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

COURSE STRUCTURE & SYLLABUS (R-21)
(w.e.f. 2021-2022 batch onwards)

DEPARTMENT OF CHEMICAL ENGINEEERING
JNTUH COLLEGE OF ENGINEERING HYDERABAD
(Autonomous)
Kukapally, Hyderabad-085

JNTUH COLLEGE OF ENGINEERING HYDERABAD
(AUTONOMOUS)
B.TECH. FOUR YEAR DEGREE COURSE
(CHEMICAL ENGINEEERING)
COURSE STRUCTURE (R-21)

I Year **I Semester**

S. No.	Course Code	Course Title	L	T	P	Credits
1	BSC	Matrix Algebra and Calculus	3	1	0	4
2	BSC	Engineering Physics	3	1	0	4
3	ESC	Programming for Problem Solving	3	0	0	3
4	ESC	Engineering Graphics	1	0	3	2.5
5	BSC -LC	Engineering Physics Lab	0	0	3	1.5
6	ESC -LC	Programming for Problem Solving Lab	0	0	3	1.5
		Total Credits				**16.5**

I Year **II Semester**

S. No.	Course Code	Course Title	L	T	P	Credits
1	BSC	Applied and Multi Variable Calculus	3	1	0	4
2	BSC	Engineering Chemistry	3	1	0	4
3	ESC	Classical Mechanics	3	1	0	4
4	HSMC	English	2	0	0	2
5	BSC -LC	Engineering Chemistry Lab	0	0	2	1
6	ESC-L	Engineering Workshop Practice	0	0	3	1.5
7	HSMC-LC	English Language & Communication Skills Lab	0	0	2	1
8	ESC	Applied Python Programming Lab	0	1	2	2
		Total Credits				**19.5**

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II YEAR **I SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1	BSC	Probability Distributions and Complex Variables	3	1	0	4
2	PCC	Material and Energy Balance Computations	2	1	0	3
3	PCC	Chemical Engineering Fluid Mechanics	3	1	0	4
4	BSC	Physical and Analytical Chemistry	3	0	0	3
5	ESC	Basic Electrical Engineering	3	0	0	3
6	PCC	Fluid Mechanics Lab	0	0	3	1.5
7	BSC	Physical and Analytical Chemistry Lab	0	0	3	1.5
8	ESC	Basic Electrical Engineering Lab	0	0	2	1
9	*MC	Environmental Science	2	0	0	0
		Total Credits				**21**

II YEAR **II SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1	PCC	Chemical Engineering Thermodynamics-I	3	0	0	3
2	PCC	Mechanical Operations	3	1	0	4
3	PCC	Process Heat Transfer	3	1	0	4
4	HSMC	Management Fundamentals for Engineers	3	0	0	3
5	BSC	Organic Chemistry	3	0	0	3
6	PCC	Mechanical Operations Lab	0	0	3	1.5
7	PCC	Process Heat Transfer Lab	0	0	3	1.5
8	BSC	Organic Chemistry Lab	0	0	2	1
9	*MC	Constitution of India	2	0	0	0
		Total Credits				**21**

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COURSE STRUCTURE (R-21)

III YEAR **I SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1	PE-1	Professional Elective – I	3	0	0	3
2	PCC	Mass Transfer Operations-I	3	0	0	3
3	PCC	Chemical Reaction Engineering-I	3	0	0	3
4	PCC	Instrumentation and Process Control	3	0	0	3
5	PCC	Chemical Engineering Thermodynamics-II	3	0	0	3
6	PCC	Chemical Technology	3	0	0	3
7	PCC	Instrumentation and Process Control Lab	0	0	3	1.5
8	PCC	Chemical Technology Lab	0	0	3	1.5
9	HSMC	Advanced English Communications Skills Lab	0	0	2	1
10	*MC	Introduction to Artificial Intelligence	2	0	0	0
Total Credits						**22**

Professional Elective – I

i) Petroleum Refining and Petrochemicals ii) Energy Engineering
iii) Basics of Nanotechnology

III YEAR **II SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1	OE-I	Open Elective – I	3	0	0	3
2	PE-II	Professional Elective – II	3	0	0	3
3	PCC	Computational Methods in Chemical Engineering	3	1	0	4
4	PCC	Mass Transfer Operations-II	3	1	0	4
5	PCC	Chemical Reaction Engineering-II	3	1	0	4
6	PCC	Computational Methods Lab	0	0	2	1
7	PCC	Mass Transfer Operations Lab	0	0	3	1.5
8	PCC	Chemical Reaction Engineering Lab	0	0	3	1.5
9	*MC	Introduction to Cyber security	2	0	0	0
Total Credits						**22**

Note: * MC- Mandatory Course (Non-credit course)

Open Elective-I:

1. Solid Waste Management

Professional Elective – II

i) Interfacial and Colloidal Science
ii) Process Modeling & Simulation
iii) Polymer Science and Engineering

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COURSE STRUCTURE

IV YEAR **I SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1	OE - II	Open Elective – II	3	0	0	3
2	PE-III	Professional Elective – III	3	0	0	3
3	PE-IV	Professional Elective - IV	3	0	0	3
4	PCC	Chemical Engineering Plant Design and Economics	2	0	0	2
5	PCC	Transport Phenomena	3	0	0	3
6	PCC	Process Equipment Design Lab	0	0	2	1
7	MINI PROJ	Industry Oriented Mini Project / Industrial Training	0	0	4	2
8	Seminar	Seminar	0	0	2	1
9	Proj-I	Major Project (Phase-I)	0	0	0	3
Total Credits						**21**

Open Elective-II:

1. Industrial Pollution Prevention & Control

Professional Elective – III

i) Biochemical Engineering
i) Industrial Pollution Control Engineering
ii) Fluidization Engineering

Professional Elective - IV

i) Computational Fluid Dynamics
ii) Nuclear Engineering
iii) Process Intensification

IV YEAR **II SEMESTER**

S. No.	Course Code	Course Title	L	T	P	Credits
1	OE - III	Open Elective – III	3	0	0	3
2	PE-V	Professional Elective – V	3	0	0	3
3	PE-VI	Professional Elective – VI	3	0	0	3
4	Proj-II	Major Project (Phase-II)	0	0	16	8
Total Credits						**17**

Open Elective-III:

1. Industrial Process Safety

Professional Elective – V

i) Optimization of Chemical Processes
ii) Technology of Pharmaceuticals and fine chemicals
iii) Food Processing Technology

Professional Elective – VI

i) Membrane Technology
ii) Industrial Safety Hazard Management iii) Design & Analysis of Experiments

B.Tech. Minor Program – Chemical Engineering

S. No.	Year/ Semester	Course Code	Course Title	L	T	P	Credits
1	III/I	CHM01	Introduction to Unit Operations and Process Calculations	3	0	0	3
2	III/I	CHM02	Fluid Mechanics and Heat Transfer	3	0	0	3
3	III/II	CHM03	Chemical Engineering Thermodynamics	3	0	0	3
4	IV/I	CHM04	Chemical Reaction Engineering	3	0	0	3
5	IV/I	CHM05	Chemical Reaction Engineering Lab	0	0	3	1.5
6	IV/II	CHM06	Process Dynamics and Control	3	0	0	3
7	IV/II	CHM06	Process Dynamics and Control Lab	0	0	3	1.5
Total Credits							**18**

B. Tech. Honor's Program - Chemical Engineering

S. No.	Year/ Semester	Course Code	Course Title	L	T	P	Credits
1	III/I	CHH101	Advanced Thermodynamics	3	0	0	3
2	III/I	CHH102	Advanced Process Heat Transfer	3	0	0	3
3	III/II	CHH103	Advanced Reaction Engineering	3	0	0	3
4	III/II	CHH104	Advanced Reaction Engineering Lab	0	0	2	1
5	IV/I	CHH105	Process Modeling & Simulation	3	0	0	3
6	IV/I	CHH106	Advanced Separation Processes	3	0	0	3
7	IV/I	CHH107	Advanced Separation Processes Lab	0	0	2	1
8	IV/II	CHH108	Advanced Transport Phenomena	3	0	0	3
Total Credits							**20**

MATRIX ALGEBRA AND CALCULUS

I Year B. Tech. I- Sem

L	T	P	C
3	1	0	4

Pre-requisites: Mathematical Knowledge of 12th / Intermediate 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
- Methods of solving the differential equations of first and higher order.
- 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.

UNIT-I: Matrices

Matrices: Rank of a matrix: Echelon form, Normal form, System of linear equations: solving system of Homogeneous and Non-Homogeneous equations, Gauss-elimination method, LU Decomposition method.

Linear Transformation and Orthogonal Transformation: Eigenvalues and Eigenvectors and their properties, Eigenvalues and Eigenvectors of Symmetric, Hermitian, Skew-Symmetric, Skew-Hermitian, Orthogonal and Unitary matrices.

UNIT-II: Diagonalization of a Matrix

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: Mean value theorems and Beta, Gamma functions

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. (All theorems without proof).

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.

UNIT-IV: First Order ODE

Exact differential equations, converting non-exact equations to exact equations, Linear and Bernoulli's differential equations. Applications: Newton's law of cooling, Law of natural growth and decay, orthogonal trajectories and electrical circuits. First order equations with higher degree: solvable for the differential coefficient, dependent variable and Independent variable.

UNIT-V: Ordinary Linear 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: Bending of beams, Electrical circuits and simple harmonic motion.

Text Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley &Sons,2006.

References

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint, 2002.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, LaxmiPublications, Reprint, 2008.
3. RamanaB.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi,11thReprint, 2010.

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 Eigenvectors
- Reduce the quadratic form to canonical form using orthogonal transformations.
- 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
- Solve the applications on the mean value theorems.
- Evaluate the improper integrals using Beta and Gamma functions

ENGINEERING PHYSICS

I Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Course Objectives:

The course enables the students to understand:

1. Fundamental properties of free, damped and forced harmonic oscillators.
2. The concepts of wave optics for the exploration of inference, diffraction and polarization.
3. Lasing action and study various types of lasers and to learn fundamental principles of Optical fibres.
4. The concepts of various theories of solids and the classification of materials into three groups.
5. Principles, fabrication and characterization of nanomaterials.

UNIT-I: OSCILLATIONS & WAVES

Oscillations: Introduction, Oscillations-Simple harmonic oscillations, Simple harmonic motion–Energy function, Simple harmonic Motion-Equation, Oscillations of a spring, Torsional pendulum, Projection of a uniform circular motion, Combination of simple harmonic motions, damped harmonic motion, Forced oscillations, Resonance.

Waves: Mechanical waves and types of waves, travelling wave equation, Wave speed –Dimensional method, Wave Speed-Mechanical method, Power and intensity of a wave, Standing waves, Waves in String-Laws of transverse vibration, Verification of laws of transverse vibration-Sonometer, Melde's apparatus.

UNIT-II: OPTICS

Interference and Diffraction: Introduction, Huygen's principle, Superposition of waves, Interference of light by wave front splitting- Young's double slit experiment, Amplitude splitting-Newton's rings, Fresnel and Fraunhofer diffractions, Fraunhofer diffraction at a single slit and double slit, Diffraction grating.

Polarization: Introduction to polarization, Polarized and unpolarised light, Types of polarization: Plane polarized, circularly polarized and Elliptically polarized light, Polarizer and Analyser: Production and Detection of linearly polarized light, Malus law.

UNIT-III: LASERS AND FIBRE OPTICS

Lasers: Introduction, Laser Beam Characteristics, Interaction of light with matter and the three Quantum Processes, Einstein Coefficients and their relations, Light Amplification, Components of Laser, three requirements for Lasing Action, Pumping Methods, Types of Lasers: Ruby Laser, He-Ne Laser, Semiconductor Laser, Applications of laser.

Fibre Optics: Introduction to Optical Fibre, Total Internal Reflection, Construction of optical fibre, Acceptance angle - Numerical Aperture, Classification based on materials, Refractive index profile and mode propagation, Losses in Optical Fibre, Fibre Optic Communication System, Merits of Optical Fibres, Applications.

UNIT-IV: ELECTRON THEORY OF SOLIDS

Classical and Quantum theories: Introduction, Free electron theory of metals, Classical and quantum free electron theory, Estimation of Fermi energy, Dependence of Fermi level on temperature, Density of states

Band theory of solids: Bloch's theorem, Kronig – Penny model, E-K diagram, Effective mass of electron, Origin of energy bands, Classification of materials on the basis of energy bands.

UNIT-V: NANOMATERIALS

Introduction, nanoscale, Quantum confinement, Surface to volume ratio, Bottom-up Fabrication: Sol-Gel, Precipitation, Combustion Methods, Top-Down Fabrication: Chemical Vapor Deposition, Physical Vapor Deposition, Characterization Techniques: XRD, SEM &TEM, Applications of nanomaterials.

Text Books:

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick- Wiley publications.
2. A textbook of Engineering Physics, Dr. M.N. Avadhanulu, Dr. P.G Kshirsagar – S.Chand.
3. Engineering Physics, R.K. Gaur - S.L.Gupta, Dhanpat Rai & Sons

References:

1. Introduction to Solid State Physics by Charles Kittel, Wiley student edition.
2. Ajoy Ghatak, "Optics", Mc Graw-Hill Education, 2012.
3. Applied Physics by P.K.Mittal, I.K.International.
4. Introduction to Nanotechnology, Charles P.Pode, Jr.Frank J.Owens, Wiley-India Edition.

Course Outcomes:

The student should be able to gain knowledge on:

1. Formulation of differential equations that describe the behaviour of oscillators under various conditions.
2. The Principle of optical phenomenon like interference, diffraction and polarization of light.
3. Various types of lasers and transmission characteristics of fibre optics.
4. Classical, Quantum and band theories on electrical behavior of solids and their classifications.
5. Origin, fabrication and characterization of nanomaterials.

PROGRAMMING FOR PROBLEM SOLVING

I Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Course Objectives:

1. To learn the fundamentals of computers.
2. To understand the various steps in Program development.
3. To learn the syntax and semantics of C Programming Language.
4. To learn the usage of structured programming approach in solving problems.

UNIT-I:

INTRODUCTION TO COMPUTERS – Computer Systems, Computing Environments, Computer Languages, Creating and running programs, Software Development Method, Algorithms, Pseudo code, flow charts, applying the software development method.

INTRODUCTION TO C LANGUAGE – Background, Simple C programs, Identifiers, Basic data types, Variables, Constants, Input / Output, Operators. Expressions, Precedence and Associatively, Expression Evaluation, Type conversions, Bit wise operators, Statements, Simple C Programming examples.

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, Simple C Programming examples.

DESIGNING STRUCTURED PROGRAMS- Functions, basics, user defined functions, inter function communication, Scope, Storage classes-auto, register, static, extern, scope rules, type qualifiers, recursion- recursive functions, Preprocessor commands, example C programs

UNIT-III:

ARRAYS AND STRINGS – Concepts, using arrays in C, inter function communication, array applications, two – dimensional arrays, multidimensional arrays, C program examples. Concepts, C Strings, String Input / Output functions, arrays of strings, string manipulation functions, string / data conversion, C program examples.

UNIT-IV:

POINTERS – Introduction (Basic Concepts), Pointers for inter function communication, pointers to pointers, compatibility, memory allocation functions, array of pointers, programming applications, pointers to void, pointers to functions, command –line arguments.

INPUT AND OUTPUT – Concept of a file, streams, standard input / output functions, formatted input / output functions, text files and binary files, file input / output operations, file status functions (error handling), C program examples.

UNIT-V:

DERIVED TYPES – Structures – Declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self-referential structures, unions, typedef, bit fields, enumerated types, C programming examples.

SORTING AND SEARCHING – Selection sort, Bubble sort, Insertion sort, Linear search and Binary search methods.

Textbooks:

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, Pearson Education.
3. The C Programming Language, B.W. Kernighan and Dennis M.Ritchie, PHI/Pearson Education

References:

1. C for Engineers and Scientists, H.Cheng, Mc.Graw-Hill International Edition
2. Data Structures using C – A. M.Tanenbaum, Y.Langsam, and M.J. Augenstein, Pearson Education / PHI
3. C Programming & Data Structures, P. Dey, M Ghosh R Thereja, Oxford University Press

Course Outcomes

1. Write algorithms and to draw flowcharts for solving problems.
2. Translate the algorithms/flowcharts to programs (in C language).
3. Code and test a given logic in C programming language.
4. Formulate simple algorithms for arithmetic and logical problems.
5. Decompose a problem into functions and to develop modular reusable code.
6. Use arrays, pointers, strings and structures to formulate algorithms and programs.
7. Searching and sorting problems.

ENGINEERING GRAPHICS

I Year B.Tech. I-Sem

L	T	P	C
1	0	3	2.5

Pre-requisites: Nil

Course objectives:

- To provide basic concepts in engineering drawing
- To impart knowledge about standard principles of orthographic projection of objects
- To draw sectional views and pictorial views of solids

UNIT–I:

INTRODUCTION TO ENGINEERING DRAWING:

Principles of Engineering Graphics and their Significance, Conic Sections including the Rectangular Hyperbola – General method only. Cycloid, Epicycloid and Hypocycloid, Involute. Scales – Plain, Diagonal and Vernier Scales.

UNIT-II:

ORTHOGRAPHIC PROJECTIONS:

Principles of Orthographic Projections – Conventions – Projections of Points and Lines, Projections of Plane regular geometric figures. —Auxiliary Planes.

UNIT–III:

Projections of Regular Solids – Auxiliary Views.

UNIT–IV:

Sections or Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views – Sections of Sphere. Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid and Cone

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 Auto CAD: Basic principles only

Text Books:

1. Engineering Drawing by N.D. Bhatt, Charotar
2. Engineering Drawing and Graphics by Rane and Shah, Pearson Edu.

Reference Books:

1. A Text Book of Engineering Drawing by Dhawan R K, S. Chand
2. Engineering Graphics with Auto CAD by James D Bethune, Pearson Edu.
3. Engineering Graphics by K R Mohan, Dhanpat Rai.
4. Text book on Engineering Drawingby KL Narayana, P Kannaih, Scitech

Course Outcomes:

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

- Prepare working drawings to communicate the ideas and information.
- Read, understand and interpret engineering drawings.

ENGINEERING PHYSICS LAB

I Year B.Tech. I-Sem

L	T	P	C
0	0	3	1.5

Course Objectives:

The course enables the students to understand:

1. The concepts of mechanical waves and their resultant phenomena.
2. The phenomena of interference using Newton's rings and diffraction phenomena using diffraction grating.
3. The electrical resonance using LCR circuit.
4. The band concept of semiconductor diode and light phenomenon of Lasers and Optical fibres.

List of Experiments:

1. Melde's experiment: Determination of the frequency of a vibrating bar or turning fork using Melde's arrangement.
2. Torsional pendulum: Determination of the rigidity modulus of the material of the given wire using torsional pendulum.
3. Newton's rings: Determination of the radius of curvature of the lens by forming Newton's rings.
4. Diffraction grating: Determination of the number of lines per inch of the grating.
5. Dispersive power: Determination of the dispersive power of prism by using spectrometer.
6. Coupled Oscillator: Determination of the spring constant by single coupled oscillator.
7. LCR Circuit: Determination of quality factor and resonant frequency of LCR circuit.
8. LASER: The characteristics of LASER sources.
9. Optical fibre: Determination of the bending losses of Optical fibres.
10. Optical fibre: Determination of the Numerical aperture of a given fibre.
11. Sonometer: Determination of the AC frequency.
12. Energy gap of PN Junction diode: determination energy gap of a semiconductor diode

Note: Any 8 experiments are to be performed by each student

Course Outcomes:

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

1. Understand the mechanical waves concepts and elastic properties.
2. Understand the light phenomena such as interference and diffraction.
3. Confirm the resonance produced by electrical waves.
4. Understand the band gap of semiconductor and certain characteristics of lasers and optical fibres.

PROGRAMMING FOR PROBLEM SOLVING LAB

I Year B.Tech. I-Sem

L	T	P	C
0	0	3	1.5

Course Objectives

1. To learn the fundamentals of computers.
2. To understand the various steps in Program development.
3. To learn the syntax and semantics of C Programming Language.
4. To learn the usage of structured programming approach in solving problems.

Week 1:

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.
3. Write a C program to generate the first n terms of the sequence.
4. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.
5. Write a C program to find the roots of a quadratic equation.

Week 2:

6. Write a C program to find the factorial of a given integer.
7. Write a C program to find the GCD (greatest common divisor) of two given integers.
8. Write a C program to solve Towers of Hanoi problem.
9. 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)

Week 3:

10. Write a C program to find both the largest and smallest number in a list of integers.
11. Write a C program that uses functions to perform the following:
    i) Addition of Two Matrices ii) Multiplication of Two Matrices

Week 4:

12. 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.
13. Write a C program to determine if the given string is a palindrome or not
14. 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.
15. Write a C program to count the lines, words and characters in a given text.

Week 5:

16. Write a C program to generate Pascal's triangle.
17. Write a C program to construct a pyramid of numbers
18. Write a C program to read in two numbers, x and n, and then compute the sum of this geometric progression:
    $1+x+x^2+x^3+\ldots\ldots\ldots\ldots+x^n$
    For example: if n is 3 and x is 5, then the program computes 1+5+25+125.

Print x, n, the sum

Perform error checking.

For example, the formula does not make sense for negative exponents – if n is less than 0.

Have your program print an error message if n<0, then go back and read in the next pair of numbers of without

without computing the sum. Are any values of x also illegal? If so, test for them too.

Week 6:

19. 2's complement of a number is obtained by scanning it from right to left and complementing all the bits after the first appearance of a 1. Thus 2's complement of 11100 is 00100. Write a C program to find the 2's complement of a binary number.
20. Write a C program to convert a Roman numeral to its decimal equivalent.

Week 7:

21. 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.)

Week 8:

22. . 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.)

23. . 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)

Week 9:

24. 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

Week 10:

25. 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

Textbooks:

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, Pearson Education.

3. The C Programming Language, B.W. Kernighan and Dennis M.Ritchie, PHI/Pearson Education

References:

1. C for Engineers and Scientists, H.Cheng, Mc.Graw-Hill International Edition
2. Data Structures using C – A.M.Tanenbaum, Y.Langsam, and M.J. Augenstein, Pearson Education / PHI
3. C Programming & Data Structures, P. Dey, M Ghosh R Thereja, Oxford University Press

Course Outcomes

1. Write algorithms and to draw flowcharts for solving problems.
2. Translate the algorithms/flowcharts to programs (in C language).
3. Code and test a given logic in C programming language.
4. Formulate simple algorithms for arithmetic and logical problems.
5. Decompose a problem into functions and to develop modular reusable code.
6. Use arrays, pointers, strings and structures to formulate algorithms and programs.
7. Searching and sorting problems.

APPLIED AND MULTIVARIABLE CALCULUS

I Year B.Tech. II-Sem

L	T	P	C
3	1	0	4

Pre-requisites: Mathematical Knowledge of 12th / Intermediate level

Objectives: To learn

- Concept, properties of Laplace transforms
- Solving ordinary differential equations using Laplace transforms techniques.
- Partial differentiation, concept of total derivative
- Finding maxima and minima of function of two and three variables.
- Evaluation of multiple integrals and their applications
- 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.

UNIT-I: Laplace transforms:

Laplace Transforms; Laplace Transform of standard functions, first shifting theorem, 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), solving Initial value problems by Laplace Transform method.

UNIT-II: Partial Derivatives and applications

Definitions of Limit and continuity.

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

UNIT-III: Multiple 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), Centre of mass and Gravity (constant and variable densities) by double and triple integrals (applications involving cubes, sphere and rectangular parallel piped).

UNIT-IV: Vector Differentiation

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

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. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley &Sons,2006
3. M Apostol, Calculus vol-2, John Wiley & Sons

References

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint, 2002
2. Paras Ram, Engineering Mathematics, 2nd Edition, CBS Publishes
3. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.

Course Outcomes:

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

- Use the Laplace transforms techniques for solving ODE's.
- Find the extreme values of functions of two variables with/ without constraints.
- Evaluate the multiple integrals and apply the concept to find areas, volumes, centre of mass and gravity for cubes, sphere and rectangular parallel piped
- Evaluate the line, surface and volume integrals and converting them from one to another

ENGINEERING CHEMISTRY

I Year B.Tech. II-Sem

L	T	P	C
3	1	0	4

Course Objectives:

1. To bring adaptability to the concepts of chemistry and to acquire the required skills to become a perfect engineer.
2. To acquire the knowledge of water treatment, electrochemistry and corrosion which are essential for the Engineers and in industry.
3. To acquire the skills pertaining to Polymers and Energy sources to apply them for various engineering fields etc.
4. To impart then knowledge of Engineering materials and their aspects useful for understanding material chemistry.

UNIT-I: Water and its treatment:

Introduction – hardness of water – Causes of hardness. Types of hardness: temporary and permanent. Expression and units of hardness. Estimation of hardness of water by complexometric method. Potable water and its specifications. Steps involved in treatment of water – Disinfection of water by chlorination, breakpoint chlorination, Ozonisation. Boiler troubles - Scale, Sludge, Priming, Foaming and Caustic embrittlement. Treatment of boiler feed water by Calgon conditioning, Phosphate conditioning and Colloidal conditioning. External treatment of water- Ion exchange process. Desalination of water – Reverse osmosis. Numerical problems based on Determination of hardness of water.

UNIT-II: Electrochemistry and corrosion:

Electrochemistry: Electrochemical cells – Cell, Electrode, electrode potential, standard electrode potential, Nernst equation-derivation and significance- Electrochemical series and its applications. Construction and functioning of Calomel, Quinhydrone and glass electrode. Determination of pH of a solution by using quinhydrone and glass electrode. Numerical problems. Potentiometric titrations. Batteries – Primary (Lithium cell) and secondary batteries (Lead – acid storage battery and Lithium ion battery).

Corrosion: Causes and effects of corrosion – Theories of chemical and electrochemical corrosion – mechanism of electrochemical corrosion. Galvanic corrosion, Concentration cell corrosion- water-line and pitting corrosion. Factors affecting rate of corrosion, Corrosion control methods- Cathodic protection – Sacrificial anodic protection and impressed current cathodic methods. Surface coatings – metallic coatings – Methods of coatings - Hot dipping - galvanization, tinning. cementation, electroplating and electroless plating of copper.

UNIT –III: Polymeric materials:

Polymers: Definition, Monomer, functionality and degree of polymerisation. Classification – Types of Polymerisation - Addition & Condensation – Mechanisms of Polymerisation. Plastics: Definition, characteristics - Compounding and fabrication- Methods of Moulding - Thermoplastics and Thermosets – Preparation, properties and applications– PVC, Teflon and Bakelite. Fibres: Definition, Characteristics. Preparation, Properties and applications of Terylene, Nylon 6:6. Elastomers: Definition and characteristics. Natural rubber- structure, processing of latex, Vulcanisation. Preparation, properties and applications of BuNa-S and Butyl rubber. Conducting Polymers- Definition, Classification. Mechanism of conduction in Polyacetylene, Polyaniline & Applications.

Biodegradable polymers - Concept, Synthetic and Natural polymers, Polylactic acid, Poly Vinyl alcohol, Nylon-2 and Nylon – 6. Applications and advantages of biodegradable polymers.

UNIT –IV: Energy sources:

Fuels: Definition, classification with examples. Calorific value. Determination of calorific value by Junker's gas Calorimeter. Characteristics of good fuel. Coal: Types- Analysis of coal- proximate analysis. Petroleum- Refining- Fractional distillation- composition, properties and uses of petrol, diesel and kerosene. Cracking-types, Moving bed catalytic cracking. Knocking - Octane and Cetane rating, Composition, characteristics and uses of LPG, CNG. Biodiesel-Transesterification. Advantages. Hydrogen fuel- Production, storage, advantages and limitations. Combustion - Definition, Calculation of air required for the combustion of fuel, numerical problems related to calorific value and combustion.

UNIT-V: Engineering Materials:

Portland cement: Composition and constituents. Setting and hardening of cement, special cements- properties and uses of High alumina cement, White cement and water proof cement. RCC, Decay of Concrete. Refractories: Classification, Properties - Refractoriness, RUL, Chemical inertness and porosity. Characteristics of a good refractory. Engineering Applications. Failure of a refractory. Lubricants: functions of lubricants, Classification, Mechanism of Lubrication, Properties - Viscosity, Acid value, Flash & Fire point, Cloud & Pour point, Aniline point.

Text Book:

1. Engineering Chemistry – PC Jain and M Jain – Dhanpath Rai and Sons, New Delhi.

Reference Books:

1. Text book of Engineering Chemistry by Ramadevi, Venkata Ramana Reddy & Prashanth Rath, Cengage learning publications.
2. A text book of Engineering Chemistry by Thirumala Chary, Laxminarayana, Shashikala. Pearson Publications.

Course Outcomes:

The basic concepts included in this course will help the student to gain:

1. Differentiate hard and soft water; solve the related problems on water purification and its significance in industry and daily life.
2. Understand the principles, concepts of electrochemistry and causes of corrosion, its consequences and methods to minimize corrosion to improve industrial designs.
3. The required skills to get clear concepts on polymers and energy sources and their applications to various engineering fields etc.
4. The knowledge of engineering materials such as Portland cement, white cement, concrete and lubricants etc.

CLASSICAL MECHANICS

I Year B.Tech. II-Sem

L	T	P	C
3	1	0	4

Course Objectives:

- To understand the resolving forces and moments for a given force system.
- To analyze the types of friction for moving bodies and problems related to friction.
- To determine the centroid and second moment of area

UNIT-I

Introduction to Mechanics: Basic Concepts, system of Forces Coplanar Concurrent Forces - Components in Space -Resultant -Moment of Forces and its Application - Couples and Resultant of Force Systems. Equilibrium of system of Forces: Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems.

UNIT-II:

Friction: Types of friction -Limiting friction -Laws of Friction -static and Dynamic Frictions -Motion of Bodies-Wedge Screw, Screw-jack and differential screw –jack

UNIT-III:

Centroid and Center of Gravity: Introduction – Centroids of lines – Centroids of area - Centroids of Composite figures - Theorem of Pappus -Centre of Gravity of Bodies – Centroids of Volumes – Center of gravity of composite bodies.

UNIT-IV:

Area moments of Inertia: Introduction – Definition of Moment of Inertia -Polar Moment of Inertia – Radius of gyration - Transfer Theorem for moment of inertia – Moments of inertia by integration - Moments of Inertia of Composite Figures, Product of Inertia, Transfer Formula for Product of Inertia.

UNIT-V:

Mass Moment of Inertia: Introduction - Moment of Inertia of Masses – Radius of gyration - Transfer Formula for Mass Moments of Inertia – Mass moments of inertia by integration - Mass moment of inertia of composite bodies.

Text Books:

1. Singer's Engineering Mechanics Statics and Dynamics by K. Vijaya Kumar Reddy and J. Suresh Kumar, BS Publications, 3rd Edition (SI Units) Fifth impression 2013.
2. Engg. Mechanics by Irving Shames, G. Krishna Mohan Rao, Prentice Hall

Reference Books:

1. Engineering Mechanics by Timoshenko & Young
2. Engineering Mechanics by Umesh Regl, Tayal.
3. A text of Engineering Mechanics by YVD Rao, K. Govinda Rajulu, M. Manzoor Hussain, Academic Publishing Company
4. Text Book in Applied Mechanics by Malhotra, Subramanian, Gahlot and Rathore, New Age.
5. Engineering Mechanics by KL Kumar, Tata McGraw Hill.
6. Engineering. Mechanics by M.V. Seshagiri Rao & D Rama Durgaiah.
7. Engineering Mechanics by S.S. Bhavikati & K.G. Rajasekharappa

Course Outcomes:

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

- Resolve forces and moments for a given system.
- Analyze the friction for moving bodies.
- Determine centroid and second moment for a given area of a body.

ENGLISH

I Year B.Tech. II-Sem

L	T	P	C
2	0	0	2

INTRODUCTION

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training students to acquire language skills, the syllabus of English has been designed to develop linguistic, and communicative competencies of Engineering students. In English classes, the focus would be on the skills development in the areas of vocabulary, grammar, reading and writing. For this, the teachers use the prescribed text for detailed study. The students are encouraged to read the texts leading to reading comprehension and different known/unknown passages may be given for practice in the class. The time is utilized for working out the exercises given after each excerpt. Authentic materials of a similar kind, for example, newspaper articles, advertisements, promotional material are used to supplement exercises. *The focus in this syllabus is on skill development in the areas of Vocabulary, Grammar, Reading and Writing Skills and practice of language skills in various contexts.*

LEARNING OBJECTIVES

The course will help students to:

a. Improve the language proficiency of students in English with an emphasis on Vocabulary, Grammar, Reading and Writing skills.
b. Develop study skills and communication skills in formal and informal situations.
c. Equip students to study engineering subjects more effectively and critically using the theoretical and practical components of the syllabus.

Reading Skills

Objectives

1. To develop an awareness in students about the significance of silent reading and comprehension.
2. To develop students' ability to guess meanings of words from the context and grasp the overall message of the text, draw inferences, etc.,
3. To facilitate the students practice the sub-skills of reading viz., Skimming and Scanning the text, Intensive and Extensive Reading, Reading for Pleasure, Identifying the topic sentence, Inferring lexical and contextual meaning, Recognizing Coherence/Sequencing of Sentences.

☛ **NOTE:** *The students will be trained in reading skills using the prescribed texts for detailed study. They will be tested in reading comprehension of different 'unseen' passages which may be taken from authentic texts, such as magazines/newspaper articles.*

Writing Skills

Objectives

1. To bring an awareness in the students about the difference between formal and informal writing
2. To make students understand sentence structures and variations in process writing
3. To develop students' creativity in different disciplines of academic writing

SYLLABUS

The course content / study material is divided into **Five Units.**

Unit –I

Chapter entitled '***Presidential Address' by Dr. A.P.J. Kalam*** from ***"Fluency in English– A Coursebook for Engineering Students"*** published by Orient BlackSwan, Hyderabad

Vocabulary: The Concept of Word Formation -The Use of Prefixes and Suffixes- Collocations

Grammar: Punctuation - Identifying Common Errors in Writing with reference to Articles.

Reading: Reading and its Importance- Techniques for Effective Reading.-

Writing: Sentence Structures -Use of Phrases and Clauses in Sentences- Paragraph Writing - Creating Coherence and Cohesiveness.

Unit –II

Chapter entitled ***Satya Nadella: Email to Employees on his First Day as CEO*** from ***"Fluency in English– A Coursebook for Engineering Students"*** Published by Orient BlackSwan, Hyderabad.

Vocabulary: Synonyms and Antonyms – Homonyms, Homophones and Homographs

Grammar: Identifying Common Errors in Writing with Reference to Noun-Pronoun Agreement – Words with appropriate Prepositions - Phrasal Verbs

Reading: Improving Comprehension Skills – Techniques for Good Comprehension

Writing: Writing Formal Letters **–** Format - Letter of Complaint and Reply - Letter of Requisition and Reply.

Unit –III

Vocabulary: Acquaintance with Phrases from Foreign Languages (Latin/French) with a focus on usage in English

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

Reading: Sub-skills of Reading- Skimming and Scanning.

Writing: Job Application with Resume- Writing Introduction and Conclusion - Essay Writing.

Unit –IV

Chapter entitled **'*Good Manners' by J.C. Hill*** from ***Fluency in English – A Coursebook for Engineering Students"*** published by Orient BlackSwan, Hyderabad

Vocabulary: Standard Abbreviations in English – Idioms – One Word Substitutes

Grammar: Subject-Verb Agreement - Redundancies and Clichés in Oral and Written Communication – Sequence of Tenses.

Reading: Comprehension**-** Intensive Reading and Extensive Reading- Reading Practice – *'If'* by Rudyard Kipling.

Writing: Writing Practices - Information Transfer -Précis Writing.

Unit –V

Chapter entitled ***'Father Dear Father'*** **by Raj Kinger** from ***Fluency in English – A Coursebook for Engineering Students"*** Published by Orient BlackSwan, Hyderabad

Vocabulary: Technical Vocabulary and their Usage – Indian Colloquial Terms

Grammar: Common Errors in English

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**: 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.)

Course Outcomes:

Students will be able to:

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

Prescribed Textbook:

1. ***"Fluency in English – A Coursebook for Engineering Students"*** by Board of Editors**:** Hyderabad: Orient BlackSwan Pvt. Ltd. 2016. Print.

Suggested Reading:

(i) *Practical English Usage.* Michael Swan. OUP. 1995.
(ii) *Remedial English Grammar.* F.T. Wood. Macmillan.2007
(iii) *Contemporary English Grammar Structures and Composition*. David Green. Macmillan. 2010.
(iv) *Communication Skills*. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.

ENGINEERING CHEMISTRY LAB

I Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

I. Volumetric Analysis:

1. Estimation of Ferrous iron by Dichrometry method.
2. Estimation of Ferrous iron by Permanganometry method.
3. Estimation of Hardness of water by EDTA Complexometry method.

II. Conductometry:

1. Estimation of the concentration of an acid by Conductometry.

III. Potentiometry:

1. Estimation of the amount of Fe^{+2} by Potentiomentry.

IV. *p*H Metry:

1. Determination of an acid concentration using *p*H meter.

V. Preparations:

1. Preparation of Bakelite.
2. Preparation Nylon-6.

VI. Lubricants:

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

VII. Corrosion:

1. Determination of rate of corrosion of mild steel in the presence and absence of inhibitor.

Recommended Books:

1. Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications.
2. Laboratory Manual of Engineering Chemistry by Y. Bharathi Kumari & Jyotsna C, VGS Booklinks, Vijayawada, 2009.
3. College Practical Chemistry by V.K. Ahluwalia, Narosa Publications Ltd. New Delhi (2007).
4. Engineering Chemistry Lab Manual by Cengage Publications.

ENGINEERING WORKSHOP PRACTICE

I Year B.Tech. II-Sem

L	T	P	C
0	0	3	1.5

Pre-requisites: Practical skill

Course Objectives: The objectives of this course is to acquire knowledge on the

i. To impart hands-on practice on Carpentry trade and skills.
ii. To impart hands-on practice on Fitting trade and skills
iii. To impart hands-on practice on Black Smithy trade and skills
iv. To impart hands-on practice on House Wiring trade and skills
v. To impart hands-on practice on Tin Smithy trade and skills
vi. To impart hands-on practice on Plumbing trade and skills

Note: At least two exercises to be done from each trade.

A. Carpentry
1. T-Lap Joint
2. Cross Lap Joint
3. Dovetail Joint

B. Fitting
1. Vee Fit
2. Square Fit
3. Half Round Fit

C. Black Smithy
1. Round rod to Square
2. S-Hook
3. Round Rod to Flat Ring

D. House Wiring
1. Parallel / Series Connection of three bulbs
2. Stair Case wiring
3. Florescent Lamp Fitting

E. Tin Smithy
1. Taper Tray
2. Open Scoop
3. Funnel

F. Plumbing
1. Coupling Joint
2. Elbow Joint
3. T Joint

Text Books:

1. Workshop Practice by B.L.Juneja Cengage Learning
2. Elements of Workshop Technology–S. K.Hajra Choudhury and A. K. Hajra Choudhury.

ENGLISH LANGUAGE AND COMMUNICATION SKILLS(ELCS) LAB

I Year B.Tech. II-Sem

L	T	P	C
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.

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 their mother tongue influence
- To train students to use language appropriately for public speaking, group discussions and interviews

Learning 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 approach 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 – Sentence Stress – Intonation.

Practice: Basic Rules of Word Accent - Stress Shift - Weak Forms and Strong Forms- Sentence Stress – 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-the Interference of Mother Tongue (MTI).

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

ICS Lab:

Understand: Descriptions- Narrations- Giving Directions and Guidelines.

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 audio-visual aids with a Public Address System, a T. V. or LCD, a digital stereo –audio & video system and camcorder etc.

Suggested Software:

- Cambridge Advanced Learners' English Dictionary with CD.
- Grammar Made Easy by Darling Kindersley.
- Punctuation Made Easy by Darling Kindersley.
- Oxford Advanced Learner's Compass, 8th Edition.
- 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).

References:

1. Suzanna, R. *A Practical Course in English Pronunciation (with CD).* McGraw Hill Education. 2017. Print.
2. *Exercises in Spoken English*. Part 1, 2 and 3. CIEFL. Oxford University Press, 1997. Print.
3. Hancock, M. *English Pronunciation in Use. Intermediate Cambridge*: Cambridge University Press. 2009. Print.

APPLIED PYTHON PROGRAMMING LAB

I Year B.Tech. II-Sem

L	T	P	C
0	1	2	2

Cycle - 1

1. **Downloading and Installing Python and Modules**

a) **Python 3 on Linux**
Follow the instructions given in the URL https://docs.python-guide.org/starting/install3/linux/

b) **Python 3 on Windows**
Follow the instructions given in the URL https://docs.python.org/3/using/windows.html
(Please remember that Windows installation of Python is harder!)

c) **pip3 on Windows and Linux**
Install the Python package installer by following the instructions given in the URL
https://www.activestate.com/resources/quick-reads/how-to-install-and-use-pip3/

d) **Installing numpy and scipy**
You can install any python3 package using the command pip3 install <packagename>

e) **Installing jupyterlab**
Install from pip using the command pip install jupyterlab

2. **Introduction to Python3**

a) Printing your biodata on the screen
b) Printing all the primes less than a given number
c) Finding all the factors of a number and show whether it is a *perfect* number, i.e., the sum of all its factors (excluding the number itself) is equal to the number itself

3. **Defining and Using Functions**

a) Write a function to read data from a file and display it on the screen
b) Define a boolean function *is palindrome*(<input>)
c) Write a function *collatz(x)* which does the following: if x is odd, $x = 3x + 1$; if x is even, then $x = x/2$. Return the number of steps it takes for $x = 1$
d) Write a function $N(m, s) = exp(-(x-m)^2/(2s^2))/sqrt(2\pi)s$ that computes the Normal distribution

4. **The package** numpy

a) Creating a matrix of given order $m \times n$ containing *random numbers* in the range 1 to 99999
b) Write a program that adds, subtracts and multiplies two matrices. Provide an interface such that, based on the prompt, the function (addition, subtraction, multiplication) should be performed
c) Write a program to solve a system of n linear equations in n variables using matrix inverse

5. **The package** scipy **and** pyplot

a) Finding if two sets of data have the same *mean* value
b) Plotting data read from a file
c) Fitting a function through a set a data points using *polyfit* function
d) Plotting a histogram of a given data set

6. **The** strings **package**

a) Read text from a file and print the number of lines, words and characters
b) Read text from a file and return a list of all n letter words beginning with a vowel
c) Finding a secret message hidden in a paragraph of text
d) Plot a histogram of words according to their length from text read from a file

Cycle -2

7. Installing OS on Raspberry Pi

a) Installation using PiImager

b) Installation using image file

- Downloading an Image
- Writing the image to an SD card
- using Linux
- using Windows
- Booting up

Follow the instructions given in the URL
https://www.raspberrypi.com/documentation/computers/getting-started.html

8. Accessing GPIO pins using Python

a) Installing GPIO Zero library.

First, update your repositories list:

sudo apt update

Then install the package for Python 3:

sudo apt install python3-gpiozero

b) Blinking an LED connected to one of the GPIO pin

c) Adjusting the brightness of an LED

Adjust the brightness of an LED (0 to 100, where 100 means maximum brightness) using the in-built PWM wavelength.

9. Collecting Sensor Data

a) DHT Sensor interface

- Connect the terminals of DHT GPIO pins of Raspberry Pi.
- Import the DHT library using ***import Adafruit_DHT***
- Read sensor data and display it on screen.

PROBABILITY DISTRIBUTIONS AND COMPLEX VARIABLES

II Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

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.

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.

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, Conformal mappings, Mobius transformations and their properties. (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.
3. A first course in complex analysis, D Zill,

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.

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

MATERIAL AND ENERGY BALANCE COMPUTATIONS

II Year B. Tech. I- Sem **L T P C**

2 1 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.

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, gases in chemical reactions.

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.

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, use of humidity charts, adiabatic vaporization.

UNIT- III

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- IV

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.

UNIT- V

Combustion Calculations: Introduction, fuels, calorific value of fuels, coal, liquid fuels, gaseous fuels, air requirement and flue gases, combustion calculations, incomplete combustion, material and energy balances, thermal efficiency calculations

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:

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

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. Developmasteryoverprocesscalculationsrelevanttochemicalengineeringprocesses

CHEMICAL ENGINEERING FLUID MECHANICS

II Year B. Tech. I- Sem

L	T	P	C
3	1	0	4

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.

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.

UNIT- III

Flow of compressible fluids- Definitions and basic equations, Processes of compressible flow, Isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow.

UNIT- IV

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. 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.

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

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).

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.

PHYSICAL AND ANALYTICAL CHEMISTRY

II Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre Requisites: NIL

Course Objectives:

To impart knowledge and importance of chemical kinetics, catalysis and surface Chemistry and certain concepts of analytical Chemistry.

UNIT-I: Chemical Kinetics:

Introduction, Definition: Order, molecularity, Rate, Kinetics of first and second order reaction. Theories of reaction rates – Collision theory and transition state theory. Theory of unimoleculr reactions – Lindemann's theory. Kinetics of Photochemical rections. Chain reation and their characteristics, steady state treatment – dissociation of HI, reaction between H_2 & O_2.

UNIT-II: Catalysis & Surface chemistry

Characteristics of catalysts, Homogeneous and Heterogeneous catalysis. Characteristics of enzyme catalysis – factor affecting rate of enzyme reaction – Michaelis Menten mechanism.

Concept of adsorption, factors influencing adsorption. Adsorption isotherms – Freundlich, Langmuir, B.E.T theory of adsorption equation. Determination of surface area using B.E.T. method. Adsorption of gases on solids – Physisorption and chemisorption, Applications of adsorption.

UNIT-III: Concepts of Analytical Chemistry

Role of analysis – Classification of analytical methods – Classical and Instrumental. Selecting an analytical method – analytical method validation, sensitivity, limit of detection – precision, accuracy. Quantitative analysis – Gravimetry: Precipitation- types of precipitates, impurities, co-precipitation – post precipitation – conditions for precipitation – precipitation from homogeneous solution – Gravimetric determination of Ni.

UNIT-IV: Chromatography: Principle-Types of adsorption – column chromatography – retention time, retention volume, RF value. Thinlayer chromatography-identification of spots by spraying and other methods: Gas Chromatography: Principle-block diagram of gas chromatograph, functions of each component, detectors-(FID, ECD)-Applications – Qualitative analysis, quantitative analysis, retention time, retention volume, capacity factor, area normalization method: HPLC: Principle, block diagram – functions of each component, stationary phases, eluting solvents, pumps, detectors – quantitative applications of HPLC.

UNIT-V: Spectroscopy: Electromagnetic spectrum – Molecular Spectroscopy – UV visible spectroscopy - Introduction – Definitions – absorbance, transmittance, optical density, molar extinction coefficient. Beer – Lambertt's Law – derivation and applications – Concept of Chromophores and auxochromes, bathochromic and hypschromic shifts – selection rules – Instrumentation – Double beam UV – Spectrophotometer – Applications – Quantitative analysis IR - Introduction – Hook's law – Selection rules – Modes of vibrations – Calculation of number of fundamental principle, vibrations – Applications of IR spectra in the identification of > C = 0, $-NH_2$, -COOH, -COOR, $-CONH_2$, -OH.

Text Books:

1. Quantitative analysis, R.A. Day & A.L. Underwood Prentice-Hall of India, Pvt. Ltd.
2. Vogel's Text book of Quantitative chemical analysis, J. Mendham, R.C Denny, J.D. Barnes, M J. K. Thomas, pearson education

Reference Books:

1. Elements of Physical Chemistry – Peter Atkins, Oxford Uni Press
2. Advanced Physical Chemistry – Gurudeep Raj, Goel Publishing house
3. Instrumental Methods of Chemical Analysis, BSP Galen W. Ewing.
4. Essentials of Physical Chemistry – Bahl, Tuli and ArunBahl, S. Chand and Company Ltd.,

Course Outcomes:

The students will acquire knowledge of

1. Concepts of Chemical kinetics, catalysis and surface Chemistry
2. Basic concepts of Analytical Chemistry
3. The student can acquire the knowledge of Chromatography and Spectroscopy

BASIC ELECTRICAL ENGINEERING

II Year B. Tech. I- Sem

L	T	P	C
3	0	0	3

Pre- Requisites:

Course Objectives:

1. To introduce the concepts of electrical circuits and its components.
2. To understand magnetic circuits, DC circuits and AC single phase & three phase circuits.
3. To study and understand the different types of DC/AC machines and Transformers.
4. To import the knowledge of various electrical installations.
5. To introduce the concept of power, power factor and its improvement.

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. Superposition, Thevenin and Norton Theorems.
Time-domain analysis of first-order RL and RC circuits.

UNIT-II

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 consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance in series R-L-C circuit.
Three-phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III

TRANSFORMERS

Ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

UNIT-IV

ELECTRICAL MACHINES

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

UNIT-V

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.

Text Books:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.

Reference Books:

1. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
2. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
3. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

Course Outcomes:

1. To analyze and solve electrical circuits using network laws and theorems.
2. To understand and analyze basic Electric and Magnetic circuits.
3. To study the working principles of Electrical Machines.
4. To introduce components of Low Voltage Electrical Installations.

FLUID MECHANICS LAB

II Year B. Tech. I- Sem

L	T	P	C
0	0	3	1.5

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.

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

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.

PHYSICAL AND ANALYTICAL CHEMISTRY LAB

II Year B.Tech. I-Sem

L	T	P	C
0	0	3	1.5

Pre Requisites: Physical and Analytical Chemistry

Course Objectives:

1. To determine the partition coefficient using adsorption technique.
2. To describe the chemical kinetics for a given reaction.
3. To analyze given sample using various chromatographic and spectroscopic techniques.

List of Experiments:

1. Verification of Freundlich adsorption-adsorption of acetic acid on animal charcoal.
2. Determination of rate constant of reaction between $K_2S_2O_8$ and KI.
3. Determination of Rate constant of hydrolysis of Methylacetate.
4. Complex preparations: a) $[Ni(DMG)_2]$ b) $[Co(NH_3)_4Cl]\ Cl_2$ c) $[Cu(NH_3)_4]\ SO_4$
5. Estimation of iron in cement using Spectrophotometer.
6. Thin layer chromatography:
   a) Determination of the purity (No. Of compounds present) of a given sample by thin layer chromatography (TLC).
   b) Monitoring the progress of chemical reactions of thin layer chromatography (TLC).
7. Determination of R_f values of *p*-nitoraniline and *o*-nitroaniline using TLC technique.
8. Determination of stability constant by Job's method – Cu EDTA Complex.
9. Redox titrations by Potentiometry. Estimation of Ferrous iron.

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.

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

1. Apply adsorption technique to estimate the partition coefficient value.
2. Study the chemical kinetics and interpret the order from the given chemical reaction.
3. Apply spectroscopic and thin layer chromatographic techniques by determining the purity and observing the progress of given sample.
4. Estimate the amount of dissolved oxygen and sulphates in water.
5. Perform redox titrations by using potentiometric technique.
6. Interpret the data and prepare formal lab reports describing the obtained experimental results.

BASIC ELECTRICAL ENGINEERING LAB

II Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Basic Electrical Engineering

Course Objectives:

- To analyze a given network by applying various electrical laws and network theorems
- To know the response of electrical circuits for different excitations
- To calculate, measure and know the relation between basic electrical parameters.
- To analyze the performance characteristics of DC and AC electrical machines

List of Experiments/Demonstrations:

1. Verification of Ohms Law.
2. Verification of KVL and KCL.
3. Transient Response of Series RL and RC circuits for DC excitation.
4. Transient Response of RLC Series circuit for DC excitation.
5. Resonance in series RLC circuit.
6. Calculations and Verification of Impedance and Current of RL, RC and RLC series circuits.
7. Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single Phase Transformer.
8. Load Test on Single Phase Transformer (Calculate Efficiency and Regulation).
9. Three Phase Transformer: Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta-star, Star-Star).
10. Measurement of Active and Reactive Power in a balanced Three-phase circuit.
11. Performance Characteristics of a Separately/Self Excited DC Shunt/Compound Motor.
12. Torque-Speed Characteristics of a Separately/Self Excited DC Shunt/Compound Motor.
13. Performance Characteristics of a Three-phase Induction Motor.
14. Torque-Speed Characteristics of a Three-phase Induction Motor.
15. No-Load Characteristics of a Three-phase Alternator.

Text Books:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.

References:

1. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
2. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
3. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

Course Outcomes:

- Get an exposure to basic electrical laws.
- Understand the response of different types of electrical circuits to different excitations.
- Understand the measurement, calculation and relation between the basic electrical parameters
- Understand the basic characteristics of transformers and electrical machines.

ENVIRONMENTAL SCIENCE

II Year B.Tech. I-Sem

L	T	P	C
2	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

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. Structural features, Biotic structure, Abiotic structure, Ecological succession, Types of Ecosystems, 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. **Food recourses**: Desertification, Equitable use of resource for sustainable use style.

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. Landslides, floods, cyclones. **Noise Pollution:** Sources and Health hazards, standards, **Thermal pollution:** Introduction, causes and consequences. **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: C**limate 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.

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.

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

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

Power cycles: Carnot cycle, Rankine cycle.

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, generalized property correlation for gases. Turbines, Throttling process, compression process.

Text Books:

1. J. M. Smith and HC Van Ness, Introduction to Chemical Engineering Thermodynamics, 7th ed, 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.

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.

MECHANICAL OPERATIONS

II Year B. Tech. II -Sem

L	T	P	C
3	1	0	4

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

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

Introduction to membrane separations, cross flow filtration, permeate flux for ultra-filtration, concentration polarization, particle rejection of solutes, micro filtration, electrostatic separation, magnetic separator, flotation and flotation agents.

Text Book:

1. 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.

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.

PROCESS HEAT TRANSFER

II Year B. Tech. II- Sem

L	T	P	C
3	1	0	4

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

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. Unsteady state heat conduction: Equation for one-dimensional conduction, Semi-infinite solid.

UNIT- II

Principles of heat flow in fluids: Typical heat exchange equipment, countercurrent and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, 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, effective coefficients for unsteady-state heat transfer.

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.

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.

MANAGEMENT FUNDAMENTALS FOR ENGINEERS

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

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

UNIT I :(a) **Introduction to Management** Evolution of Management, Nature & Scope-Functions of Management-Role of Manager-levels of Management-Managerial Skills - Challenges- Social Responsibility &Ethics.

(b) Planning & Organizing: Planning-Planning Process-Types of Plans-MBO-Organization Design - Organizational Structure- Departmentation–Delegation-Centralization - Decentralization-Recentralization-Organizational Culture- Organizational climate- Organizational change

UNIT II: Human Resource Management –Human Resource Planning - Recruitment & Selection – Types & Process of Selection-Training & Development -Performance appraisal methods- Employee Separation-Stress Management Practices-cross cultural Management-Diversity.

UNIT III: Operation Management- Introduction to Operations Management-Principles and Types of Plant Layout-Methods of production (Job Batch and Mass production) - Method study and Work Measurement-Quality Management - TQM-Six sigma - Inventory Management – EOQ - ABC Analysis - JIT System-Business Process Re-engineering (BPR)- Bench marking.

UNIT IV: Marketing Management- Introduction to Marketing-Functions of Marketing-Marketing vs. Selling-Marketing Mix - Marketing Strategies - Product Life Cycle - Market Segmentation -Types of Marketing - Direct Marketing -Network Marketing - Digital Marketing- Social media marketing - Supply Chain Management (SCM).

UNIT V: Project Management- Introduction to Project Management-steps in Project Management - Project Planning - Project Life Cycle-Network Analysis-Program Evaluation & Review Technique(PERT)-Critical Path Method(CPM) - Project Cost Analysis - Project Crashing - Project Information Systems-Project Risk Management.

Suggested Readings:

1. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.
2. Principles of Management, Anastasia H. Cortes, David S. Bright, and Eva Hartmann 2019.
3. Essentials of Management, Koontz Kleihrich, Tata Mc - Graw Hill.
4. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013.
5. Industrial Engineering and Management: Including Production Management, T.R.Banga, S.C Sharma, Khanna Publishers.

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.

ORGANIC CHEMISTRY

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre Requisites: **NIL**

Course Objectives: The fundamental basic mechanisms of various types of Chemical reactions and isomerism are necessary to understand the procedures of synthetic techniques. The classification of drugs and mechanism of drug action, and heterocyclics as basic components of various drugs are very important for a chemical engineer.

UNIT-I:

Bond fission: Homolytic and heterolytic fission of a covalent bond. Types of Reagents: Electrophiles, nucleophiles and free radicals. structure, reactivity, characteristics. **Polar effects** – Inductive effect electromeric effect: resonance, hyper conjugation. The influence of these effects on the acidity and basicity of organic compounds. **Oxidising agents** $K_2Cr_2O_7$, $CosO_4$, Lead Tetra acetate, **Reducing agents –** $SnCl_2$, $LiAlH_4$, $NaBH_4$, Ni – H_2/ Pd.

UNIT-II:

Electrophilic reactions: Introduction – Mechanisms and synthetic applications - a) Friedel-Crafts reactions b) Riemer- Tiemenn Reaction c) Beckmann rearrangement **Nucleophillic reactions**: Introduction, mechanisms and applications of a) Aldol condensation b) Suzuki Reaction c) Heck reaction. **Free radical reactions**: a) Halogenation of Alkane b) Addition of HBr to Alkene in the presence of peroxide c) Allylic halogenation using N-Bromo succinimide (NBS)

UNIT-III:

Drugs: Introduction -Classification by pharmacological effects by chemical structure by target system and by site of action. Pharmacophores - Introduction. Mechanism of drug action: action at enzymes and at receptors. Lipenski rule, Introduction to structure-activity relationships. Classification and examples of antihistamines, antibacterial, anti-inflammatory, antifungbal, antibiotics, anti-cancer agents. Chemotherapy.

UNIT -IV:

Green Chemistry: Introduction, principles of Green Chemistry - Green synthesis, atom economy, solvent free reactions, reactions in solid state, microwave assisted organic synthesis- green catalysts. Introduction to phase- transfer catalysis. Ultra sound assisted reactions. Use of Ionic liquids as green solvents. Advantages and limitations.

UNIT-V:

Heterocyclic compounds: Nomenclature-preparation, properties and uses of Pyrrole, Furan, Pyridine, Quinoline and Isoquinoline. IPRs and Patents: - Intellectual property rights, patents, role of patents in drug industry.

Text Books

1. Text book of Organic Chemistry – Morrison and Boyd.
2. Medicinal Chemistry by Ashutosh Khar, New Age Publications.

Reference Books.

1. Heterocyclic Chemistry by T.Gilchrist
2. Heterocyclic Chemistry – J.A.Joule, K.Mills and G.F.Smith

Course Outcomes:

The basic concepts included in the syllabus will help the student

1. To gain knowledge of reactive intermediates, oxidizing and reducing agents.
2. To improve knowledge of principles related to eletrophilic, nucleophilic and free radical reactions.
3. To learn about the mechanism of drug action and structure of drug molecule and its relation with physiological activity.
4. To know about concepts of green chemical reactions and synthetic methods for Heterocyclic compounds.
5. To make the student aware of intellectual properties and patents.

MECHANICAL OPERATIONS LAB

II Year B. Tech. II- Sem

L	T	P	C
0	0	3	1.5

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.

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.

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

PROCESS HEAT TRANSFER LAB

II Year B. Tech. II- Sem

L	T	P	C
0	0	3	1.5

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.

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.

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.

ORGANIC CHEMISTRY LAB

II Year B. Tech. II- Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Organic Chemistry Course

Course Objectives:

1. To determine the acid, iodine and saponification value of a given sample.
2. To estimate the glucose and cellulose content in a given sample.
3. To prepare various organic compounds from the given synthesis techniques.

List of Experiments:

1. Determination of Acid value of Coconut oil
2. Determination of Iodine value
3. Determination of Saponification value
4. Estimation of aniline
5. Estimation of available chlorine in bleaching powder
6. Estimation of glucose
7. Determination of capacity of a Cation exchange resin
8. Preparation of soap
9. Preparation of phenol formaldehyde resin – Nylon 6
10. Preparation of benzanilide from benzophenone
11. Cycloaddition of anthracene with maleic anhyhdride

Preparation of drug molecules:

12. Preparation of aspirin from salicylic acid
13. Preparation of paracetamol from *o*-nitrophenol
14. Synthesis of 2-styrylbenzimidazole
15. Synthesis of N arylphthalimide from phthalic anhydride and p.toluidine
16. Synthesis of 2- methyl quinolone from aniline and ethyl acetoacetate
17. Preparation of Phthalimide from Phthalicanhydride using green methodologies.
18. Preparation of hand sanitizer.

Suggested Books:

1. Quantitative and Qualitative analysis in Organic Chemistry- A.I.Vogel.
2. Laboratory Manual of Organic Chemistry -R.K. Bansal

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

1. Interpret the acid, iodine and saponification values for any given sample.
2. Estimate glucose and cellulose content for a given sample.
3. Apply the preparation techniques for soap and resin.
4. Prepare aspirin from the given organic compound and reaction involved in it.
5. Perform various synthesis reactions.
6. Interpret the data and prepare formal lab reports describing the obtained experimental results.

CONSTITUTION OF INDIA

II Year B. Tech. II- Sem

L	T	P	C
2	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 rights 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.

Syllabus

UNIT-I: History of Making of the Indian Constitution- History of Drafting Committee - Philosophy of the Indian Constitution- Preamble Salient Features

UNIT-II: 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-V: 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.

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.
4. 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.

PETROLEUM REFINING AND PETROCHEMICALS

(Professional Elective – I)

III Year B.Tech. I-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.

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:

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

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.

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.

ENERGY ENGINEERING
(Professional Elective – I)

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

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.

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.

UNIT- II

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- III

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- IV

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- V

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.

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. Fuel Science- Harker and Allen, Oliver and Boyd, 1972.

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.

BASICS OF NANOTECHNOLOGY
(Professional Elective – I)

III Year B.Tech. I-Sem

L	T	P	C
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

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.

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.

MASS TRANSFER OPERATIONS-I

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

PreRequisites: 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.

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.

Text Books:

1. R.E.Treybal,MassTransferOperations,3rdEdition,McGrawHill,NewDelhi,1983.
2. BinayK.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice HallofIndia,2007.

Reference Books:

1. Unit Operations of Chemical Engineering by W. L. Mc- Cabe, J. C. Smith & Peter Harriot, McGraw-Hill, 7thed, 2007
2. C.J. Geankoplis, Transport Processes and Separation Process Principles, 4thEdition, Pearson Education2015.

Course Outcomes:

At the end of the course, student will 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.

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, n^{th} 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, CSTR, 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.

Course Outcomes:

At the end of the course, studentwill be able to

1. Fundamentals of rate equation and determination of kinetic order of reaction
2. Study the batch reactor kinetics
3. Compare ideal reactor types (batch, CSTR and PFR) and apply quantitative methods to design and size reactors for simple chemical reaction schemes.
4. Design reactors for single and multiple reactions
5. Study the kinetics of the reaction under the effect of pressure and temperature

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

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 1^{st} order system (mercury thermometer), Response of 1^{st} 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
3. Control System Design by Graham C. Goodwin,2000.

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.

CHEMICAL ENGINEERING THERMODYNAMICS-II

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

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.

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 (SLE), Solid Vapor 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

Course Outcomes:

At the end of the course, studentwill be able to

1. Explain in detailaboutsolution 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

CHEMICAL TECHNOLOGY

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre Requisite: Nil

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.

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.

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.

INSTRUMENTATION AND PROCESS CONTROL LAB

III Year B.Tech. I-Sem

L	T	P	C
0	0	3	1.5

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.

List of Experiments:

1. Dynamics of 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
4. Experiments with two tank Non- interacting system.
   Non Interacting Tanks – Step 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. Characteristics of PID controller
   Major equipment – PID controller setup
8. Control valve characteristics
   Major equipment – Control valve set up
9. Estimation of damping coefficient for U-tube manometer
   Major equipment - U-tube manometer.

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.

CHEMICAL TECHNOLOGY LAB

III Year B.Tech. I-Sem

L	T	P	C
0	0	3	1.5

List of experiments:

1. Preparation of Soap
2. Preparation of Dinitrobenzene
3. Preparation of Azo Dye
4. Oil Analysis – 1 (Determination of Acidic Value)
5. Oil Analysis – 2 (Determination of Saponification Value)
6. Water Analysis – 1 (Estimation of Total Hardness and Permanent Hardness)
7. Water Analysis –2 (Estimation of pH, TDS and COD)
8. Estimation of Chlorides in Water
9. Determination of Equivalent Weight of Acid
10. Estimation of Glucose.

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:

- Gathering ideas and information to organize ideas relevantly and coherently.
- Engaging in debates.
- Participating in group discussions.
- Facing interviews.
- Writing project/research reports/technical reports.
- Making oral presentations.
- Writing formal letters.
- Transferring information from non-verbal to verbal texts and vice-versa.
- 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 and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
- Further, they would be required to communicate their ideas relevantly and coherently in writing.
- To prepare all the students for their placements.

3. Syllabus:

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

1. **Activities on Fundamentals of Inter- Personal Communication and Building Vocabulary** - Starting a conversation – responding appropriately and relevantly – using the right body language – Role Play in different situations & Discourse Skills- using visuals - Synonyms and antonyms, word roots, one-word substitutes, prefixes and suffixes, study of word origin, business vocabulary, analogy, idioms and phrases, collocations & usage of vocabulary.
2. **Activities on Reading Comprehension** –General Vs Local comprehension, reading for facts, guessing meanings from context, scanning, skimming, inferring meaning, critical reading& effective googling.

3. **Activities on Writing Skills** – Structure and presentation of different types of writing – *letter writing/Resume writing/ e-correspondence/Technical report writing/* – planning for writing – improving one's writing.
4. **Activities on Presentation Skills** – Oral presentations (individual and group) through JAM sessions/seminars/**PPTs** and written presentations through posters/projects/reports/ e-mails/assignments etc.
5. **Activities on Group Discussion and Interview Skills** – Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and organization of ideas and rubrics for evaluation- Concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele-conference & video-conference and Mock Interviews.

4. Minimum Requirement:

The Advanced English Communication Skills (AECS) Laboratory shall have the following infrastructural 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**
- **P – IV Processor, Hard Disk – 80 GB, RAM–512 MB Minimum, Speed – 2.8 GHZ**
- **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.

- **Oxford Advanced Learner's Compass**, 7th Edition
- **DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.**
- **Lingua TOEFL CBT Insider**, by Dreamtech
- **TOEFL &GRE**(KAPLAN, AARCO&BARRONS, USA, Cracking GRE by CLIFFS)

6. Books Recommended:

1. **Effective Technical Communication** by M Asharaf Rizvi**.** McGraw Hill Education (India) Pvt. Ltd. 2nd Edition
2. **Academic Writing: A Handbook for International Students b**y Stephen Bailey, Routledge, 5th Edition
3. **Learn Correct English – A Book of Grammar, Usage and Composition** by Shiv K. Kumar and HemalathaNagarajan. Pearson 2007
4. **Professional Communication** by ArunaKoneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
5. **Technical Communication** by Meenakshi Raman &Sangeeta Sharma, Oxford University Press 2009.
6. **Technical Communication** by Paul V. Anderson. 2007. Cengage Learning pvt. Ltd. New Delhi.

7. **English Vocabulary in Use** series, Cambridge University Press 2008.
8. **Handbook for Technical Communication** by David A. McMurrey& Joanne Buckley. 2012. Cengage Learning.
9. **Communication Skills** by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.
10. **Job Hunting by**ColmDownes, Cambridge University Press 2008.
11. **English for Technical Communication for Engineering Students,** AyshaVishwamohan**, Tata Mc Graw-Hil 2009.**

INTRODUCTION TO ARTIFICIAL INTELLIGENCE

III Year B.Tech. I-Sem

L	T	P	C
2	0	0	0

Course Objectives: To train the students to:

- Understand different types of AI agents, various AI search algorithms, fundamentals of knowledge representation, building of simple knowledge-based systems.
- To apply knowledge representation, reasoning. Study of Markov Models enable the student ready to step into applied AI.

UNIT - I

Introduction: AI problems, Agents and Environments, Structure of Agents, Problem Solving Agents **Basic Search Strategies**: Problem Spaces, Uninformed Search (Breadth-First, Depth-First Search, Depth-first with Iterative Deepening), Heuristic Search (Hill Climbing, Generic Best-First, A*), Constraint Satisfaction (Backtracking, Local Search).

UNIT - II

Advanced Search: Constructing Search Trees, Stochastic Search, A* Search Implementation, Minimax Search, Alpha-Beta Pruning

Basic Knowledge Representation and Reasoning: Propositional Logic, First-Order Logic, Forward Chaining and Backward Chaining, Introduction to Probabilistic Reasoning, Bayes Theorem.

UNIT - III

Advanced Knowledge Representation and Reasoning: Knowledge Representation Issues, Nonmonotonic Reasoning, Other Knowledge Representation Schemes.

Reasoning Under Uncertainty: Basic probability, Acting Under Uncertainty, Bayes' Rule, Representing Knowledge in an Uncertain Domain, Bayesian Networks.

UNIT - IV

Learning: What Is Learning? Rote Learning, Learning by Taking Advice, Learning in Problem Solving, Learning from Examples, Winston's Learning Program, Decision Trees.

UNIT - V

Expert Systems: Representing and Using Domain Knowledge, Shell, Explanation, Knowledge Acquisition.

Text Book

1. Russell, S. and Norvig, P, Artificial Intelligence: A Modern Approach, Third Edition,Prentice - Hall, 2010.

2. Artificial Intelligence, Elaine Rich, Kevin Knight, Shivasankar B. Nair, The McGraw Hill publications, Third Edition, 2009.Dept. of METALLURICAL ENGG B.Tech. (Reg), w.e.f. 2021-22 Academic Year

Reference Books

1. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 6th ed., 2009.

Learning resources:

1.www.techopedia.com
2.www.classcentral.com

Course Outcomes:

- Classify basic search strategies for application to AI problems.
- Use probabilistic reasoning for search trees.
- Correlate the domain knowledge for learning and decision process.

SOLID WASTE MANAGEMENT
(Open Elective – I)

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

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

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, E-waste and importances.

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. E-waste material recovery.

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. E-waste case study- batteries.

Text Books:

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.

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.

INTERFACIAL AND COLLOIDAL SCIENCE

(Professional Elective – II)

III Year B. Tech. II- 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.

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.

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.

PROCESS MODELING AND SIMULATION
(Professional Elective – II)

III Year B.Tech. II-Sem

L	T	P	C
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

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

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

UNIT- III

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

UNIT- IV

Empirical model building- method of least squares, linear, polynomialand 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:

1. 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.

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.

POLYMER SCIENCE AND ENGINEERING

(Professional Elective – II)

III Year B.Tech. II-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.

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.

Text Books:

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).

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.

COMPUTATIONAL METHODS IN CHEMICAL ENGINEERING

III Year B. Tech. II- Sem

L	T	P	C
3	1	0	4

Pre Requisite: M-I, M-II

Course Objectives:

1. Introduce students to numerical methods to solve process design problems involved in chemical processes.
2. Fundamentals of numerical methods / algorithms to solve systems of different mathematical equations (e.g. linear / non-linear algebraic equations, ordinary / partial differential equations), are introduced.
3. To learn regression analysis.

UNIT- I

Solution of Linear Algebraic Equations: Introduction, Gauss- Elimination, Gauss-Jordan Elimination, Gauss- Siedel & Jocobi methods.

Solution of Non-linear Algebraic Equations: Introduction, Bisection method, Newton- Raphson and Secant method. Chemical engineering problems involving solution of linear and No-linear algebraic equations.

UNIT- II

Regression Analysis: Introduction to regression & correlation, least squares method- linear & quadratic model, curve-fitting methods, Newton's forward formulae, Newton's backward formulae.

UNIT- III

Interpolation: Polynomial, Lagrangian Interpolation (Unequal Intervals), spline interpolation.

Numerical Integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration.

UNIT- IV

Solution of ordinary Differential Equations- Introduction to ordinary Differential Equations, Euler method, Runge-Kutta 4^{th} order method, Adaptive Runge – Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs.

UNIT- V

Solution of Partial Differential Equations: elliptic, parabolic and hyperbolic equations. Finite difference methods, Leibman's method, Crank Nicholson method. Applications to steady state and Unsteady state heat conduction and temperature distribution problems

Text Books:

1. Numerical Methods for Engineers, S.K. Gupta., New Academic Science.,2012

Reference Books:

1. S.C. Chapra & R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.
2. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.
3. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.

Course Outcomes:

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

1. Understand the fundamental mathematics and to solve problems of algebraic equations.
2. Solve problems using regression analysis.
3. Solve chemical engineering problems involving numerical differentiation and integration.
4. Solve chemical engineering problems numerically involving ordinary and differential equations.
5. Solve chemical engineering problems numerically involving partial differential equations

MASS TRANSFER OPERATIONS-II

III Year B.Tech. II-Semester

L	T	P	C
3	1	0	4

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 liquid- liquid extraction and drying
3. To justify the selection of solvents for leaching and extraction.

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, Steady-stae 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, McGraw Hill, NewDelhi,1983.

2. Binay K. Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, Prentice Hall of India, 2007

3. W.L. Mc Cabe, J. Smith and P.Harriot, Unit Operations of Chemical Engineering, 7th Edition, Tata McGraw Hill, India, 2014.

Reference Books:

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

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

CHEMICAL REACTION ENGINEERING-II

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.

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 catalysts-mechanisms 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 coremodel 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.
2. The Engineering of Chemical Reactions, 2nd ed., L.D. Schmidt, Oxford University Press, New Delhi, 2010

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.

COMPUTATIONAL METHODS LAB

III Year B. Tech. II- Sem

L	T	P	C
0	0	2	1

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 formulated Chemical Engineering Processes.

1. Programme to determine the roots of Non-linear Algebraic/Transcedental Equation by using Bisection Method
2. Programme to determine the roots of Non-linear Algebraic/Transcedental Equation by using Regula-Falsi Method
3. Programme to determine the roots of Non-linear Algebraic/Transcedental Equation by using Newton-Raphson Method
4. Programme to perform Regression Analysis to fit a curve with examples
5. Programme to Interpolate the data with and without equal intervals
6. Programme for the Numerical integration by using Trapezoidal and Simpson's Rules
7. Programme for the Solution of Ordinary Differential Equations by using Euler Method
8. Programme for the Solution of Ordinary Differential Equations by using R-K fourth order Method
9. Programme for the Application of Numerical Methods to solve problems involving chemical engineering thermodynamics such as estimation of bubble point and dew point Temperatures & Pressures
10. Programme for the Application of Numerical Methods to solve problems involving chemical reaction engineering such as solving the rate equations in case of batch reactor, CSTR.

Course Outcomes:

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

1. Formulate the process simulation problems using **MATLAB** or C.
2. Describe the bubble point and dew point calculations in a given VLE systems.
3. Interpret the data and prepare formal lab reports describing the obtained experimental results.

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.

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

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.

CHEMICAL REACTION ENGINEERING LAB

III Year B.Tech. II-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

List of Experiments

1. 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

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.

INTRODUCTION TO CYBER SECURITY

III Year B.Tech. II-Sem

L	T	P	C
2	0	0	0

Prerequisites: NIL

Course objectives:

- To familiarize various types of cyber-attacks and cyber-crimes.
- To give an overview of the cyber laws.
- To study the defensive techniques against these attacks.

UNIT - I

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc.,

Comprehensive Cyber Security Policy.

UNIT - II

Cyberspace and the Law & Cyber Forensics: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy.

Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

UNIT - III

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

UNIT- IV

Cyber Security: Organizational Implications: Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations.

Cybercrime and Cyber terrorism: Introduction, intellectual property in the cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

UNIT - V

Privacy Issues: Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.

Cybercrime: Examples and Mini-Cases

Examples: Official Website of Maharashtra Government Hacked, Indian Banks Lose Millions of Rupees, Parliament Attack, Pune City Police Bust Nigerian Racket, e-mail spoofing instances.

Mini-Cases: The Indian Case of online Gambling, An Indian Case of Intellectual Property Crime, Financial Frauds in Cyber Domain.

Text Books:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

References:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.

Online resources:

1.https:// www.mygreatlearning.com
2.https://sl-cources.iitb.ac.in
3.https://iitk.talentsprint.com

Course Outcomes:

The students will be able to

- Understand cyber-attacks, types of cybercrimes, cyber laws
- Understand how to protect them self and ultimately the entire Internet community from such attacks.

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

BIOCHEMICAL ENGINEERING
(Professional Elective – III)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

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.
3. Learn the kinetics of growth of microorganisms; hence be able to control the process.

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.

UNIT- V

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.

Course Outcomes:

At the end of the course, studentwill 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.

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.

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 for control of 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

UNIT -V

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.

Physical Treatment methods: Principle and working of screening –sedimentation – flotation – filtration – flocculation, Tertiary Treatment methods – carbon adsorption – lon exchange – Reverse Osmosis.

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.

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 non-living 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.

FLUIDIZATION ENGINEERING
(Professional Elective – III)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre Requisites: Fluid Mechanics

Course Objectives:

1. Explain the basic principles of fluidization phenomena
2. Describe the fundamental and practical aspects of basic fluidization operations for industrial application.
3. Explain in detail about the fluidized bed regimes and models.

UNIT- I

Introduction: The phenomenon of fluidization; liquid like behavior of a fluidized bed; Comparison with other contacting methods; Advantages and disadvantages of fluidized beds.

Industrial applications of fluidized beds: Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Drying of solids; FCCU

UNIT- II

Fluidization and mapping of regimes: Minimum fluidization velocity; Pressure drop vs. velocity diagram; effect of temperature and pressure on fluidization; Geldart classification of particles; terminal velocity of particles, Transport disengaging height; turbulent fluidization; pneumatic transport of solids; fast fluidization; solid circulation systems; Voidage diagram; Mapping of regimes of fluidization.

UNIT- III

Bubbles in dense bed: Single rising bubbles; Davidson model for gas flow at bubbles; Evaluation of models for gas flow at bubbles.

Bubbling Fluidized beds: Experimental findings; Estimation of bed Voidages; Physical models: simple two phase model; K-L model.

UNIT- IV

High velocity Fluidization: Turbulent fluidized bed; Fast fluidization pressure drop in turbulent and fast fluidization.

Solids Movement, Mixing, Segregation and staging: Vertical movement of solids; Horizontal movement of solids; Staging of fluidized beds.

UNIT- V

Gas Dispersion and Gas interchange in Bubbling Beds: Dispersion of gas in beds; Gas interchange between bubble and emulsion; Estimation of gas interchange coefficients.

Particle to Gas Mass Transfer: Experimental interpolation of mass transfer coefficients; Heat transfer; Experimental heat transfer from the bubbling bed model.

Text Books:

1. Fluidization Engineering by Kunil, Diazo and Octave Levenspiel, John Weiley& Sons Inc, Newyork, 1969.
2. Fluidization Engineering by J.R. Howard, Adam Heilgar.

Reference Books:

1. Yates, J.G., Fundamentals of Fluidized Bed Chemical Processes, Butterworth-Heinemann (Butterworth's Monographs in Chemical Engineering) (1983).
2. Yang, W. and Amin, N.D., Fluidization engineering: fundamentals and applications, American Institute of Chemical Engineers (1988)

Course Outcomes:

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

1. Illustrate the fluidization phenomena and operational regimes.
2. Explain the minimum fluidization velocity along with effects of temperature and pressure on fluidization.
3. Explain about the bubbles and evaluate the gas flow at the bubbles.
4. Explain about high velocity fluidization.
5. Explain about experimental interpolation of mass transfer coefficients.

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.

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

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

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

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.

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.

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 thelimitations of intensification for the chemical processes.
3. Describe the techniques of intensification to a range of chemical processes.

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, 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:

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.

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.

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:

2. To familiarize the students about various economic aspects of chemical processes**.**
3. Learn basics of Cost estimation, Working Capital and Capital Investment and understand the time value of money.
4. Learn the importance of Cash flow diagrams and Break-even analysis.

UNIT I

Process Design development: Design project procedure, flow diagrams

Cost and asset accounting: outline of accounting procedure, basic relationships in accounting, Balance sheet, cost accounting methods

Cost estimation: Cash flow for industrial operations, factors effecting investment and production cost, capital investments, estimation of capital investments, cost indices, cost factors in capital investment, production costs, fixed charges, plant overhead costs, financing

UNIT II

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.

Taxes and insurances: type of taxes, federal income taxes, insurance-types of insurance, self insurance

UNIT III

Depreciation: types of depreciation, services life, salvage value, present value,

Methods of depreciation- Straight-Line Method, Declining-Balance Method, Sum-of-the-Years-Digits Method, Sinking-Fund Method.

UNIT IV

Profitability, **alternative investments and replacements**: profitability standards, Mathematical Methods for Profitability Evaluation, discounted cash flow, capitalized cost, pay out period ,alternative investments.

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.

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

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.

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

UNIT-I

Introduction - Mechanism of molecular transport of momentum, heat and mass transfer. Flux equations -
Newton's, Fourier's' and Fick's laws - Similarities and differences- Temperature and pressure dependence of viscosity, thermal conductivity and Diffusivity.

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.

UNIT- II

Shell energy balances and temperature distributions in solids and laminar flow: shell energy balances; boundary conditions, forced convection, free convection, 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 in a cooling fin.

UNIT-III

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.

UNIT- IV

Equations of change for isothermal systems – Equation of continuity, Equation of Motion, Equations of
change in curvilinear coordinates, use of equations of change to set up steady flow problems. Equations of
change for non-isothermal systems – Equation of energy – use of equations of change to set up steady state flow problems. Equation of change for a binary mixture, Introduction to Turbulent flow and Time smoothing**.**

UNIT- V

Velocity distributions in turbulent flow-Turbulence -Introduction to Time smoothed equations of change;

Eddy properties - Intensity of turbulence Reynolds stresses; Semi empirical expressions for turbulent -

momentum, energy and mass fluxes

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.

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.

PROCESS EQUIPMENT DESIGN LAB

IV Year B.Tech, I-Sem

L	T	P	C
0	0	2	1

Pre-requisite: Chemical Process equipment design theory

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

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

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.

INDUSTRY ORIENTED MINI PROJECT / INDUSTRIAL TRAINING

IV Year B.Tech. I-Sem

L	T	P	C
0	0	4	2

Pre Requisites: All the subjects till the current semester

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.

SEMINAR

IV Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre- Requisites: Nil

Course Objectives:

1. The prime objective of this course is to make students become effective communicators and enhance their presentational and creative abilities.
2. Enhance the technical knowledge of the selected topics.

Course Outcomes:

1. Students will be able to show competence in identifying relevant information, defining and explaining the topics under discussion.
2. Able to evaluate information and use and apply relevant theories concerned to the chosen topic.
3. Able to use conventional and modern methods of presentation techniques to support the presentation / topic.
4. Develop presentation skills and confidently face the audience.
5. Respond to a range of questions posed and take part in the discussions fruitfully.
6. Recognize and demonstrate effective oral and written formats.

MAJOR PROJECT (PHASE-I)

IV Year B.Tech. I-Sem

L	T	P	C
0	0	0	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.

INDUSTRIAL PROCESS SAFETY
(Open Elective – III)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Course objectives:

- To create awareness of different hazards in process industries and need for process safety
- To educate on of hazards classifications and fire explosions in process industries
- To create awareness on chemical storage and handling and prepare data sheets for safety
- To educate on process safety plan to prepare Hazard and Operability analysis
- To create awareness on Selection of relief valves, rupture disks flame arresters and flare systems in process industries

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 BOOK:

1. Chemical process industry safety by K S N Raju, Mc-Graw Hill education (India) Pvt.Ltd,2014
2. Chemical process Safety by Crowl, Pearson Prentice Hall; 3 edition (20 May 2011)
3. Chemical process safety by Sanders, 4 th Edition, Butterworth-Heinemann, 2015.

Course outcomes:

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

- Explain different hazards in process industries and the need for process safety (L2)
- Classify different types of hazards and fire explosions in process industries (L2)
- Develop data sheets for safety and procedures for chemical storage. (L6)
- Formulate Hazard and Operability analysis (HAZOP) and HAZAN (Hazard analysis
- procedures)(L6)
- Select suitable relief valves, rupture disks, flame arresters and flare systems for process industries (L3)

OPTIMIZATION OF CHEMICAL PROCESSES

(Professional Elective – V)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre Requisites: NIL

Course 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

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.

Course Outcomes:

At the end of the course, studentwill 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.

TECHNOLOGY OF PHARMACEUTICALS AND FINE CHEMICALS
(Professional Elective – V)

IV Year B. Tech. II- Sem

L	T	P	C
3	0	0	3

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.

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.

Course Outcomes:

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

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.
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	P	C
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.

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", 2nd Edn., Applied Science, 1976.
3. Fundamentals of Food Engineering, D G Rao, PHI, New Delhi, 2012.

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.

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

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.

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

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

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

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

DESIGN AND ANALYSIS OF EXPERIMENTS
(Professional Elective – VI)

IV Year B. Tech. II-Semester

L	T	P	C
3	0	0	3

Pre Requisites: Mathematics-III

Course Objectives:

1. Review on how the design of experiments is useful during research and finds the most significant factor for an experiment.
2. Calculate the factor levels that optimize the outcome of an experiment.
3. Explain about the Factorial Design of experiments.

UNIT- I

Introduction to the role of experimental design; basic statistical concepts; sampling and sampling distribution; Testing of hypotheses about differences in means- randomized designs and paired comparison designs; testing of hypotheses about variances.

UNIT- II

Analysis of variance (ANOVA) –one-way classification ANOVA; analysis of fixed effects model; comparison of individual treatment means; the random effects model; the randomized complete block design

UNIT- III

Factorial design of experiments; two-factor factorial design-fixed effects and random effects model; General factorial design; analysis of 2^k and 3^k factorial designs.

UNIT- IV

Conforming in the 2^k factorial design in 2p block; confounding in the 3^k factorial design in 3p block; Fractional replication of the 2^k factorial design and the 3^k factorial design.

UNIT- V

Regression analysis- Simple and multiple linear regression and hypothesis testing; response surface methodology-the method of steepness ascent: response surface designs for first-order and second-order models. Evolutionary operation (EVOP).

Text Books:

1.Design and analysis of experiments, 2nd edn.,D.C.Montgomery, John Wileyand Sons, New York, 2003.

Reference Books:

1. **Design and Analysis of Experiments, Narayan C Giri, New Age International, 1988.**

Course Outcomes:

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

1. Explain the basic concepts and models of experimental design.
2. Analyze the results of a designed experiment in order to conduct appropriate statistical analysis of data.
3. Perform factorial design of experiments
4. Illustrate the strategy in planning and conducting experiments.
5. Apply response surface methodology to optimize the process by considering the curvature.