Principles of Orthographic Projections – Conventions – Projections of Points and Lines, Projections of Plane regular geometric figures. Auxiliary Planes. Computer aided orthographic projections – points, lines and planes

UNIT – III:

Projections of Regular Solids – Auxiliary Views - Sections or Sectional views of Right Regular Solids-Prism, Cylinder, Pyramid, Cone – Auxiliary views, Computer aided projections of solids – sectional views

UNIT – IV:

Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid and Cone, Development of surfaces using computer aided drafting

UNIT – V:

Isometric Projections: Principles of Isometric Projection – Isometric Scale – Isometric Views-Conventions – Isometric Views of Lines, Plane Figures, Simple and Compound Solids – Isometric Projection of objects having non- isometric lines. Isometric Projection of Spherical Parts. Conversion of Isometric Views to Orthographic Views and Vice-versa –Conventions. Conversion of orthographic projection into isometric view using computer aided drafting.

TEXT BOOKS:

1. Engineering Drawing N.D. Bhatt / Charotar

2. Engineering Drawing and graphics Using AutoCAD Third Edition, T. Jeyapoovan, Vikas: S. Chand and company Ltd.

- 1. Engineering Drawing, Basant Agrawal and C M Agrawal, Third Edition McGraw Hill
- 2. Engineering Graphics and Design, WILEY, Edition 2020
- 3. Engineering Drawing, M. B. Shah, B.C. Rane / Pearson.
- 4. Engineering Drawing, N. S. Parthasarathy and Vela Murali, Oxford
- 5. Computer Aided Engineering Drawing K Balaveera Reddy et al CBS Publishers
- **Note:** External examination is conducted in conventional mode and internal evaluation to be done by both conventional as well as using computer aided drafting.

ENGINEERING MECHANICS

B.Tech. I Year II Sem.

L T P C 3 0 0 3

Course Objectives: The objectives of this course are to

- 1. Explain the resolution of a system of forces, compute their resultant and solve problems using equations of equilibrium
- 2. Perform analysis of bodies lying on rough surfaces.
- 3. Locate the centroid of a body and compute the area moment of inertia and mass moment of inertia of standard and composite sections
- 4. Explain kinetics and kinematics of particles, projectiles, curvilinear motion, centroidal motion and plane motion of rigid bodies.
- 5. Explain the concepts of work-energy method and its applications to translation, rotation and plane motion and the concept of vibrations

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

- 1. Determine resultant of forces acting on a body and analyse equilibrium of a body subjected to a system of forces.
- 2. Solve problem of bodies subjected to friction.
- 3. Find the location of centroid and calculate moment of inertia of a given section.
- 4. Understand the kinetics and kinematics of a body undergoing rectilinear, curvilinear,

rotatory motion and rigid body motion.

UNIT - I:

Introduction to Engineering Mechanics - Force Systems: Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy

UNIT - II:

Friction: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;

Centroid and Centre of Gravity -Centroid of Lines, Areas and Volumes from first principle, centroid of composite sections; Centre of Gravity and its implications. – Theorem of Pappus

UNIT - III:

Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Product of Inertia, Parallel Axis Theorem, Perpendicular Axis Theorem.

Mass Moment of Inertia: Moment of Inertia of Masses - Transfer Formula for Mass Moments of Inertia – Mass moment of inertia of composite bodies.

UNIT - IV:

Kinematics of Particles: Kinematics of particles – Rectilinear motion – Curvilinear motion – Projectiles. Kinetics of Particles: Kinetics of particles – Newton's Second Law – Differential equations of rectilinear and curvilinear motion – Dynamic equilibrium – Inertia force – D. Alembert's Principle applied for rectilinear and curvilinear motion.

UNIT - V:

Work - Energy Principle: Equation of translation, principle of conservation of energy, work - energy principle applied to particle motion and connected systems, fixed axis rotation. Impulse – Momentum Principle: Introduction, linear impulse momentum, principle of conservation of linear momentum, elastic impact and types of impact, loss of kinetic energy, co efficient of restitution.

TEXT BOOKS:

- 1. Shames and Rao (2006), Engineering Mechanics, Pearson Education
- 2. Reddy Vijay Kumar K. and J. Suresh Kumar (2010), Singer's Engineering Mechanics Statics & Dynamics

- 1. Timoshenko S.P and Young D.H., "Engineering Mechanics", McGraw Hill International Edition, 1983.
- 2. Andrew Pytel, Jaan Kiusalaas, "Engineering Mechanics", Cengage Learning, 2014.
- 3. Beer F.P& Johnston E.R Jr. Vector, "Mechanics for Engineers", TMH, 2004.
- 4. Hibbeler R. C & Ashok Gupta, "Engineering Mechanics", Pearson Education, 2010.
- 5. Tayal A.K., "Engineering Mechanics Statics & Dynamics", Umesh Publications, 2011.
- 6. Basudeb Bhattacharyya, "Engineering Mechanics", Oxford University Press, 2008.
- 7. Meriam. J. L., "Engineering Mechanics", Volume-II Dynamics, John Wiley & Sons, 2008.
- 8. P.C Dumir et al. "Engineering Mechanics", University press.
B.Tech. I Year II Sem.

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Course Objectives:

This course will help students to learn about the relationship between structure and properties of materials, application of various classes of materials including metals, ceramics, polymers.

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

- CO1: Understand the classification & structure of materials
- CO2: Calculate parameters for simple crystal structures & predict the behavior of crystal systems due to imperfections.
- CO3: Predict the properties of simple alloys and steels based on their phase diagrams, phase transitions and heat treatment.
- CO4: Describe the mechanical behavior, failure and strengthening mechanisms of various metals, alloys and plastics.

UNIT- I

Introduction: Engineering Materials – Classification – levels of structure, structure property relationships in materials

Crystal Geometry and Structure Determination: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions and planes: crystalline and non-crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

UNIT -II

Crystal Imperfection: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation, role of dislocation on crystal properties; surface defects, dislocation density and stress required to move dislocations.

UNIT-III

Phase diagrams: Phase rule, Primary and binary systems-general types with examples; tie line & lever rule, non-equilibrium cooling: phase diagrams of Fe-Fe3-C. Phase transformations in Fe-Fe3-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of alloying elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

UNIT -IV

Elastic, anelastic and visco elastic behaviour: elastic behaviour, rubber like elasticity, anelastic behaviour and visco elastic behaviour, spring dashpot models

Magnetic materials: Terminology and classification, magnetic moments due to electron spin, ferromagnetism and related phenomena, domain structure, hysteresis loop, soft and hard magnetic materials.

Plastic deformation and creep in crystalline materials:

Plastic deformation: Tensile stress-strain curve, Plastic deformation by slip

Creep: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials.

Fracture: Ductile fracture and brittle fracture.

TEXT BOOK:

1. Materials Science and Engineering by V. Raghavan 5th ed., PHI Learning Pvt. Ltd., New Delhi, 2011.

REFERENCES:

- 1. Elements of Materials Science, L.H. Van Vlack,
- 2. Science of Engineering Materials, vols. 1 & 2, Manas Chanda, McMillan Company of India Ltd.

PYTHON PROGRAMMING LABORATORY

B.Tech. I Year II Sem.	L T P C
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Course Objectives:	

- To install and run the Python interpreter.
- To learn control structures.
- To Understand Lists, Dictionaries in python.
- To Handle Strings and Files in Python.

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

- Develop the application specific codes using python.
- Understand Strings, Lists, Tuples and Dictionaries in Python
- Verify programs using modular approach, file I/O, Python standard library
- Implement Digital Systems using Python

Note: The lab experiments will be like the following experiment examples

Week -1:

1. i) Use a web browser to go to the Python website http://python.org. This page contains information about Python and links to Python-related pages, and it gives you the ability to search the Python documentation.

ii) Start the Python interpreter and type help () to start the online help utility.

- 2. Start a Python interpreter and use it as a Calculator.
- 3. i) Write a program to calculate compound interest when principal, rate and number of periods are given.

ii) Given coordinates (x1, y1), (x2, y2) find the distance between two points

- 4. Read name, address, email and phone number of a person through keyboard and print the details. Week 2:
- 1. Print the below triangle using for loop.
 - 5
 - 44
 - 333
 - 2222
 - 11111
- 2. Write a program to check whether the given input is digit or lowercase character or uppercase character or a special character (use 'if-else-if' ladder)
- 3. Python Program to Print the Fibonacci sequence using while loop
- 4. Python program to print all prime numbers in a given interval (use break)

Week - 3:

- 1. i) Write a program to convert a list and tuple into arrays.
 - ii) Write a program to find common values between two arrays.
- 2. Write a function called gcd that takes parameters a and b and returns their greatest common divisor.
- 3. Write a function called palindrome that takes a string argument and returnsTrue if it is a palindrome and False otherwise. Remember that you can use the built-in function len to check the length of a string.

Week - 4:

- 1. Write a function called is_sorted that takes a list as a parameter and returns True if the list is sorted in ascending order and False otherwise.
- 2. Write a function called has_duplicates that takes a list and returns True if there is any element that

appears more than once. It should not modify the original list.

i). Write a function called remove_duplicates that takes a list and returns a new list with only the unique elements from the original. Hint: they don't have to be in the same order.

ii). The wordlist I provided, words.txt, doesn't contain single letter words. So you might want to add "I", "a", and the empty string.

iii). Write a python code to read dictionary values from the user. Construct a function to invert its content. i.e., keys should be values and values should be keys.

3. i) Add a comma between the characters. If the given word is 'Apple', it should become 'A,p,p,l,e' ii) Remove the given word in all the places in a string?

iii) Write a function that takes a sentence as an input parameter and replaces the first letter of every word with the corresponding upper case letter and the rest of the letters in the word by corresponding letters in lower case without using a built-in function?

4. Writes a recursive function that generates all binary strings of n-bit length

Week - 5:

- 1. i) Write a python program that defines a matrix and prints
 - ii) Write a python program to perform addition of two square matrices
 - iii) Write a python program to perform multiplication of two square matrices
- 2. How do you make a module? Give an example of construction of a module using different geometrical shapes and operations on them as its functions.
- 3. Use the structure of exception handling all general purpose exceptions.

Week-6:

- 1. a. Write a function called draw_rectangle that takes a Canvas and a Rectangle as arguments and draws a representation of the Rectangle on the Canvas.
 - b. Add an attribute named color to your Rectangle objects and modify draw_rectangle so that it uses the color attribute as the fill color.
 - c. Write a function called draw_point that takes a Canvas and a Point as arguments and draws a representation of the Point on the Canvas.
 - d. Define a new class called Circle with appropriate attributes and instantiate a few Circle objects. Write a function called draw_circle that draws circles on the canvas.
- 2. Write a Python program to demonstrate the usage of Method Resolution Order (MRO) in multiple levels of Inheritances.
- 3. Write a python code to read a phone number and email-id from the user and validate it for correctness.

Week-7

- 1. Write a Python code to merge two given file contents into a third file.
- 2. Write a Python code to open a given file and construct a function to check for given words present in it and display on found.
- 3. Write a Python code to Read text from a text file, find the word with most number of occurrences
- 4. Write a function that reads a file *file1* and displays the number of words, number of vowels, blank spaces, lower case letters and uppercase letters.

Week - 8:

- 1. Import numpy, Plotpy and Scipy and explore their functionalities.
- 2. a) Install NumPy package with pip and explore it.
- 3. Write a program to implement Digital Logic Gates AND, OR, NOT, EX-OR
- 4. Write a program to implement Half Adder, Full Adder, and Parallel Adder
- 5. Write a GUI program to create a window wizard having two text labels, two text fields and two buttons as Submit and Reset.

TEXT BOOKS:

- 1. Supercharged Python: Take your code to the next level, Overland
- 2. Learning Python, Mark Lutz, O'reilly

REFERENCE BOOKS:

- 1. Python Programming: A Modern Approach, Vamsi Kurama, Pearson
- 2. Python Programming A Modular Approach with Graphics, Database, Mobile, and Web Applications, Sheetal Taneja, Naveen Kumar, Pearson
- 3. Programming with Python, A User's Book, Michael Dawson, Cengage Learning, India Edition
- 4. Think Python, Allen Downey, Green Tea Press
- 5. Core Python Programming, W. Chun, Pearson
- 6. Introduction to Python, Kenneth A. Lambert, Cengage

ENGINEERING CHEMISTRY LABORATORY

B.Tech. I Year II Sem.

for engineering student. The student will learn:

- Estimation of hardness of water to check its suitability for drinking purpose.
- Students are able to perform estimations of acids and bases using conductometry, potentiometry and pH metry methods.
- Students will learn to prepare polymers such as Bakelite and nylon-6 in the laboratory.
- Students will learn skills related to the lubricant properties such as saponification value, surface tension and viscosity of oils.

Course Outcomes: The experiments will make the student gain skills on:

- Determination of parameters like hardness of water and rate of corrosion of mild steel in various conditions.
- Able to perform methods such as conductometry, potentiometry and pH metry in order to find out the concentrations or equivalence points of acids and bases.
- Students are able to prepare polymers like bakelite and nylon-6.
- Estimations saponification value, surface tension and viscosity of lubricant oils.

List of Experiments:

I. Volumetric Analysis: Estimation of Hardness of water by EDTA Complexometry method.

II. Conductometry: Estimation of the concentration of an acid by Conductometry.

III. Potentiometry: Estimation of the amount of Fe+2 by Potentiomentry.

IV. pH Metry: Determination of an acid concentration using pH meter.

V. Preparations:

1. Preparation of Bakelite.

2. Preparation Nylon – 6.

VI. Lubricants:

- 1. Estimation of acid value of given lubricant oil.
- 2. Estimation of Viscosity of lubricant oil using Ostwald's Viscometer.

VII. Corrosion: Determination of rate of corrosion of mild steel in the presence and absence of inhibitor.

VIII. Virtual lab experiments

- 1. Construction of Fuel cell and its working.
- 2. Smart materials for Biomedical applications
- 3. Batteries for electrical vehicles.
- 4. Functioning of solar cell and its applications.

REFERENCE BOOKS:

- 1. Lab manual for Engineering chemistry by B. Ramadevi and P. Aparna, S Chand Publications, New Delhi (2022)
- 2. Vogel's text book of practical organic chemistry 5th edition
- 3. Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications.
- 4. College Practical Chemistry by V.K. Ahluwalia, Narosa Publications Ltd. New Delhi (2007).

ENGINEERING MATERIALS LABORATORY

I Year B.Tech. II-Sem

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Course Objective:

• The objective of this course is to give hands on experience on testing of materials.

Course Outcomes:

At the end of the course student will be able to

- Gain knowledge on atomic arrangements in different crystal structures and learning of crystal structure models.
- Distinguish the hard and soft materials based on its hardness.
- Identify different materials based on its physical and mechanical properties.

LIST OF EXPERIMENTS:

- 1. Crystal structures model preparation SC, BCC, FCC and HCP.
- 2. Study of grain size measurement methods.
- 3. Density measurement of different materials using Archimedes Principle.
- 4. Determination of influence of temperature on viscosity of lubricating oils.
- 5. Determination of Rockwell hardness of Fe alloys.
- 6. Determination of Rockwell hardness of Cu alloys.
- 7. Determination of Rockwell hardness of Al alloys.
- 8. Determination of Brinell hardness of ferrous alloys.
- 9. Determination of Brinell hardness of non-ferrous alloys.
- 10. Study of electrical and optical properties of engineering materials.

PROBABILITY, STATISTICS AND COMPLEX VARIABLES

II Year B.Tech. I-Sem

Pre-requisites: Mathematics courses of first year of study.

Course Objectives: To learn

- The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
- The basic ideas of statistics including measures of central tendency, correlation and regression.
- The statistical methods of studying data samples.
- Differentiation and integration of complex valued functions.
- Evaluation of integrals using Cauchy's integral formula and Cauchy's residue theorem.
- Expansion of complex functions using Taylor's and Laurent's series.

Course Outcomes:

After learning the contents of this paper the student must be able to

- Formulate and solve problems involving random variables and apply statistical methods for analysing experimental data.
- Apply concept of estimation and testing of hypothesis to some case studies.
- Analyse the complex function with reference to their analyticity, integration using Cauchy's integral and residue theorems
- Taylor's and Laurent's series expansions of complex function

UNIT-I: Basic Probability

Probability spaces, conditional probability, independent events, and Bayes' theorem. Random variables: Discrete and continuous random variables, Expectation of Random Variables, Variance of random variables.

UNIT-II: Probability distributions

Binomial, Poisson, evaluation of statistical parameters for these distributions, Poisson approximation to the binomial distribution, Continuous random variables and their properties, distribution functions and density functions, Normal and exponential, evaluation of statistical parameters for these distributions.

UNIT-III: Estimation & Tests of Hypotheses

Introduction, Statistical Inference, Classical Methods of Estimation.: Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Estimating a Proportion for single sample, Difference between Two Means, difference between two proportions for two Samples.

Statistical Hypotheses: General Concepts, Testing a Statistical Hypothesis, Tests Concerning a Single Mean, Tests on Two Means, Test on a Single Proportion, Two Samples: Tests on Two Proportions.

UNIT-IV: Complex Differentiation

Limit, Continuity and Differentiation of Complex functions, Analyticity, Cauchy-Riemann equations (without proof), finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties. Conformal mappings, Mobius transformations.

UNIT-V: Complex Integration

Line integral, Cauchy's theorem, Cauchy's Integral formula, Zeros of analytic functions, Singularities, Taylor's series, Laurent's series; Residues, Cauchy Residue theorem, (All theorems without Proof)

Text Books

- 1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.
- 2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, keying Ye, Probability and statistics for engineers and scientists, 9th Edition, Pearson Publications.

References

- 1. Fundamentals of Mathematical Statistics, Khanna Publications, S C Guptha and V.K. Kapoor.
- 2. Miller and Freund's, Probability and Statistics for Engineers, 8th Edition, Pearson Educations
- 3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, LaxmiPublications, Reprint, 2010.
- 4. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

MATERIAL AND ENERGY BALANCE COMPUTATIONS

II Year B. Tech. I- Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. To describe the fundamentals of stoichiometric relations to calculate composition of different mixtures and solutions.
- 2. To solve problems on mass balance, using, different gas laws, vapor pressure laws and humidity concept and psychometric charts
- 3. To demonstrate enthalpy balance concept needed for solution of energy balance of different chemical engineering processes in industries.

Course Outcomes:

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

- 1. Apply basic principles of stoichiometry and material balance on unit operations and processes
- 2. Identify equations of state and properties of gases and liquids, including phase transition
- 3. Evaluate humidity with / without the use of psychometric chart.
- 4. Demonstrate elementary flow-sheeting, material and energy balance calculations with out and with chemical reactions, and involving concepts like recycle, by pass and purge.
- 5. Develop mastery over process calculations relevant to chemical engineering processes

UNIT- I

Stoichiometric & Composition relations: Stoichiometric relation, basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales.

Behavior of Ideal gases: Kinetic theory of gases, application of ideal gas law, gaseous mixtures, Average molecular weight.

UNIT- II

Vapor pressure: Liquefaction and liquid state, vaporization, boiling point, effect of temperature on vapor pressure, Antoine equation, vapor pressure plots, estimation of critical properties, vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Nonvolatile solutes.

UNIT-III

Humidity and Saturation: Partial saturation, Humidity- Absolute Humidity, Vaporization process, Molal humidity, Relative and percentage saturation, dew point, humid heat, wet bulb and dry bulb temperatures, Psychrometric chart, adiabatic vaporization.

UNIT-IV

Material balances: Tie substance, Yield, conversion, limiting reactant, excess reactant, processes involving reactions, Material balances with the help of Stoichiometric equations, Material balances involving drying, dissolution, & crystallization. Material balance calculations for processes involving recycle, bypass and purge.

UNIT- V

Thermo physics: Energy, energy balances, heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heats, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non -polar liquids enthalpy and its evaluation.

Thermo chemistry: Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchhoff's equation, enthalpy concentration change, calculation of theoretical and actual flame temperatures.

Text Books:

- 1. Basic principles and calculations in chemical engineering by D. H. Himmelblau, 7th Ed. PHI, 2013
- **2.** Chemical process principles, Part -I, Material and Energy Balance, Hougen O A, Watson K.M. and Ragatz R.A. 2nd Edition, John Wiley and Sons, New York, 1963.

Reference Books:

 Stoichiometry by B.I. Bhatt and S. M. Vora (3rd Ed.) Tata McGraw Hill publishing company, Ltd. New Delhi (1996)

CHEMICAL ENGINEERING FLUID MECHANICS

II Year B. Tech. I- Sem

Pre Requisites: Basic of Hydrostatics and Hydrodynamics-Mechanics of Fluid flow **Course Objectives**:

- 1. To describe the fundamentals of stoichiometric relations to calculate composition of different mixtures and solutions.
- 2. To solve problems on mass balance, using, different gas laws, vapor pressure laws and humidity concept and psychometric charts
- 3. To demonstrate enthalpy balance concept needed for solution of energy balance of different chemical engineering processes in industries.

Course Outcomes:

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

- 1. Illustrate by simplification of equations of motion in simple1-D flows
- 2. Calculate Boundary layer thicknesses, friction factor, pressure drop
- 3. Explain about the compressible fluid flow
- 4. Design fluidized and packed beds.
- 5. Select pump based on their performance and flow measurement by various meters.

UNIT- I

Unit operations and unit processes, unit systems, basic concepts, nature of fluids, hydrostatic equilibrium, applications of fluid statics.

Fluid flow phenomena- Laminar flow, Shear rate, Shear stress, Rheological properties of fluids, Turbulence, Boundary layers, Basic equation of fluid flow –Mass balance in a flowing fluid; continuity equation, differential momentum balance; equations of motion, Macroscopic momentum balances, Bernoulli equation, pump work in Bernoulli equation.

UNIT- II

Incompressible Flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction, Dimensional analysis including Buckingham π Theorem and Rayleigh's method, Definitions and basic equations of compressible flow.

UNIT-III

Flow past immersed bodies, Drag and Drag coefficient, friction in flow through beds of solids, Kozeny - Carman, Blake-Plummer and Ergun equations, and motion of particles through fluids.

UNIT-IV

Fluidization: Definition of fluidization, Conditions for fluidization, Minimum fluidization velocity, Types of fluidization, Expansion of fluidized beds, Applications of fluidization. Continuous fluidization; slurry and pneumatic transport.

UNIT- V

Transportation and Metering of fluids- Pipes, fittings and valves, Fluid-moving machinery- Fans, blowers, and compressors. Measurement of flowing fluids- variable head meters- Orifice meter, Venturi meter, Pitot tube; Area meters- Rotameter.

Text Books:

- 1. Unit Operations of Chemical Engineering by W. L. Mc- Cabe, J. C. Smith & Peter Harriot, McGraw-Hill, 7thed, 2007
- 2. Chemical Engineering Fluid Mechanics by Ron Darby, CRC Press, 2nd Edn,2001

Reference Books:

- 1. Transport processes and unit operations by Christie J. Geankoplis, PHI (2009).
- 2. Chemical Engineering, Vol-I, Coulson and Richardson, Pergamon Press (1991).

INORGANIC AND PHYSICAL CHEMISTRY

II Year B.Tech. I-Sem

To impart knowledge and importance of

- 1. Bonding in metal carbonyls and catalytic activity of organometallic compounds.
- 2. Concept of biological significance of metals, oxygen transport and its applications.
- 3. Theories of bonding in metal complexes CFT, MOT.
- 4. Catalysis and applications of adsorption
- 5. Concepts of electrochemistry principles and its applications in batteries.

Course Outcomes:

Student is able to understand

- 1. Applications of carbonyls and organometallic compounds.
- 2. Significance of essential elements, haemoglobin and myoglobin.
- 3. Concepts of CFT, MOT and LCAO.
- 4. Applications of different catalytic processes and the concepts of adsorption
- 5. Principles and applications of electrochemistry and battery chemistry.

UNIT-I: Metal Carbonyls and Organometallic Chemistry:

Introduction-Preparation and properties of Ni(CO)4. Structural features of Ni(CO)4, Fe(CO)5, Fe2(CO)9, Fe3(CO)12 and Cr(CO)6 -18 valence electron rule. Definition, nomenclature and classification of organometallic compounds. Methods of preparation, properties and applications of alkyl and aryl compounds of Li, Cu & Al.

UNIT -II: Bio-inorganic Chemistry

Introduction-Essential elements, biological significance of Na, K, Mg, Ca, Fe, Co, Ni, Cu and Zn, Toxic metal Ions-As, Hg &Pb, Oxygen transport and storage–structures of haemoglobin and myoglobin, binding and transport of oxygen.

UNIT -III: Bonding in Metal Complexes:

Crystal Field Theory: Salient features of CFT, d-orbital splitting patterns in regular Octahedral, Tetrahedral and Square planar geometries. Concept of weak field and strong field ligands. - Calculation of crystal field stabilization energies (CFSE's) in six and four coordinate complexes.

Molecular Orbital Theory: Atomic and Molecular orbitals. Linear Combination of Atomic Orbitals (LCAO), molecular orbitals and energy level diagrams of N2, O2 and NO molecules, Bond order.

UNIT -IV: Catalysis and Surface Chemistry

Catalysis: Introduction-Classification of catalysis, homogeneous and heterogeneous catalysis. examples. Enzyme catalysis.

Adsorption: Types of adsorption- Factors influencing adsorption, Freundlich adsorption isotherm, Langmuir theory of unilayer adsorption isotherm, Applications.

UNIT -V: Electrochemistry

Electrochemical cells – electrode potential, standard electrode potential, types of electrodes – Calomel, Quinhydrone and glass electrode. Nernst equation, Determination of pH of a solution by using quinhydrone and glass electrode. Electrochemical series and its applications. Numerical problems. Batteries – Primary (Lithium cell) and secondary batteries (Lead – acid storage battery and Lithium ion battery).

Reference Books:

- 1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications (1996).
- 2. Concise Inorganic Chemistry by J.D. Lee 3rd edn. Van Nostrand Reinhold Company (1977).
- 3. Basic Inorganic Chemistry by F. A. Cotton, G. Wilkinson and Paul. L. Gaus 3rd edn Wiley Publishers (2001).
- 4. Inorganic Chemistry Principles of structure and reactivity by James E.Huhey, E.A. Keiter and R.L. Keiter 4th edn. (2006).
- 5. Textbook of Inorganic Chemistry by R Gopalan, Universities Press,(2012).
- 6. Text book of Engineering Chemistry by Jain & Jain, Dhanpat Rai Publishing company(P)Ltd.,New Delhi.
- 7. Principles of physical chemistry by Bahl and Bahl.
- 8. Text Book of Physical Chemistry by Soni and Dharmahara.

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

II Year B. Tech. I- Sem

L T P C 3 0 0 3

Pre-requisites: --

Course Objectives:

- To introduce the concepts of electrical circuits and its components
- To understand magnetic circuits, DC circuits and AC single phase & three phase circuits
- To study and understand the different types of DC/AC machines and Transformers.
- To import the knowledge of various electrical installations.
- To introduce the concept of power, power factor and its improvement.
- To introduce the concepts of diodes & transistors, and
- To impart the knowledge of various configurations, characteristics and applications.

Course Outcomes:

- To analyze and solve electrical circuits using network laws and theorems.
- To understand and analyze basic Electric and Magnetic circuits
- To study the working principles of Electrical Machines
- To introduce components of Low Voltage Electrical Installations
- To identify and characterize diodes and various types of transistors.

UNIT-I:

D.C. CIRCUITS

Electrical circuit elements (R, L and C), voltage and current sources, KVL&KCL, analysis of simple circuits with dc excitation.

A.C. CIRCUITS

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits, Three-phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-II:

ELECTRICAL INSTALLATIONS

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

UNIT-III:

ELECTRICAL MACHINES

Working principle of Single phase transformer, equivalent circuit, losses in transformers, efficiency, Three-phase transformer connections. Construction and working principle of DC generators, EMF equation, working principle of DC motors, Torque equations and Speed control of DC motors, Construction and working principle of Three-phase Induction motor, Torques equations and Speed control of Three-phase induction motor . Construction and working principle of synchronous generators.

UNIT-IV:

P-N JUNCTION AND ZENER DIODE: Principle of Operation Diode equation, Volt-Ampere characteristics, Temperature dependence, Ideal versus practical, Static and dynamic resistances, Equivalent circuit, Zener diode characteristics and applications.

RECTIFIERS AND FILTERS: P-N junction as a rectifier - Half Wave Rectifier, Ripple Factor - Full Wave Rectifier, Bridge Rectifier, Harmonic components in Rectifier Circuits, Filters – Inductor Filters, Capacitor Filters, L- section Filters, π - section Filters.

UNIT-V:

BIPOLAR JUNCTION TRANSISTOR (BJT): Construction, Principle of Operation, Amplifying Action, Common Emitter, Common Base and Common Collector configurations, Comparison of CE, CB and CC configurations.

FIELD EFFECT TRANSISTOR (FET): Construction, Principle of Operation, Comparison of BJT and FET, Biasing FET.

TEXT BOOKS:

- 1. Basic Electrical and electronics Engineering -M S Sukija TK Nagasarkar Oxford University
- 2. Basic Electrical and electronics Engineering-D P Kothari. I J Nagarath, McGraw Hill Education

REFERENCES:

- 1. Electronic Devices and Circuits R. L. Boylestad and Louis Nashelsky, PEI/PHI, 9th Ed, 2006.
- 2. Millman's Electronic Devices and Circuits J. Millman and C. C. Halkias, Satyabrata Jit, TMH, 2/e, 1998.
- 3. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6th edition.
- Linear circuit analysis (time domain phasor and Laplace transform approaches) 2nd edition by Raymond A. De Carlo and Pen-Min-Lin, Oxford University Press-2004.
- 5. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
- 6. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
- 7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
- 8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
- 9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

FLUID MECHANICS LAB

Pre Requisites: Chemical Engineering Fluid Mechanics

Course Objectives:

- 1. Verify Bernoulli's equation using Bernoulli's apparatus.
- 2. Analyze and compare orifice and venturi coefficients.
- 3. Test the characteristics of centrifugal pump.

Course Outcomes:

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

- 1. Understand the concept of fluid flow phenomena and the types of flow by calculating Reynolds Number.
- 2. Calibrate the flow meters with actual discharge, characterize the centrifugal pump and its efficiency
- 3. Calculate the coefficient of contraction in an orifice and venture meters.
- 4. Calculate the pressure drop in packed bed for different velocities.
- 5. Calculate the discharge coefficient in notches.
- 6. Interpret the data and prepare formal lab reports describing the obtained experimental results.

List of Experiments

- 1. Identification of laminar and turbulent flows
- 2. Measurement of point velocities
- 3. Verification of Bernoulli's equation
- 4. Calibration of Rotameter
- 5. Variation of Orifice coefficient with Reynolds Number
- 6. Determination of Venturi coefficient
- 7. Friction losses in Fluid flow in pipes
- 8. Pressure drop in a packed bed for different fluid velocities
- 9. Pressure drop and void fraction in a fluidized bed
- 10. Studying the coefficient of contraction for a given open orifice
- 11. Studying the coefficient of discharge in a V-notch
- 12. Studying the Characteristics of a centrifugal pump

INORGANIC AND PHYSICAL CHEMISTRY LAB

0 0 2 1

Pre Requisites: Inorganic and Physical Chemistry

Course Objectives:

- 1. To learn the concepts of adsorption
- 2. To prepare various metal complexes
- 3. To analyze and estimate the ion concentration using different instrumentation.

Course Outcomes:

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

- 1. Verify Freundlich adsorption isotherm.
- 2. Prepare various metal complexes of biological importance.
- 3. Experience the usage of various analytical instruments.

List of Experiments:

- 1. Verification of Freundlich adsorption isotherm-adsorption of acetic acid on animal charcoal.
- 2. Preparation of [Ni(DMG)₂] complex
- 3. Preparation of [Co(NH₃)₄Cl₂] complex
- 4. Preparation of [Cu(NH₃)₄] SO₄ Complex
- 5. Determination of sulphates through turbidometry.
- 6. Estimation of the amount of Fe^{+2} by potentiometry
- 7. Estimation of mixture of acids vs a strong base by conductometry.
- 8. Determination of the strength of acid using pHmetry.

Suggested Books:

- 1. Vogel's Text book of Quantitative Chemical Analysis, Sixth Edition- J. Mendham et al, Pearson Education.
- 2. Practical Manual of Analytical Chemistry- Neelam, Singh, Navneet Kaur and Kanchan kohli.

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LAB

0 0 2 1

Pre-requisites: Basic Electrical and Electronics Engineering

Course Objectives:

- To introduce the concepts of electrical circuits and its components
- To understand magnetic circuits, DC circuits and AC single phase & three phase circuits
- To study and understand the different types of DC/AC machines and Transformers.
- To import the knowledge of various electrical installations.
- To introduce the concept of power, power factor and its improvement.
- To introduce the concepts of diodes & transistors, and
- To impart the knowledge of various configurations, characteristics and applications.

Course Outcomes:

- To analyze and solve electrical circuits using network laws and theorems.
- To understand and analyze basic Electric and Magnetic circuits
- To study the working principles of Electrical Machines
- To introduce components of Low Voltage Electrical Installations
- To identify and characterize diodes and various types of transistors.

List of experiments/demonstrations:

PART A: ELECTRICAL

- 1. Verification of KVL and KCL
- 2. (i) Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single Phase Transformer

(ii) Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Deltastar, Star-Star) in a Three Phase Transformer

- 3. Measurement of Active and Reactive Power in a balanced Three-phase circuit
- 4. Performance Characteristics of a Separately Excited DC Shunt Motor
- 5. Performance Characteristics of a Three-phase Induction Motor
- 6. No-Load Characteristics of a Three-phase Alternator

PART B: ELECTRONICS

- 1. Study and operation of
 - (i) Multi-meters (ii) Function Generator (iii) Regulated Power Supplies (iv) CRO.
- 2. PN Junction diode characteristics
- 3. Zener diode characteristics and Zener as voltage Regulator
- 4. Input & Output characteristics of Transistor in CB / CE configuration
- 5. Full Wave Rectifier with & without filters
- 6. Input and Output characteristics of FET in CS configuration

- 1. Basic Electrical and electronics Engineering -M S Sukija TK Nagasarkar Oxford University
- 2. Basic Electrical and electronics Engineering-D P Kothari. I J Nagarath, McGraw Hill Education

REFERENCES:

- 1. Electronic Devices and Circuits R. L. Boylestad and Louis Nashelsky, PEI/PHI, 9th Ed, 2006.
- 2. Millman's Electronic Devices and Circuits J. Millman and C. C. Halkias, Satyabrata Jit, TMH, 2/e, 1998.
- 3. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6th edition.
- Linear circuit analysis (time domain phasor and Laplace transform approaches) 2nd edition by Raymond A. De Carlo and Pen-Min-Lin, Oxford University Press-2004.
- 5. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
- 6. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
- 7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
- 8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
- 9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

CONSTITUTION OF INDIA

II Year B. Tech. I- Sem

L	Т	Р	С
3	0	0	0

Course Objectives

Students will be able to:

- 1. Understand the premises informing the twin themes of liberty and freedom from a civil right perspective.
- 2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- 3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes

Students will be able to:

- 1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- 2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- 3.Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution
- 4. Discuss the passage of the Hindu Code Bill of 1956.

UNIT-I: History of Making of the Indian Constitution- History of Drafting Committee – UNIT-II: Philosophy of the Indian Constitution- Preamble Salient Features UNIT-III: Contours of Constitutional Rights & Duties - Fundamental Rights

- Right to Equality
- Right to Freedom
- Right against Exploitation
- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies
- Directive Principles of State Policy
- Fundamental Duties.

UNIT-III: Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

UNIT-IV: Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO ZilaPanchayat: Position and

role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT-VI: Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Reading

- 1. The Constitution of India, 1950 (Bare Act), Government Publication.
- 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
- 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
- 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

CHEMICAL ENGINEERING THERMODYNAMICS-I

II Year B. Tech. II-Semester

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. To provide the knowledge on basics of thermodynamics like system, properties, processes, reversibility, equilibrium, phases, components; the relationship between heat and work.
- 2. To learn in details the laws of thermodynamics and their applications; thermodynamic relations
- 3. To learn the basics of sensible & latent heat effects of industrial processes

Course Outcomes:

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

- 1. Apply fundamental concepts of thermodynamics to engineering applications
- 2. Estimate thermodynamic properties of substances in gas and liquid states
- 3. Apply mass, energy and entropy balances to flow processes.
- 4. Describe about various power cycles.
- 5. Understand the thermodynamic properties of fluids.

UNIT- I

Introduction: The scope of thermodynamics, temperature, defined quantities; volume, pressure, work, energy, heat, Joules Experiment.

The first law and other basic concepts: The first law of thermodynamics, thermodynamic state and state functions, enthalpy, the steady-state steady-flow process, equilibrium, the phase rule, the reversible process, constant- V and constant- P processes, heat capacity, isobaric, isochoric, isothermal, adiabatic and polytrophic processes.

UNIT-II

Volumetric properties of pure fluids: The PVT behavior of pure substances, Virial equations, the ideal gas, the applications of the Virial equations, second Virial coefficients from potential functions. Cubic equations of state, generalized correlations for gases, generalized correlations for liquids, molecular theory of fluids.

UNIT-III

The second law of thermodynamics: Statements of the second law, heat engines, thermodynamic temperatures scales, thermodynamic temperature and the ideal gas scale, Entropy, Entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point, calculation of ideal work and lost work.

UNIT-IV

Heat effects: Sensible heat effects, Latent heats of pure substances, heat effects of industrial reactions, heat effects of mixing processes. Standard heat of reaction, Standard heat of formation, Standard heat of combustion, temperature dependence of heat of reaction

UNIT- V

Refrigeration and liquefaction: The Carnot refrigerator, the vapor compression cycle, the comparison of refrigeration cycles, the choice of refrigerant, absorption refrigeration, the heat pump, liquefaction processes.

Thermodynamic properties of fluids: Property relations for homogeneous phases, Maxwell relations, residual properties, thermodynamic diagrams. Turbines, Throttling process, compression process.

Text Books:

1. J. M. Smith and HC Van Ness, Introduction to Chemical Engineering Thermodynamics, 7thed, McGraw Hill,2005.

Reference Books:

- 1. Y. V. C. Rao, Chemical Engineering Thermodynamics, Universities Press (1997).
- 2. K. V. Narayanan, Chemical Engineering Thermodynamics, PHI, 2013.

MECHANICAL OPERATIONS

II Year B. Tech. II -Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. To describe the numerous industrial operations dealing with the particulate solids, their handling in various unit operations, and those in which particle- fluid interactions are important.
- 2. To explain fluid-particle mechanics, such as the notion of drag, and builds on those fundamentals to develop design concepts for various industrial processes like packed bed operation, fluidized operations, sedimentation, filtration, separation of solids and fluids, etc. Industrial applications are discussed.
- 3. To explain the methods of separations based on motion of a particle through fluids.
- 4. To describe the working of size reduction equipment's

Course Outcomes:

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

- 1. State the significance and usage of different particulate characterization parameters and equipment to estimate them
- 2. Describe size reduction energy requirements, estimate performance of equipment, selection and sizing of equipment.
- 3. Calculate the drag force and terminal settling velocity for single particles.
- 4. Calculate pressure drop in fixed and fluidized beds
- 5. Analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage.

UNIT- I

Properties, handling and mixing of particulate solids: Characterization of solid particles, properties of particulate mass, storage and mixing of solids, types of mixers, mixers for cohesive solids, mixers for free flowing solids. Transportation of solid particulate mass, belt, screw, apron conveyers, bucket elevators, pneumatic conveying.

UNIT- II

Size reduction: Principles of comminution, computer simulation of milling operations, size reduction equipment-crushers, grinders, ultra-fine grinders, cutting machines, Equipment operation. Laws of crushing: Kick's law, Bond's law, Rittinger's law. Screening, Industrial screening equipments, Effectiveness of the screen, differential & cumulative analysis.

UNIT-III

Separations based on motion of particles through fluids, gravity settling processes and centrifugal settling processes, float and sink method, differential settling, design of thickeners, coagulation, cyclone separator, electro-static precipitators.

UNIT-IV

Filtration: cake filters, centrifugal filters, principles of cake filtration. Clarifying filters, liquid clarification, gas cleaning, and principles of clarification.

UNIT- V

Agitation and mixing of liquids: Concept of agitation & mixing, Agitation of liquids, circulation velocities, power consumption in agitated vessels. Blending and mixing of liquids, suspension of solid particles, dispersion operations.

Text Book:

 Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, Mc. Graw Hill 7thedn. 2001.

Reference Books:

- 1. Chemical engineers hand book, J.H. Perry, 7th ed. Mc- Graw Hill
- 2. Introduction to Chemical Engineering by J.T. Banchero & W.L Badger, TMH, 1997.

PROCESS HEAT TRANSFER

II Year B. Tech. II- Sem

L T P C 3 0 0 3

Pre Requisites: Chemical Engineering Fluid Mechanics

Course Objectives:

- 1. To differentiate various modes of heat transfer
- 2. To formulate the equations for calculating heat flux for conduction, convection, radiation, boiling, condensation
- 3. To develop the governing equations for designing and analyzing heat transfer equipment

Course Outcomes:

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

- 1. Explain the fundamentals of heat transfer and identify principles of different modes of heat transfer
- 2. Illustrate the various heat exchange equipment and calculate various heat transfer coefficients.
- 3. Explain the importance of thermal boundary layer and forced convection.
- 4. Explain in detail about natural convection and radiation.
- 5. Apply the principle of heat transfer in heat exchanger, evaporator design.

UNIT- I

Introduction: Nature of heat flow, conduction, convection, natural and forced convection, radiation.

Heat transfer by conduction in Solids: Fourier's law, thermal conductivity, steady state conduction in plane wall & composite walls, compound resistances in series, heat flow through a cylinder, conduction in spheres.

UNIT-II

Principles of heat flow in fluids: countercurrent and parallel current flows heat exchangers, energy balances, rate of heat transfer, overall heat transfer coefficient, critical radius of insulation, logarithmic mean temperature difference, variable overall coefficient, multi-pass exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients.

UNIT- III

Heat Transfer to Fluids without Phase change: Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies and analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.

Heat transfer to fluids with phase change: Heat transfer from condensing vapors; heat transfer to boiling liquids.

UNIT-IV

Natural convection: Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar-flow heat transfer.

Radiation: Introduction, properties and definitions, black body radiation, real surfaces and the gray body, absorption of radiation by opaque solids, radiation between surfaces, radiation shielding, radiation to semitransparent materials, combined heat transfer by conduction, convection and radiation.

UNIT- V

Heat exchange equipment: General design of heat exchange equipment, heat exchangers, condensers, boilers and calendrias, extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers and heat transfer in packed beds.

Evaporators: Evaporators, performance of tubular evaporators, capacity and economy, multiple effect evaporators, methods of feeding, vapor recompression.

Text Books:

1. Unit Operations in Chemical Engineering by W.L. McCabe and J.C. Smith and Peter Harriott, Mc. Graw Hill 7thedn. 2001.

2. Process Heat Transfer, D.Q. Kern, Tata McGraw-Hill, New Delhi, 1997.

Reference Books:

1. Holman, J. P.S. Bhattacharya, Heat Transfer, 10thEd., Tata McGraw-Hill(2011).

2. Chemical Engineering, Volume-I, J. Coulson and R.F. Richardson, Pergamon Press.

FUNDAMENTALS OF MANAGEMENT FOR ENGINEERS

II Year B.Tech. II-Sem

L	Т	Р	C
3	0	0	3

Course Objective: To understand the Management Concepts, applications. Practical aspects of business and development of Managerial Skills for Engineers.

Course Outcome: The students understand the significance of Management in their Profession. The various Management Functions like Planning, Organizing, Staffing, Leading, Motivation and Control aspects are learnt in this course. The students can explore the Management Practices in their domain area.

Unit-1: Introduction to Management:

Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management, Evolution of Management Classical Approach- Scientific and Administrative Management. The Behavioral approach; The Quantitative approach: The Systems Approach; Contingency Approach, IT Approach

Unit-2: Planning and Decision Making:

General Framework for Planning Planning Process, Types of Plans, Management by Objectives. Production Planning and Control Decision making and Problem Solving - Programmed and Non Programmed Decisions, Steps in Problem Solving and Decision Making: Bounded Rationality and Influences on Decision Making, Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work

Unit-3: Organization and HRM:

Principles of Organization: Organizational Design & Organizational Structures, Departmentalization, Delegation, Empowerment, Centralization, Decentralization. Recentralization; Organizational Culture, Organizational Climate and Organizational Change

Human Resource Management & Business Strategy Job Satisfaction, Job Enrichment, Job Enlargement, Talent Management. Strategic Human Resource Planning: Recruitment and Selection, Training and Development, Performance Appraisal.

Unit 4: Leading and Motivation:

Leadership, Power and Authority, Leadership Styles, Behavioral Leadership, Situational Leadership, Leadership Skills, Leader as Mentor and Coach, Leadership during adversity and Crisis, Handling Employee and Customer Complaints, Team Leadership Motivation. Types of Motivation: Relationship between Motivation, Performance and Engagement, Content Motivational Theories Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y

Unit- 5: Controlling:

Control, Types and Strategies for Control Steps in Control Process. Budgetary and Non-Budgetary Controls Characteristics of Effective Controls, Establishing control systems, Control frequency and Methods

Text Books:

- 1. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.
- 2. Fundamentals of Management, Stephen P.Robbins, Pearson Education, 2009.

References:

- 1. Essentials of Management, Koontz Kleihrich, Tata Mc Graw Hill.
- 2. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013.
- 3. Industrial Engineering and Management: Including Production Management, T.R.Banga, S.C Sharma, Khanna Publishers.

ORGANIC AND ANALYTICAL CHEMISTRY

II Year B.Tech. II-Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. The student should learn about the various intermediates involved in the reaction processes.
- 2. The knowledge of Heterocyclic compounds which are a part of various drugs with reference to their synthesis.
- 3. The student should have concepts of C C formation, save drug molecules and their activity.
- 4. The basic concept of analytical chemistry should be learnt by the student.
- 5. To understand the principles of separation of components from mixture, the techniques like TLC, column chromatography are to be learnt.

Course Outcomes:

The basic concepts included in the syllabus will help the student

- 1. To gain knowledge of reactive intermediates and polarization effects.
- 2. To improve knowledge of principles related hetero cyclic molecules and dyes.
- 3. To learn about the mechanism of C C bond formation and drug chemistry.
- 4. To know about concepts of analytical techniques and validation of method.
- 5. To make the student aware of separation techniques.

UNIT-I: Reaction Mechanism and Intermediates:

Bond polarization: Factors influencing the polarization of covalent bonds, inductive effect. Application of inductive effect i) Basicity of amines ii) Acidity of carboxylic acids iii) Stability of carbonium ions. Resonance - Mesomeric effect, applications to i) acidity of phenol. ii) acidity of carboxylic acids and basicity of amines. Stability of carbo cations, carbanions and free radicals. Hyper conjugation and its application to stability of carbonium ions, free radicals.

UNIT - II: Heterocyclic compounds and Dyes:

Introduction and definition: Five membered ring compounds with one hetero atom-preparation of furan, pyrrole and thiophene, properties-aromatic character. Electrophillic substitution-halogenation, nitration and sulphonation

Dyes: Definition, characteristics, chromophore and auxochrome. Synthesis and applications of Congo Red, Malachite Green, Indigo and Bismark brown.

UNIT -III: C-C bond formation reactions and drugs:

C-C bond formation: Grignard reagent-applications, Palladium catalyzed Reactions-Suzuki coupling, Heck reactions and their mechanisms, Gilman reagent-applications

Drugs: Definition, Classification (based on therapeutic action). Brief idea of the following terms: Receptors, Drug-receptor interaction, Bioavailability, Drug toxicity, Drug addiction. - Mechanism of drug action: action at enzymes and at receptors. Lipenski rule, Classification and examples of antihistamines, antibacterial, antiinflammatory, antifungbal, antibiotics, anti-cancer agents-chemotherapy.

UNIT -IV: Concepts of Analytical Chemistry:

Role of Analysis, Classification of analytical methods – classical and instrumental. Selecting an analytical method, Analytical Method validation, Statistical treatment of analytical data, Sensitivity & Detection limits, Precision & Accuracy – significant figures. Errors – types of errors, determinate, indeterminate or random errors, minimization of errors, Mean and standard deviation- Parameters of method validation (selectivity, specificity, accuracy, ruggedness, robustness, linearity, LOD, LOQ, Range).

UNIT -V: Separation Techniques:

Introduction, Classification of chromatographic techniques, differential migration rates, partition ratio, retention time. Thin layer chromatography: stationary phase, adsorbents, liquid phase supports, plate preparation, mobile phase, sample application, development, detection of spot, R_f values (effect of adsorbent, solvent, solute, development process), quantitative analysis-applications. Column chromatography- matrix materials, stationary phase, column packing, column development and sample elution, detectors and fraction collectors, applications.

Reference Books:

- 1. "Advanced Organic Chemistry", Jerry March, John Wiley & Sons, (2001).
- 2. *Guide-book to Mechanism in Organic Chemistry*", by Peter Sykes Orient Longmans Ltd., New Delhi (1976).13)
- 3. Organic Chemistry", R.T.Morison and R.N.Boyd, Allyn & Bacon Inc., (printed in Singapore) (2001).
- 4. "Heterocyclic Chemistry", T.Gilchrist.
- 5. "Heterocyclic Chemistry", Raj K.Bansal
- 6. J. W. Munson, pharmaceutical Analysis, Modern methods Part A &B, 2001, Marcel Dekker.
- 7. Principles of Instrumental analysis: A. Skoog, James, 5th edition, Saunders college Publishing.
- 8. Analytical Chemistry by Gary Christian, 6th edition, Wiley Publishing House

II Year B. Tech. II- Sem

L T P C 0 0 2 1

Pre Requisites: Mechanical Operations

Course Objectives:

- 1. Estimate the average size of the particles in a given feed and verify the various crushing laws using size reduction equipment with various mesh screens.
- 2. Calculate the thickener area using batch sedimentation data.
- 3. Calculate the reduction ratio of a given sample in a grinder.

Course Outcomes:

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

- 1. Pick or take a representative amount of sample and conduct sieve analysis.
- 2. Determine the reduction ratio in crushing and grinding of different materials using various size reduction units.
- 3. Evaluate the recovery percentage from froth flotation unit and thickener area.
- 4. Interpret the data and prepare formal lab reports describing the obtained experimental results.
- 5. Calculate power consumption of crushers by using laws

List of Experiments

- 1. Sampling of an ore from the bulk by
 - (i) Coning and quartering method. (ii) Riffle sampler.
- 2. Determination of average particle size of a given material by sieve analysis.
- 3. Determine the average particle size of a given sample by optimum sieve analysis
- 4. Verification of Stoke's Law.
- 5. Size reduction of the given material using Jaw Crusher and determine the reduction ratio.
- 6. Size reduction of the given material using Roll Crusher and verification of comminution laws.
- 7. Size reduction of the given material using Ball Mill and determine the reduction ratio.
- 8. Calculate the thickener area from the batch sedimentation process under the given conditions.
- 9. Determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.
- 10. Calculate the separation efficiency of particles in a mixture using cyclone separator.
- 11. Determination of recovery percentage of the concentrate by Froth-Floatation process.

II Year B. Tech. II- Sem

L T P C 0 0 2 1

Pre Requisites: Process Heat Transfer **Course Objectives:**

- 1. Categorize various heat transfer processes and equipment like heat exchangers and evaporators.
- 2. Impart the knowledge in heat transfer measurements and different heat transfer equipment.
- 3. Demonstrate about natural and forced convection.

Course Outcomes:

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

- 1. Explain the basic heat transfer principles.
- 2. Calculate the natural and forced convective heat transfer coefficients.
- 3. Understand the concept of boiling and condensation processes.
- 4. Calculate Stefan-Boltzmann constant.
- 5. Calculate the emissivity for a given plate at various temperatures.
- 6. Interpret the data and prepare formal lab reports describing the obtained experimental results.

List of Experiments:

- 1. Determination of total thermal resistance and thermal conductivity of composite wall.
- 2. Determination of thermal conductivity of a metal rod.
- 3. Determination of natural convective heat transfer coefficient for a vertical tube
- 4. Determination of critical heat flux point for pool boiling of water.
- 5. Determination of forced convective heat transfer coefficient for air flowing through a pipe
- 6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
- 7. Determination of heat transfer coefficient for a helical coil in an agitated vessel.
- 8. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions
- 9. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
- 10. Determination of Stefan Boltzmann constant.
- 11. Determination of emissivity of a given plate at various temperatures.

ORGANIC AND ANALYTICAL CHEMISTRY LAB

II Year B. Tech. II- Sem

L T P C 0 0 2 1

Pre-Requisites: Organic and Analytical Chemistry Course

Course Objectives:

- 1. To prepare various organic compounds from the given synthesis techniques.
- 2. To separate, purify and monitor the progress of a chemical reaction using chromatographic techniques.
- 3. To prepare various dyes.
- 4. To Estimate the given drug samples.

Course Outcomes:

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

- 1. Interpret the mechanism of an organic synthesis.
- 2. Synthesize an organic compound by greener approach.
- 3. Prepare and understand the characteristics of dye molecules
- 4. Learn the principles of separation and purification of organic mixtures by chromatographic techniques.
- 5. Estimate the amount of drug molecule in a given sample.

List of Experiments:

- 1. Preparation of benzanilide from benzophenone -Beckmann rearrangement
- 2. Cycloaddition of anthracene with maleic anhyhdride-Diels Alder reaction
- 3. Green synthesis of N-arylphthalimide from phthalicanhydride and aniline.
- 4. Synthesis of 2-methylbenzimidazole
- 5. Synthesis of 2-styrylbenzimidazole
- 6. Preparation of Malachite green dye
- 7. Preparation of indigo dye
- 8. Study of progress of a chemical reaction using TLC
- 9. Determination of R_f value of ortho and para nitro phenols by TLC
- 10. Separation of mixture of ortho and para nitro anilines by column chromatography.
- 11. Estimation of Ibuprofen.
- 12. Estimation of Paracetamol.

Suggested Books:

- 1. Quantitative and Qualitative analysis in Organic Chemistry A. I. Vogel.
- 2. Laboratory Manual of Organic Chemistry R.K. Bansal
- 3. Instrumental Methods of Chemical Analysis, BSP Galen W. Ewing
REAL-TIME RESEARCH PROJECT/FIELD-BASED PROJECT

II Year B. Tech. II- Sem

L T P C 0 0 4 2

GENDER SENSITIZATION LAB

II Year B. Tech. II- Sem

L T P C 0 0 2 0

COURSE DESCRIPTION

This course offers an introduction to Gender Studies, an interdisciplinary field that asks critical questions about the meanings of sex and gender in society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary. It draws on multiple disciplines-such as literature, history, economics, psychology, sociology, philosophy, political science, anthropology and media studies – to examine cultural assumptions about sex, gender, and sexuality.

This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with race, class, caste, nationality and other social identities. This course also seeks to build an understanding and initiate and strengthen programmes combating gender-based violence and discrimination. The course also features several exercises and reflective activities designed to examine the concepts of gender, gender-based violence, sexuality, and rights. It will further explore the impact of gender-based violence on education, health and development.

Objectives of the Course

- To develop students' sensibility with regard to issues of gender in contemporary India.
- To provide a critical perspective on the socialization of men and women.
- To introduce students to information about some key biological aspects of genders.
- To expose the students to debates on the politics and economics of work.
- To help students reflect critically on gender violence.
- To expose students to more egalitarian interactions between men and women.

Learning Outcomes:

- Students will have developed a better understanding of important issues related to gender in contemporary India.
- Students will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from research, facts, everyday life, literature and film.
- Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.
- Students will acquire insight into the gendered division of labor and its relation to politics and economics.
- Men and women students and professionals will be better equipped to work and live together as equals.
- Students will develop a sense of appreciation of women in all walks of life.
- Through providing accounts of studies and movements as well as the new laws that provide protection and relief to women, the textbook will empower students to understand and respond to gender violence.

UNIT-I: UNDERSTANDING GENDER

Introduction: Definition of Gender-Basic Gender Concepts and Terminology-Exploring Attitudes towards Gender-Construction of Gender-Socialization: Making Women, Making Men - Preparing for Womanhood. Growing up Male. First lessons in Caste.

UNIT – II: GENDER ROLES AND RELATIONS

Two or Many? -Struggles with Discrimination-Gender Roles and Relations-Types of Gender Roles-Gender Roles and Relationships Matrix-Missing Women-Sex Selection and Its Consequences-Declining Sex Ratio.

Demographic Consequences-Gender Spectrum: Beyond the Binary

UNIT – III: GENDER AND LABOUR

Division and Valuation of Labour-Housework: The Invisible Labor- "My Mother doesn't Work." "Share the Load."-Work: Its Politics and Economics -Fact and Fiction. Unrecognized and Unaccounted work. –Gender Development Issues-Gender, Governance and Sustainable Development-Gender and Human Rights-Gender and Mainstreaming

UNIT – IV: GENDER - BASED VIOLENCE

The Concept of Violence- Types of Gender-based Violence-Gender-based Violence from a Human Rights Perspective-Sexual Harassment: Say No!-Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment-Further Reading: "Chupulu".

Domestic Violence: Speaking OutIs Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Thinking about Sexual Violence Blaming the Victim-"I Fought for my Life...."

UNIT – V: GENDER AND CULTURE

Gender and Film-Gender and Electronic Media-Gender and Advertisement-Gender and Popular Literature- Gender Development Issues-Gender Issues-Gender Sensitive Language-Gender and Popular Literature – Just Relationships: Being Together as Equals Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Rosa Parks-The Brave Heart.

Note: Since it is Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

- Classes will consist of a combination of activities: dialogue-based lectures, discussions, collaborative learning activities, group work and in-class assignments. Apart from the above prescribed book, Teachers can make use of any authentic materials related to the topics given in the syllabus on "Gender".
- ESSENTIAL READING: The Textbook, "*Towards a World of Equals: A Bilingual Textbook on Gender*" written by A.Suneetha, Uma Bhrugubanda, DuggiralaVasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu published by Telugu Akademi, Telangana Government in 2015.

ASSESSMENT AND GRADING:

- Discussion & Classroom Participation: 20%
- Project/Assignment: 30%
- End Term Exam: 50%

MASS TRANSFER OPERATIONS-I

III Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: Fundamentals of Unit operations & Material Energy balance computations **Course Objectives:**

- 1. To discuss the fundamental concepts of mass transfer principles and to apply those concepts to real engineering problems.
- 2. To impart the basic concepts of molecular diffusion, mass transfer coefficients and analysis of different mass transfer processes.
- 3. Applies the concepts of diffusion mass transfer, mass transfer coefficients, convective mass transfer, inter-phase mass transfer, equipment for gas-liquid operations.

Course Outcomes:

At the end of the course, studentwill be able to

- 1. Recognize the various modes of mass transfer; determine mass transfer rates using Fick's Law.
- 2. Explain about tray column and packed column.
- 3. Design absorption column by various methods.
- 4. Explain the principles of humidification and dehumidification, design the cooling towers.
- 5. Interpret Drying mechanism and principles of crystallization.

UNIT-I

Molecular Diffusion in gases and Liquids: Diffusion and Mass transfer- Mass transfer operations and their applications, Fick's first law – steady state molecular diffusion in binary mixture of gases, liquids. Diffusivity in gases by Stefan's Method- Estimation of diffusion coefficients in binary mixtures of gases and liquids by correlations.

Mass transfer theories & analogies: Film, Penetration and Surface Renewal Theories-Film mass transfer coefficients Correlations for Mass transfer coefficients, Reynolds and Colburn analogies.

UNIT-II

Inter phase mass transfer: Mass transfer coefficients, Relationship between individual and overall mass transfer coefficients, two resistance theory, Gas phase and liquid phase controlled situations.

Equipment for Gas- liquid operations: Description of Continuous and stage wise contact equipment – Packing for packed columns-liquid distribution, Mass transfer coefficients in packed columns, Flooding in packed and plate columns, Ideal plate, Murphree, Point, Plate and column efficiency. Comparison of packed and plate columns.

UNIT-III

Absorption and Stripping: Solubility of gases in liquids, two component system, counter current and co current isothermal absorption and stripping of single component.

Single component absorption material balances –operating lines – Minimum flow rate, Determination of number of transfer units and height of continuous contact absorbers. HETP, NTU,HTU concepts for single component absorption. Counter current multi stage absorption – Determination of number of plates.

Absorption factor – Kremser Brown Equation.

UNIT-IV

Humidification and Dehumidification: basic concepts of humidity of vapor-air system, Psychrometric charts, Operating lines and Design of Packed humidifiers, Dehumidifiers and Cooling towers, Spray Chambers, Evaporative cooling.

UNIT-V

Crystallization: crystal geometry, principles of crystallization equilibria and yields, nucleation, crystal growth, ΔL law, crystallization equipment including MSMPR crystallizers.

Drying: Theory and mechanism of drying, Moisture content of solids, Equilibrium, bound, unbound free and critical moisture contents. Drying conditions, Rate of Batch drying, drying time of Batch drying, through circulation drying, Design of Batch and continuous dryers. CHEMICAL

Text Books:

- 1. R. E. Treybal, Mass Transfer Operations, 3rdEdition, McGraw Hill, New Delhi, 1983.
- 2. Binay K. Dutta, Principles of Mass Transfer and Separation Processes, 2nd edition, Prentice Hall of India, 2007.

Reference Books:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, 4thEdition, Pearson Education 2015.

CHEMICAL REACTION ENGINEERING-I

III Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. Emphasis on the fundamentals of chemical reaction kinetics and chemical reactor operation.
- 2. Integrate concepts from science & engineering to constitute a basis for the design of chemical reactor, a key element in the design of chemical process.
- 3. Provide a foundation on deriving rate expressions for series, parallel, reversible reactions and the knowledge about product distribution in multiple reactions, recycle reactors and auto catalytic reactions
- 4. Provide the knowledge about design of reactors.

UNIT- I

Overview of chemical reaction engineering- reaction rate, variables affecting the rate of reaction, Kinetics of homogenous reactions- concentration dependent term of rate equation, Temperature dependent term of rate equation, theories of reaction rate.

Interpretation of batch reactor data- constant volume batch reactor: -Analysis of total pressure data obtained in a constant-volume system, the conversion, Integral method of analysis of data– general procedure, irreversible unimolecular type first order reactions, irreversible bimolecular type second order reactions, irreversible trimolecular type third order reactions,

UNIT- II

Constant volume batch reactor: empirical relations of nth order, zero-order reactions, overall order of irreversible reactions from the half-life, fractional life method, irreversible reactions in parallel &series, autocatalytic reactions, first order & second order reversible reactions, Differential method of analysis of data.

Variable volume batch reactor: rate equation, differential method of analysis, integral method of analysis, zero order, first order, second order, nth order reactions.

UNIT-III

Introduction to reactor design: general discussion, symbols and relationship between C_A and X_A . Ideal reactors for a single Reaction-Ideal batch reactor, Steady-state mixed flow reactor, Steady-state plug reactors.

Design for single reactions- Size comparison of single reactors, Multiple- reactor systems, Recycle reactor, Autocatalytic reactions.

UNIT-IV

Design for parallel reactions- introduction to multiple reactions, qualitative & quantitative treatment of product distribution and of reactor size.

Multiple Reactions-Irreversible first order reactions in series, quantitative & qualitative discussion about product distribution, plug flow reactor, batch reactor, quantitative treatment, mixed flow reactor, first-order followed by zero-order reaction, zero order followed by first order reaction.

UNIT- V

Temperature and Pressure effects: single reactions- heat of reaction from thermodynamics, heat of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, general graphical design procedure, optimum temperature progression, heat effects, adiabatic operations, non-adiabatic operations, comments and extensions. Exothermic reactions in mixed flow reactors-A special problem, multiple reactions.

Text Books:

1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiely& Sons, 1999.

Reference Books:

- 1. Elements of Chemical Reaction Engineering, 2nd ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.
- 2. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.

INSTRUMENTATION AND PROCESS CONTROL

III Year B.Tech. I-Sem

L T P C 3 0 0 3

PreRequisites: Mathematics-II

Course Objectives:

- 1. Describe the various elements of instruments, measurement of temperature, pressure and level in process industries.
- 2. Define the basics of process control and develop transfer function models for dynamic processes.
- 3. Drawthe block diagrams and analyze process stability

Course Outcomes:

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

- 1. Illustrate the various instruments for measuring various process variables such as temperature, pressure, flow.
- 2. Evaluate the transfer functions for various first order and second order examples.
- 3. Explain the various types of controllers using block diagram along with the concept of stability.
- 4. Analyze in more detail the stability criteria using various methods.
- 5. Explain about the various controller tuning techniques.

UNIT- I

Instrumentation: Elements of instruments, static and dynamic characteristics, basic concepts of first order type instruments, mercury in glass thermometer, bimetallic thermometer, pressure spring thermometer. Industrial thermocouples, thermocouple wires, thermo couple wells. Direct measurement of liquid level, pressure measurement in open vessels, level measurements in pressure vessels.

UNIT- II

Process control: Review of Laplace transforms and Inverse Laplace transform, initial value & final value theorem,

Response of First Order Systems: Transfer function of 1st order system (mercury thermometer), Response of 1st order system for step, impulse and sinusoidal inputs.

Physical examples of first order systems- Liquid level system, mixing process, R- C circuit. Linearization, Transfer function of interacting and non- interacting systems

UNIT-III

Second order systems: Transfer function of a second order system (damped vibrator), Response of second order system for step input, Terms used to describe under damped second order system, Response of second order system for impulse & sinusoidal inputs, transportation lag.

Control system: Components of a control system, block diagram, Negative feedback Vs positive feedback, Servo Vs regulator problem, development of block diagram.

Controllers and final control elements: Control valve and its construction, Transfer functions of P, PI, PD, PID controllers, closed loop transfer functions

UNIT-IV

Stability: Concept of Stability, Stability criterion, Routh test for stability, theorems of Routh test **Root locus**: concept of root locus, rules for plotting the root locus diagram.

Frequency response: Substitution rule, bode diagrams, bode stability criterion, Gain and Phase margins.

UNIT- V

Controller tuning: Tuning of P, PD, PI, PID controllers, criteria for good control, Ziegler- Nichols tuning rules, Cohen and Coon rules.

Advanced control strategies: Cascade control, feed forward control, ratio control.

Text Books:

1. Industrial instrumentation by Donald P.Eckman, Wiley eastern, 1950.

2. Process Systems Analysis and Control, 2nd ed., D.R. Coughanowr, McGraw-Hill, 1991

Reference Books:

1. Chemical Process Control, G. Stephanopoulos, PHI Learning Pvt. Ltd., New Delhi, 2010

2. Process Control, B.W. Bequette, PHI Learning Pvt. Ltd., New Delhi, 2010

CHEMICAL ENGINEERING THERMODYNAMICS-II

III Year B.Tech. I-Sem	L	Т	Р	С
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Pre Requisite: Chemical Engineering Thermodynamics-I

Course Objectives:

- 1. To introduce the concepts of fugacity, activity coefficient, chemical potential excess properties.
- 2. To perform the phase equilibrium calculations using simple models for VLE, Gamma/Phi approach and equation of state approach.
- 3. To introduce the concept of chemical reaction equilibria.

Course Outcomes:

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

- 1. Explain in detail about solution thermodynamics and phase equilibrium
- 2. Generate VLE data; to check the consistency of experimental VLE data; to calculate bubble and dew points
- 3. Calculate differences in thermodynamic properties using equations of state.
- 4. Learn chemical reaction equilibrium; to calculate equilibrium conversion for homogeneous and heterogeneous reactions
- 5. Explain the importance of molecular thermodynamics

UNIT- I

Solution Thermodynamics: Theory, Fundamental property relation, chemical potential and phase equilibria, partial properties, Gibbs/ Duhem equation, partial properties in binary solutions, ideal gas mixtures, fugacity and fugacity coefficient for pure species, fugacity and fugacity coefficient for species in solutions.

UNIT- II

Solution Thermodynamics: Theory: The fundamental Residual property relation, fugacity coefficients from Virial equations of state, generalized correlations for Fugacity coefficient, The ideal solutions, excess properties.

Solution Thermodynamics: Applications: The liquid phase properties from VLE data, activity coefficient, models for the excess Gibbs energy, Margules equations, van Laar equations and Wilson equation for activity coefficients, property changes of mixing.

UNIT-III

VLE at low to moderate pressures: The nature of equilibrium, phase rule, Duhems theorem, the gamma /Phi formulation of VLE, Raoult's law and modified Raoult's law, Dew point and bubble point calculations, flash calculations.

Thermodynamic Properties and VLE from Equations of State: properties of fluids from the virial equations of state, properties of fluids from cubic equations of state, fluid properties from correlations of the Pitzer type.

UNIT IV

Topics in Phase Equilibria: Equilibrium and stability, Liquid-Liquid Equilibrium (LLE), Vapor-Liquid–Liquid Equilibrium (VLLE), Solid-Liquid Equilibrium (SVE).

UNIT V

Chemical Reaction Equilibria: The reaction coordinate, application of equilibrium criterion to chemical reactions, The standard Gibb's energy change and the equilibrium constant, effect of temperature on equilibrium constants, relation of equilibrium constants to composition, equilibrium conversion for single reactions, Phase rule and Duhem's theorem for reacting systems

Text Books:

1. Introduction to Chemical Engineering Thermodynamics, 7th ed., J.M. Smith, H.C. Van Ness and M.M. Abbott, Tata McGraw-Hill, New Delhi, 2015.

Reference Books:

- 1. Y.V.C.Rao, Chemical Engineering Thermodynamics, University publications
- 2. K.V. Narayanan, Chemical Engineering Thermodynamics, PHI, 2001

PROCESS MODELING AND SIMULATION

III Year B.Tech. I-Sem

LTPC

3 0 0 3

Pre Requisites: Chemical Reaction Engineering-I, Process heat transfer, Mass transfer operations-I **Course Objectives**:

- 1. To impart knowledge on modeling of various equipment and their simulation using different numerical techniques.
- 2. Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.
- 3. Formulate and solve process design problems, based on fundamental analysis and using mathematical models of chemical processes

Course Outcomes:

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

- 1. Understand the stages involved in the development of a process model.
- 2. Formulate a chemical engineering problem as a mathematical model from basic engineering principles.
- 3. Identify the appropriate numerical solutions used in solving the models.
- 4. Solve problems using least square analysis.
- 5. Apply various simulation tools for solving the chemical engineering models developed.

UNIT- I

Introduction: Uses of mathematical models, Principles of formulation, fundamental laws: Continuity equation, component Continuity equation, energy equation, Equation of motion. Classification of mathematical models- steady state Vs dynamic models, lumped Vs distributed parameter models, deterministic Vs stochastic models.

UNIT- II

Examples of mathematical models of chemical engineering systems: Series of isothermal constant hold-up CSTRs, CSTRs with variable hold-ups, two heated tanks, gas phase pressurized CSTR, Non-isothermal CSTR.

UNIT-III

Examples of mathematical models of chemical engineering systems: Single component vaporizer, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with hold-up.

UNIT-IV

Empirical model building- method of least squares, linear, polynomial and multiple regression, non-Linear regression.

Process Simulation examples: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR **UNIT-V**

Process simulation using modular and equation based solving approaches: Modular approaches to process simulation: Analysis Vs Design mode, sequential modular approach, Simultaneous modular approach, Equation solving approach, Introduction to various simulation software packages in chemical engineering.

Text Books:

- Process Modeling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
- 2. Process Plant Simulation, B.V. Babu, Oxford University Press, 2004

Reference Books:

- 1. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.
- 2. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010.

III Year B.Tech. I-Sem

Pre Requisite: Nil

LTPC 2 0 0 2

Course Objective:

- 1. Unit operations, unit processes involved in manufacture of important and widely employed organic and inorganic chemicals.
- 2. Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- 3. Demonstrate the importance of updating the latest technological developments in producing products economically and environment friendly.

Course Outcomes:

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

- 1. Make a neat and easy to understand the plant process flow sheet.
- 2. Keeps up the productivity while maintaining all safety norms stipulated, during their job.
- 3. Solve Engineering problems that are likely to come across during the operation of plants.
- 4. Suggest alternative manufacturing process in terms of Economic viability of the product.

UNIT – I

Chlor-Alkali Industry: Manufacture of Soda ash, caustic soda and chlorine.

Industrial gases: Manufacture of carbon dioxide & hydrogen, Manufacture of oxygen & Nitrogen Fuel Gases: Manufacture of water gas & producer gas.

UNIT – II

Nitrogen industries: Manufacture of synthetic ammonia, urea, nitric acid, ammonium chloride, ammonium phosphate and complex fertilizers, manufacture of sulphuric acid, hydrochloric acid, Aluminum sulphate and alum.

UNIT – III

Cement: manufacture of cement, special cements, miscellaneous calcium compounds, magnesium compounds.

Organic Chemical Industries: Manufacture of phenols, formaldehyde, vinyl chloride and vinyl acetate, manufacture of phenol- formaldehyde resin and polyvinyl chloride polymer, SBR.

UNIT – IV

Oils: Definition, constitution, extraction of vegetable oils, refining and hydrogenation of oils. Synthetic fibers: Classification, manufacture of Nylon 66, polyester fiber and viscose rayon fiber.

UNIT – V

Soaps and detergents: Definitions, continuous process for the production of fatty acids, glycerin and soap, production of detergents.

Pulp and paper industry: methods of pulping, production of sulphate and sulphite pulp, production of paper –wet process

Text books:

- 1. Shreve's Chemical Process Industries edited by Austin, Mc. graw-Hill.5th ed.1985.
- 2. Dryden's Outlines of Chemical Technology edited by M. Gopal Rao and M. Sittig, 2nd ed. 1973.

References:

- 1. Industrial Chemistry by B.K. Sharma,
- 2. Hand book of industrial chemistry Vol 1& II K.H.Davis & F.S. Berner Edited by S.C. Bhatia, CBS publishers
- 3. Chemical Technology: G.N. Panday, Vol 1& Vol II.

III Year B.Tech. I-Sem

L T P C 0 0 2 1

Pre Requisites: Instrumentation and Process Control

Course Objectives:

- 1. Study about process dynamics and various forms of mathematical models to express them
- 2. Determine the time lag for first and second order systems.
- 3. Emphasize theoretical concepts of open and close loop runs on liquid level and liquid temperature.

Course Outcomes:

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

- 1. Calculate the time lag for first and second order systems.
- 2. Compare and contrast the response for interacting and non-interacting systems.
- 3. Compare the open and closed loop systems.
- 4. Evaluate the controller actions for level and temperature control for a given process.
- 5. Compare the different types of controllers.
- 6. Interpret the data and prepare formal lab reports describing the obtained experimental results.

List of Experiments:

1.Calibration and determination of time lag of various first and second order instruments Major equipment - First order instrument like Mercury-in-Glass thermometer and Overall second order instrument like Mercury-in-Glass thermometer in a thermal well

2. Experiments with single tank system.

Single tank - Step Response

Single tank - Impulse Response

3. Experiments with two tank system with interaction.

Interacting Tanks – Step Response

Interacting Tanks – Impulse Response

4.Experiments with two tank system without interaction.

Non-Interacting Tanks - Step Response

Non-Interacting Tanks – Impulse Response

5. Level control trainer

Major equipment - Level control trainer set up with computer

6. Temperature control trainer

Major equipment - Temperature control trainer with computer

7. Experiments on proportional, reset, rate mode of control etc.

Major equipment - PID control apparatus

8. Control valve characteristics

Major equipment - Control valve set up

9. Estimation of damping coefficient for U-tube manometer Major equipment - U-tube manometer.

PROCESS SIMULATION LAB

III Year B. Tech. I- Sem

Pre Requisites: Process Modeling and Simulation, Process Dynamics and Control

Course Objectives:

- 1. Solve the various process simulation problems using MATLAB or C.
- 2. Illustrate the open loop and closed loop systems.
- 3. Illustrate the bubble point and dew point calculations in VLE systems.

The following experiments have to be conducted using C or MATLAB

- 1. General introduction to MATLAB
- 2. Functions (log, exp, conv, roots).
- 3. Matlab Scripts and function files
- 4. Gravity Flow tank.
- 5. Three CSTRs in series open loop
- 6. Three CSTRs in series Closed loop
- 7. Non isothermal CSTR
- 8. Binary Distillation column
- 9. Batch Reactor isothermal; Batch reactor non iso thermal closed loop
- 10. Isothermal batch reactor open loop
- 11. Heat Exchanger
- 12. Interacting System- two tank liquid level
- 13. Non interacting system-two tank liquid level
- 14. Plug flow reactor
- 15. Bubble point calculations
- 16. Dew point calculations

Course Outcomes:

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

- 1. Formulate the process simulation problems using MATLAB or C.
- 2. Compare the open loop and closed loop systems.
- 3. Explain the isothermal and non-isothermal systems.
- 4. Explain the difference between interacting and non-interacting systems.
- 5. Describe the bubble point and dew point calculations in a given VLE systems.
- 6. Interpret the data and prepare formal lab reports describing the obtained experimental results.

ADVANCED ENGLISH COMMUNICATION SKILLS LAB

III Year B.Tech. I-Sem

L T P C 0 0 2 1

1. Introduction

The introduction of the Advanced Communication Skills Lab is considered essential at 3rd year level. At this stage, the students need to prepare themselves for their careers which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalized context.

The proposed course should be a laboratory course to enable students to use 'good' English and perform the following:

- 1. Gathering ideas and information to organise ideas relevantly and coherently.
- 2. Making oral presentations.
- 3. Writing formal letters.
- 4. Transferring information from non-verbal to verbal texts and vice-versa.
- 5. Writing project/research reports/technical reports.
- 6. Participating in group discussions.
- 7. Engaging in debates.
- 8. Facing interviews.
- 9. Taking part in social and professional communication.

2. Objectives:

This Lab focuses on using multi-media instruction for language development to meet the following targets:

- To improve the students' fluency in English, through a well-developed vocabulary
- The enable them to listen to English spoken at normal conversational speed by educated English speakers
- The respond appropriately in different socio-cultural and professional contexts.
- To communicate their ideas relevantly and coherently in writing.
- To prepare all the students for placements.

3. Syllabus:

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills (AECS) Lab:

- 1. Activities on Listening and Reading Comprehension: Active Listening-Development of Listening Skills Through Audio clips-Benefits of Reading-Methods and Techniques of Reading-Basic Steps to Effective Reading-Common Obstacles-Discourse Markers or Linkers Sub-skills of reading Reading for facts, negative facts and Specific Details- Guessing Meanings from Context, Inferring Meaning-Critical Reading-Reading Comprehension-Exercises for Practice.
- 2. Activities on Writing Skills: Vocabulary for Competitive Examinations-Planning for Writing-Improving Writing Skills-Structure and presentation of different types of writing-Free Writing and Structured Writing-Letter Writing-Writing a Letter of Application-Resume vs. Curriculum Vitae-Writing a Resume-Styles of Resume-e-Correspondence-Emails-Blog Writing- (N) etiquette-Report Writing-Importance of Reports-Types and Formats of Reports-Technical Report Writing-Exercises for Practice.

- 3. Activities on Presentation Skills Starting a conversation-responding appropriately and relevantly-using the right language and body language-Role Play in different situations including Seeking Clarification, Making a Request, Asking for and Refusing Permission, Participating in a Small Talk-Oral presentations (individual and group) through JAM sessions- PPTs-Importance of Presentation Skills- Planning, Preparing, Rehearsing and Making a Presentation-Dealing with Glossophobia or Stage Fear-Understanding Nuances of Delivery-Presentations through Posters/Projects/Reports-Checklist for Making a Presentation and Rubrics of Evaluation
- 4. Activities on Group Discussion (GD): Types of GD and GD as a part of a Selection Procedure-Dynamics of Group Discussion- Myths of GD-Intervention, Summarizing- Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas-Do's and Don'ts-GD Strategies-Exercises for Practice.
- 5. **Interview Skills**: Concept and Process-Interview Preparation Techniques-Types of Interview Questions-Pre-interview Planning, Opening Strategies, Answering Strategies-Interview Through Tele-conference & Video-conference- Mock Interviews.

4. Minimum Requirement:

The Advanced English Communication Skills (AECS) Laboratory shall have the following infra-structural facilities to accommodate at least 35 students in the lab:

- Spacious room with appropriate acoustics
- Round Tables with movable chairs
- Audio-visual aids
- LCD Projector
- Public Address system
- One PC with latest configuration for the teacher
- T. V, a digital stereo & Camcorder
- Headphones of High quality

5. Suggested Software:

The software consisting of the prescribed topics elaborated above should be procured and used.

- TOEFL & GRE(KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)
- **Oxford Advanced Learner's Dictionary**, 10th Edition
- Cambridge Advanced Learner's Dictionary
- DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.
- Lingua TOEFL CBT Insider, by Dreamtech

6. Books Recommended:

- Rizvi, M. Ashraf (2018). *Effective Technical Communication*. (2nd ed.). McGraw Hill Education (India) Pvt. Ltd.
- 2. Suresh Kumar, E. (2015). Engineering English. Orient BlackSwan Pvt. Ltd.
- 3. Bailey, Stephen. (2018). Academic *Writing: A Handbook for International Students*. (5th Edition). Routledge.
- 4. Koneru, Aruna. (2016). Professional Communication. McGraw Hill Education (India) Pvt. Ltd.
- 5. Raman, Meenakshi & Sharma, Sangeeta. (2022). *Technical Communication, Principles and Practice*. (4TH Edition) Oxford University Press.
- 6. Anderson, Paul V. (2007). Technical Communication. Cengage Learning Pvt. Ltd. New Delhi.
- 7. McCarthy, Michael; O'Dell, Felicity & Redman, Stuart. (2017). *English Vocabulary in Use* Series. Cambridge University Press
- 8. Sen, Leela. (2009). Communication Skills. PHI Learning Pvt Ltd., New Delhi.
- 9. Elbow, Peter. (1998). *Writing with Power*. Oxford University Press.
- 10. Goleman, Daniel. (2013). Emotional Intelligence: Why it can matter more than IQ. Bloomsbury Publishing.

L T P C 3 0 0 0

UNIT – I

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT – III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT – IV

Trade Secrets: Trade secret law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

UNIT – V

New development of intellectual property: new developments in trade mark law; copy right law, patent law, intellectual property audits. International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

Text & Reference Books:

- 1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
- 2. Intellectual property right Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd

Pre Requisites: Mass Transfer Operations-I

Course Objectives:

- 1. To describe stage wise mass transfer operations, principles of various stage wise contact processes like distillation, extraction, leaching, adsorption and drying
- 2. To design a distillation column, as well as design of a absorber and calculations involved in liquidliquid extraction and drying
- 3. To justify the selection of solvents for leaching and extraction.

Course Outcomes:

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

- 1. Describe how batch distillation is conducted in several ways
- 2. Design distillation equipments with simple and rigorous methods
- 3. Examine liquid-liquid extraction
- 4. Separate the components by leaching
- 5. Interpret the principles of fixed bed adsorption

UNIT -I

Distillation: Principles of VLE for binary systems, VLE phase diagrams, Tie line and mixture rule, Relative volatility, Ideal solutions, azeotropes. Methods of Batch Distillation: Flash, Differential and steam Distillation, Batch Distillation with reflux for binary mixture, continuous fractionation of binary mixtures.

UNIT -II

Multistage tray towers- Ponchon Savarit Method, Mc-Cabe & Thiele method of determination of ideal plates for binary mixtures- Enriching section, exhausting section, feed location, total reflux, minimum and optimum reflux ratios, use of total and partial condensers, use of open steam system, types of condensers and reboilers. Packed bed distillation, Principles of azeotropic and extractive distillation.

UNIT-III

Liquid- Liquid Extraction: Solubility of ternary liquid systems, Triangular and solvent free coordinate (rectangular coordinate) systems, choice of solvent, Extraction with insoluble and partially soluble systems. Single stage and multistage cross current and multistage counter current extraction without reflux and with reflux, fractional extraction, Continuous contact extraction (Packed beds), Equipment for liquid- liquid extraction operation, use of super critical fluid in extraction.

UNIT-IV

Leaching: Introduction, leaching process, preparation of solid for leaching, Rates of leaching, Steadystae and unsteady state operation, in situ leaching. Heap leaching, percolation leaching, Shanks systems, Agitated vessels, Percolation Vs Agitation. Steady state continuous operation- equipment for leaching– methods of calculation. Stage efficiency and particle equilibrium, Single stage leaching, multistage cross current leaching, multistage counter current leaching (under variable underflow and constant underflow conditions)

UNIT-V

Adsorption: Principles of adsorption and their applications, types of adsorption, Industrial adsorbents, adsorption equilibrium, adsorption isotherms for vapour and dilute solutions, Freundlich equation, Langmuir and BET isotherms. Single stage and multistage adsorptions, unsteady state adsorption, adsorption wave and breakthrough curve and fixed bed adsorption. Equipment for adsorption (single stage and continuous contact), Ion exchange.

Text Books:

- 1.R. E. Treybal, Mass Transfer Operations, 3rdEdition, Mc Graw Hill, New Delhi,1983.
- 2. Binay K. Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India,2007
- 3. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, Tata Mc Graw Hill, India, 2014.

Reference Books:

1. C. J. Geankoplis, Transport Processes and Separation Process Principles, 4thEdition, Pearson Education2015.

III Year B.Tech. II-Sem

L T P C 3 1 0 4

Pre Requisites: Chemical Reaction Engineering-I

Course Objectives:

- 1. Learn the importance of RTD and the various models such as compartmental models, dispersion model, tanks in series model for modeling of Non-ideal flow reacting vessels.
- 2. Knowledge of rate law given the rate controlling step in catalytic reactions, internal and external diffusion effects.
- 3. Shrinking core model for spherical particles of unchanging size and design the fluid-solid reactors.

Course Outcomes:

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

- 1. Distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information.
- 2. Develop rate laws for heterogeneous reactions.
- 3. Design of reactors for non-catalytic and catalytic reactions.
- 4. Evaluate the rate and performance equations for deactivating catalysts.
- 5. Design fluid-solid reactors.

UNIT- I

Basics of non-ideal flow: E, the exit age distribution function of fluid, the RTD, conversion in non-ideal flow reactors, diagnosing reactors (qualitative discussion only). The dispersion model: axial dispersion, correlations for axial dispersion, chemical reaction and dispersion.

UNIT-II

The tanks in series model: pulse response experiments and the RTD, chemical conversion. The convection model for laminar flow- the convective model and its RTD, chemical conversion in laminar flow reactors. Earliness of mixing, segregation and RTD: self-mixing of a single fluid, mixing of two miscible fluids.

UNIT-III

Catalysis and Catalytic reactors: catalysts, steps in catalytic reactions, synthesizing a rate law, mechanism and rate limiting step. (From chapter 10, Fogler)

Heterogeneous reactions: Introduction to Solid catalyzed reactions: The rate equation for Surface Kinetics- Pore diffusion resistance combined with surface kinetics, Porous catalyst particles, heat effects during reaction, Performance equations for reactors containing porous catalyst particles.

UNIT- IV

Solid catalyzed reactions: Experimental methods for finding rates. Deactivating catalystsmechanisms of catalyst deactivation, the rate and performance equations. UNIT-V **Fluid-fluid reactions**: kinetics- the rate equation. **Fluid-particle reactions**: kinetics- selection of a model, shrinking core model for spherical particles of unchanging size, rate of reaction for shrinking spherical particles, extensions, determination of rate controlling step.

Text Books:

- 1. Chemical Reaction Engineering, 3rd ed., O. Levenspiel, John Wiley & Sons, 1999.
- 2. Elements of Chemical Reaction Engineering, 4th ed., H.S. Fogler, PHI Learning Pvt. Ltd., New Delhi, 2010.

Reference Books:

- 1. Chemical Engineering Kinetics, 3rd ed., J.M. Smith, McGraw-Hill, New York, 1981.
- The Engineering of Chemical Reactions, 2nd ed., L.D. Schmidt, Oxford University Press, New Delhi, 2010

III Year B.Tech. II-Sem

L T P C 2 0 0 2

Pre Requisites: Chemical Reaction Engineering, Mass transfer operation, Process heat transfer. **Course Objectives:**

The present course enables one to learn about the complete process design of reaction vessel, Heat Exchanger, Packed column and Distillation column.

Course Outcomes:

At the end of the course students can able to

- 1. Understand basic concepts of process equipment design.
- 2. Understand the calculation of different stresses to design the equipment.
- 3. Understand different types of reactors & design concepts.
- 4. Design of heat exchanger like Double pipe, shell and tube heat exchanger.
- 5. Process design of distillation column and internals.

UNIT-I

Basic consideration in Process equipment design: Nature of process equipment, General design procedure, Fabrication techniques, equipment classification.

Materials & Protective Coatings: Properties, Resistance to corrosion, Choice of material, Protective Coatings, linings for chemical plant & equipments.

Stress analysis: Introduction, Stress, strains, elastic constants, thermal stresses, **Static stresses**, blending, torsion, struts & flat plates. Stresses in cylinders & spheres, stress concentration. **Dynamic stresses**, stresses in rotating rims & discs. Impact stresses & compound stresses.

UNIT-II

Reaction Vessels: Introduction, materials of construction. Agitation. Classification of reaction vessels-Batch reactor, continuous flow reactor & semi-batch reactor. Heating systems- types of jackets & coils. Design consideration- design of vessel shell with half coil & with channel jacket.

UNIT-III

Heat Exchangers: Introduction, types of heat exchangers- Double pipe, shell & tube & Special type – Pipe coils, spiral, plate type and finned tube heat exchangers. Design of shell and tube heat exchangers-fluid flow pattern, classification of shell & tube, material of construction, design pressure, temperature, corrosion allowance.

UNIT-IV

Distillation and fractionation Equipment: Introduction, basics of fractionation equipment, stresses in column shell, shell thickness determination- axial stress due to pressure, stress due to dead loads, stress due to wind load, stress due to eccentricity of loads, stress due to seismic load & determination of height of the column.

Distillation: Column internals, design of column internals- Equilibrium stage columns, plates with & without downcomers. Feed systems, draw offs, manholes, Differential column- Packed column, liquid distributors, support plates.

Supports for vessels: Introduction, Bracket, leg, skirt and saddle supports.

Reference Books:

Sinnott, R.K., "Coulson and Richardson's Chemical Engineering Series: Chemical Engineering Design", Vol. VI, 4th Ed., 2005, Elsevier Butterworth-Heinemann.

III Year B.Tech. II-Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. To give an outline on the formation, refining of crude oil and products of refinery.
- 2. To identify processing data including thermal properties, important products characteristics of petroleum products.
- 3. Explain about cracking/reforming/alkylation/isomerization/hydrocracking processes.

Course Outcomes:

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

- 1. Describe the formation of crude oil, its refining techniques.
- 2. Explain about the crude oil distillation and its products.
- 3. Acquire knowledge about catalytic cracking / reforming processes.
- 4. Evaluate the petrochemical feedstock for manufacture of various value added chemicals.
- 5. Explain the technologies of low carbon alkane and alkynes based high value chemicals.

UNIT- I

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum Industry. Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products, properties and test methods.

UNIT- II

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude pipe still heaters, distillation of petroleum, blending of gasoline. Treatment techniques: fraction-impurities, treatment of gasoline, treatment of kerosene, treatment of lubes.

UNIT-III

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, Naphtha cracking, coking, Hydrogenation processes, Alkylation processes, Isomerization process.

UNIT-IV

Petrochemical Industry – Feed stocks Chemicals from methane: Introduction, production of Methanol, Formaldehyde, Ethylene glycol, PTFE, Methylamines.

UNIT- V

Chemicals from Ethane-Ethylene-Acetylene: Oxidation of ethane, production of Ethylene, Manufacture of Vinyl Chloride monomer, vinyl Acetate manufacture, Ethanol from Ethylene, Acetylene manufacture, Acetaldehyde from Acetylene.

Text Books:

Rao, B.K.B. "Modern Petroleum Refining Processes", 4thEdition, Oxford and IBH Publishing, 2002.
Nelson. W.L. "Petroleum refining Engineering", 4thEdition, Mc Graw Hill, New York, 1969.

Reference Books:

- 1. Dr.B.K.Bhaskara Rao, "A text on petrochemicals", Khanna Publishers
- 2. Goldstine. R.F. "The Petroleum Chemicals Industry", Taylor and Francis, London, 1967.
- 3. Gruese. W.S.and Stevens, D.R. "Chemical Technology of Petroleum", McGraw Hill, 1980.
- 4. Chauvel. A. and Lefevrev, "Petro Chemicals", Volume 1 and 2, Gulf Publishing company 1989.

SUSTAINABLE ENERGY TECHNOLOGY (Professional Elective – I)

III Year B.Tech. II-Sem

Pre Requisites: NIL

Course Objectives:

- 1. Explain about the conventional energy sources and their utilization.
- 2. Describe the importance of heat recovery and energy conservation methods and energy audit
- 3. Identify different types of fuel sources for energy production.

Course Outcomes:

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

- 1. Describe about conventional energy sources and discuss about various types of fuels.
- 2. Explain the importance and applications of liquid fuels.
- 3. Illustrate about the importance of steam along with various energy sources.
- 4. Explain the various waste heat recovery techniques.
- 5. Analyze energy audits applying various schemes.

UNIT- I

Sources of energy- energy and relative forms. Calorific value- gross and net value, calculation of calorific value from fuel analysis, experimental determination, energy resources present and future energy demands with reference to India.

Solid fuels: origin of coal, occurrence, reserves, petrography, classification, ranking, analysis, testing, storage, coal carbonization and byproduct recovery, liquefaction of coal, gasification of coal, burning of coal and firing mechanism, burning of pulverized coal.

UNIT- II

Liquid fuels: Origin of petroleum, occurrence, reserves, composition, classification, characteristics, fractionation, reforming, cracking, petroleum products, specification of petroleum products, burning of liquid fuels. Natural gas, coke oven gas, producer gas, water gas, LPG, burning of gaseous fuels, hydrogen (from water) as future fuel, fuel cells, flue gas, analysis: orsat apparatus.

UNIT-III

Steam Plant: Run time cycle, boiler plant, steam cost, steam distribution and utilization, combined heat and power systems, energy from biomass and biogas plants, gas purification, solar energy, wind energy, energy storage.

Waste heat recovery: Sources of waste heat, various types of heat recovery systems, regenerators, recuperators, waste heat boilers

UNIT-IV

Energy conservation: conservation methods in process industries, theoretical analysis, practical limitations.

Energy auditing: short term, medium term, long term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing.

L T P C 3 0 0 3

UNIT- V

Sustainable Technology: Bio fuels, Circular Economy. Gasification, IGC Technology, EV Batteries.

Text Books:

- 1. Fuels, Furnaces and Refractories, O.P.Gupta
- 2. Fuels and Combustion, 3rd ed., Samir Sarkar, Universities Press, 2009.

Reference Books:

- 1. Non-conventional Energy Resources, G.D.Rai, Khanna Publishers.
- 2. Fuel and Energy, Harker and Backhurst, Academic press London 1981.
- 3.progress in sustainable energy technology generating renewable energy Ibrahim Dieser. (2014)
- 4. Energy sustainability through green energy Atul Sharma.
- 5. Fuel Science- Harker and Allen, Oliver and Boyd, 1972.

BASICS OF NANOTECHNOLOGY (Professional Elective – I)

3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. Discuss about the basics of nanotechnology
- 2. Classify and explain the various properties of nano materials
- 3. Describe the various methods for synthesis of nano materials and their applications

Course Outcomes:

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

- 1. Describe the importance of nano structured materials.
- 2. Explain the effect of nano dimensions on material behavior properties.
- 3. Explain the various magnetic properties of nano materials.
- 4. Describe the various routes for nano material preparation.
- 5. Describe about the nano powders and application of nano materials in various fields.

UNIT- I

Introduction: History and Scope, Can Small Things Make a Big Difference? Classification of Nano structured Materials, Fascinating Nanostructures, Applications of Nano materials, Nature: The Best of Nanotechnologist, Challenges and Future Prospects.

UNIT- II

Unique Properties of Nano materials: Microstructure and Defects in Nano crystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations.

Effect of Nano-dimensions on Materials Behavior: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, Enhanced solid solubility.

UNIT-III

Magnetic Properties: Soft magnetic nano-crystalline alloy, Permanent magnetic nano-crystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

UNIT-IV

Synthesis Routes: Bottom up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly

UNIT- V

Top down approaches: Mechanical alloying, Nano-lithography.

Consolidation of Nano powders: Shock wave consolidation, Hot isostatic pressing and Cold isostatic pressing Spark plasma sintering.

Applications of Nano materials: Nano-electronics, Nanosensors, Nanocatalysts, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defence and Space Applications

Text Books:

- 1. Text Book of Nano Science and Nano Technology B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
- 2. Introduction to Nanotechnology Charles P. Poole, Jr., and Frank J. Owens, Wley India Edition, 2012.

Reference Books:

- 1. Nano: The Essentials by T. Pradeep, Mc Graw-Hill Education.
- 2. Nanomaterials, Nanotechnologies and Design by Michael F. Ashby, Paulo J. Ferreira and Daniel L. Schodek
- 3. Transport in Nano structures- David Ferry, Cambridge University press 2000.

SOLID WASTE MANAGEMENT (Open Elective – I)

Pre Requisites: NIL

Course Objectives:

- 1. To understand the sense of onsite handling storage and collection systems including transportation
- 2. To understand the various processing technologies with mechanical volume reduction and thermal volume reduction corporate land filling, deep well injections.
- 3. Learn to estimate material recovery a energy recovery from a given waste data using case standing

Course Outcomes:

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

- 1. Apply the knowledge of characterization of waste and develop a suitable management plan
- 2. Describe various transfer and transportation techniques.
- 3. Describe various processing techniques.
- 4. Suggest processing waste for material for energy recovery.
- 5. Application of solid waste management techniques in various industries.

UNIT- I

Introduction: Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

General aspects: Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

UNIT- II

Engineered systems: Typical generation rates. Estimation and factors effecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

UNIT-III

Processing Techniques: Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

UNIT-IV

Material recovery: Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

Energy recovery: Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

UNIT- V

Case studies: Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

- 1. Howard S. Peavy, Environmental Engineering, McGraw Hill International Edition, 1986.
- 2. Dutta, Industrial Solid Water Management and Land Filling Practice, Narose Publishing House, 1999.

Reference Books:

- 1. Sastry C.A., Waste Treatment Plants, Narose Publishing House, 1995.
- 2. Lagrega, Hazardous Waste Management, McGraw Hill, 1994.

MASS TRANSFER OPERATIONS LAB

III Year B.Tech. II-Sem

L T P C 0 0 3 1.5

Pre Requisites: Mass Transfer Operations-I **Course Objectives:**

- 1. Study about diffusion and diffusivity coefficient for various systems such as, Liquid-liquid and Vapor-gas system.
- 2. Explain the hydrodynamics of single drop extraction, perforated plate tower.
- 3. Estimate the mass transfer coefficients for given system such as packed bed absorption, wetted wall tower, humidification and de-humidification.

Course Outcomes:

At the end of the course, studentwill be able to

- 1. Explain the VLE, LLE systems
- 2. Explain about diffusion and diffusivity coefficient for any given system.
- 3. Explain the different types of distillation
- 4. Evaluate the H.E.T.P of a packed bed distillation column.
- 5. Evaluate the equilibria data for any given system
- 6. Evaluate the characteristic curves in a batch drying.
- 7. Interpret the data and prepare formal lab reports describing the obtained experimental results.

List of Experiments

- 1. Estimation of Diffusivity of Carbon tetra Chloride -Air system
- 2. Mass Transfer Coefficient using Absorption in wetted wall Column
- 3. Mass Transfer Coefficient using Absorption in Sieve Tray Column
- 4. Mass Transfer Coefficient using Absorption in Packed Bed Column
- 5. Mass Transfer Coefficient in Humidification and Dehumidification
- 6. Studies on Vapour Liquid Equilibrium Data for Methanol -Water system
- 7. Studies on Batch Distillation and Verification of Rayleigh's Equation
- 8. Liquid Liquid Extraction in a Packed Column
- 9. Studies on Ion Exchange System
- 10. Study of Drying in Tray Drier
- 11. Leaching Equilibrium Data for Nacl- Calcium Carbonate –Water system
- 12. Solubility Characteristics of Acetic Acid -Chloroform-Water system
- 13. Studies on Extraction for Acetic Acid- Iso propyl ether-Water system
- 14. Studies on Steam Distillation
- 15. Batch Adsorption Studies of Dyes using Activated Carbon

CHEMICAL REACTION ENGINEERING LAB

III Year B.Tech. I-Sem

L T P C 0 0 3 1.5

Pre Requisites: Chemical Reaction Engineering-I, Chemical Reaction Engineering-II
Course Objectives:

- 1. To impart knowledge on the determination of the kinetics of a chemical reaction.
- 2. Analyze the concentration versus time data and determine the specific rate constant and the order of the reaction.
- 3. Explain about the various parameters of non-ideal flow models, RTD in CSTR, PFR, packed bed

Course Outcomes:

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

- 1. Calculate the order and kinetics of simple reactions
- 2. Evaluate the reaction rate constant of a reaction of a known order using batch reactor.
- 3. Compare the various types of reactors and their mode of operation
- 4. Calculate the residence time distribution (RTD) characteristics of all basic reactors including packed column reactor
- 5. Explain the concepts of dispersion number
- 6. Interpret the data and prepare formal lab reports describing the obtained experimental results.

List of Experiments

- Determination of the order of a reaction using a batch reactor and analyzing the data by

 (a) differential method
 (b) integral method.
- 2. Determination of the activation energy of a reaction using a batch reactor
- 3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR.
- 4. To determine the specific reaction rate constant of a reaction of a known order using a batch reactor.
- 5. To determine the order of the reaction and the rate constant using a tubular reactor.
- 6. CSTRs in series- comparison of experimental and theoretical values for space times and volumes of reactors.
- 7. Mass transfer with chemical reaction (solid-liquid system) determination of mass transfer coefficient.
- 8. Axial mixing in a packed bed. Determination of RTD and dispersion number for a packed-bed using a tracer
- 9. Determination of RTD and dispersion number in a tubular reactor

PROCESS EQUIPMENT DESIGN AND DRAWING LAB

IV Year B. Tech. I-Sem

Pre-requisite: Chemical Process equipment design theory

Course Objective: To make the student familiar with design and drawing aspects of chemical processes equipments.

Course Outcome:

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

- 1. Develop key concepts and techniques to design the process equipment in a process plant.
- 2. Identify the various flow sheet symbols in a process industry.
- 3. Derive and analyze the deign parameters theoretically and diagrammatically.

LIST OF EXPERIMENTS:

- 1. Drawing of flow sheet symbols.
- 2. Drawing of instrumentation symbols.
- 3. Drawing of instrumentation diagrams.
- 4. Mechanical aspects chemical equipment design and drawing of following equipment.
 - a) Double pipe heat exchanger
 - b) Shell and tube heat exchanger
 - c) Evaporator
 - d) Distillation column
 - e) Batch reactor.

TEXT BOOK:

- 1. Process Equipment Design by M. V. Joshi
- 2. Chemical Process Equipment Design and Drawing, S.C. Maidargi, PHI, 2013

REFERENCES:

- 1. Process Equipment Design by Brownell and Young
- 2. Chemical Process Equipment Design by Bhattacharya
- 3. Process Equipment Design by Wallas

INDUSTRY ORIENTED MINI PROJECT / INTERNSHIP

III Year B.Tech. II-Sem

Course Objectives:

- 1. To offer students a glimpse into real world problems and challenges that need Chemical Engineering based solutions.
- 2. To enable students to create very precise specifications of the Chemical Engineering problems to be solved.
- 3. To introduce students to the vast array of literature available of the various research challenges in the present scenario of different industries.

Course Outcomes:

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

- 1. Discover the potential research areas in Chemical Engineering involving various applications.
- 2. Conduct a survey of several available literatures in the preferred field of study.
- 3. Compare and contrast the several existing solutions for research challenge.
- 4. Demonstrate an ability to work in teams and manage the conduct of the research study.
- 5. Formulate and propose a plan for creating a solution for the research plan identified.
- 6. Report and present the findings of the study conducted in the preferred domain.

ENVIRONMENTAL SCIENCE

B.Tech. III Year II Sem.

L T P C 3 0 0 0

Course Objectives:

- Understanding the importance of ecological balance for sustainable development.
- Understanding the impacts of developmental activities and mitigation measures.

• Understanding the environmental policies and regulations

Course Outcomes:

• Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

UNIT - I

Ecosystems: Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

UNIT - II

Natural Resources: Classification of Resources: Living and Non-Living resources,

Water resources: use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems.

Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources, Land resources: Forest resources,

Energy resources: growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

UNIT - III

Biodiversity and Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values.

India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

UNIT - IV

Environmental Pollution and Control Technologies: Environmental Pollution: Classification of pollution, Air Pollution: Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. Water pollution: Sources and types of pollution, drinking water quality standards. Soil Pollution: Sources and types, Impacts of modern agriculture, degradation of soil. Noise Pollution: Sources and Health hazards, standards, Solid waste: Municipal Solid Waste management, composition and characteristics of e-Waste and its management. Pollution control technologies: Wastewater Treatment methods: Primary, secondary and Tertiary.

Overview of air pollution control technologies, Concepts of bioremediation. **Global Environmental Issues and Global Efforts:** Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol. NAPCC-GoI Initiatives.

UNIT - V

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act-1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development Goals, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

TEXT BOOKS:

- 1 Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
- 2 Environmental Studies by R. Rajagopalan, Oxford University Press.

REFERENCE BOOKS:

- 1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
- 2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
- 3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
- 4. Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.
- 5. Text book of Environmental Science and Technology Dr. M. Anji Reddy 2007, BS Publications.
- 6. Introduction to Environmental Science by Y. Anjaneyulu, BS. Publications.

TRANSPORT PHENOMENA

IV Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: Fluid mechanics, Process Heat Transfer, CRE-I, CRE-II **Course Objectives:** 1. Practice the concepts of Momentum, heat and mass transport

- 2. Solve the problems on Momentum, Energy and Mass transfer
- 3. To develop Model Equation for prototype system to scale up

Course Outcomes:

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

- 1. Identify the chemical and physical transport processes and their mechanism.
- 2. Analyze momentum transfer problems with shell balance.
- 3. Analyze shell energy balance problems along with appropriate approximations and boundary conditions.
- 4. Develop shell mass balance and analyze problems related to mass transfer.
- 5. Solve transport problems with turbulent flow and derive the equations of change.

UNIT-I

Viscosity and the mechanisms of momentum transfer: Newton's law of viscosity (molecular momentum transport), generalization of Newton's law of viscosity, pressure and temperature dependence of viscosity, molecular theory of the viscosity of gases at low density, molecular theory of the viscosity of liquids. Thermal conductivity and the mechanisms of energy transport: Fourier's law of heat conduction (molecular energy transport), temperature and pressure dependence of thermal conductivity, and theory of thermal conductivity of gases at low density. Diffusivity and the mechanisms of mass transport: Fick's law of binary diffusion (molecular mass transport), temperature and pressure dependence of diffusivities, theory of diffusion in gases at low density.

UNIT- II

Shell momentum balances and velocity distributions in laminar flow: shell momentum balances and boundary conditions, flow of a falling film, flow through a circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

UNIT-III

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, heat conduction with an electrical heat source, heat conduction with a nuclear heat source, heat conduction with a viscous heat source, heat conduction with a chemical heat source, heat conduction through composite walls, heat conduction in a cooling fin, forced convection, free convection.

UNIT-IV

Concentration distributions in solids and laminar flow: shell mass balances; boundary conditions, diffusion through a stagnant gas film, diffusion with a heterogeneous chemical reaction, diffusion with a homogeneous chemical reaction, diffusion into a falling liquid film (gas absorption), diffusion into a falling liquid film (solid dissolution), diffusion and chemical reaction inside a porous catalyst.

The equations of change: Derivation of the equation of continuity in Rectangular and Polar coordinates, the equation of motion, the equation of energy, the equation of continuity of a component in multi component mixture (in rectangular coordinates only) the equations of change in terms of the substantial derivative. Use of equations of change to solve one dimensional steady state problems of momentum, heat and component transfer, Introduction to Turbulent flow and Time smoothing.

Text Books:

1. Transport phenomena by Bird R.B., Stewart W.C., Lightfoot F.N., 2nd ed. John Wiley & Sons Inc, U.S.A, 1960.

Reference Books:

- 1. Transport phenomena for engineers by L. Theodore, International text book company, U.S.A.1971.
- 2. Transport processes and unit operations by C.J. Geankoplis, PHI, 3rd ed. 1997.
- 3. Fundamental of heat, momentum and mass transfer, Welty, Wickson, Wilson, John Wiley.

CHEMICAL ENGINEERING PLANT DESIGN AND ECONOMICS

IV Year B.Tech. I-Sem

L T P C 2 0 0 2

Pre Requisites: Nil **Course Objectives**:

1. To familiarize the students about various economic aspects of chemical processes.

- 2. Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money.
- 3. Learn the importance of Cash flow diagrams and Break-even analysis.

Course Outcome:

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

- 1. Learn about various costs involved in a process industry.
- 2. Evaluate the tax burden of an establishment.
- 3. Compute break even period for an investment and rate of return.

UNIT I

Introduction: Process Design development, General design considerations, Cost and asset accounting. Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment

UNIT II

Organizations for presenting capital investments, estimates by compartmentalization, estimation of total product of cost direction, production costs, fixed charges, plant overhead costs, financing.

Interest and investment cost, type interest, nominal and effective interest rates, continuous interest, present worth and discount annuities, cost due interest on investment, source of capital.

UNIT III

Taxes and insurances, type of taxes: federal income taxes, insurance-types of insurance, self-insurance. Depreciation: types of depreciation, services life, salvage value, present value, methods for determining depreciation, single unit and group depreciation.

UNIT IV

Profitability: alternative investments and replacements, profitability standards, discounted cash flow, capitalized cost, pay out period, alternative investments, analysis with small investments, increments and replacements.

UNIT V

Optimum design and design strategy, incremental cost, general procedure for determining optimum condition, comparison of graphical and analytical methods, optimum production rates, semi continuous cyclic operation, fluid dynamics, mass transfer strategy of linearization

TEXT BOOK:

1. Plant Design and Economics for Chemical Engineering, 4th ed., M.S. Peters and K.D. Timmerhaus, McGraw-Hill,1991

REFERENCE:

1. Process Engineering Economics, Schweyer

INTERFACIAL AND COLLOIDAL SCIENCE (Professional Elective – II)

IV Year B. Tech. I- Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. Understand the basic nomenclature, concepts and tools of colloid and interface science and engineering; multi-phase nano-systems; mechanics and thermodynamics on small scales.
- 2. Explain the difference between the surface and bulk dominated regimes, their behavior and exploitation of nano-systems.
- 3. Importance of various components of interfacial science in different chemical engineering industries viz. food, paint and pharmaceutical industries are emphasized.

Course Outcomes:

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

- 1. Distinguish between colloid and interface and explain properties of colloid dispersion
- 2. Explain the differences between surfactants, emulsions
- 3. Apply the methods for measurement of contact angle, surface tension and interfacial tension
- 4. Explain about the various forces acting on colloids
- 5. Explain about the adsorption evaluating techniques.

UNIT I

Basic concepts of Colloids and Interfaces: Introduction, Examples of Interfacial Phenomena, Solid-Fluid Interfaces, Colloids. Properties of Colloid Dispersions: Introduction, Sedimentation under Gravity, Sedimentation in a Centrifugal Field, Brownian Motion, Osmotic pressure, Optical properties, Electrical Properties, Rheological Properties of Colloid Dispersions.

UNIT II

Surfactants micelles, films and their properties: Introduction, Surfactants and their Properties, Emulsions and Micro emulsions, foams. Emulsion polymerization, liquid-liquid extraction& membranes.

UNIT III

Surface and Interfacial Tension: Introduction, Surface tension, Interfacial Tension, Contact Angle and Wetting, Shape of the Surfaces and interfaces. Measurement of Surface and Interfacial Tension, Measurement of Contact Angle

UNIT IV

Intermolecular and Surface Forces: Introduction, Vander walls Forces. Intermolecular and Surface Forces: Electrostatic double layer force, The DLVO theory, Non-DLVO forces.

UNIT V

Adsorption at interfaces: Introduction, The Gibbs Dividing surface, Gibbs Adsorption Equation, Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state(EOS), Effect of Salt on Adsorption of Surfactants. Adsorption Isotherms incorporating the Electrostatic Effects, Calculation of Free energy of Adsorption.

Text Books:

- 1. Interfacial Science: An Introduction by G. Barnes, I. Gentle, Oxford University Press, USA, 2006.
- 2. Foundations of Colloid Science by R. J. Hunter, 2nd edition, Oxford University Press, USA, 2001.

Reference Books:

- 1. Principles of Colloid and Surface Chemistry, Third edition, Revised and Expanded, Paul C. Hiemenz and Raj Rajagopalan.
- 2. Physical Chemistry of Sciences, 6th edition, A. Adamson, 1997.
- 3. Colloid and Interface Science by Pallab Ghosh, PHI, New Delhi.

POLYMER SCIENCE AND ENGINEERING (Professional Elective – II)

IV Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. To provide a broad and fundamental knowledge of the polymers and their chemical, physical and mechanical behaviour.
- 2. Emphasize on the processing techniques, along with the production of polymers.
- 3. The student should be able to correlate structure-processing-properties relationships for polymers, blends and composites.

Course Outcomes:

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

- 1. Understand the structure-processing-property relationship of polymers.
- 2. Illustrate different polymerization processes.
- 3. Understand the kinetics of various polymerization techniques.
- 4. Describe the manufacturing techniques of different synthetic fibers and plastics.
- 5. Describe testing and evaluation of plastics and rubbers.

UNIT-I

Basic Concepts: Concepts and classification of polymers, Functionality, Glass transition temperature, Addition, condensation, step-growth and chain-growth polymerization, Molecular weight estimation: Number and weight average, Sedimentation and viscosity average molecular weights, Molecular weight and degree of polymerization, Polydispersity, Significance of molecular weight.

UNIT-II

Polymerization Processes: Bulk, solution, emulsion and suspension polymerization, Comparison of polymerization processes.

UNIT-III

Polymerization Kinetics: Chemistry of step reaction polymerization, Mechanism and kinetics of poly condensation reactions, Relationship between average functionality, extent of reaction and degree of polymerisation. Mechanism and kinetics of free- radical chain polymerization, kinetic chain length, chain transfer reactions, Inhibition and retardation

UNIT-IV

Synthetic Fibres: Types of Fibres, Spinning Techniques, Manufacturing Technology and Applications of different types of fibres: cellulosic fibres, polyamides, acrylics, vinyls and vinylidines, fluorocarbons. **Plastics:** Manufacturing Technology and applications of different types of plastics: Polyester, polyethylene, Phenolics.

UNIT- V

Plastics: Rubbers, structure, properties and preparation natural rubber synthetic rubbers: SBR, rubber compounding and reclaiming.

Testing and Evaluation of plastics and rubbers:

Physical testing, Electrical Properties, Softening Temperature tests, Melt flow Index.

- 1. Gowariker V. R., Viswanathan N. V., Sreedhar J., "Polymer Science", New Age International Publishers, (1996).
- 2. Billmeyer F. W., "Text Book of Polymer Science", Wiley Tappers, (1994).

Reference Books:

- 1. Ghosh P., "Polymer Science and Technology of Plastics and Rubber", Tata McGraw Hill, (2001).
- 2. Gupta R. K., Kumar A., "Fundamentals of Polymer Engineering", 2nd Edition, Marcel Dekkar, (2003).
- 3. Fried J. R. "Polymer Science and Technology", PHI Learning, (2008).

OPTIMIZATION OF CHEMICAL PROCESSES (Professional Elective – II)

IV Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: NILCourse Objectives:1. To learn problem formulation of optimization.

- 2. To realize the numerical methods of un-constrained optimization.
- 3. To learn linear programming and its applications

Course Outcomes:

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

- 1. Knowledge of optimization to formulate the problems and analyze the optimization criterion for solving problems.
- 2. Apply different methods of single variable optimization and to suggest a technique for specific problem.
- 3. Apply various methods of multivariable optimization techniques or specific problem.
- 4. Understand the optimization of various unit operations.
- 5. Describe linear programming with its applications.

UNIT- I

Nature and organization of optimization problems: introduction to optimization scope and hierarchy of optimization, examples of applications of optimization, essential features of optimization problems, general procedure for solving optimization problems, Optimization of a manufacturing problem with a stepwise procedure, obstacles of optimization, constraints in optimization, examples and formulation of constrained optimization problems.

UNIT-II

Basic concepts of optimization: Continuity of functions, unimodal versus Multi model functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function.

UNIT-III

Optimization of unconstrained single variable functions: Region elimination methods: Fibonacci search, Golden section search. Polynomial approximation methods- Sequential search. Methods specifying optimum by a point: Newton's method, Secant method, Quadratic interpolation, Cubic interpolation. Applications of one dimensional search methods to chemical engineering problems.

UNIT- IV

Optimization of Unit operations: Optimal pipe diameter, minimum work of compression, optimizing recovery of waste heat, optimization of multiple effect evaporator, shell and tube heat exchanger.

UNIT- V

Linear programming and applications: Basic concepts of linear programming, graphical solution, artificial variable technique, exceptional cases in LPP, non-existing feasible solution, degeneracy, duality in linear programming, simplex method.

Text Books:

1. Optimization of Chemical Processes, T.F. Edgar and D.M. Himmelblau, McGraw-Hill, New York, 2001.

2. Optimization for Engineering Design, Kalyan Moy Deb, PHI Pvt. Ltd., New Delhi, 2000.

Reference Books:

- 1. S.S.Rao, Engineering Optimization Theory and Practice, 3rd edition, New Age International Publishers, India.
- 2. K.Deo, Optimization techniques, Wiley Eastern, 1995.

BIOCHEMICAL ENGINEERING (Professional Elective – III)

IV Year B.Tech. I-Sem

Pre Requisites: NIL **Course Objectives**:

1. Relate the chemical engineering principles to biochemical systems.

2. Be able to explain the biological systems and kinetics of enzymatic reactions.

L T P C 3 0 0 3 3. Learn the kinetics of growth of microorganisms; hence be able to control the process.

Course Outcomes:

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

- 1. Evaluate the kinetics of enzyme action in substrate and inhibitor.
- 2. Determine the rate constants and understand the kinetics involved in enzyme activity.
- 3. Describe the biocatalysts involved in enzyme immobilization and evaluate the kinetics of the reaction.
- 4. Evaluate the kinetics and mechanism of microbial growth.
- 5. Design the various bioreactors and explain their mode of operation.

UNIT- I

Introduction to microbiology: Biophysics and the cell doctrine, the structure of cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins.

Enzyme Kinetics: Kinetics of single-substrate enzyme catalyzed reactions, Michaelis - Menten equations, Brigg's Haldane equation & estimation of constants using graphical techniques, Turnover number (k_{cat}). Kinetics for reversible reactions, Enzyme inhibition kinetics: reversible and irreversible inhibition, substrate, product and toxic substances inhibition.

UNIT- II

Pre-steady-state and multi-substrate enzyme kinetics: pre-steady-state kinetics: Rapid mixing, Stopped flow and Relaxation techniques, Determination of the number of active sites of enzyme and determination of rate constants. Enzyme kinetics at limiting conditions: Dilute substrates, solid substrates and enzyme activity at interfaces.

Kinetics of multi-substrate reactions: Mechanism for two substrates reactions, compulsory order, random order reactions and Ping-Pong mechanism.

UNIT-III

Enzyme immobilization & kinetics of immobilization: Immobilization of Biocatalysts an Introduction, Electrostatic effect, Effect of charged and uncharged support, Effect of external and internal mass transfer, Effect of Intra-particle diffusion with uncharged supports, Simultaneous external and internal mass transfer resistances and partitioning effects. Dam Kohler number and effectiveness factor.

UNIT-IV

Unstructured model for microbial growth: The development of different microbial growth kinetics like Malthus, Pearl and reed, Monod Model, Konark Model. The limitation of Monod model and development of other constitutive models of growth.

Sterilization: Media sterilization, Kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilization, coupling of Arrhenius equation and cell death kinetics, sterilization of air and filter design, Radiation and Chemical sterilization.

Bioreactors: Different types of Bioreactor, Different modes of operation, Main components of the bioreactor and their functions. Bioreactor design: Batch reactor, cell death in batch reactor, chemostat, endogenous metabolism, maintenance, product & substrate inhibition on chemostat, multiple steady state analysis, enzyme catalysis in CSTR, cascade reactor, plug flow reactor, fed batch reactor, Chemostat with cell recycle and feed forward control.

Text Books:

- 1. Biochemical Engineering Fundamentals, 2nd ed., J.E. Bailey and D.F. Ollis, McGraw-Hill, New York, 1987.
- 2. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker (1987).

Reference Books:

- 1. Biochemical Engineering, J. M. Lee, Prentice-Hall, New Jersey 1992.
- 2. Bioprocess Engineering Principles, P. M. Doran, Elsevier, Gurgaon.
- 3. Bioprocess Engineering, 2nd ed., M. L. Shuler and F. Kargi, PHI Learning Pvt. Ltd, New Delhi, 2009.

INDUSTRIAL POLLUTION CONTROL ENGINEERING (Professional Elective – III)

IV B.Tech. I-Semester

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. To understand various air pollution control techniques.
- 2. To understand various biological treatment methods of waste water.
- 3. To understand various physical treatment methods of waste water.

Course Outcomes:

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

- 1. Understand the different types of wastes generated in an industry, their effects on living and nonliving things.
- 2. Understand environmental regulatory legislations and standards and climate changes.
- 3. Understand the atmospheric dispersion of air pollutants, and operating principles, design calculations of particulate control devices.
- 4. Understand about the quantification and analysis of wastewater and treatment.
- 5. Understand the different unit operations and unit processes involved in conversion of highly polluted water to potable standards.

UNIT-I

Introduction to industrial pollution and types of pollution from chemical industries, Effects of pollution as environment and ecosystems-global warming-greenhouse effect; Environmental legislation-standards and guidelines, water act 1974, air act 1981.

UNIT –II

Air pollution-Meteorological aspects of pollution dispersion-adiabatic lapse rate-Environmental lapse rate-Turbulence and stability of atmosphere, Richardson number-Plume raise-plume behavior and characteristics, effective stack height. Major air pollutants and their sources, measurement of air pollutants

UNIT -III

General methods of control air pollutants removal of sulphur dioxide, oxides of nitrogen and organic vapors from gaseous effluents; Removal of particulate matter – principle and working of setting chambers, cyclone separators, fabric and fibre filters – electro static precipitators, Treatment of gaseous effluents.

UNIT -IV

Introduction to water pollution – water pollutants classification –characteristics of liquid effluents from fertilizer, pulp & paper and petroleum industries, estimation of oxygen demands – DO, BOD, COD, TOC – BOD curves, oxygen sag curve – modeling of BOD curves

Biological treatment of waste waters – aerobic and anaerobic methods– suspended and attached growth processes – bacteria – Reproduction in bacterial – Bacterial growth crushes, conventional activated sludge process – Trickling filters, Aerated lagoons – stabilization ponds – fluidized bed contractors.

UNIT -V

L T P C 3 0 0 3

Physical Treatment methods: Principle and working of screening –sedimentation – flotation – filtration – flocculation, Tertiary Treatment methods – carbon adsorption – lon exchange – Reverse Osmosis, Boralin Chlorinating – Ultra filtration, Sludge treatment and disposal, removal of chromium and phenol from liquid effluents.

Text Books:

1.Pollution control in process industries by S.P. Mahajan TMH.,1985

2. Waste water treatment by M. Narayana Rao and A. K. Datta, Oxford and IHB publisher, New Delhi.

Reference Books:

- 1. Environmental pollution and control engineering by Rao C. S. –Wiley EasternLimited, India, 1993.
- 2. Air pollution control by P. Prathapmouli and N. Venkatasubbayya. Divya Jyothi Prakashan, Jodhpur.

BIO-FUELS AND BIO-REFINERY (Professional Elective-III)

B.Tech. IV Year I Sem.

Prerequisite: Nil

Course objectives:

The students are expected to learn about:

- 1. The current energy challenges and the importance biofuels in achieving energy security and minimizing greenhouse gases emissions.
- 2. The overview of available renewable and alternative energy sources.

- 3. Biomass resources, types of biofuels and the bio-refinery concept.
- 4. The concept of 1st generation, 2nd generation, and advance biofuels.
- 5. Techno-economic analysis of various biofuel conversion technologies and their environmental attributes.

Course outcomes:

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

- 1. Understand on multidisciplinary subjects and current issues related to energy engineering.
- 2. Understand renewable energy and their impact on societal and global context.
- 3. Design experiments and conduct lab works pertinent to biofuel research.
- 4. Emerge technologies and their impact on environmental issues.
- 5. Identify and formulate an engineering problem, collect relevant data, critically analyze and interpret data to develop a solution.

UNIT-I:

Introduction, energy units, terminologies, energy security, and renewable energy sources, Greenhouse Gases, Photosynthesis for Biofuels.

UNIT-II:

Types of biomass and available resources, Lignocellulosic biomass composition and characterizations, Pyrolysis, bio-oil upgradation, and biochar, Biomass gasification followed by Fischer-Tropsch synthesis for liquid fuels

UNIT-III:

Hydrothermal (sub- and supercritical water) technology for Biofuels, Biochemical Conversion Process, bioethanol production from 1st and 2nd generation biomass feedstock, biohydrogen, and methane, Biopower, co-firing, biomass torrefaction and carbonization.

UNIT-IV:

Biodiesel Process, vegetable oil sources and production, current technologies and challenges, Algae to biofuels and challenges.

UNIT-V:

Bio based products, life cycle analysis, and water use in biofuels, Biofuels economics and policies.

Text books:

- 1. Biorenewable Resources: Engineering New Products from Agriculture by Robert C. Brown, Wiley-Blackwell.
- 2. Biomass for Renewable Energy, Fuels, and Chemicals by Donald Klass, Academic Press Publications.
- 3. Gasoline, Diesel and Ethanol Biofuels from Grasses and Plants by Ram B. Gupta and Ayhan Demirbas, Cambridge University Press.

Reference Books:

1. Biofuels Engineering Process Technology by Cave Drapcho, John Nghiem, and Terry Walker, McGraw Hill Publications.

COMPUTATIONAL FLUID DYNAMICS (Professional Elective – IV)

IV Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. Apply finite difference, finite volume and finite element methods to fluid flow problems.
- 2. To relate brief introduction of Computational Fluid Dynamics along with chemical engineering application specifically, analysis of fluid mechanics and heat transfer related problems.

3. Analyze issues surrounding two-phase flow modeling and grid generation.

Course Outcomes:

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

- 1. Solve PDEs.
- 2. Use finite difference and finite volume methods in CFD modeling.
- 3. Generate and optimize the numerical mesh.
- 4. Simulate simple CFD models and analyze is results.
- 5. Analyze issues of two-phase flow modeling.
- 6. Apply equations of fluid flow and heat transfer for turbulence models.
- 7. Apply finite volume to solve fluid flow problems

UNIT- I

Introduction - Finite difference methods- finite element method - finite volume method- Treatment of boundary conditions- Governing differential equations. Finite difference methods - Taylor's series - Errors associated with FDE- FDE formulation for steady state heat transfer problems.

UNIT- II

Cartesian, cylindrical and spherical coordinate systems- boundary conditions- Un steady state heat conduction Explicit Method - Stability criteria - Implicit Method - Crank Nickolson method - 2-D FDE formulation ADI- ADE. Finite volume method - Generalized differential equation, Basic rules for control volume approach, Source term linearization, boundary conditions. Un-steady state one, two, three dimensional heat conduction.

UNIT-III

Convection and diffusion, different methods i.e., upwind scheme, Exponential scheme, Hybrid scheme, power law scheme, calculation of flow field, staggered grid method, pressure and velocity corrections, SIMPLE Algorithms & SIMPLER (revised algorithm). Solution methods of elliptical, parabolic and hyperbolic partial differential equations in fluid mechanics - Burgers equation.

UNIT-IV

Formulations for incompressible viscous flows - vortex methods pressure correction methods.

UNIT- V

Treatment of compressible flows- potential equation, Navier - Stokes equation - flow field dependent variation methods, boundary conditions. Linear fluid flow problems, 2-I) and 3-1) fluid flow problems.

Text Books:

1. Numerical heat transfer and fluid flow - S.V. Patankar

2. Computational Fluid Dynamics, T.J. Chung, Cambridge University.

Reference Books:

1. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

NUCLEAR ENGINEERING (Professional Elective – IV)

IV Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: Process Heat Transfer **Course Objectives**:

- 1. To learn the basics of Nuclear physics
- 2. Understand the principles of Nuclear reactions and reactors
- 3. Know the safety aspects of Nuclear installations

Course Outcomes:

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

- 1. Summarize about the concepts of nuclear physics
- 2. Design the reactor components and explain about the nuclear reactions.
- 3. Explain about the nuclear cycles.
- 4. Explain about the various nuclear reactors and the heat transfer techniques involved.
- 5. Evaluate the various hazards and safety measures involved while handling the reactors.

UNIT- I

Introduction: Motivation for Nuclear Energy, India's Nuclear Power Program

Nuclear Physics: Nuclear model of the atom - Equivalence of mass and energy - Binding - Radio activity - Half-life - Neutron interactions - Cross sections.

UNIT-II

Nuclear Reactions and Reactor Materials

Mechanism of nuclear fission and fusion - Radio activity - Chain reactions - Critical mass and composition - Nuclear fuel cycles and its characteristics - Uranium production and purification - Zirconium, thorium, beryllium.

UNIT-III

Reprocessing: Nuclear fuel cycles - spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment.

UNIT-IV

Nuclear Reactors: Reactors - Types of fast breeding reactors - Design and construction of fast breeding reactors - heat transfer techniques in nuclear reactors - reactor shielding.

UNIT-V

Safety, Disposal and Proliferation: Nuclear plant safety- Safety systems - Changes and consequences of an accident - Criteria for safety - Nuclear waste - Type of waste and its disposal - Radiation hazards and their prevention - Weapons proliferation.

Text Books:

- 1. Thomas J. Cannoly, "Fundamentals of Nuclear Engineering ", John Wiley (1978).
- 2. G, Vaidyanathan," Nuclear Reactor Engineering", Chand Publishers, 2013

Reference Books:

- 1. Collier J.G., and G. F. Hewitt, " Introduction to Nuclear Power ", (1987), Hemisphere Publishing, New York.
- 2. Lamarsh U.R. " Introduction to Nuclear Engineering Second Edition ", (1983), Addison Wesley M.A.
- 3. Lipschutz R.D. " Radioactive Waste Politics, Technology and Risk ", (1980), Ballingor, Cambridge.

PROCESS INTENSIFICATION (Professional Elective – IV)

IV Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: Process heat transfer, Mass Transfer-I, Mass Transfer-II **Course Objectives:**

- 1. Explain the concept of Process Intensification.
- 2. Define the limitations of intensification for the chemical processes.
- 3. Describe the techniques of intensification to a range of chemical processes.

Course Outcomes:

At the end of the course, studentwill be able to

- 1. Be familiar with process intensification in industrial processes.
- 2. Assess the valuesand limitations of process intensification, cleaner technologies and waste minimization options.
- 3. Measure and monitor the usage of raw materials and wastes generating from production and frame the strategies for reduction, reuse and recycle.
- 4. Process challenges using intensification techniques.
- 5. Describe the applications of process intensification in various chemical industries.

UNIT- I

Introduction to Process Intensification(PI): sustainability-relatedissues in process industry, definitions of Process Intensification, fundamental principles and techniques of PI, the original ICI PI strategy, benefits of PI and obstacles to PI issues in designing of a sustainable, inherently safer processing plant

UNIT-II

PI Approaches: STRUCTURE - PI approach in spatial domain, ENERGY - PI approach in thermodynamic domain, SYNERGY - PI approach in functional domain and TIME - PI approach in temporal domain

Mechanisms involved in PI: Mechanisms of intensified heat transfer, mass transfer, electrically enhanced processes, microfluidics

UNIT-III

Application of PI techniques to heat transfer: Compact & micro heatexchangers

Application of PI techniques to reactors: Spinning disc reactors, oscillatory baffled reactors (OBR), Rotating reactors, Micro reactors, membrane reactors, micro reactors, Reactive separation/ super critical operation and other intensified reactor types.

UNIT-IV

Intensification of Separation Processes: Distillation, Centrifuges, membranes, drying, precipitation and crystallization

Intensified Mixing: Inline mixers, mixing on spinning disk, induction heated mixer

UNIT-V

Application areas of PI: Petrochemicals and Fine Chemicals: Refineries, Bulk Chemicals, Fine Chemicals and Pharmaceuticals, bio processing Offshore Processing, Nuclear Industries, Food and drink water sector, Textiles, Aerospace, biotechnology

Text Books:

- 1David Reay, Colin Ramshaw, Adam Harvey, Process Intensification-Reengineering for efficiency, sustainability and flexibility, Butterworth Heinemann, (Elsevier)2008.
- 2.Stankiewicz, A. and Moulijn, (Eds.), Reengineering the Chemical Process Plants, Process Intensification, marcel dekker 2003

Reference Books:

Dept. of Chem. Engg. / JNTUH UCESTH

- 1. Frerich Johannes Keil, Modeling of process intensification, Wiley 2007
- 2. Juan Gabriel Segovia Hernandez, Andrian Bonilla-Petericiolet, Process Intensification in Chemical Engineering: Design optimization and control, Springer 2016.

INDUSTRIAL POLLUTION PREVENTION & CONTROL (Open Elective – II)

IV Year B.Tech. I-Sem

L T P C 3 0 0 3

Pre Requisites: Nil Course Objectives:

To familiarize

1. Methods of pollution prevention in industries

2. Cleaner technologies and sustainability

3. Principles of various processes involved in the treatment of Air, Water pollution

UNIT- I

SUSTAINABILITY: Industrial activity and environment, industrialization and sustainable development indicators of sustainability-sustainability strategies. Barriers to sustainability, Pollution prevention in achieving sustainability

UNIT-II

ENVIRONMENTAL REGULATIONS: Prevention vs control of industrial pollution, Environment policies and Regulations to encourage pollution prevention, Environment friendly chemical processes, Regulations for clean environment and implications for industries

UNIT-III

POLLUTION: Definition of pollutant, types of pollution; Air, Water, Land, noise- adverse effects of pollutants eco system and human health - need for effluent treatment and toxicity, control. Water standards for portable, agricultural and left-off streams- air standards for cities, industrial areas, resorts. **UNIT -IV**

AIR POLLUTION CONTROL METHODS: Particulate emission control- gravitational settling chambers- cyclone separators, fabric filters, electrostatic precipitators, wet scrubbers, absorbers. Control of sulphur dioxide, oxides of nitrogen, carbon monoxide and hydrocarbons. Noise pollution measurements and its control.

UNIT -IV

PRINCIPLES OF WATER TREATMENT: Primary, secondary and tertiary treatments - advanced waste water treatments; recovery of metals from process effluents

TEXT BOOK

- 1. Bishop.P, "Pollution Prevention: Fundamentals and Practice", McGraw Hill International Edn., McGraw Hill Book Co., Singapore, 2000
- 2. Freeman.H.M, "Industrial Pollution Prevention Hand Book", McGraw Hill, 1995

3. James. G. Mann and Liu.Y.A, "Industrial Water Reuse and Waste Water Minimization", McGraw Hill, 1999

REFERENCES

- 1. Rose.G.R.D, "Air pollution and Industry", Van Nostrand Reinhold Co., New York 1972
- 2. Pandey.G.N and Carney.G.C, "Environmental Engineering", Tata McGraw Hill, New Delhi, 1989
- 3. Kapoor. B. S, "Environmental Engineering", 3rd Edn., Khanna publishers, 1997

PROJECT STAGE-1

IV Year B.Tech. I-Sem

L T P C 0 0 6 3

Pre Requisites: NIL

Course Objectives:

- 1. To create awareness among the students about the characteristics of several domain areas where Chemical Engineering applications can be effectively used.
- 2. To enable students to use all the concepts of Chemical Engineering in selecting a problem.
- 3. To improve the team building, communication and management skills of the students.

Course Outcomes:

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

- 1. Explain the importance of the proposed problem and the challenges faced due to that in the current scenario in industries.
- 2. Propose research question and present them in a clear and distinct manner through different sources using oral, written and design techniques.
- 3. Propose the various problem solving methodologies and discuss the time-plans and strategies in using those methods.
- 4. Compare and contrast the several existing solutions and explain in detail about the proposed solving technique.
- 5. Evaluate and comment on other student's research questions and their project proposals.

AI & ML IN CHEMICAL ENGINEERING (Professional Elective – V)

IV Year B. Tech. II- Sem

Pre Requisites: NIL

Course outcomes:

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

CO1: Able to understand Artificial Intelligence (AI) principles to Chemical EngineeringCO2: Able to understand Machine Learning (ML) principles to Chemical EngineeringCO3: Able to understand the principle of Game TheoryCO4: Able to use Probability and Bays' Theorem to real problemsCO5: Able to use search techniques

L T P C 3 0 0 3

UNIT-I

Introduction to Artificial Intelligence and Problem-Solving Agent: Problems of AI, AI technique, Tic – Tac – Toe problem. Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal-based agents, utility-based agents, learning agents. Defining the problem as state space search, production system, problem characteristics, and issues in the design of search programs.

UNIT - II

Search Techniques: Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. Heuristic search strategies Greedy best -first search, A* search, AO* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search

UNIT - III

Constraint Satisfaction Problems and Game Theory: Local search for constraint satisfaction problems. Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening

UNIT - IV

Knowledge & Reasoning: Statistical Reasoning: Probability and Bays' Theorem, Certainty Factors and Rule-Base Systems, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic. AI for knowledge representation, rule-based knowledge representation, procedural and declarative knowledge, Logic programming, Forward and backward reasoning

UNIT - V

Introduction to Machine Learning: Exploring sub-discipline of AI: Machine Learning, Supervised learning, Unsupervised learning, Reinforcement learning, Classification problems, Regression problems, Clustering problems, Introduction to neural networks and deep learning.

Textbooks:

- 1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Third Edition, 2015.
- 2. Nils J. Nilsson, "Artificial Intelligence: A New Synthesis", 1st Edition, Morgan-Kaufmann, 1998.

Reference Books:

- 1. Elaine Rich, Kevin Knight, & Shivashankar B Nair, "Artificial Intelligence", McGraw Hill, 3rd ed.,2017.
- 2. Patterson, "Introduction to Artificial Intelligence & Expert Systems", Pearson, 1st ed. 2015.
- 3. Saroj Kaushik, "Logic & Prolog Programming", New Age International, Ist edition, 2002.
- 4. Joseph C. Giarratano, Gary D. Riley, "Expert Systems: Principles and Programming", 4th Edition, 2007.

PHARMACEUTICAL TECHNOLOGY (Professional Elective – V)

IV Year B. Tech. II- Sem

Pre Requisites: NIL

Course Objectives:

- 1. To provide knowledge on various grades of chemicals and sources of impurities.
- 2. To provide the basic knowledge of principles involved in the identification and estimation of pharmaceutical substances.
- 3. To provide the basic knowledge on pharmaceutical unit operations and manufacturing processes.

Course Outcomes:

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

L T P C 3 0 0 3

- 1. Understand the knowledge of base chemicals and drug intermediates.
- 2. Describe the preparation and their properties of various pharmaceuticals and fine chemicals.
- 3. Describe the properties and uses of some pharmaceuticals with flow sheets.
- 4. Draw flow sheets for manufacture of fine chemicals with their properties and uses.

UNIT- I

A brief outline of grades of chemicals, sources of impurities in chemicals, principles (without going into details of individual chemicals) of limit test for arsenic, lead, iron, chloride and sulfate in Pharmaceuticals.

UNIT- II

Outlines of Preparation, properties, uses and testing of the following Pharmaceuticals - sulfacetamide, paracetamol, riboflavin, nicotinamide,

Outlines of Preparation, properties, uses and testing of the following fine chemicals - Methyl orange, fluorescence, procaine hydrochloride, paramino salicylic acid, isonicatinic acid hydrazide.

UNIT-III

Manufacture with flow sheets, properties, uses and testing of the following Pharmaceuticals – aspirin, penicillin, calcium gluconate.

UNIT-IV

Manufacture with flow sheets, properties, uses and testing of the following ferric ammonium citrate, pthallic anhydride and phenol flourobenzene process and benzene sulfate process, other processes in outline only.

UNIT- V

Tablet making and coating, granulation equipments, Preparation of capsules, extraction of crude drugs. Sterilization: introduction, risk factor, methods of sterilization, heat (dry and moist), heating with bactericide, filtration, gaseous sterilization and radiation sterilization, suitable example to be discussed.

Text Books:

1. Remington's Pharmaceutical Science, 16th ed, Mac publishing company, 1980.

2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley & Sons, 1965.

Reference Books:

1. Blently's Text Book of Pharmaceutical Chemistry, 8th ed, H A Rawlins,

- 2. B Tindell and Box, Oxford University Press, London, 1977.
- 5. Understand tablet making and coating, preparation of capsules and extraction of crude drugs.

FOOD PROCESSING TECHNOLOGY (Professional Elective – V)

IV Year B.Tech. II-Sem

L T PC 3 0 0 3

Pre Requisites: Mechanical Operations, Fluid Mechanics, Process Heat Transfer, Material and Energy Balance Computations.

Course Objectives:

- 1. To impart knowledge to the students about food processing and various unit operations involved in it.
- 2. To learn about the principles, equipment of food processing and methods that affect the quality of food products.
- 3. Aim to learn the difference between microwave and conventional heating.

Course Outcomes:

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

- 1. Interpret the material and energy balances in food engineering processes.
- 2. Understanding the various causes of food deterioration and food poisoning.
- 3. Compare microwave versus conventional heating.
- 4. Learn chemical unit operations involved in food processing.
- 5. Analyze product quality and effect of processing technique on it and identify appropriate processing, preservation, and packaging methods.

UNIT- I

Food process engineering - Fundamentals: Fundamentals of food process engineering, application of quantitative methods of material and energy balances in food engineering practices.

UNIT- II

Unit Operations in food industries: Fluid flow, thermal process calculations, refrigeration, evaporation and dehydration operations in food processing.

UNIT-III

Microwave heating: Theory of microwave heating, microwave properties of foods, comparison of microwave and conventional heating, benefits of microwave heating, applications in food processing, microwave heating equipment, hazards of microwave heating.

UNIT-IV

Mechanical Operations in food processing: Conversion operations, Size reduction and screening of solids, mixing and emulsification, filtration and membrane separation, centrifugation, crystallization, extraction.

UNIT- V

Preservation operations: Preservation methods & Strategies, Thermal Methods, Nabla Factor Sterilization Types Pasteurization Dehydro freezing Irradiation Dosimetry Transport of food & Preservation strategies Cheap and applicable everywhere.

Text Books:

- 1. R. T. Toledo, "Fundamentals of Food Process Engineering", AVI Publishing Co., 1980.
- 2. P. G. Smith, "Introduction to Food Process Engineering", Springer 2003.
- 3. R. Angold, G. Beech and J. Taggart, "Food Biotechnology", Cambridge University Press, 1989.

Reference Books:

- 1. J. M. Jackson and B. M. Shinn, "Fundamentals of Food Canning Technology", AVI Publishing Co., 1978.
- 2. J. G. Bernnan, J. R. Butters, N. D. Cowell and A. E. V. Lilley, "Food Engineering Operations", 2ndEdn., Applied Science, 1976.
- 3. Fundamentals of Food Engineering, D G Rao, PHI, New Delhi, 2012.

MEMBRANE TECHNOLOGY (Professional Elective – VI)

IV Year B.Tech. II-Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. Explain the basic principles of membrane separation processes.
- 2. Describe about the characterization of membrane.
- 3. Introduce the concepts of polarization, fouling, module and process design
- 4. Review the membrane modules used for the industrial applications
- 5. Discuss the preparation of synthetic membranes

Course Outcomes:

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

1. Explain various types of membranes and preparation techniques.

- 2. Understand the characterization and transport in membranes.
- 3. Understand the underlined principles and importance of ultrafiltration, reverse osmosis, electro dialysis, nano filtration etc., in industrial waste water treatment.
- 4. Learn gas separation in porous and non-porous membranes.
- 5. Design membranes for intended application

UNIT- I

Introduction: Separation processes, Introduction to membrane processes, definition of a membrane, classification of membranes. Preparation of Synthetic membranes: Types of Membrane materials, preparation of Synthetic membranes, phase inversion membranes, preparation technique for immersion precipitation, and preparation technique for composite membranes.

UNIT-II

Characterization of membranes; Introduction, membrane characterization, characterization of porous membranes, characterization of non-porous membranes.

Transport in membranes: introduction, driving forces, non-equilibrium thermodynamics, transport through porous, non-porous, and ion exchange membranes.

UNIT-III

Membrane Processes: Introduction, Osmosis, pressure driven membrane processes: Introduction, microfiltration, membranes for microfiltration, industrial applications, ultrafiltration: membranes for ultrafiltration, industrial applications, reverse Osmosis and nanofiltration: membranes for reverse osmosis and nanofiltration, industrial applications, Electrically Driven processes: Introduction, electrodialysis, Process parameters, membranes for electrodialysis, applications, Membrane electrolysis, Bipolar membranes, Fuel Cells.

UNIT-IV

Concentration driven membrane processes: gas separation: gas separation in porous and non-porous membranes, membranes for gas separation, applications, pervaporation, membranes for pervaporation, applications, dialysis: membranes for dialysis, applications, liquid membranes: aspects, liquid membrane development, choice of the organic solvent and carrier, applications, introduction to membrane reactors.

UNIT- V

Polarization phenomenon and fouling: Introduction to concentration polarization, turbulence promoters, pressure drop, gel layer model osmotic pressure model, boundary layer resistance model, concentration polarization in diffusive membrane separations and electro dialysis, membrane fouling, methods to reduce fouling, compaction. Module and process design: Introduction, plate and frame module, spiral wound module, tubular module, capillary module, hollow fiber module, comparison of module configurations.

Text Books:

- 1. Membrane Separations, M.H.V. Mulder, Springer Publications, 2007
- 2. Rate-Controlled Separations, P. C. Wanket, Elsevier AppliedScience, London, 1994.

Reference Books:

- 1. Membrane Technology in the Chemical Industry, S.P. Nunes, K.V. Peinemann, Wiley-VCH
- 2. Membrane Processes in Separation and Purification, J.G.Crespo, K.W.Bodekes, Kluwer Academic Publications.
- 3. Membrane Separation Processes, K. Nath, PHI Pvt. Ltd., New Delhi, 2008.

INDUSTRIAL SAFETY AND HAZARD MANAGEMENT (Professional Elective – VI)

IV Year B.Tech. II-Sem

L T P C 3 0 0 3

Pre Requisites: NIL

Course Objectives:

- 1. To describe awareness of different hazards in process industries
- 2. To show classification of hazards and their identifications
- 3. To demonstrate precautions in chemical storage and handling

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

- 1. Illustrate the history accidents and priority towards safety.
- 2. Categorize hazards in industries
- 3. Prepare material safety and data sheet
- 4. Practice HAZOP, Fault tree analysis and other loss prevention techniques.
- 5. Devise and design safety equipments in a planned manner

UNIT- I

Introduction, Factors Contributing to the Costs of Accidents, List of some Notable accidents in the process industry/selected case histories, some common features of high cost accidents, reasons for high priority towards safety.

UNIT- II

Material hazards1: Introduction Hazardous substances-categories, Toxicity, Radiation, Flammability, Ignition, Fires and explosions.

UNIT-III

Material hazards 2: Fire balls, Fire damage, run away chemical reaction, incompatible materials, material safety and data sheets

Process and plant Hazards: Hazards of pressure, causes of over pressures, flow deviations, effects of leakages/releases, hazards of temperatures.

UNIT-IV

Hazard analysis: process safety management, process hazards analysis, hazards analysis methods, check list, preliminary hazard analysis, what-if / check list, hazard and operability analysis, FMEA, Fault tree analysis, cause and consequence analysis.

UNIT- V

Preventive and protective measures: Safety options, process safety approaches, inherent safety and design, plant layout, inherent security, explosion prevention and protection, personal protective systems, plant modifications and management change, relief valves and rupture discs, breather vents for storage tanks, explosions vents, flame arresters, flare systems

Text Books:

- 1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014
- 2. Chemical process Safety by Crowl

Reference Books:

1. Chemical process safety by Sanders

FUEL CELL TECHNOLOGY (Professional Elective – VI)

IV Year B. Tech. II- Sem

L T P C 3 0 0 3

Pre Requisites: Hydrogen energy and fuel cells

Course Objectives:

- 1. To describe how to produce, store, use hydrogen and show the difficulties.
- 2. To present hydrogen applications especially fuel cells.
- 3. To describe working principle of fuel cell.
- 4. To describe manufacture and working principle of SOFC

Course Outcomes:

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

- 1. Learn working principle of fuel cells.
- 2. Understand the hydrogen production and storage methods.
- 3. Select the suitable materials for electrode, membrane for fuel cells.
- 4. Be familiar with fuel cell types and their applications.
- 5. Design and stack making process.

UNIT- I

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

UNIT- II

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others, liquid hydrogen and compressed hydrogen-metal hydrides, alkaline fuel cell.

UNIT-III

Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents, current density, power density, potential and thermodynamics of fuel cell, Introduction to direct methanol fuel cell.

Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

UNIT-IV

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling.

UNIT- V

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO₂ and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal, Using renewable fuels for SOFCs.

Text Books:

- 1. Hoogers G., Fuel Cell Technology Hand Book, CRC Press, 2003.
- 2. Karl Kordesch & Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.

Reference Books:

- 1. F. Barbir, PEM Fuel Cells: Theory and Practice, 2nd Ed., Elsevier/Academic Press, 2013.
- 2. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, 2003.
- 3. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY 2006.

4. Fuel cells for automotive applications –professional engineering publishing UK.

SAFETY IN INDUSTRIES (Open Elective – III)

IV Year B.Tech. II-Sem

L T P C 3 0 0 3

UNIT-I

Safety in construction industry: Safety precautions in- Excavation work, Drilling, Loading & Blasting, Crusher plants. Hazards and control measures in water works.

UNIT-II

Safety in construction industry: Precautions prior to demolition and during demolition in construction industry, Dust hazards, Ergonomic aspects in construction work. Duties of safety officer in construction industry. Hazards in construction industry while working at heights and fall protection measures.

UNIT-III

Safety in chemical industry: Dow index, computation of fire and explosion index as per Dow index,

work permit system in industry, Static electricity- prevention and control, Run away reactions and their prevention, types of PPE.

Safety in chemical industry: Risk assessment methods in chemical industry, fire and explosion hazards in pharmaceutical industry - 'prevention and control measures, hazards in exothermic chemical reactions, role of a safety officer in chemical industry.

UNIT-IV

Electrical Industries- Electricity, its usefulness and hazards, statutory provisions, Indian standards, Effects of electrical parameters on human body.

Electrical Industries: Safety measures for electric work, Overload and other protections, Energy conservation and safety. Electrical work in hazardous atmosphere, Static electricity.

UNIT-V

Safety in engineering industry- Need of safety in engineering industry, general health hazards and control measures in engineering industry.

References:

- 1. "Accident Prevention Manual" NSC, Chicago, 1982.
- 2. "Occupational safety Manual" BHEL, Trichy, 1988.
- 3. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
- 4. "Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996.

PROJECT STAGE – II INCLUDING SEMINAR

IV Year B. Tech. II- Sem

L T P C 0 0 22 11

Pre Requisites: NIL

Course Objectives:

- 1. Explain about the proposed problem in the relevant field with more details.
- 2. Describe the solution for the proposed problem effectively.
- 3. Improve them in solving various problems in the relevant field similar to their problem.
- 4. The prime objective of this course is to make students become effective communicators and enhance their presentational and creative abilities.
- 5. Enhance the technical knowledge of the selected topics.

Course Outcomes:

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

- 1. Explain the various simulation methods or process techniques involved in solving the problem.
- 2. Interpret the results and explain them elaborately with effective techniques.
- 3. Explain in detail the duration and time-plan for solving the problem.
- 4. Analyse the results by comparing with results from literature.
- 5. Prepare the project report in well-defined manner.
- 6. Students will be able to show competence in identifying relevant information, defining and explaining the topics under discussion.
- 7. Able to evaluate information and use and apply relevant theories concerned to the chosen topic.
- 8. Able to use conventional and modern methods of presentation techniques to support the presentation / topic.
- 9. Develop presentation skills and confidently face the audience.
- 10. Respond to a range of questions posed and take part in the discussions fruitfully.
- 11. Recognize and demonstrate effective oral and written formats.