CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instructions of I Semester of B.Tech. – Chemical Engineering
(In line with AICTE Model Curriculum with effect from AY 2022-23)

DEPARTMENT OF CHEMICAL ENGINEERING

SEMESTER – I

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC02	Calculus	3	1	0	3	40	60	4
2	22CYC01	Chemistry	3	0	0	3	40	60	3
3	22EEC01	Basic Electrical Engineering (BEE)	2	1	0	3	40	60	3
4	22CSC01	Problem Solving and Programming	2	1	0	3	40	60	3
PRACTICAL									
5	22CYC02	Chemistry Lab	0	0	3	3	50	50	1.5
6	22MBC02	Community Engagement	0	0	3	3	50	0	1.5
7	22CSC02	Problem Solving and Programming Lab	0	0	3	3	50	50	1.5
8	22MEC37	Robotics & Drones Lab	0	2	2	4	100	0	3
9	22EEC02	Basic Electrical Engineering Lab	0	0	2	3	50	50	1
TOTAL			**10**	**5**	**13**				**21.5**

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

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22MTC02

CALCULUS (CHEM)

Instruction	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES: This course aims to

1. To explain the solutions of system of linear equations by Matrix Methods.
2. To discuss mean value theorems.
3. To explain the Partial Derivatives and the extreme values of functions of two variables.
4. To explain the shape of curves, their areas and volumes of revolutions.
5. To discuss the convergence and divergence of the series.

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

1. Apply the Matrix Methods to solve system of linear equations.
2. Analyze the geometrical interpretation of Mean value theorems and curvature.
3. Determine the extreme values of functions of two variables.
4. Find the shape of the curve, surface areas and volumes of revolution.
5. Examine the convergence and divergence of infinite Series.

CO-PO Articulation Matrix:

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	-	-	-	-	-	-	-	2
CO 3	3	3	3	3	-	-	-	-	-	-	-	2
CO 4	3	3	3	3	-	-	-	-	-	-	-	2
CO 5	3	3	3	1	-	-	-	-	-	-	-	1

UNIT-I

Matrices: Rank of a matrix, Echelon form, consistency of linear system of equations, Linear dependence and independence of vectors. Eigen values, Eigenvectors, Properties of Eigen values and Eigen vectors, Cayley Hamilton theorem, Quadratic form, Reduction of quadratic form to canonical form by linear transformation, Nature of quadratic form.

UNIT-II

Calculus: Rolle's Theorem, Lagrange's Mean value theorem, Cauchy's Mean value theorem (without proofs). Curvature, Radius of curvature, Centre of curvature, Evolute and Involute, Envelopes.

UNIT-III

Partial Differentiation and Its Applications: Functions of two or more variables, Partial derivatives, Higher order partial derivatives, Total derivative, Differentiation of implicit functions, Jacobians, Taylor's expansion of functions of two variables, Maxima and minima of functions of two variables.

UNIT-IV

Applications of definite integrals: Curve tracing of standard curves (Cartesian only), Applications of definite integrals to evaluate length of curves, surface areas and volumes of revolutions.

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UNIT-V

Sequences and Series: Convergence of sequence and series. Tests for convergence of series: Comparison test, limit comparison test, D'Alembert's ratio test, Raabe's test, Cauchy's root test, Alternating series, Leibnitz's series, absolute and conditional convergence**.**

TEXT BOOKS:

1. B.S.Grewal, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

SUGGESTED READING:

1. B.V.Ramana., "Higher Engineering Mathematics", 11th Reprint, Tata McGraw-Hill, New Delhi, 2010.
2. R.K.Jain, S.R.K.Iyengar, "Advanced Engineering Mathematics", 5th edition, Narosa Publications, 2016.
3. David.Poole, "Linear Algebra: A Modern Introduction", 2nd Edition, Brooks/ Cole, 2005.

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22CYC01

CHEMISTRY
(CHEMICAL)

Instruction:	3L Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	60 Marks
Continuous Internal Evaluation:	40 Marks
Credits:	3

COURSE OBJECTIVES: This course aims to

1. This syllabus helps at providing the concepts of chemical bonding and chemical kinetics to the students aspiring to become practicing engineers
2. Thermodynamic and Electrochemistry units give conceptual knowledge about processes and how they can be producing electrical energy and efficiency of systems.
3. To teach students the value of chemistry and to improve the research opportunities knowledge of stereochemistry and organic reactions is essential.
4. Water chemistry unit impart the knowledge and understand the role of chemistry in the daily life.
5. New materials lead to discovering of technologies in strategic areas for which an insight into Polymers, nanomaterials and basic drugs of modern chemistry is essential.

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

1. Identify the microscopic chemistry in terms of molecular orbitals, intermolecular forces and rate of chemical reactions.
2. Discuss the properties and processes using thermodynamic functions, electrochemical cells and their role in batteries and fuel cells.
3. Illustrate the major chemical reactions that are used in the synthesis of organic molecules.
4. Classify the various methods used in treatment of water for domestic and industrial use.
5. Outline the synthesis of various Engineering materials & Drugs.

CO-PO Articulation Matrix

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	-	-	2	2	-	-	-	-	2
CO 2	3	2	2	-	-	2	2	-	-	-	-	2
CO 3	3	2	3	-	-	2	2	-	-	-	-	2
CO 4	3	2	3	-	-	2	2	-	-	-	-	2
CO 5	3	2	2	-	-	2	2	-	-	-	-	2

UNIT-I

Atomic and molecular structure and Chemical Kinetics: Atomic and molecular structure: Molecular Orbital theory - atomic and molecular orbitals. Linear combination of atomic orbitals (LCAO) method. Molecular orbitals of diatomic molecules. Molecular Orbital Energy level diagrams (MOED) of diatomic molecules & molecular ions (H_2, He_2^+, N_2 , O_2 , O_2^- , CO, NO). Pi- molecular orbitals of benzene and its aromaticity.

Chemical Kinetics: Introduction, Terms involved in kinetics: rate of reaction, order & molecularity; First order reaction-Characteristics: units of first order rate constant & its half-life period, second order reaction-Characteristics: units of second order rate constant & its half- life period. Numericals.

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UNIT-II

Use of free energy in chemical equilibria: Use of free energy in chemical equilibria: Thermodynamic functions: Internal energy, entropy and free energy. Significance of entropy and free energy (criteria of spontaneity). Free energy and emf (Gibbs Helmholtz equations and its applications). Cell potentials, electrode potentials, and – Reference electrodes (NHE, SCE) electrochemical series. Nernst equation and its applications. Determination of pH using combined Glass & Calomel electrode. Potentiometric Acid base & Redox Titrations. Numericals.

Battery technology: Rechargeable batteries & Fuel cells.

Lithium batteries: Introduction, construction, working and applications of Li-MnO_2 and Li-ion batteries.

Fuel Cells: Introduction, difference between conventional cell and fuel cell, limitations & advantages. Construction, working & applications of methanol-oxygen fuel cell.

UNIT- III

Stereochemistry and Organic reactions: Stereochemistry: Representations of 3 dimensional structures, Types of stereoisomerism- Conformational isomerism – confirmations of n-butane (Newman and sawhorse representations), Configurational isomerism -Geometrical (cis-trans) isomerism & Optical isomerism- optical activity, Symmetry and chirality: Enantiomers (lactic acid)&Diastereomers (Tartaric acid), Absolute configurations, Sequence rules for R&S notation.

Types of Organic reactions: Substitution Reactions- Electrophilic substitution (Nitration of Benzene); Nucleophilic Substitution (S_N1& S_N2); Free Radical Substitution (Halogenation of Alkanes)

Addition Reactions: Electrophilic Addition – Markonikoff's rule, Free radical Addition - Anti Markonikoff's rule (Peroxide effect), Nucleophilic Addition – (Addition of HCN to carbonyl compounds)

Eliminations-E1 and E2 (dehydrohalogenation of alkyl halides), Cyclization (Diels - Alder reaction)

UNIT–IV

Water Chemistry: Hardness of water – Types, units of hardness, Disadvantages of hard water, Alkalinity and Estimation of Alkalinity of water, Boiler troubles - scales & sludge formation, causes and effects, Softening of water by lime soda process (Cold lime soda process), ion exchange method and Reverse Osmosis. Specifications of potable water & industrial water. Disinfection of water by Chlorination; break point chlorination, BOD and COD definition, Estimation (only brief procedure) and significance, Numericals.

UNIT-V

Engineering Materials and Drugs: Introduction, Terms used in polymer science; Thermoplastic polymers (PVC) &Thermosetting polymers (Bakelite); Elastomers (Natural rubber). Conducting polymers- Definition, classification and applications.

Polymers for Electronics: Polymer resists for integrated circuit fabrication, lithography and photolithography

Nano materials-Introduction to nano materials and general applications, basic chemical methods of preparation-Sol-gel method. Carbon nanotubes and their applications. Characterisation of nanomaterials by SEM and TEM (only Principle).

Drugs-Introduction, Synthesis and uses of Aspirin (analgesic), Paracetamol (Antipyretic), Atenolol (antihypertensive).

TEXT BOOKS

1. P.C. Jain and M. Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company Ltd., New Delhi,16th edition (2015).
2. W.U. Malik, G.D.Tuli and R.D.Madan, "Selected topics in Inorganic Chemistry", S Chand & Company Ltd, New Delhi, reprint (2009).
3. R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, "Organic Chemistry", Pearson,Delhi, 7thedition(2019).
4. A Textbook of Polymer Science and Technology , Shashi Chawla ,Dhanpat Rai & Co. (2014)
5. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill Education, Delhi, 2012
6. G.L. David Krupadanam, D. Vijaya Prasad, K. Varaprasad Rao, K.L.N. Reddy and C.Sudhakar, "Drugs", Universities Press (India) Limited, Hyderabad (2007).

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SUGGESTED READINGS

1. B. H. Mahan, "University Chemistry", Narosa Publishing house, New Delhi, 3rd edition (2013).
2. B.R. Puri, L.R. Sharma and M.S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Company Ltd., 46th edition(2013).
3. T.W. Graham Solomons, C.B. Fryhle and S.A. Snyder, "Organic Chemistry", Wiley,12th edition (2017).
4. P.W. Atkins, J.D. Paula, "Physical Chemistry", Oxford, 8th edition (2006).

22EEC01

BASIC ELECTRICAL ENGINEERING

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. To understand the behaviour of different circuit elements R, L & C, and the basic concepts of electrical AC circuit analysis
2. To comprehend the basic principle of operation of AC and DC machines
3. To infer about different types of electrical wires and cables, domestic and industrial wiring, safety rules and methods of earthing.

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

1. Understand the concepts of Kirchhoff's laws and their application various theorems to get solution of simple dc circuits.
2. Predict the steady state response of RLC circuits with AC single phase/three phase supply.
3. Infer the basics of single phase transformer
4. Describe the construction, working principle of DC machine and 3-phase Induction motor.
5. Acquire the knowledge of electrical wires, cables, earthing, Electrical safety precautions to be followed in electrical installations and electric shock and its safety and energy calculations.

CO-PO-PSO Matrix

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO-1	3	3	2	-	-	-	-	-	1	2	-	3
CO-2	3	3	2	-	-	-	-	-	1	2	-	3
CO-3	3	3	2	1	-	-	-	-	1	2	-	3
CO-4	2	1	-	-	-	-	-	-	1	2	-	3
CO-5	2	-	2	-	-	-	-	-	1	2	-	3

UNIT-I

DC Circuits: Electrical circuit elements (R,L and C), voltage and current sources, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin's and Norton's Theorems.

UNIT-II

AC 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, series RL and RC. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III

Single Phase Transformer: Construction, Working principle, EMF Equation, Ideal and Practical transformer, Equivalent circuit of Transformer, OC and SC tests on a transformer, Efficiency and Regulation

UNIT-IV

DC and AC Machines: DC Generators: Construction, Principle of operation, EMF equation, Classification, Characteristics of shunt generators. DC Motors: Classification, Torque Equation, Characteristics and Speed control of DC Shunt and Series Motors, Losses and efficiency Three - Phase Induction Motors: Principle of operation, Applications

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UNIT-V

Electrical Installations: Electrical Wiring: Types of wires and cables, Electrical Safety precautions in handling electrical appliances, electric shock, and first aid for electric shock, safety rules. Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, Earthing (Elementary Treatment only), Elementary calculations for energy consumption

TEXT BOOKS:

1. L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
2. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.

SUGGESTED READING:

1. D. P. Kothari & I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989
3. D.C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009
4. P.V. Prasad, S. Sivanagaraju, R. Prasad, "Basic Electrical and Electronics Engineering" Cengage Learning, 1st Edition, 2013

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22CSC01

PROBLEM SOLVING AND PROGRAMMING

Instruction	2L + 1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. Develop logical skills and basic technical skills so that students should be able to solve basic computational problems.
2. Learn any basic programming language.

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

1. Understand real world problems and develop computer solutions for those problems.
2. Understand the basics of Python.
3. Apply Python for solving basic programming solutions.
4. Create algorithms/flowcharts for solving real-time problems.
5. Build and manage dictionaries to manage data.
6. Handle data using files.

CO-PO-PSO Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
1	3	1	1	-	1	-	-	-	-	-	-	1
2	3	1	1	-	1	-	-	-	-	-	-	1
3	3	1	1	-	1	-	-	-	-	-	-	1
4	3	1	1	-	1	-	-	-	-	-	-	1
5	3	1	1	-	1	-	-	-	-	-	-	1
6	3	1	1	-	1	-	-	-	-	-	-	1

UNIT I

Introduction to Programming - *Evolution of languages*: Machine, Assembly and High-level languages. *Software requirements for programming*: OS, compiler, linker, loader, editor. Design specification: Algorithms and Flowcharts.

UNIT II

Data Types and Operators, Variable, Sequences and Iteration - Data types, Expressions, Precedence Rules, Operators: arithmetic, relational, logical, bit-wise and miscellaneous operators; local variable, global variables, List, String, Tuples, Sequence mutation and accumulating patterns.

UNIT III

Conditional Statement, Loops, Arrays and Strings, user-defined Data Types - if..else, for, while, nested iteration, Concept and use of arrays, declaration and usage of arrays, 2-dimensional arrays, different types of user defined data types.

UNIT IV

Dictionaries and Dictionary Accumulation, Functions/Methods - Dictionary basics, operations, methods, accumulation, advantages of modularizing program into functions, function definition and function invocation. Positional parameters passing arrays to functions, recursion, library functions.

UNIT V

File Handling and Memory Management - Concepts of files and basic file operations, writing/reading data to/from a .csv file, Memory Management Operations.

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TEXT BOOKS AND REFERENCES:

1. R.S. Salaria, “Programming for Problem Solving”, First Edition, Khanna Book Publishing Co., Delhi.
2. Jeeva Jose, “Taming Python by Programming”, Revised Edition, Khanna Book Publishing Co., Delhi.
3. Mark Lutz, “Learning Python”, 5th Edition, O'Reilly Media, Inc.
4. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes, No Starch Press.
5. “Programming in Python”, R.S. Salaria, Khanna Book Publishing Co., Delhi.

NPTEL/SWAYAM COURSE:

1. Introduction to Problem Solving and Programming, Video Lectures, Prof. D Gupta, IIT Delhi.
2. Problem Solving Aspects and Python Programming, Dr. S Malinga, Dr Thangarajan, Dr. S V Kogilavani, Kongu Engineering College.
3. https://www.coursera.org/specializations/python-3-programming

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CHEMISTRY LAB
(CHEMICAL)

Instruction:	3P Hours per Week
Duration of Semester End Examination:	3 Hours
Semester End Examination:	50 Marks
Continuous Internal Evaluation:	50 Marks
Credits:	1.5

COURSE OBJECTIVES: This course aims to

1. To impart fundamental knowledge in handling the equipment / glassware and chemicals in chemistry laboratory.
2. To provide the knowledge in both qualitative and quantitative chemical analysis
3. The student should be conversant with the principles of volumetric analysis
4. To apply various instrumental methods to analyse the chemical compounds and to improve understanding of theoretical concepts.
5. To interpret the theorical concepts in the preparation of new materials like drugs and polymers.

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

1. Identify the basic chemical methods to analyse the substances quantitatively & qualitatively.
2. Estimate the amount of chemical substances by volumetric analysis.
3. Determine the rate constants of reactions from concentration of reactants/ products as a function of time.
4. Calculate the concentration and amount of various substances using instrumental techniques.
5. Develop the basic drug molecules and polymeric compounds.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	-	-	2	2	-	-	-	-	2
CO 2	3	2	1	-	-	1	2	-	-	-	-	2
CO 3	3	2	3	-	-	2	2	-	-	-	-	2
CO 4	3	2	2	-	-	2	2	-	-	-	-	2
CO 5	3	2	3	-	-	2	2	-	-	-	-	2

LIST OF EXPERIMENTS:

1. Introduction: Preparation of standard solution of oxalic acid and standardisation of NaOH.
2. Estimation of metal ions (Co^{+2} & Ni^{+2}) by EDTA method.
3. Estimation of temporary and permanent hardness of water using EDTA solution
4. Determination of Alkalinity of water
5. Determination of rate constant for the reaction of hydrolysis of methyl acetate. (first order)
6. Determination of rate constant for the reaction between potassium per sulphate and potassium Iodide. (second order)
7. Estimation of amount of HCl Conductometrically using NaOH solution.
8. Estimation of amount of HCl and CH_3COOH present in the given mixture of acids Conductometrically using NaOH solution.
9. Estimation of amount of HCl Potentiometrically using NaOH solution.
10. Estimation of amount of Fe^{+2} Potentiometrically using $KMnO_4$ solution
11. Preparation of Nitrobenzene from Benzene.
12. Synthesis of Aspirin drug and Paracetamol drug.
13. Synthesis of phenol formaldehyde resin.

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TEXT BOOKS

1. J. Mendham and Thomas , "Vogel's text book of quantitative chemical analysis", Pearson education Pvt.Ltd. New Delhi ,6th ed. 2002.
2. Senior practical physical chemistry by B.D.Khosla, V.C.Garg & A.Gulati,; R. Chand & Co. : New Delhi (2011).

SUGGESTED READINGS

1. Dr. Subdharani , "Laboratory Manual on Engineering Chemistry", Dhanpat Rai Publishing, 2012.
2. S.S. Dara , "A Textbook on experiment and calculation in engineering chemistry", S.Chand and Company, 9th revised edition, 2015.

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22MBC02

COMMUNITY ENGAGEMENT

Instruction	3P Hours per week
SEE	Nil
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to

1. Develop an appreciation of Rural culture, life-style and wisdom among the Students.
2. Learn about the various livelihood activities that contribute to Rural economy.
3. Familiarize the Rural Institutions and the Rural Development Programmes in India.

COURSE OUTCOMES: After the completion of this Course, Student will be able to

1. Gain an understanding of Rural life, Culture and Social realities.
2. Develop a sense of empathy and bonds of mutuality with Local Communities.
3. Appreciate significant contributions of Local communities to Indian Society and Economy.
4. Exhibit the knowledge of Rural Institutions and contributing to Community's Socio-Economic improvements.
5. Utilise the opportunities provided by Rural Development Programmes.

Module I Appreciation of Rural Society

Rural life style, Rural society, Caste and Gender relations, Rural values with respect to Community, Nature and Resources, elaboration of 'soul of India lies in villages' (Gandhi), Rural Infrastructure.

Module II Understanding Rural Economy and Livelihood

Agriculture, Farming, Landownership, Water management, Animal Husbandry, Non-farm Livelihood and Artisans, Rural Entrepreneurs, Rural markets, Rural Credit Societies, Farmer Production Organization/Company.

Module III Rural Institutions

Traditional Rural organizations, Self-Help Groups, Panchayati Raj Institutions (Gram Sabha), Gram Panchayat, Standing Committees, Local Civil Society, Local Administration.

Module IV Rural Development Programmes

History of Rural Development in India, Current National Programmes: SarvaShikshaAbhiyan, BetiBhachao, BetiPadhao, Ayushman, Bharat, Swachh Bharat, PM AwasYojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA etc.

TEXT BOOKS:

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015, un.org/sdgs
4. M.P Boraia, Best Practices in Rural Development, Shanlax Publishers, 2016.

Journals:

1. Journal of Rural development (published by NIRD & PR, Hyderabad).
2. Indian Journal of Social Work, (by TISS, Bombay).
3. Indian Journal of Extension Educations (by Indian Society of Extension Education).
4. Journal of Extension Education (by Extension Education Society).
5. Kurukshetra (Ministry of Rural Development, GOI).
6. Yojana (Ministry of Information & Broadcasting, GOI).

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22CSC02

PROBLEM SOLVING AND PROGRAMMING LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to

1. Master the fundamentals of writing Python scrips.
2. Learn Python elements such as variables, flow controls structures, and functions.
3. Discover how to work with lists and sequence data, and files.

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

1. Understand various Python program development Environments.
2. Demonstrate the concepts of Python.
3. Implement algorithms/flowcharts using Python to solve real-world problems.
4. Build and manage dictionaries to manage data.
5. Write Python functions to facilitate code reuse.
6. Use Python to handle files and memory.

CO-PO-PSO Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
1	3	2	1	-	-	-	-	-	-	-	-	1
2	3	3	2	2	3	-	-	-	-	-	-	1
3	2	3	3	2	3	-	-	-	-	-	-	1
4	2	3	3	2	2	-	-	-	-	-	-	1
5	2	3	3	3	3	-	-	-	-	-	-	1
6	2	3	3	3	3	-	-	-	-	-	-	1

Laboratory / Practical Experiments:

1. Explore various Python Program Development Environments.
2. Demonstration of input/output operations.
3. Demonstration of operators.
4. Demonstration of selective control structures.
5. Demonstration of looping control structures.
6. Demonstration of List, Tuple and Set
7. Demonstration of Python Dictionaries.
8. Implementation of searching and sorting techniques.
9. Implementation of string manipulation operations.
10. File handling and memory management operations.

Text Books and References:

1. R.S. Salaria, “Programming for Problem Solving”, First Edition, Khanna Book Publishing Co., Delhi.
2. Jeeva Jose, “Taming Python by Programming”, Revised Edition, Khanna Book Publishing Co., Delhi.
3. Mark Lutz, “Learning Python”, 5th Edition, , O'Reilly Media, Inc.,
4. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes, No Starch Press.
5. “Programming in Python”, R.S. Salaria, Khanna Book Publishing Co., Delhi.

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NPTEL/SWAYAM Course:

1. Introduction to Problem Solving and Programming, Video Lectures, Prof. D Gupta, IIT Delhi.
2. Problem Solving Aspects and Python Programming, Dr. S Malinga, Dr Thangarajan, Dr. S V Kogilavani, Kongu Engineering College.
3. https://www.coursera.org/specializations/python-3-programming.

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22MEC37

ROBOTICS AND DRONES LAB

(Common to All Branches)

Instruction	2T + 2P Hours per week
CIE	100 Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. To develop the students' knowledge in various robot and drone structures and their workspace.
2. To develop multidisciplinary robotics that have practical importance by participating in robotics competitions
3. To develop students' skills in performing spatial transformations associated with rigid body motions, kinematic and dynamitic analysis of robot systems.
4. Through projects done in lab, increase the true hands-on student learning experience and enhance their conceptual understanding, increase students' ability, competence and teamwork skills on dealing with real-life engineering problems

COURSE OUTCOMES: After completion of course, students would be able to

1. Demonstrate knowledge of the relationship between mechanical structures of robotics and their operational workspace characteristics
2. Understand mechanical components, motors, sensors and electronic circuits of robots and build robots.
3. Demonstrate knowledge of robot controllers.
4. Use Linux environment for robotic programming.
5. Write Python scripts to control robots using Python and Open CV.

COURSE ARTICULATION MATRIX

PO#/ CO#	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	P0 10	PO 11	PO 12
O1	3	2	1	1	1	2	1	1	1	2	2	2
O2	2	3	1	2	3	1	1	1	1	2	2	1
CO3	2	2	2	2	2	1	1	1	1	2	2	2
CO4	2	2	1	2	2	2	1	1	1	2	2	2
CO5	1	1	1	1	1	3	3	3	1	3	3	3

LAB EXPERIMENTS:

1. Assembling of robot mechanical components, mounting of motors, sensors, electronic circuits to the chassis.
2. Connecting to electronic circuitry: motor drivers, incremental encoders proximity sensors, micro controller,
3. Different types of batteries, selection of suitable battery for application, safety precaution.
4. Introduction to Linux Command Line Interface: basic file and directory management and other useful commands
5. Controlling robot using Python: i) Move robot using Python code, ii) Make robot move in patterns using Python
6. Robot programming with Sensor inputs: i) Read sensor data using Python, ii) Visualize sensor data using Python, iii) Code robot to avoid obstacles by using sensor data
7. Open CV: i) Create an Image and display an image; ii) Read and change pixel values; iii) Create colored shapes and save image; iv) Extract the RGB values of a pixel; v) Reading and Writing Videos
8. Open CV: i) Extraction of Regions of Interest; ii) Extraction of RGB values of a pixel

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9. Coding robot to work with colors, follow colored objects, identifying shape of the object-oriented
10. Projects: i)Making a line follower robot using a Camera; ii) Writing code for a complex function
11. Assembly of a drone

SUGGESTED READINGS

1. https://www.geeksforgeeks.org/robotics-introduction/
2. https://www.ohio.edu/mechanical-faculty/williams/html/PDF/IntroRob.pdf
3. https://www.idtechex.com/en/research-report/new-robotics-and-drones-2018-2038-technologies-forecasts-players/584
4. https://dronebotworkshop.com/

22EEC02

BASIC ELECTRICAL ENGINEERING LAB

Instruction	2P Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to

1. To acquire the knowledge on different types of electrical elements and to verify the basic electrical circuit laws and theorems.
2. To determine the parameters and power factor of a coil, calculate the time and frequency responses of RLC circuits and to familiarize with measurement of electric power & energy.
3. To determine the characteristics of Transformers, dc, ac machines and switch gear components

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

1. Comprehend the circuit analysis techniques using various circuital laws and theorems.
2. Analyse the parameters of the given coil and measurement of power and energy in AC circuits
3. Determine the turns ration/performance parameters of single-phase transformer
4. Infer the characteristics of DC shunt motor different tests.
5. Illustrate different parts and their function of electrical components, equipment and machines.

CO-PO Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	-	-	2	2	-	-	-	-	2
CO 2	3	2	1	-	-	1	2	-	-	-	-	2
CO 3	3	2	3	-	-	2	2	-	-	-	-	2
CO 4	3	2	2	-	-	2	2	-	-	-	-	2
CO 5	3	2	3	-	-	2	2	-	-	-	-	2

List of Laboratory Experiments/Demonstrations:

1. Verification of KCL and KVL.
2. Verification of Thevenin's theorem.
3. Verification of Norton's theorem.
4. Charging and discharging of Capacitor.
5. Determination of parameters of a choke or coil by Wattmeter Method.
6. Power factor improvement of single-phase AC System.
7. Active and Reactive Power measurement of a single-phase system using
   (i) 3-Ammeter method (ii) 3-Voltmeter method
8. Measurement of 3-Phase Power in a balanced system
9. Calibration of single-phase energy meter.
10. Verification of Turns/voltage ratio of single-phase Transformer.
11. Open Circuit and Short Circuit tests on a given single phase Transformer
12. Brake test on DC Shunt Motor
13. Speed control of DC Shunt Motor
14. Demonstration of Measuring Instruments and Electrical Lab components.
15. Demonstration of Low-Tension Switchgear Equipment/Components
16. Demonstration of cut - out section of Machines like DC Machine, Induction Machine etc.

Note: TEN experiments to be conducted to cover all five Course Outcomes.

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Scheme of Instructions of II Semester of B.Tech. – Chemical Engineering
(In line with AICTE Model Curriculum with effect from AY 2022-23)

DEPARTMENT OF CHEMICAL ENGINEERING

SEMESTER –II

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			SEE in Hours SEE	Maximum Marks		
			L	T	CIE		CIE	SEE	
THEORY									
1	22MTC05	Vector Calculus and Differential Equations	3	1	0	3	40	60	4
2	22PYC07	Physics	3	0	0	3	40	60	3
3	22CEC01	Engineering Mechanics	3	1	0	3	40	60	4
4	22EGC01	English	2	0	0	3	40	60	2
PRACTICAL									
5	22PYC10	Physics Lab	0	0	3	3	50	50	1.5
6	22EGC02	English lab	0	0	2	3	50	50	1
7	22MEC01	CAD AND DRAFTING	0	1	3	3	50	50	2.5
8	22MEC38	Digital Fabrication Lab	0	0	3	3	50	50	1.5
TOTAL			**11**	**3**	**11**				**19.5**

L: Lecture **T: Tutorial** **D: Drawing** **P: Practical**

CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

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22MTC05

VECTOR CALCULUS AND DIFFERENTIAL EQUATIONS (CHEMICAL)

Instruction	3 L+1T per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES: This course aims to

1. To explain scalar and vector functions with its Physical interpretations.
2. To discuss vector line, surface and volume integrals.
3. To explain relevant methods to solve first order differential equations.
4. To discuss the solution of higher order Differential Equations
5. To learn Numerical solution of ODE and Engineering problems.

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

1. Apply the vector differential operators to Scalars and Vector functions.
2. Solve line, surface & volume integrals by Greens, Gauss and Stoke's theorems.
3. Calculate the solutions of first order linear differential equations.
4. Solve higher order linear differential equations.
5. Find solution of algebraic, transcendental and ODE by Numerical Methods.

CO-PO Articulation Matrix:

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	-	-	-	-	-	-	-	2
CO 2	3	3	3	3	-	-	-	-	-	-	-	2
CO 3	3	3	3	3	-	-	-	-	-	-	-	2
CO 4	3	3	3	3	-	-	-	-	-	-	-	2
CO 5	2	2	2	2	-	-	-	-	-	-	-	1

UNIT-I

Vector Differential Calculus and multiple Integrals: Scalar and Vector point functions, vector operator Del, Gradient, Directional derivative, Divergence, Curl, Del applied twice to point functions, Del applied to product of point functions (vector identities), Irrotational fields and Solenoidal fields, Double integral, Change of order of Integration and Triple integrals.

UNIT-II

Vector Integral Calculus: Line integral, Surface integral and Volume integral. Verification of Green's theorem in a plane (without proof), verification of Stroke's theorem (without proof) and Gauss's divergence theorem (without proof).

UNIT-III

First Order Ordinary Differential Equations: Exact differential equations, Equations reducible to exact equations, Linear equation, Bernoulli's equation, Clairaut's equation, Riccati's equation, Orthogonal trajectories, Rate of decay of Radio-active materials**.**

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UNIT-IV

Higher Orders Linear Differential Equations: Higher order linear differential equations with constant coefficients, rules for finding Complementary function, Particular Integral and General solution. Method of variation of parameters, solution of Cauchy- Euler equation, LR and LCR circuits

UNIT-V

Numerical Methods: Solution of Algebraic and transcendental equations by Bisection method, Regula-Falsi method Newton-Raphson method. Numerical Solutions of First Order Ordinary differential equations by Taylor's series method, Euler's method, Modified Euler's method and Runge-Kutta method of fourth order.

TEXT BOOKS:

1. B.S.Grewal, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.

SUGGESTED READING:

1. N.P.Bali and Dr. Manish Goyal, "A text book of Engineering Mathematics", 9th edition, Laxmi Publications, 2017.
2. R.K.Jain, S.R.K.Iyengar, "Advanced Engineering Mathematics", 5th edition, Narosa Publications, 2016.

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22PYC07

PHYSICS
(BIOTECH & CHEMICAL)

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60Marks
CIE	40Marks
Credits	3

COURSE OBJECTIVES: This course aims to

1. Learn the basic concepts of wave nature of light
2. Know about the properties of magnetic and dielectric materials
3. Understand the basics of nanomaterials
4. Familiarize with fundamental ideas of quantum mechanics

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

1. Demonstrate the physical properties of the light.
2. Find the applications of lasers and optical fibers in engineering and technology.
3. Identify different types of magnetic and dielectric materials.
4. Recall the fundamentals of nanomaterials.
5. Apply the ideas of quantum mechanics for related problems

CO-PO Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	3	1	1	1	1	2	2	1	1	2	1	2
C02	3	1	2	1	2	2	2	1	2	2	2	2
C03	2	2	1	1	1	1	1	1	1	2	1	2
C04	3	2	2	2	2	2	2	1	1	2	1	2
C05	3	2	2	2	2	1	2	2	1	2	1	2

UNIT-I

Wave Optics: Huygen's principle–Superposition of waves –Interference of light by splitting of wavefront and amplitude–Fresnel's biprism–Interference in thin films (reflected light) – Newton's rings –Fraunhofer diffraction from a single slit – Double slit diffraction–Concept of N-slits–Diffraction grating and its resolving power. Polarization: Introduction–Malus's law–Double refraction –Nicol's prism–Quarter-wave plate and half-wave plate–Optical activity– Laurent's half shade polarimeter.

UNIT-II

Lasers: Characteristics of lasers– Einstein's coefficients–Amplification of light by population inversion– Ruby laser– He-Ne laser– Semiconductor laser–Applications of lasers in engineering and medicine.

Fiber Optics: Introduction–Construction–Principle–Propagation of light through an optical fiber –Numerical aperture and acceptance angle – Step-index and graded-index fibers –Pulse dispersion –Fiber losses –Fiber optic communication system –Applications.

UNIT-III

Dielectric Materials: Introduction–Dielectric polarization–Types of dielectric polarization: electronic & ionic polarizations (quantitative); orientation & space-charge polarizations (qualitative)–Frequency and temperature dependence of dielectric polarization–Determination of dielectric constant (Schering bridge method)–Ferroelectricity–Barium titanate–Applications of ferroelectrics.

Magnetic Materials: Origin of magnetism –Magnetic moment - Bohr magneton–Classification of magnetic materials: dia, para, ferro, anti-ferro and ferrimagnetic materials– Weiss molecular field theory–Domain theory–Hysteresis curve–Soft and hard magnetic materials–Applications.

UNIT-IV

Nanomaterials: Properties of materials at reduced size–Surface to volume ratio–Quantum confinement–Preparation of nanomaterials: bottom-up approach (sol-gel method) and top-down approach (ball-milling method)–Elementary ideas of carbon nanotubes–Applications of nanomaterials.

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UNIT-V

Quantum Mechanics: Introduction–Planck's' law of black body radiation – Wien's law and Rayleigh-Jean's law from Planck's law – Photoelectric effect – Compton effect –de-Broglie hypothesis –Wave-particle duality – Physical significance of ψ –Born's interpretation of the wave function –Verification of matter waves by Davisson-Germer's experiment –Uncertainty principle – Schrodinger wave equation (time-dependent and time-independent) –Particle in infinite square well potential.

TEXT BOOKS:

1. B. K. Pandey and S. Chaturvedi, *Engineering Physics*, Cengage Publications, 2012.
2. M. N. Avadhanulu and P. G. Kshirsagar, *A Text Book of Engineering Physics*, S. Chand Publications, 2014.
3. M. Arumugam, *Materials Science*, Anuradha Publications, 2015.
4. S. L. Gupta and Sanjeev Gupta, *Modern Engineering Physics*, Dhanpat Rai Publications, 2011.

SUGGESTD READING:

1. R. Murugeshan and Kiruthiga Sivaprasath, *Modern Physics* S. Chand Publications, 2014.
2. V. Rajendran, *Engineering Physics*, McGraw-Hill Education Publications, 2013.
3. P.K. Palanisamy, *Engineering Physics*, Scitech Publications, 2012.
4. V. Raghavan, *Materials Science and Engineering*, Prentice Hall India Learning Private Limited; 6th Revised edition, 2015.

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22CEC01

ENGINEERING MECHANICS

Instruction	3L+1T Periods per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

COURSE OBJECTIVES: This course aims to

1. Understand the resolution of forces and to obtain resultant of all force systems,
2. Understand equilibrium conditions of static loads for smooth and frictional surface
3. Analyse simple trusses for forces in various members of a truss
4. Obtain centroid, centre of gravity for various regular and composite areas and bodies
5. Obtain Moment of inertia for various regular and composite areas and bodies and also to obtain Mass moments of inertia of elementary bodies

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

1. Calculate the components and resultant of coplanar forces system and Draw free body diagrams to analyze the forces in the given structure
2. Understand the mechanism of friction and can solve friction problems
3. Analyse simple trusses for forces in various members of a truss.
4. Determine the centroid of plane areas, composite areas and centres of gravity of bodies.
5. Determine moments of inertia, product of inertia of plane and composite areas and mass moments of inertia of elementary bodies,

CO-PO-PSO Matrix

PO / PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

UNIT – I

Resolution and Resultant of Force System: Basic concepts of a force system. Components of forces in a plane. Resultant of coplanar concurrent force system. Moment of a force, couple and their applications. Resultant of coplanar non-concurrent force system

Equilibrium of force system: Free body diagrams, equations of equilibrium of planar force systems and its applications. Problems on general case of coplanar force systems.

UNIT – II

Theory of friction: Introduction, types of friction, laws of friction, application of friction to a single body & connecting systems. Wedge and belt friction

UNIT – III

Analysis of Simple Trusses: Introduction to trusses, Assumptions, analysis of simple trusses using method of joints and method of sections.

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UNIT– IV

Centroid: Significance of centroid, moment of area, centroid of line elements, plane areas, composite areas, theorems of Pappus & its applications. Center of gravity of elementary and composite bodies

UNIT – V

Moment of Inertia: Definition of MI, Area MI. Polar Moment of Inertia, radius of gyration, transfer theorem, Moment of Inertia of elementary & composite areas, and Product of inertia. Mass moments of inertia of elementary bodies.

TEXT BOOKS:

1. K. Vijay Kumar Reddy and J. Suresh Kumar, Singer's Engineering Mechanics, BS Publications, Hyderabad, 2011.
2. Ferdinand L Singer, Engineering Mechanics, Harper and Collins, Singapore, 1904.

SUGGESTED READING:

1. A. Nelson, Engineering Mechanics, Tata McGraw Hill, New Delhi, 2010.
2. S. Rajashekaran & G. Sankarasubramanyam, Engineering Mechanics, Vikas publications, Hyderabad, 2002.
3. S.B. Junarkar and H.J Shah, Applied Mechanics**,** Charotar publishers, New Delhi, 2001.
4. Basudeb Bhattacharyya, Engineering Mechanics, Oxford University Press, New Delhi, 2008.
5. A K Tayal, Engineering Mechanics, Umesh Publications, New Delhi, 2010

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22EGC01

ENGLISH

(Common to All Branches)

Instruction	2L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

COURSE OBJECTIVES: This course aims to

1. To the role and importance of communication while developing their basic communication skills in English.
2. To basics of writing coherent paragraphs and formal emails.
3. To techniques of writing a précis and formal letters by using acceptable grammar and appropriate vocabulary.
4. To description, definition and classification of processes while enabling them to draft formal reports following a proper structure.
5. To gaining adequate reading comprehension techniques.

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

1. Illustrate the nature, process and types of communication and communicate effectively without barriers.
2. Construct and compose coherent paragraphs, emails and adhering to appropriate mobile etiquette.
3. Apply techniques of precision to write a précis and formal letters by using acceptable grammar and appropriate vocabulary.
4. Distinguish formal from informal reports and demonstrate advanced writing skills by drafting formal reports.
5. Critique passages by applying effective reading techniques

CO-PO-PSO Articulation Matrix

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	1	1	1	1	1	2	3	3	2	3
CO 2	1	1	1	1	-	1	1	1	2	2	1	2
CO 3	-	2	1	1	-	2	1	1	2	2	1	2
CO 4	1	2	1	2	1	2	2	1	2	2	1	2
CO 5	1	2	1	2	1	1	1	1	1	2	1	2

UNIT-I

Understanding Communication in English: Introduction, nature and importance of communication; Process of communication; Types of communication - verbal and non-verbal; Barriers to communication; Intrapersonal and interpersonal communication; Understanding Johari Window.

Vocabulary &Grammar: The concept of Word Formation; Use of appropriate prepositions and articles.

UNIT-II

Developing Writing Skills I:

Paragraph writing. – Structure and features of a paragraph; Cohesion and coherence. Rearranging jumbled sentences. Email and Mobile etiquette.

Vocabulary & Grammar: Use of cohesive devices and correct punctuation.

UNIT-III

Developing Writing Skills II:

Précis Writing; Techniques of writing precisely. Letter Writing – Structure, format of a formal letter; Letter of request and the response

Vocabulary and Grammar: Subject-verb agreement. Use of prefixes and suffixes to form derivatives. Avoiding redundancies.

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UNIT-IV

Developing Writing Skills III:

Report writing – Importance, structure, elements of style of formal reports; Writing a formal report.

Vocabulary and Grammar: Avoiding ambiguity - Misplaced modifiers. Use of synonyms and antonyms.

UNIT-V

Developing Reading Skills:

The reading process, purpose, different kinds of texts; Reading comprehension; Techniques of comprehension – skimming, scanning, drawing inferences and conclusions.

Vocabulary and Grammar: Words often confused; Use of standard abbreviations.

TEXT BOOKS:

1. Language and Life: A Skills Approach, Board of Editors, Orient Black Swan,2017.
2. Swan Michael, Practical English Usage.OUP.1995.

SUGGESTED READINGS:

1. Wood F.T, Remedial English Grammar,Macmillan,2007
2. Zinsser William, On Writing Well, Harper Resource Book, 2001
3. Sanjay Kumar and PushpLata, Communication Skills. Oxford University Press,2011.

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22PYC10

PHYSICS LAB
(Biotech & Chemical)

Instruction	3P Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to

1. Apply theoretical physics knowledge in doing experiments
2. Understand the behaviour of the light experimentally
3. Analyze the physical properties of magnetic and dielectric materials
4. Familiarize with motion of electrons in electric and magnetic fields

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

1. Interpret the errors in the results of an experiment.
2. Demonstrate the wave nature of light experimentally
3. Utilize physical properties of magnetic and dielectric materials for various applications
4. Make use of lasers and optical fibers for engineering applications
5. Explain light induced phenomenon and motion of electrons in electric and magnetic fields

CO-PO Articulation Matrix

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	3	2	2	3	1	3	1	3	3	2	1	2
C02	3	2	1	2	2	2	1	2	2	1	1	3
C03	3	2	3	2	3	1	2	2	3	2	1	2
C04	3	3	2	2	2	1	2	3	2	1	1	3
C05	3	1	2	3	2	1	1	2	2	2	1	2

Experiments

1. Error Analysis : Estimation of errors in the determination of time period of a torsional pendulum
2. Fresnel's Biprism : Determination of wavelength of given monochromatic source
3. Newton's Rings : Determination of wavelength of given monochromatic source
4. Single Slit Diffraction : Determination of wavelength of given monochromatic source
5. Diffraction Grating : Determination of wavelengths of two yellow lines of light of mercury lamp
6. Malus's Law : Verification of Malus's law
7. Double Refraction : Determination of refractive indices of O-ray and E-ray of given calcite crystal
8. Polarimeter : Determination of specific rotation of glucose
9. Laser : Determination of wavelength of given semiconductor laser
10. Optical Fiber : Determination of numerical aperture and power losses of given optical fiber
11. Dielectric constant : Determination of dielectric constant of given PZT sample
12. M & H Values : Determination of magnetic moment M of a bar magnet and absolute value H of horizontal component of earth's magnetic field

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13.	B-H curve	:	Determination of hysteresis loss of given specimen
14.	Planck's constant	:	Determination of Planck's constant using photo cell
15.	e/m of an Electron	:	Determination of specific charge of an electron by J.J. Thomson method

NOTE: A minimum of TWELVE experiments should be done.

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22EGC02

ENGLISH LAB

(Common to All Branches)

Instruction	2P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to

1. To nuances of Phonetics and give them sufficient practice in correct pronunciation.
2. To word stress and intonation.
3. To listen to listening comprehension material for honing their listening skills.
4. To activities enabling them overcome their inhibitions while speaking in English with the focus being on fluency rather than accuracy.
5. To team work, role behavior while developing their ability to discuss in groups and making oral presentations.

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

1. Define the speech sounds in English and understand the nuances of pronunciation in English
2. Apply stress correctly and speak with the proper tone, intonation and rhythm.
3. Analyze listening comprehension texts to enhance their listening skills.
4. Determine the context and speak appropriately in various situations.
5. Design and present effective posters while working in teams, and discuss and participate in Group discussions.

CO-PO-PSO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	-	-	-	-	-	-	-	-	1	1	-	1
CO 2	-	-	-	-	-	1	-	1	2	2	1	2
CO 3	-	-	-	-	-	1	1	1	2	1	1	2
CO 4	1	-	-	-	-	1	2	2	2	3	1	3
CO 5	1	1	1	1	1	2	2	2	3	3	2	3

EXERCISES

1. **Introduction to English Phonetics**: Introduction to auditory, acoustic and articulatory phonetics, organs of speech: the respiratory, articulatory and phonatory systems.
2. **Sound system of English**: Phonetic sounds and phonemic sounds, introduction to international phonetic alphabet, classification and description of English phonemic sounds, minimal pairs . The syllable: types of syllables, consonant clusters.
3. **Word stress**: Primary stress, secondary stress, functional stress, rules of word stress.
4. **Rhythm & Intonation** : Introduction to Rhythm and Intonation. Major patterns, intonation of English with the semantic implications.
5. **Listening skills** – Practice with Software available in (K-van solutions)
6. **Public speaking –** Speaking with confidence and clarity in different contexts on various issues.
7. **Group Discussions -** Dynamics of a group discussion, group discussion techniques, body language.
8. **Pictionary –** weaving an imaginative story around a given picture.
9. **Information Gap Activity –** Writing a brief report on a newspaper headline by building on the hints given
10. **Poster presentation –** Theme, poster preparation, team work and representation.

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SUGGESTED READING

1. T Balasubramanian. A Textbook of English Phonetics for Indian Students, Macmillan,2008.
2. J Sethi et al. A Practical Course in English Pronunciation (with CD), Prentice Hall India,2005.
3. PriyadarshiPatnaik. Group Discussions and Interviews, Cambridge University Press Pvt Ltd2011
4. ArunaKoneru, Professional Speaking Skills, Oxford University Press,2016

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22MEC01

CAD AND DRAFTING

Instruction	1 T + 3 D Hours per week
Duration of SEE	3Hours
SEE	50Marks
CIE	50Marks
Credits	2.5

COURSE OBJECTIVES: This course aims to

1. To get exposure to a cad package and its utility.
2. Understanding orthographic projections.
3. To visualize different solids and their sections in orthographic projection
4. To prepare the student to communicate effectively by using isometric projection.
5. To prepare the student to use the techniques, skills, and modern tools necessary for practice.

COURSE OUTCOMES: At the end of the course, the Students are able to

1. Become conversant with appropriate use of CAD software for drafting.
2. Recognize BIS, ISO Standards and conventions in Engineering Drafting.
3. Construct the projections of points, lines, planes, solids
4. Analyse the internal details of solids through sectional views
5. Create an isometric projections and views

CO-PO-PSO Correlation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	2	-	1	2	3	1	3
CO2	3	2	2	1	2	2	-	1	2	2	1	2
CO3	3	3	2	1	2	2	-	1	2	2	1	2
CO4	3	3	3	2	2	2	-	1	2	2	1	2
CO5	3	2	2	1	2	2	-	1	2	2	1	2

LIST OF EXERCISES:

1. Introduction to CAD package: Settings, draw, modify tools, dimensioning and documentation
2. Construction of Conic Sections by General method
3. Orthographic projection: Principles, conventions, Projection of points
4. Projection of straight lines: Simple position, inclined to one plane
5. Projection of straight lines inclined to both the planes (without traces and mid-point)
6. Projection of planes: Perpendicular planes
7. Projection of planes: Oblique planes
8. Projection of solids: Simple position
9. Projection of solids: Inclined to one plane
10. Sections of solids: Prism, pyramid in simple position
11. Sections of solids: Cone and cylinder in simple position
12. Isometric projections and views
13. Conversion of isometric views to orthographic projections and vice-versa.

TEXT BOOKS:

1. N.D.Bhatt, “Elementary Engineering Drawing”, Charotar Publishers, 2012.
2. K.Venugopal, “Engineering Drawing and Graphics + AutoCAD”, New Age International Pvt.Ltd, 2011.
3. Basanth Agrawal and C M Agrawal, “Engineering Drawing”, 2/e, McGraw-Hill Education (India) Pvt. Ltd.

SUGGESTED READING:

1. Shaw M.B and Rana B.C., “Engineering Drawing”, 2/e, Pearson, 2009.
2. K.L. Narayana and P.K. Kannaiah, “Text Book of Engineering Drawing”, Scitech Publications, 2011.

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22MEC38

DIGITAL FABRICATION LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES: This course aims to

1. Give a feel of Engineering Practices & develop holistic understanding of various Engineering materials and Manufacturing processes.
2. Develop skills of manufacturing, safety, precision, quality, intelligent effort, optimization, positive &team work attitude to get things right the first time.
3. Provide basic knowledge of Steel, Plastic, Composite and other materials for suitable applications.
4. Study of Principle and hands on practice on techniques of fabrication, welding, casting, manufacturing, metrology, and allied skills.
5. Advance important hard & pertinent soft skills, productivity, create skilled manpower which is cognizant of industrial workshop components and processes and can communicate their work in a technical, clear and effective way.

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

1. Understand safety measures to be followed in workshop to avoid accidents.
2. Identify various tools used in carpentry, house wiring and plumbing.
3. Make a given model by using workshop trades like carpentry, plumbing, House wiring and 3d modeling using solid works software for Additive Manufacturing.
4. Perform pre-processing operations on STL files for 3D printing, also understand reverse engineering process.
5. Conceptualize and produce simple device/mechanism of their choice.

CO-PO-PSO Correlation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
O1	1	-	-	-	-	-	-	-	-	-	-	1
CO2	1	-	-	-	1	-	-	-	-	-	-	2
CO3	2	1	1	1	3	-	1	-	-	-	-	2
CO4	2	2	2	1	3	-	-	-	-	-	-	2
CO5	3	2	1	-	3	-	-	-	-	-	-	2

LIST OF EXERCISES:

Group-1

1. To make a lap joint on the given wooden piece according to the given dimensions.
2. To make a dove tail-joint on the given wooden piece according to the given dimensions.
3.
    i. Wiring of one light point controlled by one single pole switch, a three pin socket controlled by a single pole switch
    ii. Wiring of two light points connected in series and controlled by single pole switch. Verify the above circuit with different bulbs. Wiring of two light points connected in parallel from two single pole switches and a three pin socket
4. Stair case wiring-wiring of one light point controlled from two different places independently using two 2-way switches.
5. To make external threads for GI pipes using die and connect the GI pipes as per the given diagram using taps, couplings & bends.
6.
    a. A. To connect the GI pipes as per the given diagram using, couplings, unions, reducer & bends.

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b. To connect the GI pipes as per the given diagram using shower, tap & valves and Demonstrate by giving water connection

Group- 2

1. To Study the method of Additive Manufacturing process using a 3D printer
2. To create a 3D CAD model of a door bracket using a modeling software
3. To Print a door bracket using an extruder type 3D Printer.
4. To create a 3D CAD model by reverse Engineering
5. To Design an innovative component using the CAD software
6. To Print the selected innovative component by the students using a 3D printer

TEXT BOOKS:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology, Vol. I, 2008 and Vol. II, Media promoters and publishers private limited, Mumbai, 2010.
2. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
3. Sachidanand Jha, 3D PRINTING PROJECTS: 200 3D Practice Drawings For 3D Printing On Your 3D Printer, June 7, 2019.

SUGGESTED READING:

1. Gowri P. Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Oliver Bothmann , 3D Printers: A Beginner's Guide , January 1, 2015

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20MTC08

PARTIAL DIFFERENTIAL EQUATIONS AND STATISTICS

(For CIVIL/MECH/PROD/CHEM)

Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
CIE	40 Marks
Credits	4

Course Objectives:

1. To learn Numerical solution of ODE and Engineering problems.
2. To form PDE and to find its solution.
3. To know the model of wave and heat equations.
4. Able to fit the hypothetical data using probability distribution.
5. To learn fitting of distribution and predicting the future values.

Course Outcomes: On successful completion of this course the students shall be able to

1. Find solution of initial value problems of ODE by Numerical Method.
2. Solve Linear and Non-Linear PDE‟s.
3. Solve One-Dimension Wave and Heat equations and Two Dimension Laplace equation.
4. Use the basic probability for fitting the Random phenomenon.
5. Analyze the random fluctuations of probability distribution and Principles of Least Squares approximations for the given data.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1		1	1	-	-	1	1	1
CO2	2	2	-	-	-	1		1	1	-	-	1	2	1
CO3	2	2	-	-	-	1		1	1	-	-	1	1	-
CO4	2	2	-	-	-	1		1	1	-	-	1	-	-
CO5	2	2	-	-	-	1		1	1	-	-	1	2	2

UNIT-I: Numerical Methods

Solution of Algebraic and transcendental equations by Bisection method, Regula-Falsi method Newton-Raphson method. Numerical Solutions of First Order Ordinary differential equations by Taylor‟s series method, Euler‟s method, Modified Euler‟s method and Runge-Kutta method of fourth order.

UNIT-II: Partial Differential Equations

Formation of Partial Differential Equations, Linear Equations of First Order (Lagrange‟s Linear Equations), Solution of First Order Non-linear Partial Differential Equation (Standard forms) and Charpits Method.

UNIT-III: Applications of Partial Differential Equations

Solution by Method of Separation of Variables, Solution of One dimensional Wave equation, Solution of One dimensional Heat equation, Solution of Two dimensional Laplace equation and its related problems.

UNIT-IV: Basic probability

Basic probability, Conditional probability, Baye‟s theorem. Random variable, Discrete probability distribution

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and Continuous probability distribution. Expectation, Addition and Multiplication theorem of expectation, properties of variance, Moments (Moments about the mean and moments about a point)

UNIT-V: Probability Distributions and Curve Fitting

Poisson distribution,MGF and Cumulants of the Poisson distribution, Normal distribution,characteristics of Normal distribution MGF and CGF of Normal distribution, Areas under normal curve. Correlation, Coefficient of Correlation and Lines of Regression. Curve fitting by the Method of Least Squares, Fitting of Straight lines, Second degree parabola, exponential and Growth curves.

Textbooks:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, 2017.
2. S.C.Gupta, V.K.Kappoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 2014.

Suggested Reading:

1. Erwin kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
2. S. J. Farlow, "Partial Differential Equations for Scientists and Engineers", Dover Publications, 1993.
3. Sheldon Ross, "A First Course in Probability", 9th Edition, Pearson publications, 201

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20CSC06

BASICS OF DATA STRUCTURES

(Common for all Programmes except CSE & IT)

Instruction	2 L Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	60 Marks
CIE	40 Marks
Credits	2

Prerequisites:
Basic knowledge of programming language such as C or C++ is preferred (but not mandatory) and some mathematical maturity also will be expected.

Course Objectives: To introduce

1. Basic linear and non-linear data structures.
2. Analyzing the performance of operations on data structures.
3. Different sorting and searching techniques and their complexities.

Course Outcomes: The students will be able to

1. Identify various data structures, searching & sorting techniques and their applications.
2. Describe the linear and non-linear data structures, searching and sorting techniques.
3. Apply suitable data structures to solve problems.
4. Analyze various searching and sorting techniques.
5. Evaluate the linear and non-linear data structures.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-	1	1
CO4	2	3	1	-	-	-	-	-	-	-	-	-	1	1
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	1

UNIT – 1

Introduction: Data Types, Data structures, Types of Data Structures, Operations, ADTs, Algorithms, Comparison of Algorithms- Complexity- Time and space tradeoff.

Recursion: Introduction, format of recursive functions, recursion Vs. Iteration, examples.

UNIT – 2

Linked Lists: Introduction, Linked lists and types, Representation of linked list, operations on linked list, Comparison of Linked Lists with Arrays and Dynamic Arrays.

UNIT – 3

Stacks and Queues: Introduction to stacks, applications of stacks, implementation and comparison of stack implementations. Introduction to queues, applications of queues and implementations, Priority Queues and

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applications

Searching and Sorting: Linear searching, binary Searching, sorting algorithms- bubble sort, selection sort, quick sort, heap sort

UNIT – 4

Trees: Definitions and Concepts, Operations on Binary Trees, Representation of binary tree, Conversion of General Trees to Binary Trees, Representations of Trees, Tree Traversals, Binary search Tree.

Unit –5

Graphs: Introduction, Applications of graphs, Graph representations, graph traversals, Minimal Spanning Trees

Text Books:

1. NarasimhaKarumanchi "**Data Structures and Algorithms Made Easy**", CareerMonk Publications, 2017
2. E.Horowitz ,S. Sahni and Susan Anderson-Freed, "**Fundamentals of Data structures in C**", Silicon Pr; 2 edition (1 August 2007)
3. ReemaThareja, "**Data Structures using C**",Oxford, 2014

Suggested Reading:

1. https://www.tutorialspoint.com/data_structures_algorithms/index.htm
2. https://www.edx.org/course/foundations-of-data-structures
3. https://sites.google.com/site/merasemester/data-structures/data-structures-1#DS
4. https://www.cs.usfca.edu/~galles/visualization/Algorithms
5. https://www.coursera.org/specializations/data-structures-algorithms

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20CHC01 CHEMICAL ENGINEERING THERMODYNAMICS-I

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course will help the students to understand the:

1. Basic thermodynamic laws and Principles.
2. Concept of energy conservation through the study of the First and Second laws of thermodynamics.
3. Concept of Entropy and its importance in energy conversion.
4. Chemical Engineering problems involving various types of systems and processes.
5. Application of Thermodynamics to flow process.

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

1. Understand the fundamental concepts of thermodynamics to engineering applications.
2. Understand the relation between the measurable nature of P, V, T and the un-measurable nature of H,U,A, G
3. Calculate the thermodynamic properties of real gases by using EOS.
4. Understand and analyze the various thermodynamic processes involving ideal gases.
5. Analyze the power cycles; refrigeration cycles, and liquefaction processes.
6. Apply the energy balance equations to Open and Closed systems and also to evaluate the thermodynamic efficiency of nozzles, turbines and compressors.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	-	-	-	-	-	-	-	-	2	-
CO2	2	1	2	-	-	-	-	-	-	-	-	-	1	-
CO3	-	2	1	2	-	-	-	-	-	-	-	-	-	-
CO4	2	3	1	2	-	-	-	-	-	-	-	-	-	-
CO5	-	3	1	1	-	-	-	-	-	-	-	-	-	2
CO6	2	1	1	-	-	-	-	-	-	-	-	-	-	1

UNIT – I: The First Law of thermodynamics and Other Basic Concepts: Joule"s Experiments – Internal Energy - Formulation of the first law of the thermodynamics ,Energy balance closed systems- the thermodynamic state and state functions - Enthalpy - The steady state flow processes; Equilibrium - The phase rule - The Reversible processes - Constant V and constant P processes and Heat capacity.
Volumetric Properties of Pure Fluids: PVT behavior of pure substances, Ideal gas, Virial equations and their use in the calculation of P-V-T Properties; Cubic equations of state (Van der Waals and Redlich-Kwong), generalized correlations for gases.

UNIT – II: The Second law of thermodynamics: Statement of the second law, Heat engines and Heat Pumps, thermodynamic temperature scales, Carnot Engine with Ideal-Gas-State Working Fluid, Entropy, entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, entropy from the microscopic view point.

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UNTI – III: Thermodynamic properties of fluids; Fundamental property relationships among thermodynamic properties for a homogenous phase of constant composition; Maxwell relations, Residual properties; Residual properties from the virial equations of state, Generalized Property Correlations for Gases, Two-phase systems. Thermodynamic diagrams.

UNIT – IV: Production of Power from Heat: The Steam power plant; Carnot cycle; Rankine cycle; Internal Combustion engines -Otto engine, Diesel engine. **Refrigeration and Liquefaction**: The Carnot refrigerator, the vapor - compression cycle; comparison of Refrigeration cycles; the choice of refrigerant; absorption refrigeration; the heat pump; various processes for liquefaction.

UNIT V: Applications of Thermodynamics to Flow Processes: Energy balances for steady state flow process; Duct flow of compressible fluids, flow processes-Nozzles, turbines, Compressors and Pumps; Entropy balance for Open systems, Calculation of Ideal work and lost work for flow processes.

Text Books:

1. J M Smith and H C Van Ness and M M Abbott, Introduction to Chemical Engineering Thermodynamics (in SI units) , 8th edition, Mc-Graw Hill International Edition, 2018.
2. K.V.Narayanan, A Textbook of Chemical Engineering Thermodynamics, PHI Pvt. Ltd., 2013.

Suggested Reading:

1. Gopinath Halder, Introduction to Chemical Engineering Thermodynamics, 2nd Edition,2009
2. Y V C Rao, Chemical Engineering Thermodynamics, Universities Press, 1997
3. M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engg. Thermodynamics, 8th Edition, Willey, 2018.

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20CHC02 **FLUID MECHANICS**

Instruction	3L+1T Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives: This course will help the students to understand the

1. Fluid flow phenomena for incompressible and compressible fluids.
2. Conservation of momentum principles to fluid flow.
3. Flow in Pipes, Channels and flow past immersed bodies.
4. Concepts of Compressible Fluids and Non Newtonian fluids
5. Fluidization phenomena and methods for transporting the fluids

Course outcomes: At the completion of this course, students will be able to

1. Distinguish different types of fluids, manometers
2. Apply Shell balances to illustrate fluid flow phenomena
3. Identify the concepts of incompressible flow in pipes, channels and associated frictional losses
4. Explain the concept of fluidization and flow through packed beds.
5. Choose the types of pumps for different fluids under different conditions such as toxic, acidic, slurry type.
6. Identify equipment to be used to measure fluid flow based on their properties

CO –PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	-	-	-	-	-	-	-	1	2	2
CO2	3	3	2	1	-	-	-	-	-	-	-	1	2	2
CO3	3	3	2	2	1	-	-	-	-	-	-	1	2	2
CO4	3	3	2	1	-	-	-	-	-	-	-	1	2	2
CO5	3	3	2	1	-	-	-	-	-	-	-	1	2	2
CO6	3	3	2	1	-	-	-	-	-	-	-	1	2	2

UNIT - I

Fluid Flow Phenomena and Fluid Statics: Definition of fluid, shear rate and shear stress, Newtonian and Non-Newtonian fluids, Time dependent flow, viscosity and momentum flux, compressible, incompressible, real and ideal fluids, viscosities of gases and liquids, Laminar and Turbulent flows, Reynolds experiment, Boundary layers, Hydrostatic equilibrium, U-tube manometer, inclined manometer and two fluid manometer and inverted manometer.

UNIT - II

Basic Equations of Fluid Flow: path lines, stream lines and stream tube, mass balance–equation of continuity, one dimensional flow, mass velocity, differential momentum balance- equations of motion, Couette flow, macroscopic momentum balances, momentum of stream and momentum correction factor, layer flow with free surface. Mechanical energy equation-Bernoulli equation- corrections for effects of solid boundaries, kinetic energy correction factor, corrections for fluid friction, pump work in Bernoulli equation.

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UNIT - III

Incompressible Flow in Pipes and Channels and Frictional Losses: Shear stresses and skin friction, fanning friction factor, flow in noncircular channels, laminar flow of Newtonian and Non-Newtonian fluids, velocity distribution, Hagen- Poiseuille equation, Turbulent flow, universal velocity distribution, Roughness, Moody"s friction factor chart. Pipes and valves, fittings. Friction losses due to sudden expansion and contraction, Effects of fittings and valves, form frictional losses in the Bernoulli Equation. Dimensional analysis and Buckingham π - theorem and Rayleigh theorem its applications and limitations.

UNIT – IV

Compressible Fluids and Non Newtonian fluids (with Differential Pressure estimation) Flow past immersed bodies and Fluidization, Potential flow, vortisity. Differential analysis: mass and momentum balances, Navier-Stokes equation, Unidirectional flow, Viscous flow, Stokes law, Skin drag and pressure drag and drag coefficient, Flow through packed beds of solids – Kozeny Carman equation, Burke-Plummer equation and Ergun equation. Boundary layer theory, Blasius solution, Boundary layer separation, Drag and lift force on immersed body

UNIT – V

Transportation and Metering of Fluids: Centrifugal and Positive Displacement Pumps, Characteristics of pumps, selection and design of pumps, suction lift and cavitation, NPSH, Flow meters- Venturi meter, orifice meter, Pitot tube, Rotameter, Notches and Weirs, Compressors and blowers.

Text Books

1. W. L. McCabe, J. C. Smith and P.Harriott , Unit Operations of Chemical Engineering, 7th Ed., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005.
2. C.J.Geankopolis, "Transport processes and unit operations", 3rd Ed., Prentice Hall Publishers, USA, 1993.

Suggested Readings:

1. James O. Wilkes, "Fluid Mechanics for Chemical Engineers with Micro fluids and CFD", 2nd Ed., University of Michigan, Prentice Hall Intl., 2006.
2. Kurmi, R.S., "Hydraulics, Fluid Mechanics and Hydraulic Machines", 20th Ed., S. Chand and Company Pvt. Ltd., New Delhi, 2014.

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20CHC03 **MATERIAL ENERGY BALANCE CALCULATIONS**

Instruction	3L+1T Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives: This course helps the students to understand the

1. Basis for all further chemical engineering courses that are part of the curriculum.
2. Basic calculations of process engineering.
3. Material balance calculations for with and without chemical reactions.
4. Analysis methods for identifying vapors and liquids
5. Energy balance calculations and its importance.

Course Outcomes: Upon completing this course, students will be able to:

1. Convert physico-chemical quantities from one system of units to another and identify basis of calculation
2. Solve material balance problems without chemical reactions.
3. Solve material balance problems with chemical reactions
4. Solve material balance problems with recycle, purge and bypass
5. Analyze the ideal and real behavior of gases, vapors and liquids
6. Solve energy balance problems with and without chemical reaction

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	2	-	-	-	2	2	1	1	3	2
CO2	3	2	3	3	2	-	-	-	2	2	1	1	3	2
CO3	3	2	3	3	2	-	-	-	2	2	1	1	3	2
CO4	3	2	3	3	3	-	-	-	2	2	1	1	3	2
CO5	3	2	3	3	3	-	-	-	2	2	1	1	3	2
CO6	3	3	3	3	3	-	-	-	2	2	1	1	3	2

UNIT-I

Introduction to process calculations: Units and Dimensions - Conversion of Units; Process and process variables – process flow sheet, process unit, process streams, density, specific gravity, specific gravity scales, mass and volumetric flow rates, mole concept, molecular and equivalent weights; Composition of streams; other expressions for concentration

UNIT-II

Material Balance: Introduction, Solubility, dissolution and crystallization (single solute systems) – Solving material balance problems without chemical reaction. Unit operations like absorption, distillation, evaporation, crystallization, leaching, and extraction, drying and mixing units under steady state conditions.

UNIT-III

Material Balance with Chemical Reaction: Material Balance with chemical reaction, Concept of stoichiometry and mole balances, examples, including combustion-Proximate and ultimate analysis of coal and analysis of flue

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gas. Material balances for by-pass, recycle and purge Operations.

UNIT-IV

Gases, Vapours and Liquids: Equations of state, mixture of ideal gases-Dalton‟s and Amagat‟s laws, Vapour pressure, Clausius- Clapeyron equation, Cox chart, Duhring‟s plot, Raoult‟s law. Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use.

UNIT-V

Energy Balances: Thermophysics -Heat Capacity, Calculation of enthalpy changes without and with phase change, Heat of solution and mixing; Energy balances without chemical reactions; Thermochemistry - Energy balances with chemical reactions - Standard heat of reaction, formation and combustion, Hess Law, Effect of temperature; Simultaneous material and energy balances - Adiabatic flame temperature.

Text Books:

1. Himmelblau, D. M., Riggs, J. B. “Basic Principles and Calculations in Chemical Engineering”, Eighth Ed., Pearson India Education Services,
2. Hougen O.A., Watson K.M., Ragatz R.A., Chemical Process Principles (Part-I): Material and Energy Balances, 2nd Edition, CBS Publishers, 2004

Suggested Reading:

1. Bhatt, B. I., Vora, S. M., “Stoichiometry”, Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2004
2. Narayanan K.V., Lakshmikutty B., Stoichiometry and Process Calculations, PHI Learning Pvt. Ltd., 7th Edition, 2015.
3. Sikdar, D. C., “Chemical Process Calculations”, Prentice Hall of India, 2013.
4. Felder, R. M.; Rousseau, R. W., “Elementary Principles of Chemical Processes”, Third Edition, John Wiley & Sons, 2000

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20CHC04 **MECHANICAL UNIT OPERATIONS**

Instruction	3L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course helps the students to understand the:

1. Principles of size reduction using various equipment‟s.
2. Techniques for separating solids based on size by different methods.
3. Different kinds of filtration units.
4. Various aspects of Mixing and Agitation of solids and liquids.

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

1. Decide the transport of solids based on their properties.
2. Select equipment for industrial application with respect to size reduction.
3. Design equipment for industrial application with respect to separation of solids.
4. Decide the necessary equipment to screen different particles based on their properties.
5. Apply different filtration techniques for industrial application
6. Identify the suitable technique for blending and mixing of liquids and solids.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	1	2	2	1	-	1	1	3	2
CO2	3	3	2	2	2	1	2	1	1	-	1	1	3	3
CO3	3	3	3	3	3	1	2	2	2	1	1	2	3	3
CO4	3	3	2	3	2	1	2	2	1	-	1	1	3	2
CO5	3	3	2	2	3	1	2	1	1	-	1	1	3	3
CO6	3	3	2	3	3	1	2	2	1	-	1	1	3	2

UNIT-I

Particle Technology: Characteristics of solid particles – screen analysis, Differential and cumulative mean diameters for mixture of particles, properties of particulate masses. Handling and transport of solids, storage equipment for mechanical conveyors and elevators, pneumatic transport.

Communition: principles of Communition laws and energy requirements. Size reduction - Description and working of crushing and grinding equipment – jaw, Gyratory and Roll crusher, Hammer mill, Rod mill and Ball mill, Ultra-fine grinders. Cutting machines – Open and closed circuit grinding.

UNIT-II

Size Separation: Industrial screening equipment -Grizzlies, Tromels and gyratory. Capacity and effectiveness of screen. Flotation, Frothing and dispersing agents, magnetic separation, electrostatic precipitators.

Particle dynamics: Principles of motion of particles through fluids, drag coefficient for spheres, motion of spherical particles. Free and hindered settling. Classifiers, Jigging. Sorting classifiers – Heavy medium and differential settling methods. Principle and working of cyclones and hydro cyclones.

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UNIT-III

Solid-Liquid Separation Operations: Flocculation – Batch sedimentation – Thickeners – Thickener design. Principles of centrifugal sedimentation – Centrifugal classifiers and decanters – tubular, disc, bowl and scroll centrifuges.

UNIT-IV

Filtration: Equations for batch filtration. Description of plate and frame filter press, shell and leaf filters. Rotary vacuum drum filters. Membrane filtration, Centrifugal filters. Filter aids, Theory of constant rate and centrifugal filtration.

UNIT-V

Mixing and Agitation:

Agitation equipment for liquids – Circulation velocities and power consumption in agitated vessels. Scale up of agitation equipment – Equipment for blending and mixing of liquids – Suspension of solid particles. Critical speed – Dispersion of gas in liquids. Gas holdup and power requirement .Dispersion of liquids in liquids. Equipment for mixing of solids and pastes – Mixers for dry powders – mixing index.

Text Books:

1. W. L. McCabe, J. C. Smith and P. Harriott , Unit Operations of Chemical Engineering, 7thEd., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005.
2. Foust A.S, Wenzel L.A., "Principles of Unit Operations", 2nd Ed., John Wiley and sons, New York, 1981.

Suggested Reading:

1. Coulson, J. M., and Richardson, J. F., "Chemical Engineering Series", Vol. 2, 4thEd., Pergamon Press Oxford, UK, 1991.
2. C M Narayanan and B C Bhattacharya, "Mechanical Unit Operation for Chemical Engineering", Khanna Publishers, 3rd Ed, 2011.

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20CSC07

Basics of Data Structures Lab

(Common for all Programmes except CSE & IT)

Instruction	2 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	50 Marks
Credits	1

Pre-requisites: Any Programming Language

Course Objectives:

1. Design and construct simple programs by using the concepts of Data structures as abstract data type.
2. To have a broad idea about how efficiently pointers can be used in the implement of data structures.
3. To enhance programming skills while improving their practical knowledge in data structures.
4. To strengthen the practical ability to apply suitable data structure for real time applications.

Course Outcomes: The students will be able to

1. Implement the abstract data type.
2. Demonstrate the operations on stacks, queues using arrays and linked lists
3. Apply the suitable data structures including stacks, queues to solve problems
4. Analyze various searching and sorting techniques.
5. Choose proper data structures, sorting and searching techniques to solve real world problems

CO-PO-PSO Matrix

BDS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	2	1	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-	-	-
CO4	2	3	1	-	-	-	-	-	-	-	-	-	-	-
CO5	2	3	2	-	-	-	-	-	-	-	-	-	-	-

List of Experiments

1. Implementation of operations on arrays
2. Implementation of Stack.
3. Implementation of Queue.
4. Implementation of basic operations on Single Linked List.
5. Implementation of Searching techniques.
6. Implementation of Sorting Techniques
7. Case study like Banking System, Students Marks Management, Canteen Management, Library Management etc

Text Books

1. Brian W Kernighan, Dennis Ritchie, C Programming Language, PH PTR, 2nd Edition.
2. Richard M Reese, Understanding and Using C Pointers, O`Reily , 2013.

Web Links

https://nptel.ac.in/courses/106102064/
https://www.udemy.com/algorithms-and-data-structures-in-python/

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20CHC05 **FLUID MECHANICS LAB**

Instruction	3 P Hours per week
Duration of SEE	3Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course objectives: This course will help the students to

1. Gain knowledge in verification of principles of fluid flow
2. Achieve training to use various flow measuring devices
3. Practice estimating frictional losses
4. Accumulate knowledge in measuring pressure, discharge and velocity of fluid flow.
5. Gain knowledge in usage of pumps

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

1. Identify variable area flow meters and variable head flow meters
2. Explain the fluid flow characteristics.
3. Demonstrate the Bernoulli principle
4. Analyze the flow of fluids through closed conduits, open channels
5. Interpret the characteristics of pumps
6. Analyze the flow in packed beds.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	2	-	-	-	1	2	1	-	1	2	2
CO2	2	2	-	2	-	-	-	1	2	1	-	1	2	2
CO3	2	2	-	2	-	-	-	1	2	1	-	1	2	2
CO4	2	2	-	2	-	-	-	1	2	1	-	1	2	2
CO5	2	2	-	2	-	-	-	1	2	1	-	1	2	2
CO6	2	2	-	2	-	-	-	1	2	1	-	1	2	2

List of experiments

(Minimum of 8 experiments in the list are to be performed)

1. Determination of discharge coefficient for Orifice meter and Venturi meter and their variation with Reynolds number
2. Determination of weir meter constant K for V notch / rectangular notch
3. Determination of discharge coefficient for Mouth piece under constant head and variable head
4. Calibration of rotameter and study of variation of flow rate with tube to float diameter.
5. Determination of friction factor for flow through straight pipes of different diameters and study of variation of friction factor with Reynolds number
6. Determination of friction losses in pipe fittings

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7. Determination of characteristic curves for centrifugal pumps
8. Determination of friction factor for packed beds
9. Determination of velocity profile of air in pipe by pitot tube
10. Determination of critical velocity by Reynolds Experiment

Text Books:

W. L. McCabe, J. C. Smith and P. Harriott , Unit Operations of Chemical Engineering, 7 th Ed., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005.

Suggested Reading:

Kurmi, R.S., "Hydraulics, Fluid Mechanics and Hydraulic Machines", 20th Ed., S. Chand and Company Pvt.Ltd., New Delhi, 2014.

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20CHC06 **MECHANICAL UNIT OPERATIONS LAB**

Instruction	3 P Hours per week
Duration of SEE	3Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives: This course will

1. Provide students the opportunity to acquire practical skills in mechanical unit operations.
2. Introduce students to the importance and principles of material handling.
3. Provide an overall view of size reduction equipment.
4. Demonstrate the techniques of separating solids based on size by different methods.
5. Impart the concept and functioning of the filtration unit.

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

1. Understand mechanical unit operations and their role in process industries.
2. Understand the nature of solids, their characterization, handling and the processes involving solids.
3. Analyze the performance of size reduction equipment and calculate the power and efficiency requirements.
4. Understand the principle, construction and operation of various classification equipment.
5. Analyze Solid liquid separation in industrial equipment based on settling, density and centrifugal force.
6. Design and operate filtration equipment.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	1	2	3	3	3	1	1	3	3
CO2	3	3	2	2	2	1	2	3	3	3	1	1	3	3
CO3	3	3	3	3	2	1	2	3	3	3	2	2	3	3
CO4	3	3	2	3	2	1	2	3	3	3	2	1	3	3
CO5	3	3	2	2	2	1	2	3	3	3	2	1	3	3
CO6	3	3	2	3	2	1	2	3	3	3	2	1	3	3

List of experiments

(Minimum of 8 Experiments in the list are to be performed)

1. Verification of the laws of size reduction using Jaw crusher.
2. Verification of the laws of crushing using drop weight crusher and determination of work index.
3. Determination of laws of crushing in a pulverizer.
4. Verification of the laws of crushing and determine angle of nip using roll crusher.
5. Verification of the comminution laws and critical speed of a ball mill.
6. Analysis of various sizes of given material by sieve analysis and determination of cumulative and differential analysis.

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7. Determination of the specific cake resistance and medium resistance in a vacuum filter or plate and frame filter press.
8. Calculation of the effectiveness of screen in horizontal and inclined position (vibrating screens)
9. Determination of separation factors of air and hydraulic classifiers.
10. Determine settling rate classification of particles using cyclone separator and to determine the efficiency.
11. Determination of the froth flotation characteristics in mineral concentration.

Text Books:

1. W. L. McCabe, J. C. Smith and P.Harriott , Unit Operations of Chemical Engineering, 7thEd., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005.
2. Foust A.S, Wenzel L.A., "Principles of Unit Operations", 2nd Ed., John Wiley and sons, NewYork, 1981.

Suggested Reading:

1. Coulson, J. M., and Richardson, J. F., "Chemical Engineering Series", Vol. 2, 4thEd.,Pergamon Press Oxford, UK, 1991.
2. C M Narayanan and B C Bhattacharya, "Mechanical Unit Operation for Chemical Engineering",Khanna Publishers, 3rd Ed, 2011.

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20CHC07 **CHEMICAL REACTION ENGINEERING-I**

Instruction	3 L+1T Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Course Objectives: This course helps the students to

1. Analyze experimental kinetic data to determine reaction mechanisms.
2. Design different types of chemical reactors (Batch, Tube, and CSTR).
3. Assess the advantages and disadvantages of reactor types.
4. Apply the concepts of heat effects on reactions.
5. Understand the concepts of non ideal reactors.

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

1. Classify reactions, rate and forms of rate expressions.
2. Summarize fundamentals of kinetics and interpret the data including relationships between moles, Concentration, extent of reaction and conversion.
3. Explain Batch, CSTR, and PFR performance equations from general material balances for homogeneous and heterogeneous reactions.
4. Identify the right reactor among single, multiple, recycle reactors etc
5. Determine the effect of temperature on reactor performance for adiabatic and non adiabatic operation.
6. Analyze the non ideality of reactors.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	-	1	-	-	-	-	1	1	2
CO2	3	3	3	3	2	-	1	-	-	-	-	1	2	2
CO3	3	3	3	3	1	-	1	-	-	-	-	2	3	3
CO4	3	3	3	3	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	1	-	1	-	-	-	-	-	3	2
CO6	3	3	3	3	1	-	3	-	-	-	-	1	2	2

UNIT-I

Analysis and Correlation of experimental kinetic data: Introduction: Classification of Reactions, Definition and variables affecting the rate of reaction. The rate equation and Stochiometric relations for a single phase reaction aA+bB → rR+sS. Single and multiple reactions, Elementary and non-Elementary reactions, Molecularity and order of Reaction, Specific reaction rate constant, Testing kinetic models – Steady state approximation, Equilibrium treatment, Fitting a rate law for the given reaction mechanism, predictability of reaction rate from theory. Temperature dependency from Arrhenius‟ law, Thermodynamics, Collision theory and Transition state theory, Comparison of theories with Arrhenius‟ law.

UNIT-II

Analysis and Correlation of experimental kinetic data: Constant volume batch reactor: Analysis of total pressure data, conversion. Integral method of analysis of data for single reaction, multiple reactions, Homogeneous catalyzed reactions, Auto catalytic reactions, Reversible reactions, and Reactions of shifting orders. Half life method, Partial analysis of the rate equation. Differential method of analysis of data.

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Variable Volume Batch Reactor: Fractional change in volume of the system, Differential method of analysis, Integral method of analysis.

UNIT-III

Introduction to Reactor Design: Ideal reactors for a single reaction, generalized material balance, design equations-Ideal batch reactor, Space time – space velocity, Steady state mixed flow reactor, Steady state plug flow reactor, Holding time and space time for flow reactors, graphical interpretation. Design for single reactions, Size comparison of single reactors, Multiple reactor systems, Recycle reactor, Auto catalytic reactions – optimum recycle operation, Reactor combinations.

UNIT-IV

Design for Multiple Reactions: Series, Parallel and Independent reactions, Selectivity, Yield, Qualitative discussion about product distribution, Quantitative treatment of product distribution and of reactor size.
Temperature and Pressure effects for single reactions, Heat of reaction from thermodynamics, Heat of reaction and Temperature, Equilibrium constants and equilibrium conversions from Thermodynamics. General graphical design procedure, Optimum temperature progression. Heat effects, Adiabatic Operations, Non adiabatic operations. Exothermic reactions in mixed flow reactors – a qualitative treatment.

UNIT-V

Basics of Non-Ideal flow: The residence time distribution (R T D), State of aggregation of the flowing stream, earliness of mixing, Role of R T D, state of aggregation and earliness of mixing in determining reactor behaviour. Exit age distribution of fluid, Experimental methods for finding E – pulse and step input experiments, Relationship between F and E curves. The convolution integral. Conversion in non- ideal flow reactors, Dispersion model-Axial dispersion and correlations for axial dispersion.

Text Books:

1. Octave Levenspiel, Chemical reaction Engineering, 3rd Ed, Wiley India Pvt. Ltd, New Delhi, 2006.
2. H. Scott Fogler, Elements of Chemical Reaction Engineering, Prentice Hall, Third Edition, 2002.

Suggested Reading:

1. J. M. Smith, Chemical Engineering Kinetics, McGraw – Hill , Third Edition, 1981
2. L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Press, 2 nd Edition, 2004.

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20CHC08

CHEMICAL TECHNOLOGY

Instruction	3 L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course will help the students to understand the:

1. Concept of unit operations and unit processes in chemical process industry.
2. Flow diagrams that explain the conversion of raw materials to finished products.
3. Exposure to Organic and Inorganic processes.
4. Process limitations and scale-up information.
5. Application of catalysts in various processes.

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

1. Estimate the chemical industry growth and opportunities.
2. Differentiate between unit operation and unit processes.
3. Develop flow diagrams of different processes.
4. Classify between Inorganic and Organic processes.
5. Design processes based on conditions space time, yield, conversion, recycle methods, temperature and pressure.
6. Predict the process limitations and propose a model to overcome the limitations.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	-	1	1	1	1	-	-	-	-	1	3
CO2	-	1	2	-	-	-	-	-	-	-	-	-	-	-
CO3	-	1	3	2	-	-	-	-	-	-	-	-	2	-
CO4	-	-	1	1	-	1	-	-	-	-	-	-	1	2
CO5	-	-	1	-	-	1	1	-	-	-	-	-	-	-
CO6	-	1	1	2	-	-	-	-	-	-	-	-	-	-

CO-PO-PSO Matrix

UNIT – I: Classification of Indian Chemical Industry, Introduction to unit operations and unit processes. Metallurgical Industry overview – classification of metals, manufacturing of pig Iron by blast furnace, Methods of Steel making– Steel alloys. Manufacturing of Copper and types of Copper alloys, Manufacturing of Aluminum and types of alloys. Over view of Pharmaceutical Industry with introduction and classification of pharmaceutical chemical forms.

UNIT – II: Manufacturing of H2 by Steam reforming of Hydrocarbons. NH3 Synthesis - methods and manufacturing. Urea manufacturing by various processes. Manufacturing of Mono ammonium Phosphate, Di ammonium Phosphate. Manufacturing of Single super Phosphate and
Triple super Phosphate.

UNTI – III: Introduction to Ceramics and its applications, Cement: Raw materials, Manufacturing of Portland cement, Cement types and composition. Glass: Raw materials - Manufacturing – Types of glasses – uses.

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UNIT – IV: Classification of Plastics, Manufacturing of Phenol formaldehyde resin, Polyethylene, Polypropylene, PVC,PVA,Synthetic fibers-Manufacturing of Nylon–6-6, Polyester Fiber-Classification of rubbers and Manufacturing of SBR.

UNIT V: Natural products industry: Pulp and Paper-Methods of pulping production. Recovery of chemicals from black liquor. Production of paper. Oils, Soaps and Detergents: Definitions, constituents of oils, Extraction and expression of vegetable oil. Refining and Hydrogenation of oils. Continuous process for the production of Fatty acids and Soap. Sugar: Raw and refined sugar, Byproducts of sugar industries.

Text Books:

1. George T. Austin, ―Shreve's Chemical Process Industries‖, 5th edition. McGraw Hill Book Company, 1984.
2. Rao, M. G. and Sittig, M., "Dryden"s outlines of Chemical Technology for the 21st Century, 3rd Ed., Affiliated East-West Press, New Delhi, 1998.

Suggested Reading:

1. 1.Remington-The Science And Practice of Pharmacy (Vol.1& 2), David B.Troy, 21st edition,2006, Lippincott Williams &Wilkins
2. Andreas Jess and Peter Wasserscheid, "Chemical Technology: An Integral Textbook", John Wiley and Sons, Inc., New York, 2000.
3. Faith, W. L., Keys, D. B. and Clark, R. L., "Industrial Chemicals",4th Ed., John Wiley, 1980.
4. Fertilizer Association of India, "Handbook of Fertilizer Technology",2nd Ed.,Scientific Publisher, NewDelhi, 2009.

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20CHC09 **HEAT TRANSFER**

Instruction	3 L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. Basic concepts of heat transfer
2. Convective Heat Transfer and the concept of dimensional analysis
3. Concept and functioning of different heat exchangers
4. Heat transfer with change of phase and the functioning of evaporators
5. Radiation laws and the concept of radiation shields.

Course Outcomes: Upon completing this course, students will be able to:

1. Distinguish between different types of heat transfer
2. Calculate heat transfer coefficients for forced and natural convection
3. Analyze and understand the concepts of Heat exchangers
4. Analyze the heat transfer phenomena in fluids involving phase changes
5. Identify the type of evaporator required for a specific purpose and design it
6. Explain the impact of radiation shields and laws of radiation.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	2	2	-	2	2	1	1	3	2
CO2	3	3	3	1	1	2	2	-	2	2	1	1	3	2
CO3	3	3	3	1	1	2	3	-	2	2	1	1	2	3
CO4	3	3	2	1	1	2	2	-	2	2	1	1	2	2
CO5	3	3	3	1	1	2	3	-	2	2	1	1	2	3
CO6	3	2	2	1	1	2	3	-	2	2	1	1	3	2

UNIT-I

Fundamentals of Heat Transfer - Modes of Heat Transfer, Derivation of Heat conduction equations in rectangular co-ordinates, thermal diffusivity, Differential equations of heat transfer-special forms – cylindrical co-ordinates system. One dimensional problem, heat transfer from extended surfaces, two dimensional problems, Lumped capacity systems, Insulation.

UNIT-II

Convective Heat Transfer: - Natural and forced convection in laminar and turbulent flow over plates and tubes. Dimensional Analysis, Thermal Boundary layer, Analogies and correlations. Design of Heat Transfer Equipment - Double Pipe Heat Exchanger, Concept of LMTD, Shell and tube Exchanger – Kern‟s method of design, Effectiveness - NTU methods

UNIT-III

Design aspects of finned tube and other compact heat exchangers. Basics of Heat Transfer with change of phase - Introduction to boiling. Types of boiling, Regimes of pool boiling and critical heat flux. Nucleate Boiling-Bubble formation, its growth and motion Introduction to condensation, Derivation of Nusselt‟s equation. Design aspects of Condensers.

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UNIT-IV

Types of Evaporators, Capacity and Economy of Evaporators, Design aspects of Evaporators – Material and energy Balances of single and multiple effect evaporators. Heat Transfer to agitated vessels. Description and working of crystallizers

UNIT-V

Radiation – Fundamentals of Radiation Heat Transfer, Laws of black body Radiation, Radiating heat exchange between non black body surfaces, combined heat transfer by conduction, convection and radiation, Radiation Shields

Text Books:

1. W.L.McCabe, J.C.Smirh and P.Harriott, „Unit Operations of Chemical Engineering" 7th Edition, Tata-McGraw Hill, New Delhi , 2005
2. D.Q. Kern, „Process Heat Transfer"1st Edition Tata-McGraw Hill Publishers, New Delhi, 2001

Suggested Reading:

1. Coulson JM and Richardson, J.F, Chemical Engineering Series,Vol 1, 4th Edition, Pergamon Press Oxford, UK, 1991
2. B K Dutta, Heat Transfer Principles and applications, PHI Learning Pvt Ltd, New Delhi, 2004
3. Holman, J.P.S. Bhattacharya. Heat Transfer, 10th Edition, Tata-McGraw Hill, 2011

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20CHC10 **MASS TRASFER OPERATIONS - I**

Instruction	3 L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course helps the students to

1. Identify diffusion phenomena in various chemical processes.
2. Calculate mass transfer coefficients at interfaces of multiphase mass transfer systems
3. Design equipment for gas-liquid mass transfer operations.
4. Understand the humidification operation with design of cooling tower.
5. Understand the drying concept with its mechanism.

Course Outcomes: Upon completing this course, students will be able to:

1. Apply the concepts of diffusion mass transfer to fluids and solids
2. Write the rate equations for mass transfer operations
3. Estimate the mass transfer coefficients of mixtures
4. Design Absorber/Stripper by equilibrium methods
5. Design the cooling tower with the concept of humidification.
6. Interpret the drying mechanism by estimating total drying period

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	-	2	-	-	-	2	3	3	2
CO2	3	3	3	-	2	-	2	-	-	-	2	3	3	3
CO3	3	3	3	2	1	2	2	-	-	-	-	3	3	3
CO4	3	3	3	-	2	-	2	-	2	-	2	3	3	2
CO5	3	3	3	-	2	-	2	-	2	-	2	3	3	2
CO6	3	3	3	-	1	-	2	-	2	-	2	3	3	2

UNIT – I Diffusion Mass Transfer

Introduction of Mass transfer operations & their applications, Molecular and eddy diffusion –Fick‟s first and second law, Steady state molecular diffusion in binary mixtures of gases, liquids and solids, Gas and liquid phase diffusion coefficient measurement and prediction, diffusivity in solids and its applications, Film mass transfer coefficients for the cases of equimolar counter diffusion and diffusion of one component (A) in stagnant component (B) - Correlation‟s for mass transfer coefficients and Reynolds & Colburn analogies.

UNIT – II Mass Transfer coefficients & Interphase Mass Transfer

Mass transfer coefficients concepts and classifications, Mass Transfer Theories- Film theory, penetration theory, surface renewable theory, Interphase mass transfer theory, Overall mass transfer coefficients – Two resistance theory – Gas phase and liquid phase controlled situations. Gas – liquid contact: 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 stage, Murphree, point and overall column

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efficiency, Comparison of packed and plate columns.

UNIT - III Absorption and Stripping

Introduction to absorption, Equilibrium in gas-liquid system, and minimum liquid rate, Design of packed column based on Individual and overall mass transfer coefficients, Counter current multistage operations, Determination of number of plates – absorption factor. Determination of number of transfer units and height of a continuous contact packed absorbers. Kremser – Brown equation

UNIT - IV Humidification

Basic concepts of vapor-gas mixtures- absolute humidity, relative humidity and adiabatic saturation temperature, dew point and wet bulb temperatures, psychometric charts – Enthalpy of gas vapor mixtures, Humidification and dehumidification – Operating lines and design for cooling towers.

UNIT - V Drying

Moisture contents of solids – equilibrium, bound and unbound moisture. Design conditions – Rate of batch drying under constant drying conditions – Mechanism of batch drying – total time for batch drying, Description of batch and continuous dryers.

Text Books:

1. R.E. Treybal, "Mass Transfer operations", 3rd Edition, McGraw Hill Book Co., 1981
2. Christie John Geonkoplis "Transport Processes and Separation Process Principles",4th edition. PHI, New Delhi.

Suggested Reading:

1. J Coulson and Richardson,"Fluid Flow, Heat and Mass Transfer", Volume 1, 6th Edition, Pergoman Press, 2009
2. W.L.McCabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition, 2005.

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20EGM01 **INDIAN CONSTITUTION AND FUNDAMENTAL PRINCIPLES**

(BE/BTech III/IV Semester - Common to all branches)

Instruction	2 Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	50 Marks
Credits	NC

Course Objectives

The course will introduce the students to:

1. History of Indian Constitution and how it reflects the social, political and economic perspectives of the Indian society.
2. 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. Various Organs of Governance and Local Administration.

Course Outcomes

After successful completion of the course the students will be able to:

1. Understand the making of the Indian Constitution and its features.
2. Identify the difference among Right To equality, Right To freedom and Right to Liberty.
3. Analyze the structuring of the Indian Union and differentiate the powers between Union and States.
4. Distinguish between the functioning of Lok Sabha and Rajya Sabha while appreciating the importance of Judiciary.
5. Differentiate between the functions underlying Municipalities, Panchayats and Co-operative Societies.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	1	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	1	-	1	-	-	-	-	-

Unit-I

Constitution of India: Constitutional history-Govt of India Act 1909, 1919 and 1935, Constitution making and salient features. Directive Principles of State Policy - Its importance and implementation.

Unit-II

Scheme of the Fundamental Rights & Duties: The Fundamental Rights - To Equality, to certain Freedom under Article 19, to Life and Personal Liberty Under Article 21. Fundamental Duties - the legal status.

Unit III

Union Government and its Administration - Structure of the Indian Union: Federalism, distribution of

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legislative and financial powers between the Union and the States.
Parliamentary form of government in India: Executive-President‟s role, power and position.

Unit IV

Legislature and Judiciary: Central Legislature-Powers and Functions of Lok Sabha and Rajya Sabha. Judiciary: Supreme Court-Functions, Judicial Review and Judicial Activism

Unit V

Local Self Government - District‟s Administration Head (Collector): Role and Importance. Municipalities: Introduction, Mayor and Role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: Position and Role. Block level: Organizational Hierarchy (Different departments). Village level: Role of Elected and Officials.

Text Books:

1. **Indian Government & Politics**, Ed Prof V Ravindra Sastry, Telugu Akademy, 2nd edition, 2018.
2. **Indian Constitution at Work,** NCERT, First edition 2006, Reprinted- January 2020.

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.

Online Resources:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

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20EEM01 **INDIAN TRADITIONAL KNOWELDGE**

Instruction		2 Hours per week
Duration of Semester End Examination		2 Hours
Semester End Examination		50 Marks
CIE 02	Mid sem assignments	[Optional]
Credits		No Credits

Course Objectives:

1. To get a knowledge in Indian Culture
2. To Know Indian Languages and Literature and the fine arts in India
3. To explore the Science and Scientists of Medieval and Modern India

Course Outcomes: After completion of this course, students will be able to:

1. Understand philosophy of Indian culture
2. Distinguish the Indian languages and literature
3. Learn the philosophy of ancient, medieval and modern India
4. Acquire the information about the fine arts in India
5. Know the contribution of scientists of different eras.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	1	-	-	1	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	1	-	-	-	-	-	-	-	1	-	-

UNIT-I

Culture and Civilization: Culture, civilization and heritage, general characteristics of culture, importance of culture in human literature, Cultural diversity, Aesthetics, Women seers, Indus culture, Indian cuisine, Martial arts

UNIT-II

Education system: Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India

UNIT-III

Linguistic Wealth: Indian Languages and Literature: the role of Sanskrit, Paleography, Significance of scriptures to current society, Indian semantics and lexicography, Bhakti literature, Darsanas

UNIT-IV

Art, Technology& Engineering: Sculpture, Painting and Handicrafts, Indian Music, Dance Drama and Theatre, Introduction to Mayamatam, Iron and steel technology, Use of metals in medicinal preparations

UNIT-V

Science and Logic: Helio-centic system, Sulbasutras, Katapayadi, Hindu calendar, 6 pramanas in Indian logic, Scientific method applied to therapeutics, Fallacies, Tarka – Induction&Deduction, Ayurvedic biology,

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Definition of health

Essential Readings:

1. Kapil Kapoor, Text and Interpretation: The Indian Tradition, ISBN: 81246033375, 2005
2. Samskrita Bharati,Science in Samskrit, ISBN-13: 978-8187276333, 2007
3. Satya Prakash, Founders of sciences in Ancient India, Govindram Hasanand, ISBN-10: 8170770009, 1989
4. Brajendranath Seal, The Positive Sciences of the Ancient Hindus, Motilal Banarasidass, ISBN-10: 8120809254, 1915

Suggested Readings:

1. Swami Vivekananda, *Caste, Culture and Socialism*, Advaita Ashrama, Kolkata ISBN-9788175050280
2. Swami Lokeswarananda, *Religion and Culture*, Advaita Ashrama, Kolkata ISBN-9788185843384
3. Kapil Kapoor,*Language, Linguistics and Literature: The Indian Perspective*, ISBN-10: 8171880649, 1994.
4. Karan Singh, *A Treasury of Indian Wisdom: An Anthology of Spiritual Learn*,ISBN: 978-0143426158, 2016
5. Swami Vivekananda, *The East and the West*, Advaita Ashrama, Kolkata 9788185301860
6. Srivastava R.N., *Studies in Languages and Linguistics*, Kalinga Publications ISBN-13: 978-8185163475
7. Subhash Kak and T.R.N. Rao, Computation in Ancient India, Mount Meru Publishing ISBN-1988207126
8. R.N Misra, *Outlines of Indian Arts Architecture, Painting, Sculpture, Dance and Drama*, IIAS, Shimla & Aryan Books International, ISBN 8173055149
9. S. Narain, *Examinations in ancient India*, Arya Book Depot, 1993
10. M. Hiriyanna, Essentials of Indian Philosophy, Motilal Banarsidass Publishers, ISBN-13: 978-8120810990, 2014
11. Ravi Prakash Arya, Engineering and Technology in Ancient India, Indian Foundation for Vedic Science, ISBN-10: 1947593072020

SWAYAM/Nptel:

1. History of Indian Science and Technology - https://onlinecourses.swayam2.ac.in/arp20_ap35/preview
2. Introduction to Ancient Indian Technology – https://onlinecourses.nptel.ac.in/noc19_ae07/preview
3. Indian Culture & Heritage - https://onlinecourses.swayam2.ac.in/nos21_sc11/preview
4. Language and Society - https://nptel.ac.in/courses/109/106/109106091/
5. Science, Technology & Society - https://nptel.ac.in/courses/109/103/109103024/
6. Introduction to Indian Philosophy - https://nptel.ac.in/courses/109/106/109106059/
7. Introduction to Indian Art - An appreciation - https://onlinecourses.nptel.ac.in/noc20_hs09/preview

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20CEM01

ENVIRONMENTAL SCIENCE

Instruction	2 L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	0 Marks
Credits	NC

Course Objectives: To enable the student

1. Identify environmental problems arising due to over utilization of natural resources and understand the importance of use of renewable energy sources
2. Become aware about the importance of eco system and interlinking of food chain.
3. Identify the importance of biodiversity in maintaining ecological balance.
4. Learn about various attributes of pollution management and waste management practices.
5. Contribute for capacity building of nation for arresting and/or managing environmental disasters.

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

1. Identify the natural resources and realise the importance of water, food, forest, mineral, energy, land resources and affects of over utilisation.
2. Understand the concept of ecosystems and realise the importance of interlinking of food chains.
3. Contribute for the conservation of bio-diversity.
4. Suggest suitable remedial measure for the problems of environmental pollution and contribute for the framing of legislation for protection of environment.
5. Follow the environmental ethics and contribute to the mitigation and management of environmental disasters.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	3	-	-	-	-	1	-	-
CO2	1	-	-	-	-	-	2	1	-	-	-	1	-	-
CO3	1	-	-	-	-	-	2	1	-	-	-	1	-	-
CO4	1	-	-	-	-	1	2	1	-	-	-	1	2	2
CO5	1	-	-	-	-	1	2	1	-	-	-	1	1	1

UNIT- I:

Environmental Studies: Definition, Scope and importance, need for public awareness.

Natural resources: Use and over utilization of Natural Resources - Water resources, Food resources, Forest resources, Mineral resources, Energy resources, Land resources.

UNIT – II:

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, role of producers, consumers and decomposers, energy flow in an ecosystem, food chains, food webs, ecological pyramids, Nutrient cycling, Bio-geo chemical cycles, Terrestrial and Aquatic ecosystems.

UNIT – III:

Biodiversity: Genetic, species and ecosystem biodiversity, Bio-geographical classification of India, India as a Mega diversity nation. Values of biodiversity, hot-spots of biodiversity, threats to biodiversity, endangered and

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endemic species of India, methods of conservation of biodiversity.

UNIT – IV:

Environmental Pollution: Cause, effects and control measures of air pollution, water pollution, marine pollution, soil pollution, noise pollution and Solid waste management, nuclear hazards

Environmental Legislations: Environment protection Act, Air, Water, Forest & Wild life Acts, issues involved in enforcement of environmental legislation, responsibilities of state and central pollution control boards

UNIT – V:

Social issues and the environment: Water conservation methods: Rain water harvesting and watershed management, Environmental ethics, Sustainable development and Climate change: Global warming, Ozone layer depletion, forest fires, and Contemporary issues.

Text Books:

1. Y. Anjaneyulu, "Introduction to Environmental Science", B S Publications, 2004.
2. Suresh K. Dhameja, "Environmental Studies", S. K. Kataria& Sons, 2009.

Suggested Reading:

1. C. S. Rao," Environmental Pollution Control Engineering", Wiley, 1991.
2. S. S. Dara, "A Text Book of Environmental Chemistry &Pollution Control", S. Chand Limited, 2006

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20CHE01 **ENERGY ENGINEERING**

(Professional Elective I)

Instruction	3 L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course helps the students to

1. Gain knowledge on various energy sources and their applications
2. know emerging technologies viz., fuel cells, bio fuels etc.
3. know the processes of crude fuels
4. understand the advantages and disadvantages of various energy sources
5. familiarize the concepts of energy audit and conservation

Course Outcomes: Upon completing this course, students will be able to:

1. Classify and explain energy sources
2. Summarize the basic principles and fundamentals of non-conventional energy sources
3. Summarize the basic principles and fundamentals of conventional energy sources
4. Outline the production and future perspectives of bio fuels
5. Relate the importance of future energy resources
6. Demonstrate the need for energy auditing and conservation

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	1	-	-	3	-	-	-	-	-	-	-	-
CO2	-	2	1	-	-	3	-	-	-	-	-	-	-	-
CO3	-	2	1	-	-	3	3	-	-	-	-	-	2	2
CO4	-	2	1	-	-	3	3	-	-	-	-	-	2	2
CO5	-	2	1	-	-	3	3	-	-	-	-	-	2	1
CO6	-	2	1	-	-	3	3	-	-	-	-	-	2	1

UNIT-I

Introduction:

Introduction to conventional and non conventional energy sources, alternative energy sources, their significance & availability, consumption patterns in India. Energy survey and policies for India

UNIT-II

Conventional Energy Sources: Wood and wood Charcoal, products of wood carbonization Coal and Coal derived fuels, characteristics, production methods and uses. Oil and Gases: Fuels derived from oil and gases, Characteristics, production methods and uses. Technology for combustion of fuels derived from oil and gas. Shale oil and gas, oil sands

UNIT-III

Non conventional Energy Sources:

Solar Energy: Basics, Types of Solar Energy Collectors, Applications- Solar Distillation, pumping, production

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of hydrogen.

Photo Voltaic Cells: Introduction, Types of photo voltaic Cells, Applications, Electrical Storage and Future developments

UNIT-IV

Wind-Energy: Introduction, Basic principles of wind energy conversion. Types of wind machines

Hydropower: Introduction, Capacity and Potential, Small hydro, Environmental and social impacts.

Tidal Energy: Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants

UNIT-V

Bio Fuels: Introduction, Bio mass conversion technologies- Wet processes, dry processes, Bio-gas generation. Factors affecting bio-digestion, Classification of biogas plants Production methods, characteristics, uses of bio-diesel, bio-butanol and bio-ethanol, Second generation bio-fuel feed stocks

Energy Auditing and Conservation: Short term, medium term, long term schemes, energy conversion, energy index, energy cost, representation of energy consumption, Sankey diagram, energy auditing. Conservation methods in process industries, theoretical analysis, practical limitations

Text Books:

1. G D Rai, Non -conventional energy sources,Khanna Publishers, 4th edition,2000
2. Samir Sarkar, Fuels and Combustion, Universities Press, 3rd Edition, 2009

Suggested Reading:

1. S P Sukhatme, J Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill, 2008
2. S B Spandya, Conventional Energy Technology: Fuel and Chemical Energy,Tata McGraw-Hill, 1987
3. John Twidell and Tony Weir, Renewable Energy Resources, Routledge, 2015
4. W R Murphy , Energy management, 1st Edition, , G McKay Butterwolferand Co. Ltd.,2001

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20CHE02 **FOOD PROCESSING TECHNOLOGY**

(Professional Elective I)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course helps the students to understand the

1. Basic food processing methods.
2. Physical, chemical, and/or microbiological changes in food and mechanical manipulation.
3. Learn fundamentals of modifying food to meet current nutrition recommendations
4. Learn to find credible sources of information on food science and nutrition.
5. Food processing Applications and Packaging

Course Outcomes: Upon completing this course, students will be able to:

1. Understand food demand scenario with respect to world and India
2. Explain techniques in food processing
3. Design process equipment to achieve the desired quality of food.
4. Develop novel food processes that have a minimal effect on food quality
5. Select control strategies to maintain food quality
6. Apply the scientific method to food science problems.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	2	2	3	3	3	3	3	2	2	1	2
CO2	3	2	2	2	3	2	1	1	1	-	-	3	3	2
CO3	3	3	3	3	3	2	2	1	1	-	-	3	3	3
CO4	3	3	3	3	3	2	2	1	1	-	-	3	3	3
CO5	3	3	2	3	3	2	2	1	1	-	-	3	3	3
CO6	3	3	2	3	2	1	2	2	1	-	-	3	3	2

UNIT – I

Introduction: General aspects of food industry, World food demand and Indian scenario, Constituents of food, Quality and nutritive aspects, Product and Process development, engineering challenges in the Food Processing Industry.

UNIT – II

Basic principles: Properties of foods and processing theory, Heat transfer, Effect of heat on micro-organisms, Basic Food Biochemistry and Microbiology: Food Constituents; Food fortification, Water activity, Effects of processing on sensory characteristics of foods, Effects of processing on nutritional properties, Food safety, good manufacturing practice and quality Process Control in Food Processing.

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UNIT – III

Ambient Temperature Processing: Raw material preparation, Size reduction, Mixing and forming, Separation and concentration of food components, Centrifugation, Membrane concentration, Fermentation and enzyme technology, Irradiation, Effect on micro-organisms, Processing using electric fields, high hydrostatic pressure, light or ultrasound.

UNIT – IV

Heat processing using steam, water and air: Blanching, Pasteurization, Heat sterilization, Evaporation and distillation, Extrusion, Dehydration, Baking and roasting, Heat processing by direct and radiated energy: Dielectric heating, Ohmic heating, Infrared heating, Gamma irradiation.

UNIT – V

Post Processing Applications Packaging: Coating or enrobing, Theory and Types of packaging materials, Printing, Interactions between packaging and foods, Environmental considerations.

Text Books:

1. Fellows P., Food Processing Technology: Principles and Practice, Wood head Publishing, 4th Edition, 2016.
2. Toledo R, Fundamentals of Food Process Engineering, Springer, 3rd Edition, 2010.

Suggested Reading:

1. Singh R.P. & Heldman D.R., Introduction to Food Engineering, Academic Press, 3rd Edition, 200

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20CHE03 **MATERIAL SCIENCE FOR CHEMICAL ENGINEERS**

(Professional Elective I)

Instruction	3 L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course helps the students to understand the

1. Introduction to different types of engineering materials and alloys
2. Alloying elements and factors for material selection
3. Significant properties of engineering materials
4. Specific requirements of materials for high and low temperature applications.
5. Possible and latest alternatives available for standard engineering materials.
6. Material characterization

Course outcomes: Upon completing this course, students will be able to:

1. Classify different engineering materials as ferrous and non-ferrous alloys.
2. Select materials for design and fabrication of process equipment.
3. Understand the significance of mechanical, thermal and optical properties of engineering materials
4. Select materials for high and low temperature applications.
5. Identify new or alternate materials for development and operation of process industry.
6. Characterize material using different experimental techniques.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	2	1	1	0	-	-	-	-	3	3
CO2	3	3	3	3	3	2	0	1	-	-	-	-	3	2
CO3	3	3	3	3	3	2	3	1	-	-	-	-	3	2
CO4	3	3	3	3	3	3	3	1	-	-	-	-	3	1
CO5	3	3	3	3	3	3	3	2	-	-	-	-	3	3
CO6	3	3	3	3	3	3	3	1	-	-	-	-	3	3

UNIT-I

Introduction to Engineering Materials: Classification – metals, non-metals, alloys; Ferrous metals and alloys - types of steels like mild, carbon and stainless steel, common grades of steel – 304 and 316; Non-Ferrous metals and alloys of Aluminium, Copper and Nickel; Criteria for material selection.

UNIT-II

General Properties of Engineering Materials: Mechanical Properties: Stress-strain diagram, Elastic, Plastic, Anelastic and Viscoelastic behavior. Creep, Fatigue and Fracture strengthening mechanisms; Thermal Properties: Conductivity, Expansion, Protection, Diffusivity, Stresses and Shock resistance; Optical behavior: Light & electro-magnetic spectrum, Luminescence, stimulated emission of Radiation, Lasers, Optical fibres.

UNIT-III

Materials for High and Low Temperature Applications: Classification, advantages, general properties and applications of engineering materials like Refractories, Ceramics, Super alloys, Composites; Nano-materials: carbon nanotubes, fullerene, nanosensors; Nanocomposites, role of reinforcement-matrix interface strength on composite behaviour

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UNIT-IV

New materials: Biomaterials: Biocompatibility, advantages, properties, uses, Types- Nearly inert ceramics, surface active ceramics, resorbable ceramics. Smart materials Piezoelectrics, shape memory alloys, Magneto-strictive, electro-rheological materials, 3D printing.

UNIT-V

Material characterization: Study of material characterization using X-ray diffraction (XRD), Nuclear Magnetic Resonance (NMR) spectroscopy, Scanning electron microscopy (SEM), transmission electron microscopy (TEM).

Text Books

1. Materials Science and Engineering an Introduction, William D. Callister, Jr. 5thEd., John Wiley and Sons, Inc. 2002.
2. Materials Characterization - Introduction to Microscopic and Spectroscopic Methods, Yang Leng, 2nd ed., Wiley Publishers, USA, 2013.

Suggested Readings:

1. Fundamentals of Smart Materials, Mohsen Shahinpoor, The Royal Society of Chemistry Publishing, U.K, 2020.
2. B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, John Wiley & Sons, 2004.
3. S. Upadhyaya and A. Upadhyaya, Material Science and Engineering, Anshan Publications, 2007.

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20CHE04 **PULP AND PAPER TECHNOLOGY**

(Professional Elective I)

Instruction	3 L Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course helps the students to understand

1. Basic concepts of pulp and paper making processes
2. Comprehensive overview of products, process variables, equipment operation
3. Details of physical and chemical characteristics of fibrous raw materials and black liquor
4. Various types of pulping and bleaching methodologies
5. Recovery of energy and chemicals used in pulping processes with due techno-economic and environmental considerations.

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

1. Design the operation, maintenance and safety aspects for paper making
2. Identify the factors that drive industry trends
3. Evaluate different grades of paper and boards based on testing methods
4. Select appropriate bleaching technique for required paper quality
5. Distinguish the important wood and fiber properties that affect paper quality
6. Identify, formulate and solve design problems pertaining to pulp digester

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	3	1	-	-	-	-	2	2	2
CO2	2	2	2	2	2	-	1	-	-	-	-	1	2	3
CO3	3	2	2	1	1	-	1	-	-	-	-	2	2	2
CO4	3	1	2	2	1	-	1	-	-	-	-	2	3	3
CO5	3	1	2	2	-	-	2	1	-	-	-	2	2	2
CO6	3	2	3	2	2	-	1	-	-	-	-	3	3	3

UNIT I: Introduction

Importance of paper, Definition of pulp. Distribution of wood constituents – Cellulose, Hemi-cellulose, Lignin, Extractives and Inorganic components. Wood parts & types: Ultra structure of cell wall, Wood cell types, Early & Latewood, Softwoods & Hardwoods. Comparison of different raw materials for pulp & paper making.

UNIT II: Overview of pulping process

Mechanical Pulping: Pressurized ground pulping, Refiner Pulping, Chemo (thermo) mechanical pulping processes. Kraft Pulping: Composition & analysis of white liquor, Description of Kraft cooking process, Kraft recovery, process variables, Pulp yield, End uses of kraft pulps.

UNIT III: Pulp and black liquor characterization

Pulp testing methods – Kappa number, water retention value, CED viscosity, drainability, beater evaluation, zero span tensile strength.

Black liquor characterization - Chemical properties, viscosity, calorific value, thermal conductivity, specific heat, black liquor oxidation, desilication and concentration of black liquor.

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UNIT IV: Bleaching operations

Objective of bleaching – Elemental chlorine free and Total chlorine free bleaching; Bleaching agents – form, function, advantages & disadvantages, bleaching sequences, Bleachability and its measurement, factors affecting the bleaching process.
Stages of bleaching – Oxygen delignification, Chlorination, Extraction, Hypochlorite bleaching, Ozone bleaching, Peroxide bleaching, ECF and TCF bleaching systems for chemical and mechanical pulps.

UNIT V: Paper Making and its Properties

Paper Testing Methods – Flow sheet of overall pulp and paper making process, Strength properties, Surface properties, Optical properties & Absorption properties. Different grades of paper, boards & newsprint specifications; BIS and ISO standards of paper. Paper properties dependence on paper making processes.
Paper recycling process, Effluent treatment processes with environmental considerations.

Text Books:

1. Kenneth W. Britt, "Handbook of Pulp & Paper Technology", 2nd Edition, Reinhold Publishing Corporation, 2004.
2. G. A Smook., "Handbook for Pulp & Paper Technologists", 3rd Edition, Angus Wilde Publications, 2003.

Suggested Reading:

1. Hakan Karlsson, "Fiber Guide-Fiber analysis and process applications in the pulp & paper industry", Ab Lorentz & Wetre, 1st Edition, 2006.
2. Fengel D. and Wegener G, "Wood-Chemistry, Ultrastructure, Reactions", Walter de Gruyter, Berlin, 2nd Edition, 1989.
3. EIRI Board. "Handbook of Pulp & Paper, Paper board and Paper based Technology", Engineers India Research Institute, 2nd Edition, 2015.

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20CHC11 **CHEMICAL REACTION ENGINEERING LAB**

Instruction	3 P Hours per week
Duration of SEE	3Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives: This course helps the students to understand to

1. Familiarize students with main type of chemical reactors.
2. Analyze the experimental data to obtain the reaction rate expression (reaction order and specific reaction rate constant).
3. Compare the conversion of reactants for a specific reaction in various types of reactor.
4. Understand the concept of residence time distribution in reactor systems.
5. Determine mass transfer coefficient of systems with and without chemical reaction.

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

1. Compare the performance of ideal reactors.
2. Develop rate law for use in reactor design based on reaction data from a reactor.
3. Find the conversion of reactants for a particular reaction in different reactors.
4. Interpret the kinetics of an exothermic reaction.
5. Analyze laboratory reactors through residence time distributions.
6. Determine mass transfer coefficient of Solid-Liquid and Liquid-Liquid systems.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	1	-	2	-	-	-	3	2
CO2	3	2	1	1	1	-	1	-	2	-	-	1	3	3
CO3	3	2	1	1	1	-	1	-	2	-	-	2	2	2
CO4	3	2	1	1	1	-	1	-	2	-	-	-	2	3
CO5	3	2	1	1	1	-	1	-	2	-	-	1	2	2
CO6	3	2	1	1	1	-	1	-	2	-	-	-	2	2

List of Experiments

(Minimum of 8 Experiments in the list are to be performed)

1. Studies in Batch Reactor: To find the Arrhenius form of temperature dependency of reaction.
2. Studies in Mixed Flow Reactor (CSTR): To find kinetics from reactor performance of CSTR.
3. Studies in Tubular Reactor: To determine the rate constant and to verify the order of reaction.
4. Mass Transfer with Chemical Reaction (Liquid – Liquid Reaction System): To find out the mass transfer coefficient in a stirred cell with chemical reaction and without chemical reaction.
5. Mass Transfer with Chemical Reaction (solid – Liquid Reaction System): To find the mass transfer coefficient with chemical reaction and without chemical reaction.
6. R.T D Studies in Packed bed reactor: To determine the axial mixing (axial dispersion) in the packed column.

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7. R T D Studies in Tubular Column: To determine the variance of residence time distribution and the dispersion number in a tubular column.
8. Studies in Batch Reactor: With Equimolar Feed (M = 1): To determine the rate constant and to verify the order of reaction by differential & integral methods of analysis.
9. Studies in Batch Adiabatic Reactor: To determine the kinetics of an exothermic reaction from the temperature of the reaction system.
10. Studies in Mixed Flow Reactors in series: To compare the actual & ideal performances of a reaction system.
11. Studies in Packed bed: To determine the rate constant and to verify the order of reaction from performance of the reactor.

Text Books:

1. Octave Levenspiel, Chemical Reaction Engineering, Wiley India Pvt. Ltd, New Delhi, 3rd Ed, 2006.
2. H. Scott Fogler, Elements of Chemical Reaction Engineering, Prentice Hall, 3rd Edition, 2002.

Suggested Reading:

1. J. M. Smith, Chemical Engineering Kinetics, McGraw – Hill, Third Edition, 1981.
2. L. D. Schmidt, The Engineering of Chemical Reactions, Oxford Press, 2nd Edition, 2004.

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20CHC12 **HEAT TRANSFER LAB**

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives: This course helps the students to understand to

1. Understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries
2. Familiarize heat exchangers - working principles and basic geometries

Course Outcomes: Upon completing this course, students will be able to:

1. Demonstrate and evaluate heat transfer by conduction in solids for steady state conditions
2. Determine thermal conductivity of different materials of varying geometries
3. Estimate heat transfer coefficients and determine effectiveness of pin fin for free and forced convection
4. Determine surface emissivity of a test plane and Stefan-Boltzmann's constant and compare with theoretical values
5. Determine critical heat flux in pool boiling
6. Estimate heat transfer coefficients and determine effectiveness of heat exchangers to analyze their performance

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO4	3	3	-	-	-	-	-	-	-	-	-	-	1	1
CO5	3	3	-	-	-	-	-	-	-	-	-	-	1	1
CO6	3	3	-	-	-	-	-	-	-	-	-	-	3	3

List of Experiments

(Minimum of 8 Experiments in the list are to be performed)

1. Determination of Thermal conductivity of given insulating powder under steady state conditions
2. Determination of interface temperatures in composite wall under steady state conditions
3. Determination of Heat Transfer through Lagged Pipe.
4. Determination of Thermal Conductivity for a given Asbestos Insulating powder.
5. Determination of Critical Heat Flux for a given Nichrome wire
6. Determination of inside heat transfer coefficient in coil heat exchangers
7. Determination of overall heat transfer coefficient and effectiveness of a Double pipe heat exchanger
8. Determination of heat transfer area in a 1-2- shell and tube heat exchangers
9. Determination of heat transfer coefficient in a single tube by film wise and drop wise condensation
10. Determination of emissivity and Boltzmann‟s constant of a sample body
11. Determination of heat transfer coefficient in forced convection
12. Determination of fin efficiency of longitudinal fins of extended surface
13. Determination of peak flux and critical temperature drop in pool boiling of saturated liquid
14. Determination of heat transfer coefficient of a pin fin under free convection
15. Determination of heat transfer coefficient of a pin fin under forced convection

Text Books:

1. W L McCabe, J C Smith and P Harriott, Unit Operations of Chemical Engineering, 7th Ed., Tata-McGraw Hill Chemical Engineering Series, New Delhi, 2005

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (With effect from 2022-2023)

B.Tech (Chemical Engineering)

Semester V

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE inHours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	20MBC01	Engineering Economics & Accountancy	3	-	-	3	40	60	3
2	20CHC13	Chemical Engineering Thermodynamics II	3	-	-	3	40	60	3
3	20CHC14	Mass Transfer Operations II	3	1	-	3	40	60	4
4	20CHC15	Process Modeling and Simulation	3		-	3	40	60	3
5		Professional Elective - II	3	-	-	3	40	60	3
6		Open Elective- I	3	-	-	3	40	60	3
7	20EGM03	Universal Human Values-2	3			3	40	60	3
8	20CHI02	Internship	-	-	-	-	-	-	2
PRACTICAL									
9	20CHC16	Mass Transfer Operations Lab	-	-	3	3	50	50	1.5
10	20CHC17	Process Modeling and Simulation Lab	-	-	3	3	50	50	1.5
TOTAL			**21**	**1**	**06**	**-**	**380**	**520**	**27**

S.No	Course Code	**Professional Elective II**
1	20CHE05	Catalysis
2	20CHE06	Fertilizer Technology
3	20CHE07	Pollution Control in Process Industries
4	20CHE08	Polymer Science and Technology

S.No	Course Code	**Open Elective I**
1	20CE O02	Disaster Risk Reduction and Management
2	20ME O15	Principles of Industry 4.0
3	20ADO01	Introduction to Python Programming
4	20CS O 05	Basics of Artificial Intelligence

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20MBC01 **ENGINEERING ECONOMICS & ACCOUNTANCY**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The Objectives of the Course are:

1. To demonstrate the importance of Managerial Economics in Decision Making.
2. To explain the concept of Accountancy and provide basic knowledge on preparation of Final accounts.
3. To understand the importance of Project Evaluation in a chievinga firm's Objective.

Course Outcomes: After Completion of the Course, Student will be able to:

1. Apply fundamental knowledge of Managerial Economics concepts and tools.
2. Analyze various aspects of Demand Analysis, Supply and Demand Forecasting.
3. Understand Production and Cost relationships to make best use of resources available.
4. Apply Accountancy Concepts and Conventions and preparation of Final Accounts.
5. Evaluate Capital and Capital Budgeting decision based on any technique.

CO-PO-PSO- Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	3	1	1	1	1	1	1	1	-	-	-	-	1	1
CO2	2	2	2	2	-	1	1	1	-	1	-	1	-	1	2	1
CO3	1	2	1	2	2	-	2	1	-	1	-	-	-	1	2	-
CO4	2	2	1	2	2	1	1	3	-	1	-	-	-	-	1	-
CO5	1	3	1	2	1	1	2	-	-	1	2	1	-	2	-	-

UNIT-I

IntroductiontoManagerialEconomics

Introduction to Economics and its evolution - Managerial Economics - its Nature and Scope, Importance;RelationshipwithotherSubjects.ItsusefulnesstoEngineers;BasicconceptsofManagerialeconomics- Incremental, Time perspective, Discounting Principle, Opportunity Cost, Equi marginal Principle, Contribution, Negotiation Principle.

UNIT-II

Demand and Supply Analysis

Demand Analysis-Concept of Demand, Determinants, Law of demand-Assumptions and Exceptions; Elasticity of demand - Price, Income and Cross elasticity - simple numerical problems; Concept of Supply –Determinants of Supply, Law of Supply; Demand Forecasting-Methods.

UNIT-III

Production and Cost Analysis

Theory of Production - Production function - Isoquants and Isocosts, MRTS, Input-Output Relations; Laws of returns; Internal and External Economies of Scale.

Cost Analysis: Cost concepts – Types of Costs, Cost-Output Relationship – Short Run and Long Run; Marketstructures – Types of Competition, Features, Price Output Determination under Perfect Competition, MonopolyandMonopolisticCompetition;Break-evenAnalysis– Concepts,Assumptions,Limitations,Numericalproblems.

UNIT-IV

Accountancy

Book-keeping, Principles and Significance of Double Entry Book Keeping, Accounting Concepts and Conventions, Accounting Cycle, Journalization, Subsidiary books, Ledger accounts, Trial Balance concept and preparation of Final Accounts with simple adjustments. Ratio Analysis.

UNIT-V

Capital and Capital Budgeting: Capital and its Significance, Types of Capital, Estimation of Fixed and Working capital requirements, Methods and sources of raising finance. Capital Budgeting, Methods: Traditional and Discounted Cash Flow Methods-Numerical problems.

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TextBooks:

1. Mehta P.L.,"Managerial Economics: Analysis, Problems and Cases", Sultan Chand &Son's Educational publishers,2016.
2. Maheswari S.N. "IntroductiontoAccountancy",VikasPublishingHouse,11thEdition,2013.

Suggested Readings:

1. PandayI.M. "FinancialManagement",11thedition,VikasPublishingHouse,2015.
2. VarshneyandKLMaheswari,ManagerialEconomics,SultanChand,2014.
3. M. Kasi Reddy and S.Saraswathi, Managerial Economics and Financial Accounting, Prentice Hall of India Pvt Ltd, 2007.
4. A.R. Aryasri,Managerial Economics and Financial Analysis, McGraw-Hill,2013.

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20CH C13 **CHEMICAL ENGINEERING THERMODYNAMICS – II**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Chemical Engineering Thermodynamics-I

Course Objectives: This course will help the students to understand about

1. Familiarize with the theory of Solution Thermodynamics
2. The concepts of fugacity in mixtures and various methods to obtain Fugacity Coefficient in mixtures.
3. Phase Rule and Various models used to determine the activity coefficients.
4. Calculation procedure to generate Vapour- Liquid Equilibrium (VLE) in form of T-x-y or P-x-y for miscible binary mixtures.
5. Methodology adopted to determine equilibrium constant.

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

1. Evaluate Partial molar, Residual and Excess properties.
2. Estimate Fugacity and Fugacity Coefficients for miscible binary Mixtures and also pure species.
3. Determine the activity coefficient using various models
4. Analyze Bubble and Dew point calculations for Ideal and Non Ideal solutions using VLE data
5. Predict equilibrium constant and composition of product mixture at given temperature and pressure

CO-PO-PSO Matrix

CO1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO2	3	3	3	2	2	2	2	0	1	2	0	3	3	3
CO3	3	2	1	2	2	0	1	0	1	2	0	3	3	3
CO4	3	1	1	1	1	0	0	0	1	1	0	1	3	3
CO5	3	3	2	2	3	1	2	0	1	2	0	3	3	3

UNIT I

Solution Thermodynamics theory: Fundamental property relation, Chemical potential and phase equilibria, Partial molar properties, Determination of partial molar properties, Relation between the partial molar properties, The Gibbs-Duhem equation, Ideal gas mixture, Fugacity and fugacity coefficient for pure species, Fugacity and fugacity coefficient for a species in solution,

UNIT-II

Solution Thermodynamics applications: Generalized Correlations for the Fugacity Coefficient, Ideal solution, Excess properties. Liquid phase properties from VLE data, Models for the Excess Gibbs free energy, Activity coefficient as the partial molar excess Gibbs free energy, One parameter and two parameter Margules equations, van Laar equations for activity coefficients,

UNIT-III

VLE using these activity coefficient models, Estimating the constants in the Whol's Margules and Van Laar equations from VLE data, infinite dilution data and azeotropic data, Property change of mixing, Basics of UNIFAC model, NRTL model, UNIQUAC model (Qualitative treatment only).

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UNIT-IV

Phase Equilibrium: The nature of equilibrium, The phase rule and the Duhem theorem, Qualitative behaviour of VLE, P-x-y and T-x-y diagrams, Raoult's law for VLE, VLE by modified Raoult's law, Henry's Law, Azeotrope formation, Types of Azeotropes. Methodology for Bubble and dew point calculations, Flash calculations.

UNIT-V

Chemical Reaction Equilibria: The Reaction Coordinate, Application of Equilibrium Criteria to Chemical Reactions, The Standard Gibbs-Energy Change and the Equilibrium Constant, Effect of Temperature on the Equilibrium Constant, Evaluation of Equilibrium Constants, Relation of Equilibrium Constants to Composition, Equilibrium Conversions for Single Reactions, Phase Rule and Duhem's Theorem for Reacting Systems Multi reaction Equilibria.

Text Books:

1. Smith J.M., Van Ness H.C., Abbott M.M., Swihart M.T., Introduction to Chemical Engineering Thermodynamics, 8th Edition, Tata McGraw Hill, 2018.
2. Narayanan K. V., Chemical Engineering Thermodynamics, PHI, 2000.

References Books:

1. Milo D. Koretsky, Engineering and Chemical Thermodynamics, 2nd Edition, John Wiley &Sons, Inc., 2013.
2. *Introduction to Chemical Engineering Thermodynamics*. Front Cover. *Gopinath Halder*, Prentice-Hall Of India Pvt. Limited, 2009.
3. Rao Y.V. C., Chemical Engineering Thermodynamics, University Press Ltd., 2001
4. Kyle B.G., Chemical and Process Thermodynamics, 3rd Edition, Pearson, 1999.

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20CHC14 **MASS TRANSFER OPERATIONS II**

Instruction	4 (3L+1T) Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: Mass Transfer Operations I

Course Objectives: This course will

1. Provide students the opportunity to acquire understand the concepts of distillation.
2. Introduce students to the importance and principles of liquid-liquid extraction over distillation.
3. Provide an overall view of design concepts solid liquid extraction process.
4. Understand the concept of adsorption and its applications in industries.
5. Help students to develop an overview of major liquid-liquid and solid liquid separation process and their applications and equipment used in industry.

Course Outcomes: At the completion of this course, students will be able to about

1. Understand the principles of different separation process used in the industry.
2. Understand the Principle and application of multi component and azeotropic distillation used in the chemical industries.
3. Understand the Principle and designing of distillation column used in the chemical industries
4. List situations where liquid–liquid extraction might be preferred to distillation.
5. List the situation where solid liquid extraction might be preferred in industry
6. Explain the concept of breakthrough in fixed-bed adsorption.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	3	-	-	-	2	-	2	3	3	2
CO2	3	3	1	-	3	-	-	-	2	-	2	3	3	3
CO3	3	3	3	-	-	-	-	-	-	-	-	2	2	3
CO4	3	3	2	-	3	-	-	-	2	-	2	3	3	3
CO5	3	3	3	-	-	-	-	-	-	-	-	2	2	3
CO6	3	3	2	-	-	-	-	-	-	-	-	2	2	3

UNIT I

Distillation: VLE phase diagrams, Tie lines and mixture rule Raoult's law, Relative Volatility - Flash vaporization and differential distillation for binary mixtures- Steam distillation. Batch distillation with reflux for binary mixtures.

UNIT II

Distillation: Continuous fractionation of binary mixtures, multistage tray towers – Ponchon and Savarit method, Mc Cabe and Thiele method of determination of ideal plates for binary mixtures- enriching section, exhausting section, feed introduction, total reflux, minimum and optimum reflux ratios, use of total and partial condensers. Use of open steam. 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 systems. Choice of solvent. Extraction with insoluble and partially soluble systems- single stage, multistage cross current and multistage counter current extraction without reflux and with reflux. Continuous contact extraction (packed beds). Equipment for liquid- liquid extraction operation.

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UNIT IV

Leaching: Preparation of solid for leaching, Unsteady state operation, in-place leaching, heap leaching, percolation leaching, Shanks system, agitated vessels, Percolation vs Agitation. Steady state continuous operation equipments- methods of calculation, stage efficiency and particle equilibrium. Single stage leaching, multistage cross current leaching, multistage counter current leaching.

UNIT V

Adsorption: Principles of adsorption and their applications- Types of adsorption- Adsorbents- Adsorption equilibrium- Adsorption Isotherms for vapor and dilute solutions. Single stage and multistage adsorption- unsteady state adsorption, adsorption wave and breakthrough curve and fixed bed adsorption. Equipment for adsorption. Ion-Exchange.

TEXTBOOK:

1. Mass Transfer Operations, 3rd ed., R. E. Treybal, McGraw-Hill, New York, 1980.

REFERENCES:

1. Transport Processes and Separation Process Principles 4th ed., C. J. Geankoplis, PHI, Learning Pvt. Ltd., New Delhi, 2009.
2. Principles of Mass Transfer and Separation Processes, B.K. Dutta, PHI Learning Pvt. Ltd., New Delhi, 2007.

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20CHC15 **PROCESS MODELING AND SIMULATION**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Some background of Fluid Flow operations, CRE-I, and Mathematics

Course Objectives:

1. This course is helpful to learn the formulation of a mathematical process model
2. Students are introduced toframe the concerned equations of a chemical process models leading to ODE.
3. Understanding and Framing a chemical process models using fundamental principles of conservation.
4. Understanding lumped parameter model and distributed parameter model
5. Students get familiar with the solution techniques of the developed model equations.
6. Application this knowledge of for entire chemical plant design.

Course Outcomes: After completing the course students will be able to

1. Understand the concepts modeling and simulation
2. Familiarize with conservation laws, continuity equation, equation of motion and its application in mathematical model building
3. Understand mathematical models of Reactors and Separation equipment
4. Understand the basic concept for solving the developed model equations
5. Familiarize with flow sheet for chemical process simulation with the software packages.

CO-PO-PSO Matrix

CO	PO1	PO2	PO	PO	PO	PO	PO	PO	PO	PO1	PO1	PO1	PSO1	PSO
1	1	2	1	2	2	2	1	1	1	0	0	1	2	1
2	1	2	2	2	2	2	1	1	1	0	0	1	2	1
3	3	3	3	3	2	2	3	1	1	0	0	1	3	2
4	3	3	3	3	3	3	3	1	1	0	0	2	3	2
5	3	3	3	3	3	3	2	1	2	1	0	3	3	1

UNIT-I

Introduction: Modelling and simulation, definition, concept and uses of mathematical models, Classification of mathematical models- steady state Vs dynamic models, lumped Vs distributed parameter models, deterministic Vs stochastic models.

Fundamental laws: Principles of formulation,Continuity Equation, Component Continuity Equation, Energy equation, and Equation of motion.

UNIT – II

Examples of mathematical models of reactor systems: Series of isothermal constant hold-up Continuous Stirred Tank Reactors (CSTRs), CSTRs with variable hold-ups, batch reactor, and gas phase pressurized CSTR, Non-isothermal CSTR.

UNIT – III

Examples of mathematical models of separation and other important systems: Gas absorber,Single component vaporizer, ideal binary distillation column, batch distillation with hold-up, Laminar flow of liquid in pipe, gravity flow tank.

UNIT – IV

Empirical model building- Method of least squares, linear, polynomial

Solution of non-linear algebraic equations- Bisection, False position, Newton- Raphson method

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Numerical solution of ordinary differential equations- Euler's method, Modified Euler's method, Runge- Kutta 4th order method

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.

Simulation of Chemical Processes: Introduction to various simulation software packages in chemical engineering, Simulation of models such as isothermal CSTR, non-isothermal CSTR, and batch reactor.

Textbooks:

1. William L Luyben, "Process Modeling, Simulation and Control for Chemical Engineers", McGraw Hill Publishing Company, 2nd edition, 1990
2. S.K. Gupta, Numerical Methods for Engineers, Wiley Eastern, New Delhi, 1995
3. B.V.Babu, Process Plant Simulation, Oxford University Press, 2004

Suggested Reading:

1. Steven C. Chapra and Raymond P Canale, "Numerical methods for Engineers", McGraw Hill International, 2nd edition, 1988

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20EGM03 **UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY**
(B.E/B.Tech II/III Year -Common to all Branches)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60Marks
CIE	40 Marks
Credits	3

Pre-requisites: Universal Human Values - I

Introduction

This course discusses the role of human values in one's family, in society and in nature. In the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

Course Objectives

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in human being, family, society and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course Outcomes

By the end of the course,

1. Students are expected to become more aware of themselves, and their surroundings (family, society, nature)
2. They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. They would have better critical ability.
4. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

The course has 28 lectures and 14 practice sessions:

Unit I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking- disliking.

Unit II

Understanding Harmony in the Human Being - Harmony in Myself

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in'I'
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of

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- Physical needs, meaning of Prosperity in detail
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Unit III

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
- Understanding the meaning of Trust; Difference between intention and competence
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
- Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals
- Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Unit IV

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self- regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all – pervasive space
- Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Unit V

Implications of the above Holistic Understanding of Harmony on Professional Ethics

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of
- people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order:
  a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
  b. At the level of society: as mutually enriching institutions and organizations

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Mode of Conduct (L-T-P-C 2-1-0-3)

- Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions.
- While analysing and discussing the topic, the faculty mentor's role is in pointing to essential

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elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.
- Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practicals are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

Assessment:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.
Example:
Assessment by faculty mentor: 10 marks
Self assessment/Assessment by peers: 10 M
Socially relevant project/Group Activities/Assignments: 20 marks
Semester End Examination: 60 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

Textbooks

The Text Book

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Valuesand Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1 The teacher's manual
2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN978-93-87034-53-2

Reference Books

1. A Nagaraj Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amar kantak,1999.
2. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi,2004.
3. Cecile Andrews, Slow isBeautiful
4. Gandhi - Romain Rolland (English)
5. Dharampal, "Rediscovering India"
6. E. FSchumacher. "Small isBeautiful"
7. J. C. Kumarappa "Economy ofPermanence"
8. Pandit Sunderlal "Bharat Mein AngrejiRaj"
9. Mohandas Karamchand Gandhi "The Story of My Experiments withTruth"
10. 10.Mohandas K. Gandhi, "Hind Swaraj or Indian Home Rule"
11. Maulana Abdul Kalam Azad, India Wins Freedom-
12. Vivekananda - Romain Rolland(English)
13. The Story of Stuff (Book)

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20CH E05 **CATALYSIS**
(Professional Elective II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60Marks
CIE	40Marks
Credits	3

Pre-requsites : Chemical Reaction Engg- I

Course objectives: This course helps the students to understand
1. Different types of catalysts, their structures and synthesis processes
2. Mechanism and kinetics of heterogeneous catalysts
3. Physical and chemical catalytic properties
4. Applications of catalysis in processes
5. Catalytic reactions and reactor design

Course Outcomes: At the end of the course, student will be able to
1. Explain the basic concepts of catalysis
2. Summarize the methods of preparation and characterization o f catalysts
3. Analyze the role of heat and mass transfer in the catalytic reactor design
4. Distinguish the performance of catalytic reactors
5. Identify the role of catalysts in the environmental protection
6. Explain the commercial aspects of catalytic reactors

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	-	-	-	-	-	-	-	2	2	2
CO2	3	2	1	1	1	-	-	-	-	-	-	2	2	2
CO3	3	2	2	1	1	1	1	-	-	-	-	2	2	2
CO4	3	2	1	1	1	1	1	-	-	-	-	1	2	2
CO5	3	2	2	1	1	1	1	-	-	-	-	1	2	2
CO6	3	2	2	1	1	1	-	-	-	-	-	1	2	2

UNIT – I

Catalysis: Introduction to Catalysis, Comparison of Catalyst Types, Basics of Heterogeneous and Homogeneous Catalysis.

UNIT – II

Basic concepts in heterogeneous catalysis: Catalyst characterization for physical and Chemical properties, Optimal distribution of catalyst in a pellet. Surface reactivity and kinetics of reaction on surfaces, poisoning and regeneration.

UNIT – III

Heat and mass transfer and its role in heterogeneous catalysis. Calculations of effective diffusivity and thermal conductivity of porous catalysts

UNIT – IV

Industrially important catalysts and processes such as oxidation, processing of petroleum and hydrocarbons, synthesis gas and related processes, Environmental catalysis. Zeolite catalysts, preparation, characterization and applications

UNIT – V

Commercial Catalytic Reactors (Adiabatic, fluidized bed, trickle bed, slurry etc.).Selection and design and preparation of catalysts

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Textbooks:

1. John MeurigThomas, W. J. Thomas, Principles and Practice of HeterogeneousCatalysis,WileyVCH;2nd Edition,2014
2. James John Carberry, Chemical and Catalytic Reaction Engineering, Dover Publications, INC,2001

Suggested Readings:

1. L K Doraiswamy, M M Sharma, Heterogeneous Reactions: Fluid-fluid- solid Reactions, Wiley,1984
2. B Viswanathan, S Sivasanker, and A V Ramaswamy, Catalysis: Principles and Applications, Narosa Publishing House, 2002

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20CH E06 **FERTILIZER TECHNOLOGY**
(Professional Elective II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: MEBC, MUO, Chemical Technology

Course objectives: This course helps the students to understand the:

1. Use of fertilizers in improving soil productivity and crop yield.
2. Different types of the nitrogenous, phosphoric and potash fertilizers.
3. Various fertilizer application methods.
4. Different organic fertilizer production methods.

Course outcomes: At the end of the course, the students will be able to:
1. Identify the different nutrients and significance of feed stocks for the production of fertilizers.
2. Identify methods for the production of various nitrogenous fertilizers.
3. Apply different manufacture methods for various phosphorous fertilizers.
4. Production methods for potassium and mixed complex fertilizers
5. Differentiate the need, application techniques and uses of new variety of fertilizers.
6. Design effluent treatment methods and impact of fertilizers on environment.

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	-	-	-	-	-	-	-	-	-	2	2
2	2	2	2	-	-	-	-	-	-	-	-	-	2	2
3	3	2	2	-	-	-	-	-	-	-	-	-	2	-
4	2	3	3	3	3	-	-	-	-	-	2	-	-	2
5	2	2	-	-	-	2	2	-	-	-	2	-	2	2

UNIT – I
Introduction: Fertilizer Technology, Plant Nutrients, Role of essential elements for plant growth, macro & micro elements.. Availability of feed stocks. Secondary nutrients; feedstock and raw materials for nitrogenous fertilizer. Secondary nutrients; phosphatic & potassic fertilizer.

UNIT –II
Nitrogen fertilizers: Introduction, Manufacture of Nitric acid and other nitrogenous fertilizers such as ammonium sulphate, ammonium nitrate, calcium ammonium nitrate, ammonium chloride, Sodium Nitrate.

UNIT – III
Phosphatic fertilizers: Phosphatic fertilizers - raw materials, phosphate rock, process for the production of sulphuric and phosphoric acids, ground phosphate rock,single super phosphate, triple super phosphate – methods of production, characteristics and specifications.

UNIT –IV
Potassium fertilizers: Introduction, Potassium Sulphate and Potassium Nitrate, Mixed and Compound fertilizers. Liquid fertilizers. Bio fertilizers – Introduction, advantages over chemical fertilizers, types and uses.

UNIT –V
Fertilizer application techniques: different soil controlled release fertilizers. Effluent treatment methods for various fertilizer plants. Environmental impact of fertilizer plants on Ecosystem. Indian Fertilizer industry – production Economics and future plans.

Text Books:

1. Brahma Mishra, "Fertilizer Technology and Management", IK International Publishing House Pvt. Ltd., New Delhi, 2012.
2. Dr. Shalini Suri, "Bio Fertilizers and Bio pesticides", 1st Ed., APH publishing Corporation, New Delhi, 2011.

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Suggested Reference Books :

1. Fertilizer Association of India, "Fertilizer Handbook", 2nd Ed., Scientific Publisher, New Delhi, 2009.
2. UNIDO, "Fertilizer Manual", 3rd edition, Kluwer Academic Publishers, New Delhi,1998.

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20CH E 07 **POLLUTION CONTROL IN PROCESS INDUSTRIES**
(Professional Elective II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Environmental Studies, MUO

Course Objectives: This course will help the students to understand the:
1. Effects of pollution on environment and ecosystems
2. Types and sources of pollution from process industries
3. Measurement of air and water pollution in process industries
4. Different methods and equipment used in industrial pollution abatement
5. Pollution control practices in process industries

Course Outcomes: At the completion of this course, students will be able:
1. Differentiate the types of wastes generated in an industry, their effects on living and non-living things
2. Understand the effect of climate changes, atmospheric dispersion of air pollutants, and operating principles.
3. Working principles of particulate control devices.
4. Quantify industrial wastewater and its treatment.
5. Analyze the hazardous and non-hazardous solid wastes and select the treatment and disposal methods.
6. Apply environmental management systems (EMS) to an industrial activity

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	1	1	2	1	1	1	1	1	2	2	2
CO2	2	2	2	2	1	1	2	1	1	1	1	2	2	2
CO3	2	2	1	1	1	2	2	1	1	1	1	2	3	2
CO4	2	1	2	1	1	2	3	1	1	1	1	2	2	3
CO5	2	2	2	2	1	1	3	1	1	1	1	2	3	3
CO6	2	1	1	1	1	2	1	2	1	1	2	2	2	2

UNIT- I
Introduction: Definition and types of pollution from chemical industries. Effects of pollution on environment and ecosystems - global warming - greenhouse effect. Laws and standards for pollution. Sources, types, characteristics and effects of air pollutants, liquid effluents, solid wastes in process industries.

UNIT- II
Air Pollution: Meteorological aspects of pollution dispersion, adiabatic and environmental lapse rate, Turbulence and stability of atmosphere. Indoor air pollution - smoke and hydrocarbons. Richardson Number, Plume raise, plume behavior and characteristics, effective stack height.
General Control Methods and Equipment: removal of sulphur dioxide, oxides of nitrogen and carbon, organic vapors from gaseous effluents. Removal of particulate matter - principle and working of settling chambers cyclone separators solid traps, fabric and fiber filters, electro-static precipitators.

UNIT- III
Water Pollution: Concepts and estimation of oxygen demands - DO, BOD, COD, and TOD. Oxygen sag curve, BOD curves and modeling. Wastewater Treatment – Concept, significance and classification as Primary, Secondary, Tertiary methods. Principle, working mechanism and applications of biological treatment techniques like stabilization ponds, Aerated lagoons, conventional activated sludge process, aerobic and anaerobic methods, suspended and attached growth processes, fluidized bed contractors. Trickling filters.

UNIT- IV
Industrial Solid Waste Management: Industrial solid wastes "Types, classification, properties, management and general disposal methods. Industrial solid wastes – environmental effects and disposal methods commonly practiced. Methods practiced in paper and textile industries.

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UNIT- V

Pollution control practices in Process Industries: Principle, working mechanism and application of tertiary treatment methods like carbon adsorption, Ion-exchange, Reverse Osmosis, Ultra Filtration in process industries. Sludge treatment and disposal methods like Incineration and land filling. Pollution control in petroleum and fertilizer industries

Text Books

1. C.S.Rao, "Environmental Pollution Control Engineering", 2nd Ed, New Age International, 2007.
2. S.P.Mahajan, "Pollution control in process industries", 27th Ed, McGraw Hill Pub, 2002.

Suggested Reading:

1. Metcalf and Eddy, "Wastewater Engineering: Treatment and Reuse", 4th Ed, MGH publishing, 2004.
2. M.N Rao and H.V.N Rao, "Air Pollution", Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000.
3. Peavy, H.S., Rowe, D.R. and Technobanolous, G., "Environmental Engineering", McGraw Hill, 1985.

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20 CHE08 **POLYMER SCIENCE AND TECHNOLOGY**

(Professional Elective II)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60Marks
CIE	40Marks
Credits	3

Pre-requisites: MEBC, MUO, Chemical Technology

Course objectives: This course helps the students to

1. Understand the fundamental- chemical, physical and mechanical behavior of polymers.
2. Understand the structure-processing-property relationship of polymers.
3. Estimate the processing techniques, along with the production of polymers.
4. Evaluate the synthesis, manufacture, processing and characterization of different polymers
5. Understand the basic concepts involved in polymer blends, composites and nano composites.

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

1. Explain the basic concepts of polymers, polymerization techniques and behavior in polymers
2. Distinguish different types of polymerizations
3. Determine the molecular weight of polymers by different techniques
4. Interpret the various processing techniques used for polymers, rubbers and fibers
5. Summarize the manufacturing and characterization of various industrially important polymers
6. Explain the concepts of polymer blends, composites and nanocomposites

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	2	2	-	-	-	1	2	3	2
CO2	3	3	3	-	-	2	2	-	-	-	1	2	3	3
CO3	3	3	3	-	-	2	2	-	-	-	1	2	3	3
CO4	3	3	3	-	-	2	2	-	-	-	1	2	3	2
CO5	3	3	3	-	-	2	2	-	-	-	1	2	3	2
CO6	3	3	3	-	-	2	2	-	-	-	1	2	3	2

UNIT-I

Definitions and concepts of terms used in polymer engineering, Classification of polymers; Polymer structures, functionality; polymerization reactions–mechanism of polymerization; stereo specific polymerization, copolymerization. Polymer material structure and Properties: Deformation, flow and melt characteristics. Morphology and order in crystalline polymers. Rheology and the mechanical properties of polymers. Polymers tructure and physical properties

UNIT-II

Polymerization reactors, polymerization processes, characterization of polymers, analysis of polymerization reactions, polymer degradation, Condensation polymerization, Addition polymerization, Ionic and coordination polymerization.

UNIT- III

Molecular weight and molecular weight distribution in polymers, Experimental methods for molecular weight determination: cryoscopy, ebulliometry, membrane osmometry, light scattering method, viscometry, intrinsic viscosity measurement, gel permeation chromatography. Structure and Properties: Thermal transitions, Crystallinity, Molecular weight characterization, Nuclear Magnetic Resonance (NMR) and Fourier Transform Infrared (FTIR) techniques.

UNIT–IV

Polymer processing: modeling– compression & transfer, injection & jet; casting; extrusion, calendaring, lamination, spinning & finishing. Processing methods , effect of additives used, plasticizers, colourants, heat stabilizers, antioxidants, ultraviolet absorbers, antistatic agents, flame retardants, blowing agents, fillers etc.

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Molding techniques for plastics, injection molding, compression molding, calendaring, blow moulding, extrusion, thermoforming, spinning methods for fibres, compounding methods for elastomers, general study of elastomer processing methods.

UNIT-V

Industrial polymers: Manufacturing processes, properties and uses of Polyethylene, Polypropylene, Polyvinylchloride, Polystyrene, Nylon, Polyethylene terephthalate. Hydrocarbon plastics and elastomers. Other carbon chain polymers. Hetero chain thermoplastics. Thermo setting resins. Polymer Blends: Types, Compatibility, Thermal and Mechanical Properties. Polymer Composites: Types, Properties, Preparation, Fibre-reinforced composites, In-situ composites. Polymer Nano composites: Basic concepts, Processing, Characterization.

TextBooks:

1. Text Book of Polymer Science, F.W. Billmeyer, JohnWiley,NewYork,1962
2. Polymer Science & Technology, P.Ghosh, TMC,2001

Suggested Reading:

1. The elements of Polymer Science & Engineering, Alfred Rudin, Academic Press, 2nd Edition,1998
2. Introduction to Polymers, R.J.Young, Chapman & Hall, London,1991

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20CE O02 **DISASTER RISK REDUCTION AND MANAGEMENT**

(Open Elective-I)

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CEE	40 Marks
Credits	3

Course Outcomes: Upon completion of this course, the student will be able to,

1. Identify and understand the concepts of hazards, causes and impacts of disasters.
2. Develop a critical capacity to evaluate the principles and practices of disaster risk reduction and management;
3. Develop a deep awareness of disaster resilience, risk mitigation, and recovery policies as they arise from natural hazards around the globe
4. Apply knowledge about existing global frameworks and existing agreements and role of community in successful Disaster Risk Reduction.
5. Evaluate DM study including data search, analysis and presentation as a case study.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	2	2	1	2	2	2	1	1	1	1
CO2	1	1	2	2	2	3	3	1	2	1	1	1	1	1	
CO3	2	2	2	2	2	2	3	2	1	1	2	1	1		
CO4	2	2	2	2	3	2	1	1	1	1	1	1			
CO5	2	1	2	1	2	3	1	2	2	2	2	1	1	1	1

UNIT I

- Hazard and disaster-concepts, vulnerability and risk
- Hazard and disaster type – Natural, Water- related, Pandemic and Human induced hazards disasters
- Causes and Impacts of disasters – Impacts on natural eco systems: physical, psychological and social impact
- Disaster and financial resilience
- GIS and remote sensing
- Disaster vulnerability profile of India –Specific to geographical regions and states (as per regional significance)

UNIT II

- Disaster Management Cycle –Rescue, Relief, Rehabilitation, Prevention, Mitigation and Preparedness
- Disaster risk reduction {DRR) –Community based DRR, institutions concerned with safety, disaster mitigation and construction techniques as per Indian standards
- Early warning systems

UNIT III

- Trauma and stress management
- First aid and emergency procedures
- Awareness generation strategies for the community on safe practises in disaster (as per regional significance)

UNIT IV

- Components of disaster management –preparedness of rescue and relief, mitigation, rehabilitation &reconstruction
- Institutional frame work of disaster management in India (NDMA-SDMA, NDRF, Civic volunteers, NIDM)
- Phases of disaster/risk management and post-disaster responses
- Compensation and insurance
- Applications of remote sensing &GIS in disaster management

UNIT V

- Capacity building for disaster/damage mitigation (structural and non structural measures).
- Disaster risk reduction strategies and national disaster management guidelines

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- Disaster management Act -2005
- Regional issues as per regional requirement/university can take minimum two topics as per high powered committee

Books:

1. Singh, R. (2017), "Disaster management Guidelines for Earth quakes, Landslides, Avalanches and Tsunami". Horizon Press publications.
2. Taimpo (2016), "Disaster management and preparedness". CRC Press Publications
3. Nidhi, G.D. (2014), "Disaster management preparedness". CBS Publications Pvt. Ltd.
4. Gupta, A.K.,Nair, S.S., Shiraz, A. and Dey, S. (2013), "Flood Disaster Risk Management-CBS Publications Pvt Ltd.
5. Singh, R. (2016), "Disaster management Guidelines for Natural Disasters" Oxford University Press Pvt. Ltd.

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20ME O15 **PRINCIPLES OF INDUSTRY 4.0**

(Open Elective I)

Instruction	3L	Hours per week
Duration of SEE	3	Hours
SEE	60	Marks
CIE	40	Marks
Credits	3	

Objectives:

1. Understand the concept and applications of Digital Manufacturing and Industry 4.0.
2. Relate different Additive manufacturing processes as a part of Digital Manufacturing
3. Understand the concept of Virtual prototyping, digital design and Importance of reverse engineering in Digital Manufacturing
4. To understand the concept of Industry 4.0 and allied technologies.
5. To Provide an understanding on the challenges faced and relevant industrial applications of Industry 4.0

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

1. Understand the Basics and applications of Digital Manufacturing and Industry 4.0.
2. Understand the role of Additive Manufacturing, Virtual prototyping and Reverse Engineering processes and their adaptability to Digital Manufacturing.
3. Understand the concepts of digital manufacturing based product life cycle and its management.
4. Understand the concept of Industry 4.0 and allied technologies.
5. Understand the basics of Internet of things and cloud computing pertaining the fourth industrial revolution.

UNIT-I

Introduction to digital manufacturing: Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System, Impact on manufacturing careers, Advantages of digital manufacturing and design, Information sharing in the digital thread, Digital twins and Files format (STL, AMF, 3MF), Multiple organizations in the manufacturing process. Introduction of Industry 4.0, case study on car manufacturing by Bosch.

UNIT-II

Additive Manufacturing Processes: Additive Manufacturing processes – Engineering polymers, metals and ceramics. Stereo lithography, Selective Laser Sintering, Fused Deposition Modeling, Layered object manufacturing. Electronic Materials, Bio-printing, Food Printing. Preprocessing and Post processing in AM

Virtual Prototyping & Reverse Engineering: Virtual Prototyping, Applications, Virtual Prototyping and Virtual Manufacturing.Reverse Engineering, Application of Reverse Engineering in Digital Manufacturing. Self-Learning of Manufacturing System and Intelligent Manufacturing System.

UNIT-III:

Key Technology of Digital Manufacturing: Various Digital Technologies in Product Lifecycle, Digital Equipment and Digital Processing Technology, Technology of Digital Maintenance and Diagnosis.

Product life cycle management: Introduction, Types of Product Data, Product life cycle management (PLM) systems. Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

UNIT-IV

Industry 4.0: Various Industrial Revolutions, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, automation, data exchanges, cloud, cyber-physical systems, mobile robots, Big Data, deep machine learning, Production Systems, IoT, Challenges of implementing Industry 4.0, Impact of implementing Industry 4.0 in various sectors, Applications domains and the way forward.

UNIT –V

Internet of Things (IoT) - IoT design methods, physical devices and enabling technologies, Industrial Internet of Things (IIoT), Smart Manufacturing.**Cloud Computingand Manufacturing-** Cloud models, cloud manufacturing examples, cloud based manufacturing, Cloud service and platforms for manufacturing.

Augmented Reality and Virtual Reality in Manufacturing.

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Text Books:

1 Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of DigitalManufacturing Science, Springer-Verlag London Limited,2012
2 Brent Stucker, David Rosen, and Ian Gibson, Additive Manufacturing Technologies, ISBN 978-1-4419-1120-9, Springer, 2010
3 Chee Kai Chua, Kah Fai Leong, 3D printing and additive manufacturing: principles and Application, 4th edition of rapid prototyping
4 Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things.

Suggested reading:

1. Lihui Wang and Andrew Yeh Ching Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009
2. Venuvinod, PK; Ma, W; Rapid prototyping – Laser based and other technologies, Kluwer,2004

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20ADO01 **INTRODUCTION TO PYTHON PROGRAMMING**

(Open Elective I)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

1. To introduce the python programming environment.
2. To impart knowledge basics data types and operation.
3. To familiarize with function, tuple, dictionary to process the data.
4. To introduce various packages in python
5. To familiarize class, object, exception handling and working with files.

Course Outcomes:

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

1. Explore data operations on list, tuple and dictionary in python.
2. Understand deployment of models on different datasets.
3. Apply supervised, unsupervised, resembling and NLP models on different datasets.
4. Perform data analysis using python packages.
5. Build and evaluate the models using python programming.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	1	-	-	-	1	1	1	1			
CO2	2	1	2	1	2	-	-	-	-	-	1	-			
CO3	2	1	2	2	1	-	-	-	-	-	-	-			
CO4	2	1	1	1	1	-	-	-	-	-	-	1			
CO5	2	1	1	1	1	-	-	-	-	-	-	1			

UNIT-I:

Introduction: Historical introduction to python, Installing Python, python interpreter and its environment: Argument passing and interactive mode, source encoding; Informal introduction to python: Python as calculator: Numbers, Strings, Lists, Programming steps.

UNIT - II

Control Statements and functions: control flow tools: if statement**,** for statements, range function, break and continue statements, else clauses on loops, pass and match statements; Defining function: default and keywords argument values, special parameters: positional-or-keywords arguments, positional parameters, keywords arguments, function examples, Arbitrary and Unpacking argument lists, lambda expression, documentation strings, function annotations, coding style, Input and output, reading and writing files.

UNIT - III

Data structures and Modules: More on lists: Lists as stack and queues, list comprehensions, nested list comprehensions, del statement, Tuples and sequences, sets and operations, Dictionaries, looping and conditional statements on dictionary; Modules: Executing modules as scripts, module search path, compiled python files, standards modules, dir() function, packages: Importing * from packages, intra packages references, packages in multiple directories, error and exception handling.

UNIT - IV

Design with Classes: Classes and Objects, python scopes and namespaces, class defining syntax: class objects, instances, method objects, instances variables, Inheritance, private variables, odds and ends, Iterators, generators and

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their expressions, standards library: OS interfaces and string pattern matching, virtual environment and packages, pip, floating point arithmetics: issue and limitations, error representation.

UNIT - V

Graphical User Interfaces: GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons. Simple Graphics and Image Processing: Overview of Turtle Graphics, Two dimensional Shapes, Colors and RBG System, Image Processing, GUI case studies.

Text Book:

1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning. 2. Think Python First Edition, by Allen B. Downey, O'reilly publishing

Suggested Reading:

1. Introduction to Computation and Programming Using Python. John V. Guttag, The MIT Press.
2. James Payne, Beginning Python using Python 2.6 and Python 3, Wrox publishing
3. Paul Gries, Practical Programming: An Introduction to Computer Science using Python 3,The Pragmatic Bookshelf, 2nd edition (4 Oct. 2013)

Web Resources:

1. https://python.org/tutorial/
2. Joy of computing Nptel course by prof. Sudersan Iyengar, IIT Roper
3. https://www.udemy.com/course/python-programming-beginner-to-advanced/

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20CSO05

BASICS OF ARTIFICIAL INTELLIGENCE

(Open Elective)

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Course Objectives: The objectives of this course are,

1. To learn fundamental concepts in Artificial Intelligence.
2. To explore various paradigms involved in solving AI problems involving perception, reasoning and learning.
3. To apply AI concepts for building an expert system to solve the real-world problems.

Course Outcomes: On Successful completion of this course, student will be able to,

1. Differentiate between a rudimentary Problem and an AI problem, its Characteristics and problem-solving Techniques.
2. Compare and contrast the various knowledge representation schemes of AI.
3. Appraise knowledge in Uncertainty and Probabilistic reasoning approaches.
4. Understand the different learning techniques.
5. Apply the AI techniques to solve the real-world problems.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO 1	3	3	3	1	3	-	-	-	-	-	-	-	3	3	1	-
CO 2	3	3	3	1	3	-	-	-	-	-	-	-	3	3	3	1
CO 3	3	3	3	1	3	-	-	-	-	-	-	-	3	3	3	1
CO 4	3	3	3	1	3	-	-	-	-	-	-	-	3	3	3	1
CO 5	3	3	3	1	3	3	-	-	-	-	-	-	3	3	3	1

UNIT - I

Introduction: History Intelligent Systems, Foundations of Artificial Intelligence, Sub areas of Al, Applications.
Problem Solving - State - Space Search and Control Strategies: Introduction, General Problem Solving Characteristics of problem, Exhaustive Searches, Heuristic Search Techniques, Iterative - Deepening A*, Constraint Satisfaction.

UNIT - II

Logic Concepts and Logic Programming: Introduction, Propositional Calculus Propositional Logic, Natural Deduction System, Axiomatic System, Semantic Table, A System in Propositional Logic, Resolution, Refutation in Propositional Logic, Predicate Logic, Logic Programming.
Knowledge Representation: Introduction, Approaches to knowledge Representation, Knowledge Representation using Semantic Network, Extended Semantic Networks for KR, Knowledge Representation using Frames.

UNIT - III

Uncertainty Measure - Probability Theory: Introduction, Probability Theory, Bayesian Belief Networks, Certainty Factor Theory, Dempster - Shafer Theory.

UNIT - IV

Intelligent Agents: Agents vs Software programs, classification of agents, Multi- agent systems, Architecture of intelligent agents, Multi-agent application.
Expert System and Applications: Introduction, Phases in Building Expert Systems Expert System Architecture, Expert Systems Vs Traditional Systems, Truth Maintenance Systems, Application of Expert Systems, List of Shells and tools.

UNIT - V

Machine - Learning Paradigms: Introduction, Machine learning System, Supervised and Unsupervised Learning, Inductive Learning, Learning Decision Trees, Deductive Learning, Clustering, Support Vector Machines

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Text Books:

1. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, First Edition, 2011.
2. Russell, Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 3rd Edition, Prentice Hall.

Suggested Reading:

1. Rich, Knight, Nair, "Artificial Intelligence", Tata McGraw Hill, 3rd Edition, 2009.
2. Trivedi, M.C., "A Classical Approach to Artificial Intelligence", Khanna Publishing House, Delhi.

Online Resources:

1. https://nptel.ac.in/courses/106105077
2. https://nptel.ac.in/courses/106106126

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20CHI02 **INTERNSHIP-II INDUSTRIAL / RURAL INTERNSHIP**

Instruction	3 to 4 weeks/90 hours
Duration of End Examination	-
Semester End Examination	-
Continuous Internal Evaluation	50 Marks
Credits	2

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20CHC16 **MASS TRANSFER OPERATIONS LAB**

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: MTO I and MTO II

Course objectives: This course will help the students to understand about

1. Estimate the efficiency of simple and steam distillation
2. Plotting the drying curve and estimating total drying time
3. Estimate diffusion co-efficient and mass transfer coefficients
4. Estimate the height of packed bed column.
5. Estimate separation efficiency of VLE, LLE, and leaching.
6. Determine the relationship between vapor and liquid at different temperatures

Course Outcomes: The students able to know

1. Calculate diffusivity coefficient
2. Separation of components by simple and steam distillation
3. Separation components by drying
4. Separation components by liquid- Liquid Extraction and solid-liquid extraction
5. Calculate mass transfer coefficient in wetted wall column.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO2	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO3	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO4	2	2	3	2	2	2	3	1	1	0	0	1	3	1
CO5	2	2	3	2	2	2	3	1	1	0	0	1	3	1

List of Experiments:
(Any 10 experiments to be conducted)

1. Estimation of diffusivity coefficient for the gaseous system (CCl_4 - Air).
2. Perform the simple distillation of methanol- water system.
3. Measure the purity of distillate by carrying out Steam Distillation.
4. Calculation of height equivalent to theoretical plate in packed column.
5. Experiment on Liquid - Liquid Extraction.
6. Experiment on Solid-Liquid Extraction (Leaching).
7. Determine Mass transfer coefficient using wetted wall column.
8. .Batch Drying
9. Determination of vapor - liquid equilibrium data for the given system.
10. Determine the PVT behavior of pure fluids by using Equation of state Liquid- Liquid Equilibrium Equipment
11. Calculate the property change of mixing
12. To determine the relationship between vapor and liquid at different temperatures
13. To determine the solubility characteristics of given solution at different temperatures
14. Determine distribution coefficient for toluene- acetic acid and chloroform- acetic acid mixture.
15. Construct Ternary Diagram for system of three liquid, one pair partially soluble i.e.acetic acid-Benzene-Water system.

Textbooks

1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983
2. Introduction to Chemical Engineering Thermodynamics (in SI units) by J M Smith and H C Van Ness and M M Abbott, 7th edition, Mc-Graw Hill International Edition, 2005

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20CHC17 **PROCESS MODELING AND SIMULATION LAB**

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: C or C++ or MATLAB and basic knowledge of chemical processes

Course Objectives: This practical course helps the students to understand the:

1. Application of their MATLAB coding and skills learnt in previous semesters, as a prerequisite for problem solving.
2. Formulation of a process models leading to ODE.
3. Formulation of a process models leading to non linear equations.
4. Open-loop simulation through MATLAB coding for simple chemical processes.
5. Steady state simulation of the process models using ASPEN
6. Application this knowledge of aspen for entire plant design.

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

1. Develop chemical engineering process models based on fundamental laws of mass and energy transfer
2. Dynamically simulate and interpret two heated tanks, using MATLAB
3. Dynamically simulate and analyze continuous reactors in Series using MATLAB
4. Adapt ASPEN software to perform steady state simulation of valves
5. Apply ASPEN software for simulation of batch Distillation
6. Utilize ASPEN software to design Plug flow reactor

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	3	-	-	-	1	-	2	2	2
CO2	3	3	2	3	3	1	-	-	-	1	-	3	3	2
CO3	3	3	3	3	3	3	-	-	-	1	-	2	3	3
CO4	3	2	2	3	3	2	-	-	-	2	-	2	3	2
CO5	3	3	3	3	3	2	-	-	-	1	-	2	3	3
CO6	3	3	3	3	3	3	-	-	-	1	-	2	3	3

Introduction: Software Packages. Understanding the basic concepts and steps involved for developing process flow sheet. Setting up models for simulation

List of Experiments (Minimum of 10 experiments in the list are to be performed)

Part I: Dynamic simulation using MATLAB

1. Two-heated Tanks in series.
2. Three CSTRs in series at isothermal constant holdup condition.
3. Batch Reactor.
4. Vapor Liquid Equilibrium.
5. Ideal Binary distillation.
6. Gas-Phase Pressurized CSTR

Part II: Steady State simulation using ASPEN

1. Simulation of simple units like valves, pumps, flash columns
2. Estimation of thermodynamics properties of the system through simulation

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3. Simulation of reactor systems
4. Simulation of Distillation columns
5. Simulation of Heat exchangers
6. Flow-sheeting of chemical process.

Textbooks:

1. Chemical Process Modeling And Computer Simulation by Amiya K. Jana .2018
2. Manjeet KaurBedi, Prof. Vikram Singh, A Textbook Of Simulation And Modeling, Laxmi Publications, 2011.
3. Aspen Plus (R) - Chemical Engineering Applications (English, Hardcover, Al-Malah K)

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Choice Based Credit System (With effect from 2022-2023)

B.Tech (Chemical Engineering)

Semester VI

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE inHours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	20CHC18	Chemical Reaction Engineering II	3		-	3	40	60	3
2	20CHC19	Plant Design &Economics	3	1	-	3	40	60	4
3	20CHC20	Instrumentation &Process Control	3	1	-	3	40	60	4
4	20 CHC21	Transport Phenomena	3	1	-	3	40	60	4
5		Professional Elective – III *	3	-	-	3	40	60	3
PRACTICAL									
6	20EGC03	Employability Skills			2	2	50	50	1
7	20CHC22	Plant Design Lab	-	-	3	3	50	50	1.5
8	20CHC23	Instrumentation &Process Control Lab	-	-	3	3	50	50	1.5
	TOTAL		**15**	**03**	**08**	**-**	**350**	**450**	**22**

	Course Code	**Professional Elective III**
1	20CHE09	Fuel Cell Technology
2	20CHE10	Petrochemical Technology
3	20CHE11	Pharmaceutical Technology
4	20CHE12	Safety and Hazard Analysis

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20CHC18 **CHEMICAL REACTION ENGINEERING II**

Instructions:	3L Hours per
Duration of End Examination:	3 Hours
Semester End Examination:	60 Marks
CIE:	40 Marks
Credits:	3

Pre-requisites: Chemical Reaction Engineering I

Course Objectives This course helps the students to understand

1. Basic Concepts of Catalysis
2. Kinetics and Mechanistic aspects of Catalysts
3. Design and Rating of Catalytic Reactors
4. Design Aspects of Gas-Liquid Reactors

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

1. Indentify and characterize solid catalysts
2. Explain the kinetics for solid catalyzed reactions
3. Interpret the kinetics of fluid and particle reactions
4. Identify regions of mass transfer control and reaction rate control in fluid-fluid reactions
5. Apply the concepts to fluid- fluid reactors
6. Apply the concepts to catalytic fluid- solid reactors

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	1	-	-	-	2	2
CO2	3	2	2	1	1	-	-	1	1	-	-	2	2	2
CO3	3	2	2	1	1	1	1	1	1	-	-	2	2	2
CO4	3	2	2	1	1	1	1	1	1	-	-	1	2	2
CO5	3	2	2	1	1	1	1	1	1	-	-	1	2	2
CO6	3	2	2	1	1	1	-	-	1	-	-	1	2	2

UNIT – I

Solid Catalysts - Adsorption, adsorption isotherms, surface area, void volume and solid density, pore volume distribution. Theories of heterogeneous catalysis, classification of catalysts, catalyst preparation, promoters and Inhibitors

UNIT – II

Solid Catalyzed Reactions - Introduction; Development of rate expressions from L- H - H - W models for reaction A + B ↔ R + S under adsorption, surface reaction and desorption controlling condition. Pore diffusion resistance combined with surface kinetics (Single cylindrical pore, first order reaction) Porous catalyst particles, mass and heat transfer within catalyst pellets. Experimental methods for finding rates.

UNIT – III

Kinetics of fluid-particle reactions: selection of a model, PCM, SCM, comparison of models with real situations. Shrinking core model for spherical particles of unchanging size: Diffusion through gas film controls, Diffusion through ash layer controls, chemical reaction controls. Rate of reaction for shrinking spherical particles.

UNIT – IV

Kinetics of fluid - fluid reactions: The rate equation for straight mass transfer of A (absorption). The general rate equation and the rate equation for reaction with mass transfer (infinitely fast to very slow reaction).Clues to the Kinetic Regime from Solubility Data

UNIT V

Fluid- Fluid Reactors: Design of reactors for straight mass transfer and mass transfer plus not very slow reaction cases

Catalytic gas solid reactors: Design of single adiabatic fixed bed catalytic reactor

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Textbooks

1. Levenspiel O., "Chemical Reaction Engineering", 3rdEdition, John Wiley & Sons, Singapore, (1999).
2. Smith J. M., "Chemical Engineering Kinetics", 3rd Edition, McGraw Hill, (1981).

Suggested References Books

1. Fogler H. S., "Elements of Chemical Reaction Engineering", 3rdEdition, Prentice Hall Inc., (1999)
2. Chemical and Catalytic Reaction Engineering, Carberry, J. J., Dover Books on Chemistry, 2001.
3. Chemical Reactor Analysis and Design Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, John Wiley & Sons, Incorporated, 2010

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20CHE19 **PLANT DESIGN AND ECONOMICS**

Instruction	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: MEBC, FM, HT, MUO

Course objectives: This course helps the students to understand the

1. Basics of plant design and plant layout.
2. Criteria of selecting process equipment, based on which optimized design can be identified.
3. Importance of process economics in process industries.

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

1. Learn the basic aspects of plant design and its elements
2. Select a suitable optimized cost-effective equipment for a given process.
3. Learn the basics of cost accounting and perform the cost analysis of a plant.
4. Identify methods of estimation of depreciation and profitability studies.
5. Design cost-effective process equipment and plants.
6. Design and optimize the process parameters

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO	PO	PO	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	2	-	2	1	-	1
CO2	3	1	1	-	-	-	-	-	2	-	1	1	1	1
CO3	3	2	2	-	-	-	-	-	2	-	1	1	-	2
CO4	3	2	2	-	-	-	-	-	2	-	1	1	-	2
CO5	3	2	2	-	-	-	-	-	2	-	1	1	3	2
CO6	3	2	2	-	-	-	-	-	2	-	1	1	3	2

UNIT−I

Basic Aspects of Process Design: Introduction – definitions of plant design, process synthesis, process simulation; design factors, design problem and steps; Process flow diagram and Block flow diagram; Mass and energy balances; Piping and Instrumentation diagram; Equipment Design Codes and standards.

UNIT− II

Selection of Process Equipment, Specification and Design; Process Utilities, Utility flow diagram with Examples; Materials choice; Plant location – general site considerations, Site layout and Plant layout, Ethics in Engineering design. Safety factors.

UNIT− III

Process Economics –Cost Accounting – Capitalinvestment, cost index, Equipment cost; Elements of cost; Expenses; Project cost and cost of production, Various components of cost of production and their estimation, Various components of project cost, variable cost, fixed cost, break even point and their estimation. Estimation of Working Capital. Balance sheets, Project financing, concept of interest, (Present Worth, Future Worth) time value of money, Margin of Safety.

UNIT – IV

Depreciation – Types, Methods of determining Depreciation

Profitability Analysis of Projects, Alternatives Investment, Replacements, Payout time and Rate of return, Total annualized cost, cost indices, payback period, discounted cash flow; Sensitivity analysis, Inflation.

UNIT −V

Design of Fluid Transport Equipment and costs–Pumps, Pressure vessels.
Design of Heat Transport equipment and costs– Heat exchangers, Evaporators
Design of Reactors and cost analysis
Design of Separation Equipment and costs– Distillation, Absorption, Stripping.
Optimization in Design – general procedures.

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Textbooks:

1. Peters. M.S. and Timmerhaus, K.D., "Plant Design and Economics for Chemical Engineering", 4th Edition, McGraw Hill, Singapore, 1991.
2. Coulson, J.M., Richardson J.E. and Sinnott R.K., "Chemical Engineering", Vol. VI, Pergamon Press, 1991

Suggested Reading

1. Schweyer. H.E., "Process Engineering Economics", McGraw Hill, 1st edition, New York, 1955.
2. Edgar T.F. and Himmelblau D.M., "Optimization of Chemical Processes" 2nd edition, McGraw Hill, International editions, Chemical Engineering series, 2001.

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20 CHC20 **INSTRUMENTATION AND PROCESS CONTROL**

Instruction	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Pre-requisites: Fluid Mechanics, Process Heat Transfer

Course Objectives: This course helps the students to understand:

1. The components and characteristics of industrial measurement systems
2. The transient behavior of simple chemical processes
3. Control loop - concepts, terminology, methods, and performance
4. Tuning and stability of a controllers
5. Advanced control strategies

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

1. Understand the measurement techniques for different process variables
2. Understand the dynamic behavior of different processes
3. Analyze different components of a control loop
4. Analyze stability of feedback control system
5. Identify the suitable controller for the given processes
6. Design controllers for first and second order processes

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	3	-	-	-	-	-	-	3	3
CO2	3	1	3	3	2	3	-	-	-	-	-	-	3	3
CO3	3	1	3	3	2	3	-	-	-	-	-	-	3	3
CO4	3	1	3	3	2	3	-	-	-	-	-	-	3	3
CO5	3	1	3	3	2	3	-	-	-	-	-	-	3	3
CO6	3	1	3	3	2	3	-	-	-	-	-		3	3

UNIT-I

Introduction to process control: process variables, Measurement of process variables, sensors and transducers, general Industrial instruments – I/P and P/I converters, pneumatic and electric actuators. P&ID diagrams and equipment symbols.

Characteristics of Measurement System: Elements of instruments, static and dynamic characteristics,

UNIT-II

Response of First order systems: Transfer Function, Transient response to step, impulse, sinusoidal forcing function, physical examples of first order systems, liquid level, mixing process, concept of time constant, linearization, response of first order systems in series, interacting and non-interacting systems

Response of Second Order Systems: Transient response of under damped, critically damped, over damped systems to step, impulse and sinusoidal forcing functions. Transportation lags. Dynamic responses of various systems, systems with inverse response

UNIT-III

Control Systems: Negative and Positive feedback control systems, Servo and Regulatory control problems, Development of Block diagram, Controllers and final control elements, Ideal transfer functions of P, PI, PD and PID controllers

Reduction of physical control systems to block diagrams: Closed loop transfer functions for servo and regulator problems. Overall Transfer functions for multi loop control systems. Transient response of simple control systems for servo and regulator problems, measurement lags. Stability of a control system by Routh's Criterion.

UNIT-IV

Root Locus: concept of root locus, plotting of the root locus diagram for feedback control systems, Transient response of control system from root locus plot.

Frequency response: Bode diagrams for first order, first order system in series, second order systems and for controllers and transportation lag. Bode stability criterion. Gain margin and phase margin

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UNIT-V

Advanced Control Strategies: Cascade Control, Feed Forward Control, Ratio control

Controller tuning and Process Identification: ISE, ITAE, IAE, Ziegler – Nicholas and Cohen-Coon tuning methods, Process reaction curve, process identification by step, frequency and pulse testing.

Control valves: control valve characteristics

Textbooks:

1. Eckman Donald P., Industrial Instrumentation, Wiley Eastern Ltd., 2004
2. Donald R Coughanowr , Steven E LeBlanc ,Process Systems Analysis and Control, 3rd edition, McGraw Hill Education (India) Edition 2013.

Suggested books:

1. D Patranabis, Principles of Industrial Instrumentation, , 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi, 2013.
2. Seborg D.E., Edgar T. E and Millichamp D.A, Process Dynamics and Control, John Wiley & Sons, 2004
3. Stephanopolis G., Chemical Process Control, Prentice Hall India, 2008
4. Bequette, B.W., Process Control: Modeling, Design and Simulation, 2007.
5. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, 1st Edition, Tata McGraw-Hill Education Private Limited, 2009.
6. Peter Harriott , "Process Control", Tata McGraw Hill Ltd.

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20CH C21 **TRANSPORT PHENOMENA**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Basic knowledge of FM, HT, and MTO

Course Objectives: This course introduces the students to

1. Fundamentals to solve flow problems involving transport of momentum, mass and energyusing a unified approach
2. The analogy between momentum, mass and energy transport.
3. The common mathematical structure of transport problems.
4. The turbulentphenomena and the methods of characterizing the turbulent fluxes.
5. Equations of change for isothermal and non-isothermal systems and multi-component mixtures.

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

1. Identify analogy between momentum, mass and energy transport
2. Develop expressions for velocity profiles using shell balances
3. Develop expressions for temperature profiles using shell balances
4. Develop expressions for concentration profiles using shell balances
5. Apply equations of change to solve flow problems
6. Understand transport mechanism in turbulent flows

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	2	1	-	-	-	-	-	3	3
CO2	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO3	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO4	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO5	3	3	3	2	-	-	-	-	-	-	-	-	3	3
CO6	3	3	3	2	-	-	-	-	-	-	-	-	3	3

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.

Velocity distributions in laminar flow - shell momentum balances -flow of a falling film - flow of fluids through circular tubes, annulus and immiscible fluids between parallel plates.

UNIT – II

Temperature distributions in solids and in laminar flow – shell balances - Heat conduction with electrical, Nuclear, viscous and chemical heat source

Heat conduction through composite walls and cooling fin, Forced convection and free convection

UNIT – III

Concentration distributions in solids and in laminar flow - shell mass balances, diffusion through a stagnant gas film, Diffusion with homogenous chemical reaction and heterogeneous chemical reaction. Diffusion into a falling liquid film-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

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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. R B Bird, W E Stewart, and E NLightfoot, Transport Phenomena, Revised 2nd Edition, John Wiley & Sons Inc., 2007

Suggested Reading:

1. R S Broadkay, Introduction to Transport Phenomena, McGraw Hill Publications, 1980
2. J R Welty, C E Wicks and R E Wilson, Fundamentals of Momentum, Heat and Mass Transfer, 3rd Ed., 1984
3. Geankoplis, Transport Processes and Separation Processes Principles. 4th Edition, Prentice Hall, 2003

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20CHE09 **FUEL CELL TECHNOLOGY**

(Professional Elective III)

Instruction	3L Periods per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Engineering Chemistry and CRE

Course Objectives: This course helps the students to:

1. Create awareness about alternate clean fuel available.
2. Evaluate the concepts and chemistry of fuel cell
3. Examine the details of fuel used in fuel cell technology
4. Explain the application of fuel cell in different sectors
5. Evaluate the fuel cell system balance plant and future opportunities

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

1. Apply know-how of thermodynamics, electrochemistry and principle of fuel cell
2. Understand the different types of fuel cell
3. Understand the components of hydrogen-based fuel cell
4. Evaluate the performance of fuel cells.
5. Explain the application of fuel cell in transport, stationary and portable sector
6. Understand the impact of this technology in a global and societal context

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	2	3	-	-	-	1	2	3	2
CO2	3	3	3	-	-	2	2	-	-	-	1	2	3	3
CO3	3	3	3	-	-	2	2	-	-	-	1	2	3	3
CO4	3	3	3	-	-	2	2	-	-	-	1	2	3	2
CO5	3	3	3	-	2	2	3	-	-	-	1	2	3	2
CO6	3	3	3	-	-	2	3	-	-	-	1	2	3	2

UNIT - I

Introduction: Electrochemical Systems and Fuel Cell, Fuel Cell Fundamentals and Basic Concepts, Fuel Cell Degradation, Fuel Cell Operation, Types Of Fuel Cell And Its Applications: Direct Carbon Fuel Cell, Solid Oxide Fuel Cell, Polymer Electrolyte Fuel Cell, Alkaline Fuel Cell, Phosphoric Acid Fuel Cell, Molten Carbonate Fuel Cell, Fuel Cell Thermodynamics - Heat, Work Potentials, Prediction of Reversible Voltage, Fuel Cell Efficiency.

UNIT – II

Fuels and Fuel Processing: Introduction, Feedstock for H_2 production: Natural gas, Liquefied petroleum gas, Liquid hydrocarbon Fuels: Gasoline and Diesel, Alcohols- Methanol and Ethanol, Ammonia, Biomass, Fuel processing for fuel cell applications: Desulfurization, fuel reforming, water gas shift reaction, Carbon monoxide Removal.

UNIT – III

Fundamental and Components of Portable Hydrogen Fuel Cell: Introduction, PEM Fuel cell Components and their properties: Membrane, Electrode, Gas diffusion layer, Bipolar plates, Stack design principles, system design, performance analysis, current/voltage, voltage efficiency and power density, ohmic resistance, direct methanol and other non-hydrogen fuel cells, biofuel cell

UNIT – IV

Application of Fuel Cell: Hydrogen fuel cell use in transport, stationary Fuel cell characterization: - in-situ and ex-situ characterization techniques, i-V curve, frequency response analyses; Fuel cell modelling and system integration: - 1D model - Analytical solution and CFD models.

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UNIT – V:

Balance of plant and commercialization issues, Future Opportunities, obstacles and challenges associated in fuel cell systems, impact of this technology in a global and societal context

Text Books

1. Nigel M. Sammes ,Fuel Cell Technology, Reaching Towards Commercialization, Springer London, 2006.
2. David A Berry, Dushyant Shekhawat, J.J. Spivey, Fuel Cells: Technologies for Fuel Processing, , Elsevier Science, 2011.

Suggested Readings

1. Shigenori Mitsushima, Viktor Hacker Fuel Cells and Hydrogen, From Fundamentals to Applied Research, Elsevier Science, 2018.

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20CHE10 **PETROCHEMICAL TECHNOLOGY**
(Professional Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Chemical Technology

Course objectives: This course helps the students to understand the
1. Petroleum refineries worldwide.
2. Extraction and production of oil and gas to meet energy needs.
3. Importance of refining crude oil for a wide spectrum of useful products such as petrochemicals, plastics.

Course Outcomes: At the end of the course, the students will be able to
1. Explain the composition, applications and formation theories of crude oil
2. Summarize the refining process of crude oil and the treatment methods for upgrading products.
3. Outline Ethylene derivatives and identify their manufacturing processes.
4. Outline Propylene and C4 derivatives and explain their manufacturing processes.
5. Classify higher paraffin derivatives and outline manufacturing processes.
6. Identify Aromatic derivatives sources and separation methods for aromatics.

CO, PO AND PSO MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-				1	1	-	-	-	-	1	1	2
CO2	2	1	-	-	-	1	1	-	-	-	-	1	1	2
CO3	2	1	-	-	-	1	1	-	-	-	-	1	2	1
CO4	2	1	-	-	-	1	1	-	-	-	-	1	2	1
CO5	2	1	-	-	-	1	1	-	-	-	-	1	2	1
CO6	2	1	-	-	-	1	1	-	-	-	-	1	2	1

UNIT–I

Origin and formation of Petroleum: Organic theories, Inorganic theories and biological methods for explaining the formation of Crude oil, History, Indian and World scenario of Petroleum Industry and Refineries; Composition of crude oil: Alkanes, Alkenes, Alkynes classification Petroleum Refining products, properties and testing methods: Overall refining of crude petroleum, Production of Natural gas, gasoline, kerosene and lubricating oils; API Gravity, Aniline point, Octane number, Cetane number, Smoke point, Fire point, Flash point, Diesel Index etc.

UNIT– II

Overview of Refining Processes; Crude pre-treatment methods
Rebuilding of Hydrocarbons and techniques involved:
Cracking: Definition, types, reactions, fluidized bed cracking, description of the reactors.
Alkylation: - Hydrofluoric acid process and sulphuric acid process
Isomerization: -Aluminum chloride process and isomerization with platinum catalyst.
Olefin Polymerization: Polymerization in presence of sulphuric acid, polymerizations in presence of phosphoric acid.
Reforming; Visbreaking; Coking

UNIT– III

Petrochemicals Overview: Classification of Various Feed stocks and products
Manufacture of Methanol from Synthesis gas; Formaldehyde from Methanol
Ethylene Derivatives: Ethylene Industry - Various products with ethylene as the starting materials. Manufacturing and applications of the following: Vinyl Chloride Monomer, Ethyl alcohol by direct hydration and liquid phase hydration methods, Vinyl acetate monomer, Ethylene oxide and Ethanol Amine, Polyethylene.

UNIT – IV

Propylene derivatives: List of propylene derivatives; Manufacturing of the following: Isopropyl alcohol, Acetone, Cumene, Acrylonitrile, Propylene oxide, Isoprene and Oxo-processing of Olefins.

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Butylene Derivatives: List of butadiene derivatives, Manufacturing of butadiene from n-butylene and by oxidative dehydrogenation; butylene glycol.

UNIT −V

Derivatives of Aromatics and their Manufacture: Aromatic Industry; BTX and their derivatives; Production of Benzene, Toluene, Xylene and their separation; Phenol, Styrene manufacture by different routes.

Derivative of Higher Paraffins: Manufacturing of Isoprene, olefins of C5 , C6, long chain and straight chain Olefins.

Textbooks:

1. W.L.Nelson, "Petroleum refinery engineering" 4th ed., McGraw Hill company, 2013.
2. B.K.Bhasker Rao, "Modern petroleum refining process", 5th ed., Oxford and IBH, 2008.
3. Uttam Ray Chaudari, "Fundamentals of Petroleum and Petrochemical Engineering", CRC Press, 2011.

Suggested Reading

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers, 1998.
2. N.K.Sinha, "Petroleum Refining and PetroChemicals", 1st edition, Umesh publications , 2003.
3. Kirk-Othmer, "Encyclopedia of Chemical Technology", 3rd Ed..John Wiley and sons.Inc, 2004.
4. Meyers Robert, "HandBook of Petroleum Refining Processes", 3rd edition McGraw Hill, 2003

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20CHE11 **PHARMACEUTICAL TECHNOLOGY**

(Professional Elective III**)**

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: MEBC, MUO, Chemical Technology

Course Objectives: This course helps the students to understand:

1. Grade of chemicals, Principles &Various Tests.
2. Preparation & testing of Pharmaceuticals & fine chemicals.
3. The Concepts & Principles to draw the flow sheets.
4. Methods & equipment used for Tablets, Capsules Preparation
5. Sterilization methods.

Course Outcomes: Upon completing this course, students will be able to:

1. Identify the different grades of chemicals, their impurities and limit tests
2. Compare the properties Pharmaceuticals and fine chemicals
3. Apply the testing methods for Pharmaceuticals and fine chemicals
4. Draw flow sheets for manufacturing common Pharmaceuticals
5. Draw flow sheets for manufacturing fine chemicals
6. Preparation of tablets and capsules and sterilization methods

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	-	1	-	1	-	-	-	-	-	1	-	-
CO2	1	2	1	1	-	-	-	-	-	-	-	-	-	-
CO3	1	2	1	2	-	-	-	-	-	-	-	-	2	1
CO4	2	-	-	-	-	-	-	-	-	-	-	-	2	2
CO5	2	-	-	-	-	-	-	-	-	-	-	-	2	2
CO6	-	1	2	2	-	1	-	-	-	-	-	1	-	1

UNIT - I

Introduction and 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 sulphate in Pharmaceuticals.

UNIT - II

Properties, uses and testing of Pharmaceuticals like sulfacetamide, paracetamol, riboflavin, nicotinamide. Fine chemicals like Methyl orange, fluorescence, procaine hydrochloride, isonicatinic acid hydrazide, para-amino salicylic acid.

UNIT - III

Flowsheet and process description for manufacturing common Pharmaceuticals like aspirin, penicillin, calcium gluconate with uses, properties, flow sheets and testing Methods.

UNIT - IV

Flowsheet and process description for manufacturing of fine chemicals like ferric ammonium citrate, phthalic anhydride. Comparison of phenol fluorobenzene process and benzene sulphate process.

UNIT - V

Tablet making, coating, granulation and granulation equipments. Preparation of capsules, extraction of crude drugs. Introduction to sterilization, risk factor, methods of sterilization like heating with bactericide, gaseous and radiation type.

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Textbooks:

1. Ajay Semalty and Mona Semalty Essentials Of Pharmaceutical Technology, 2nd Edition, BS publishers, 2018
2. Dr Shaik Harun Rasheed, A Textbook of Pharmaceutical Technology, Sia publishers, 2017

Suggested Reading:

1. Blently's Text Book of Pharmaceutical Chemistry, 8th ed, H A Rawlins, B Tindell and Box,. Oxford University Press, London, 1977.
2. Industrial Chemicals, 3rd ed., Faith, Kayes and Clark, John Wiley &Sons,. 1965.
3. Remington's Pharmaceutical Science, 17th ed, Mac publishing company, 1985

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20CHE12 **SAFETY AND HAZARD ANALYSIS**

(Professional Elective III**)**

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites: Chemical Technology

Course Objectives: This course will help the students to understand the

1. Importance of safety culture in process industry.
2. Disregard for ethical decision making based on numerous case studies.
3. Interaction and implementation of trade-offs concept in chemical plant operation.
4. Examples of problems that can occur with inadequate process design, improper process modification.
5. Different case studies related to industrial processes

Course outcomes: At the completion of this course, students will be able to

1. Evaluate effect of chemical hazards and risks of toxicants.
2. Analyze chemical incidents and possible consequences to plant facilities, workers, and the general public.
3. Analyze fire and explosion hazards.
4. Integrate safety concepts into chemical plant design.
5. Apply ethics during process plant operation
6. 6.Understand the overall safety aspects and safety audit norms for chemical process plant

CO, PO AND PSO MATRIX

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO2	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO3	3	3	3	2	2	2	3	1	1	0	0	1	3	1
CO4	2	2	3	2	2	2	3	1	1	0	0	1	3	1
CO5	2	2	3	2	2	2	3	1	1	0	0	1	3	1
CO6	2	2	3	2	2	2	3	1	1	0	0	1	3	1

UNIT-I

Introduction: Process industrial safety –definition, importance. Safety awareness – Safety aspects of site selection, plant planning and layout, check list, inline arrangement of tower drums, exchangers, pumps and main pipelines. Case studies of major disasters due to safety violations: Chernobyl disaster, Bhopal disaster, recent oil spills. Chemical hazards and workers safety, industrial process case studies.

UNIT – II

Organized labor interest in safety: Involvement of unions in accident prevention, recommendation of occupational health committees. Work Policy of MCA in accident prevention at process industries. Risk assessment procedures (HAZOP) and typical operational practices. Necessary precautionary measures (OSHA). Hazards: Identification and operability studies. Involvement of chemical criminals in process industries and their prevention. DOW Fire and explosion index, calculation of the DOW Fire and EI. Chemical safety data sheets and guides.

UNIT – III

Safety education and training: Training of personnel, on- the- job and job instructed training, meeting and instructional presentations. Effects of toxic Agents, chemicals and smoke on skin, eyes, respiratory tract, digestive tract. Primary protection equipment (PPE) – types, significance and applications. Measuring safety effectiveness: criteria for effective measurement, disabling (Lost-time) injuries, frequency rate, severity rate. Problem related safe-t-score. The technique of safe process design, separation sections, materials handling, storage sections, flow sheet review.

UNIT – IV

Fires and explosions: Types of Explosions, Runaway reactions, Safety valve rupture and risk assessment. Definition of fire, fire triangle, Classification of fires as Class-A, B, C and D. Reaction of fires. Fire extinguishers: Portable fire

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extinguishers applications and their uses, Construction and working of water, Mechanical foam, CO_2, stored powder, ABC powder. Automatic multiple CO_2 extinguishers in chemical process industries.

UNIT – V

Emergency preparation and accident investigation: On-site and off-site emergency plan and infrastructure, learning from accidents, layered investigation, equipment aiding in diagnosis. Safety audit: Introduction, essentials, requirements, programs and procedures.

Text Books

1. D. A. Crowl and J.F. Louvar, "Chemical Process Safety", Prentice Hall, New Delhi, 2011.
2. Howard H. Fawcett and W. S. Wood, "Safety & Accident prevention in chemical operations", 2nd Ed., John Wiley and Sons Inc, 1982.

Suggested Reading:

1. Coulson and Richadson, "Chemical Engineering Design", 3rd ed., Vol 6, TMH, 1999.
2. Fulekar M.H, "Industrial Hygiene and Chemical Safety", I.K. International Publisher, 2006.
3. Sanders R.E., "Chemical Process Safety: Learning from case Histories", Butterworth-Heinemann (Elsevier) pub, 2005.

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20EGCO3 **EMPLOYABILITY SKILLS**

(BE/BTech V & VI semester - Common to all Branches)

Instruction	2L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1

Course Objectives: To help the students

1. Learn the art of communication; participate in group discussions and case studies with confidence and to make effective presentations.
2. With- resume packaging, preparing them to face interviews.
3. Build an impressive personality through effective time management, leadership qualities, self-confidence and assertiveness.
4. Understand professional etiquette and to make them learn academic ethics and value system.
5. To be competent in verbal aptitude.

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

1. Become effective communicators, participate in group discussions with confidence and be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long-term goals, learn to manage time effectively and deal with stress.
4. Mak**e** the transition smoothly from campus to work, use media with etiquette and understand the academic ethics.
5. Enrich their vocabulary, frame accurate sentences and comprehend passages confidently.

UNIT 1

Verbal Aptitude: Error Detection, Articles, Prepositions, Tenses, Concord and Transformation of Sentences- Jumbled Words/Sentences- Vocabulary, Synonyms, Antonyms, One Word Substitutes, Idioms and Phrases, Word/Sentence/Text Completion- Reading Comprehension.

UNIT 2

Group Discussion & Presentation Skills: Dynamics of Group Discussion-Case Studies- Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Accuracy, Coherence. Elements of Effective Presentation – Structure of a Presentation – Presentation tools – Body language - Preparing an Effective PPT

UNIT 3

Behavioural Skills: Personal strength analysis-Effective Time Management- Goal Setting- Stress management- **Corporate Culture** – Grooming and etiquette-Statement of Purpose (SOP).

UNIT 4

Mini Project: Research-Hypothesis-Developing a Questionnaire-Data Collection-Analysis-General and Technical Report - Writing an Abstract –Technical Report Writing-Plagiarism-Project Seminar.

UNIT 5

Interview Skills: Cover Letter and Résumé writing – Structure and Presentation, Planning, Defining the Career Objective, Projecting ones Strengths and Skill-sets – Interviews: Concept and Process, Pre-Interview Planning, Opening Strategies, Answering Strategies, Mock Interviews.

Suggested Reading:

1. Leena Sen, “Communication Skills”, Prentice-Hall of India, 2005
2. Dr. Shalini Verma, “Body Language - Your Success Mantra”, S Chand, 2006
3. Edgar Thorpe and ShowickThorpe , “Objective English”, 2nd edition, Pearson Education, 2007
4. Ramesh, Gopalswamy, and Mahadevan Ramesh, “The ACE of Soft Skills”, New Delhi: Pearson, 2010
5. Gulati and Sarvesh, “Corporate Soft Skills”, New Delhi: Rupa and Co., 2006
6. Van Emden, Joan, and Lucinda Becker, “Presentation Skills for Students”, New York: Palgrave Macmillan, 2004

7. A Modern Approach to Verbal & Non-Verbal Reasoning by R S Aggarwal, 2018
8. Covey and Stephen R, "The Habits of Highly Effective People", New York: Free Press, 1989

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20CHE22 **PLANT DESIGN LAB**

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	35 Marks
CIE	15 Marks
Credits	1.5

Pre-requisites: MEBC, FM, HT, MUO

Course Objectives: This course will

1. Provide students the opportunity to acquire simulation skills in Chemical Plant equipment design.
2. Introduce students to the importance and principles of design of a plant
3. Provide an overall view of design concepts of various unit operations and processes.
4. Demonstrate the overview of plant layout, flow sheeting and perform economic evaluation and sensitivity analysis of the plant
5. Help students to develop simulation skills using various chemical Engineering software like Aspen Plus, Aspen Hysys software, CAD, Pro-II etc.

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

1. Acquire simulation skills in Chemical Plant equipment design.
2. Understand and apply the design concepts to various unit operations and processes.
3. Design various Heat and mass transfer equipment.
4. Design pumps, pressure vessels and reactors.
5. Analyze the performance of a process plant using economic evaluation and sensitivity analysis.
6. Perform simulation of design case studies in Aspen Plus/Aspen Hysys software/CAD/Pro-II.

CO-PO-PSO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO	PO11	PO12	PSO11	PSO12
CO1	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO2	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO3	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO4	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO5	3	2	2	2	2	-	-	-	2	-	-	2	3	2
CO6	3	2	2	2	2	-	-	-	2	-	-	2	3	2

LIST OF EXERCISES (Minimum of 10 experiments in the list are to be performed)

1. Symbols for Piping and Instrumentation, Flow sheet symbols for unit operations.
2. Design and analysis of pumps and pressure vessels.
3. Design of Heat Transfer Equipment - Shell and Tube Heat Exchanger
4. Design of Heat Transfer Equipment - Condensers/Evaporators
5. Design of Reactors - 1
6. Design of Reactors - 2
7. Design of Mass Transfer Equipment - 1
8. Design of Mass Transfer Equipment - 2
9. Economic Evaluation Analysis in Aspen Plus - Case Study 1
10. Economic Evaluation Analysis in Aspen Plus - Case Study 2
11. Performing Sensitivity Analysis in Aspen Plus - Case Study 1
12. Performing Sensitivity Analysis in Aspen Plus - Case Study 2
13. Overall Plant layout and Design - Case Study

Text Books

1. Vilbrandt, C.T. and Dryden, C.E., "Chemical Engineering plant design", 4th Ed., Kogakusha, 1979.
2. Joshi, M.V. "Process Equipment Design", 2nd Ed., McMillan Co. of India Limited, Madras, 1976.
3. Bachurst, J.R. and Harker, J.A. "Process Plant Design", Heiman Education Books, London, 1973.
4. Peters. M.S. and Timmerhaus, K.D., "Plant Design and Economics for Chemical Engineering", 4th Edition, McGraw Hill, Singapore, 1991.

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5. Evans, F.L., "Equipment Design HandBook for Refineries and Chemical Plants", Vol .I, 1979, Vol. II, 1980, Gulf Publishing Co., Houston, Texas.
6. Chemical Process Design and Simulation: Aspen Plus and Aspen Hysys Applications, JumaHaydary, AICHE, Wiley Pub.

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20 CHC23 **INSTRUMENTATION & PROCESS CONTROL LAB**

Instruction	3P Hours per week
Duration of SEE	3Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Pre-requisites: Instrumentation & Process Control theory

Course Objectives: This course helps the students to understand the:

1. Dynamic response of first and second order processes
2. The difference between interacting and non-interacting systems
3. Characteristics of various controller modes
4. Method and significance of controller tuning
5. Relation between valve stem position and the fluid flow through a control valve

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

1. Calibrate the different process instruments
2. Evaluate the performance of a first and second order systems
3. Analyze step response of simple feedback control systems
4. Determine frequency response of control systems
5. Analyze the behavior of a control system using different modes of control when subjected to a permanent disturbance
6. Apply closed loop and open loop techniques to tune process controllers

CO-PO-PSO Matrix

CO	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	3	-	3	-	-	3	-	3	-	3	2
CO2	2	1	-	2	-	3	-	-	3	-	3	-	3	2
CO3	2	1	-	1	-	3	-	-	3	-	3	-	3	2
CO4	2	2	-	2	-	3	-	-	3	-	3	-	3	2
CO5	2	2	-	-	-	3	-	-	3	-	3	-	3	2
CO6	3	2	-	-	-	3	-	-	3	-	3		3	2

List of Experiments (Minimum of 10 Experiments in the list are to be performed)

1. Calibration of thermocouples
2. Calibration of differential pressure transmitter
3. Determination of dynamics of a first order system (thermometer)
4. Determination of second order under damped characteristics from the dynamics of second order system (manometer/thermo well)
5. Determination of dynamics of interacting liquid level system
6. Determination of dynamics of non-interacting liquid level system
7. Level control trainer
8. Flow control trainer
9. Temperature control trainer
10. Control valve characteristics

Text Books:

1. Donald R Coughanowr , Steven E LeBlanc ,Process Systems Analysis and Control, 3rd edition, McGraw Hill Education (India) Edition2013.
2. D Patranabis, Principles of Industrial Instrumentation, , 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi, 2013.

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18CH C 21 **TRANSPORT PHENOMENA**

Instruction	3L + 1T Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: This course introduces the students to

1. Fundamentals to solve flow problems involving transport of momentum, mass and energy using a unified approach
2. The analogy between momentum, mass and energy transport
3. The common mathematical structure of transport problems
4. The turbulent phenomena and the methods of characterizing the turbulent fluxes
5. Equations of change for isothermal and non-isothermal systems and multi-component mixtures

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

1. Develop expressions for velocity, temperature and concentration profiles using shell balances
2. Identify analogy between momentum, mass and energy transport
3. Formulate and solve one-dimensional transport problems by using the conservation equations
4. Apply equations of change to solve flow problems
5. Understand transport phenomena in turbulent flows

UNIT – I

Introduction - Mechanism of molecular transport of momentum, heat and Mass Transfer. Flux equations - Newton's, Fouriers' and Fick's laws - Similarities and differences

Non-Newtonian fluids, transport properties - estimation, temperature and pressure dependence, estimation of transport properties of binary gaseous mixtures

Velocity distributions in laminar flow - shell momentum balances - Flow of falling film - flow of fluids through circular tubes, annulus and Immiscible fluids between parallel plates.

UNIT – II

Temperature distributions in solids and in laminar flow – shell balances - Heat conduction with electrical, Nuclear, viscous and chemical heat source

Heat conduction through composite walls, and cooling fin; Forced convection and free convection

UNIT – III

Concentration distributions in solids and in laminar flow - shell mass balances, diffusion through a stagnant gas film, Diffusion with homogenous chemical reaction and heterogeneous chemical reaction. Diffusion into a falling liquid film-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 – Equation of continuity of a component in curvilinear coordinates

UNIT – V

Unsteady state problems in momentum, energy and Mass Transfer operations; Turbulence -Introduction to Time smoothing; Eddy properties - Intensity of turbulence Reynolds stresses; Semi empirical expressions for turbulent - momentum , energy and mass fluxes

Text Books:

1. R B Bird, W E Stewart, and E N Lightfoot , Transport Phenomena, John Wiley &Sons, 1960
2. R B Bird, W E Stewart, and E N Lightfoot, Transport Phenomena, Revised 2nd Edition, John Wiley & Sons Inc., 2007

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Suggested Reading:

1. R S Broadkay, Introduction to Transport Phenomena, McGraw Hill Publications, 1980
2. J R Welty, C E Wicks and R E Wilson, Fundamentals of Momentum, Heat and Mass Transfer, 3rd Ed., 1984
3. Geankoplis, Transport Processes and Separation Processes Principles. 4th Edition, Prentice Hall, 2003

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18CH C 22 **PROCESS TECHNOLOGY AND ECONOMICS**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand about the

1. Manufacturing processes of various industry relevant inorganic chemicals
2. Understanding about raw materials, energy sources, consumption and operating conditions of petroleum processing
3. Applying knowledge of unit operations, unit processes to draw flow diagrams for the manufacturing various petrochemical products
4. Application of industry relevant fuels
5. Applying and analyzing profitability of projects

Course Outcomes: At the completion of this course students will be able to

1. Explain various sources and processes of manufacture of various industrially important chemicals
2. Apply unit operations to draw block diagrams/ process flow diagrams of the processes used for manufacture of industrially important chemicals
3. Find out energy sources, requirement of raw materials and operating conditions of petrochemicals
4. Outline the application of industry relevant fuels
5. Apply various economic equations to evaluate project viability

UNIT- I

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of Inorganic Chemicals, such as: inorganic acids Sulphuric Acid by contact process, Phosphoric Acid by sulphuric Acid digestion process, chloro-alkali chemicals (Soda ash by Solvay process, Caustic Soda) Ammonia, Fertilizers (Urea, MAP and DAP)

UNIT- II

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for Petroleum processing: Constituents of petroleum, various unit operations and unit process of refining products of refining and cracking operations, syngas and hydrogen by steam reforming of hydrocarbons

UNIT- III

Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram for manufacture of Petrochemicals: Chloromethanes, Ethanol amines, Acrylonitrile, Acetylene, phenol, toluene, xylene.

UNIT- IV

Industrially relevant fuels, coal, coal based chemicals and fuels Common utilities such as electricity, cooling water, steam, hot oil, refrigeration and chilled water

UNIT- V

Introduction to project cost and cost of production, Various components of cost of production and their estimation, Various components of project cost variable cost, fixed cost, breakeven point and their estimation. Estimation of Working Capital. Balance sheets, Project financing, concept of interest, (Present Worth, Future Worth) time value of money, depreciation. Profitability Analysis of Projects, Payout time and Rate of return

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Text Books:

1. Shreve's Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984
2. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013

Suggested Reading:

1. Chemical Process Technology, Moulijn, M. and van Dippen, Wiley, 2013
2. Dryden's Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East West Press, 1997
3. Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005

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18CH C 23 **PROCESS INSTRUMENTATION**

Instruction	2 Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	20 Marks
Credits	2

Course Objectives: This course will help the students to understand the

1. Fundamental elements of industrial instruments and their characteristics
2. Different types of temperature measuring instruments and their industrial applications
3. Different types of pressure measuring instruments
4. Different types of flow meters and level measuring devices
5. Methods applied for composition analysis in process industries

Course Outcomes: At the completion of this course students will be able to

1. Identify instruments required in process industry based on their purpose and function
2. Compare the range of operation and working of different temperature measuring instruments
3. Interpret the different pressure measuring instruments based on their application
4. Select the required flow and level measuring instruments for process industry
5. Apply the different methods of composition analysis for industrial analysis

UNIT- I

Importance of industrial instrumentation: Need, significance, applications and classification. Functional units – elements of instruments and their functions as sensors, transducers, transmitters and receivers. Static and dynamic characteristics of instruments.

UNIT- II

Temperature measurement: Expansion thermometers – types, mercury in glass, bimetallic, pressure spring type, drawbacks for industrial applications. Industrial thermocouples – types and range of operation, lead wires, need of thermowells. Industrial resistance thermometers – types of sensors, Resistive Temperature Detectors [RTD], Thermistors. Infrared thermometry – pyrometers, radiation receiving elements, radiation pyrometer, optical pyrometer.

UNIT- III

Pressure measurement: Manometers types – U-tube, well type, enlarged leg, inclined leg, ring balance type. Elastic transducer elements– bourdon, bellow and diaphragm. Electrical pressure transducers – Linear variable differential transformer (LVDT) and strain gauge. Introduction to standard vacuum gauge – McLeod gauge and Pirani gauge.

UNIT- IV

Flow and Level measurement: Flow meters – head type, area type, mass flow meter, electromagnetic flow meters. Level measurement – hydrostatic head, float type, RF capacitance, Radar type.

UNIT- V

Analytical Techniques: Spectroscopic analysis, absorption type – infrared, UV, X-ray and NMR. Emission and Mass spectroscopy Analysis of moisture in gases (humidity) by psychrometer, hygrometer, dew point methods. Introduction to chromatography – types, uses, Gas Liquid Chromatography, Thin layer Chromatography.

Text Books:

1. D Patranabis, Principles of industrial instrumentation, 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi, 2013
2. Donald P Eckman, Industrial Instrumentation, CBS pub and distr. Pvt. Ltd., New Delhi, 2004

Suggested Reading:

1. N V S Raju, Instrumentation Operation, Measurement, Scope and Application, B S Pub., Hyd., 2016
2. Arun K Ghosh, Introduction to Measurements and Instruments, PHI learning Pvt. Ltd., New Delhi, 2013

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18CH E 13 **MINERAL PROCESSING TECHNOLOGY**

(Core Elective V)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand

1. Various unit operations involved in mineral processing technology and the mineral concentration processes
2. Importance and principles of materials handling in the mineral processing plant with special emphasis on feeding and conveying of bulk material
3. Opportunities to acquire practical skills in concentrates handling, grade
4. Heavy media separations and separation vessels
5. Recovery and loss calculation and participatory laboratory experiments

Course Outcomes: At the completion of this course the students able to

1. Explain the principles governing a range of processes applied in the mineral industry
2. Identify typical unit processes and flow-sheets for production of a number of metals
3. Apply basic engineering principles to the design of mineral processes
4. Develop conceptual designs for simple extraction processes
5. Summarize the operation of beneficiation units for coal and mineral

UNIT- I

Introduction to Mineral Processing, Objectives, Scope and importance. Properties and Types of Minerals

Ore handling: removal of harmful materials - sampling of ores: moisture sampling, assay sampling, sampling Techniques, sample division methods.

UNIT- II

Mineral liberation: Degree of liberation, concentration, measures of assessing metallurgical performance viz., Recovery, Ratio of Concentration, Grade, Enrichment ratio and Recovery vs Grade

Laboratory sizing: Particle size and shape, Sieve analysis, Sub sieve techniques, centrifugal methods (warmancyclosizer), microscopic sizing, online particle size analysis.

UNIT- III

Classification: Principle of Classification, Types of Classifiers

Gravity concentration: Principle, Jigs, Basic Construction of Jig, Types of Jigs viz., Harz Jig, circular and radial jigs, coal jigs (Baum and Batac jigs)

Gravity concentration in streaming currents: Pinched sluice, cones, spirals, shaking table.

UNIT- IV

Heavy medial separation: Principle, liquids and suspension for heavy media separation.

Separation vessels: Gravitational vessels (Wemco Cone separator, Drum separator)

Centrifugal separators: (Vorsyl separator, LARCODEMS, Dyna whirlpool separator) DMS cyclone , DMS circuits.

UNIT- V

Flotation – History and theory: Flotation practice: ore and pulp preparation, contact angle, work of adhesion; Flotation Reagents: collectors, frothers, regulators; and their action –reagents and conditioning- Flotation Machines: pneumatic (Davcra cell, flotation column, Jameson cell, froth separators) and mechanical (Denver cell, Wemco cell) electro flotation, skin flotation,

Case studies: i) Advanced Beneficiation processes. ii) Different methods for fine particles collection (Copper, Iron, Gold).

Text Books:

1. B.A.Wills – "Mineral Processing Technology", 7th edition Maxwell International Edition - 1987
2. Introduction to Mineral Processing (Kelly and Spottiswood)
3. Principles of Mineral Dressing (A. M. Gaudin)
4. Coal Preparation (J. W. Leonard)
5. The Coal Handbook: Towards Cleaner Production (D. Osborne)

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Suggested Reading:

1. Ashoka Gupta & Denis Yen, Mineral Processing Design and Operations, 1st Edition, Elsevier Publishers
2. S.K.Jain,Ore Processing, Oxford and TBHY Publishing Co. (P) Ltd., India , 1986
3. S. K. Jain, Ore Processing, Oxford- IBH Publishing Company, 2005

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18CH E 14 **CORRODION ENGINEERING**

(Core Elective V)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. Definition and classification of corrosion.
2. Principles of corrosion, common corrosion forms
3. Different corrosion testing methods.
4. Corrosion control methods and material selection for cost reduction.
5. Modern theories to explain corrosion

Course Outcomes: At the completion of this course students will be able to

1. Explain and predict various corrosion mechanism based on the corrosion theories
2. Distinguish and identify various types of corrosion
3. Explain and apply corrosion testing methods
4. Identify and apply various corrosion prevention techniques
5. Apply modern theories and techniques to predict and prevent corrosion

UNIT- I

Introduction: Corrosion principles, Types of Corrosion, Acid Theory, Dry chemical corrosion, Wet theory or Electrochemical Theory, Electro- chemical aspects of Corrosion, environmental effects, Pilling-Bedworth Rule, Metallurgical aspects, corrosion rate expressions, methods of estimation of corrosion rates, Passivity.

UNIT- II

Types of corrosion: Forms of corrosion, uniform attack, galvanic corrosion, Examples of galvanic corrosion, Factors affecting galvanic corrosion, Crevice corrosion, Types of Crevice corrosion, pitting Corrosion: Principle and Theory, inter-granular corrosion, Knife line attack, selective leaching: Dezincification and Graphitization, Cavitation damage, Fretting Corrosion.

UNIT- III

Erosion-corrosion and some case studies, Factors affecting erosion- corrosion, stress corrosion cracking and Factors affecting stress corrosion.

Corrosion testing procedures: Introduction, Purpose of Testing, Steps involved in Corrosion testing, Standard expression for corrosion rate, NACE test, Slow stain rate test, Linear Polarization, Paint test, Seawater test, In vivo corrosion test (Field test).

UNIT- IV

Corrosion prevention methods:

Protection against Corrosion: Material selection, alteration of environment, Use of inhibitors, Protection by proper Designing, Modification of the properties of the metal, Cathodic Protection and Anodic Protection Units, Use of protective coatings -organic and inorganic coatings, Methods of application of metallic coatings, cladding.

UNIT- V

Advanced techniques:

Modern Theory: Principle, Thermodynamics: Free energy, Cell Potential, SHE and EMF series, Application of Thermodynamics to corrosion, Pourbaix Diagram. Electrode Kinetics: Exchange current density, Activation Polarization, Concentration Polarization, Combined Polarization, Mixed electrodes, Passivity with modern aspects.

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Predicting corrosion behaviour: Effect of oxidisers, Velocity effects, Galvanic coupling, Alloy evaluation. Corrosion prevention: Anodic Protection and Noble-Metal Alloying.

Text Books:

1. Corrosion Engineering, 3rd ed., M G Fontana, Tata McGrawHill,2005

Suggested Reading:

1. Corrosion and Corrosion Control, H HUhlig, Wiley, 3rd edition,2011
2. Handbook of Corrosion Engineering, Pierre Roberge, McGraw- Hill, New York,2000

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18CH E 15 **SCALE-UP METHODS**
(Core Elective V)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course helps the students to
1. Understand prototypes, models, principle of similarity Understand physical, static, dynamic, thermal and chemical similarity understand the scale-up principles of mixing and heat transfer equipment
2. Develop scale-up techniques for chemical reactors
3. Develop scale-up techniques for both batch and continuous separation process

Course Outcomes: At the end of the course students will be able to
1. Explain principles of scale-up
2. Apply dimensional analysis technique for scale up problems
3. Deduce the scale up of mixers and heat exchangers
4. Outline the scale up of chemical reactors
5. Design the distillation columns and packed towers scale up process.

UNIT- I
Principals of Similarity, Pilot Plants & Models: Introduction to scale-up methods, pilot plants, models and principles of similarity, Industrial applications.

UNIT- II
Dimensional Analysis and Scale-Up Criterion: Dimensional analysis, regime concept, similarity criterion and scale up methods used in chemical engineering, experimental techniques for scale-up.

UNIT- III
Scale-Up of Mixing and Heat Transfer Equipment: Typical problems in scale up of mixing equipment and heat transfer equipment.

UNIT- IV
Scale-Up of Chemical Reactors: Kinetics, reactor development & scale-up techniques for chemical reactors

UNIT- V
Scale-Up of Distillation Column and Packed Towers: Scale-up of distillation columns and packed towers for continuous and batch processes.

Text Books:
1. Marko Zlokamik, Scale-up in Chemical Engineering, Wiley-VCH, 2ndEdition, 2006
2. Johnstone, Thring, Pilot Plants Models and Scale-up methods in Chemical Engineering, McGraw Hill, NewYork, 1962

Suggested Reading:
1. Hoyle W, Pilot Plants and Scale-Up, Royal Society of Chemistry, 1999
2. Bruce Nauman E, Chemical Reactor Design, Optimization and Scale-up, McGraw Hill Handbooks, New York, 2002

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18ME O 11 **MODERN MANUFACTURING PROCESSES**
(Open Elective II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Understand the opportunities and challenges brought about by Industry4.0.
2. Familiarize with the basic concept and process of digital manufacturing.
3. Understand real-life scenarios and recommend the appropriate use of 3D printing technology.
4. Acquire the knowledge of non-traditional machining processes.
5. Learn the procedure for the fabrication of micro-electronic devices.

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

1. Understand the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.
2. Apply the concept, architecture and process of digital manufacturing.
3. Evaluate real-life scenarios and recommend the appropriate use of 3Dprintingtechnoloy
4. Compare various non-traditional machining processes.
5. Demonstrate the procedure for the fabrication of micro-Electronic devices.

UNIT –I

Introduction to industry 4.0: The various industrial revolutions, digitalization and its impact, comparison of industry 4.0 factory and today's factory. business issues in industry 4.0, internet of things (IoT) & industrial internet of things (IIoT) & internet of services, smart manufacturing, cyber physical systems, trends of industrial big data, cloud computing, robotic automation and collaborative robots, cyber security.

UNIT –II

Digital manufacturing process : Introduction to digital manufacturing and design, concepts , research and development status of digital manufacturing, definition, features and development of digital manufacturing, transition to digital manufacturing and design, advantages of digital manufacturing and design. digital thread, information sharing in the digital thread, data procurement standards, manufacturing supply chains, integrated information systems in the product lifecycle.

UNIT –III

Additive manufacturing processes: Introduction to 3D printing, evolution, distinction between 3D printing & CNC machining.

Processes and principles: Photo polymerization, powder bed fusion, binder jetting, material jetting, sheet metal lamination, material extrusion, direct energy deposition. Application in aerospace industry, automotive industry, jewelry industry, medical and bioengineering applications, planning and simulation of complex surgery, forensic science.

UNIT–IV

Nontraditional machining processes: Requirement, process description of ultrasonic machining, abrasive jet machining, water jet machining, water abrasive jet machining, electro discharge machining, electrochemical machining, chemical machining, ion beam etching, plasma arc machining, laser beam machining and electron beam machining.

UNIT-V

Fabrication of micro- electronic devices: Introduction, semiconductors and silicon, fabrication of integrated circuits and silicon wafers, film deposition, lithography, etching, diffusion and ion implantation, metallization and testing, bonding and packaging, printed circuit boards.

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Text Books:

1. Mikell P. Grover, "Fundamentals of Modern Manufacturing Materials, Processes and Systems", 4/e, John wiley& sons, inc,2009.
2. Zude Zhou, Shane (Shengquan) Xie and DejunChen, "Fundamentals of Digital Manufacturing Science", Springer-Verlag London Limited,2012.
3. Brent Stucker, David Rosen, and Ian Gibson, "Additive Manufacturing Technologies" Springer,2010.

Suggested Reading:

1. Serope Kalpak Jain, Steven R.Schmid, "Manufacturing Engineering and Technology", 4/e, Pearson Education India, 2006
2. Amitabh Ghosh and Mallick, "Manufacturing Science", Assoc. East West Press Pvt. Ltd., 4/e,2011.

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18EE O 02 **ENERGY MANAGEMENT SYSTEMS**

(Open Elective II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course objectives:

1. To know the concept of Energy management
2. To understand the formulation of efficiency for various engineering systems
3. To explore the different ways to design various technologies for efficient engineering systems.

Course Outcomes: After completion of this course, students will able to:

1. Know the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Evaluate the performance of existing engineering systems
4. Explore the methods of improving energy efficiency in different engineering systems
5. Design different energy efficient devices.

UNIT-I

Basics of Energy and its Various Forms: Overview of engineering, elements Solar energy,electricity generation methods using solar energy, PV cell, elements of wind energy, electricity generation using wind energy, elements of bio energy, bio mass energy conservation, elements of geothermal energy, sources of geothermal energy, sources of chemical energy, fuel cells, Energy Scenario in India

UNIT-II

Energy Management - I: Defining Energy management, need for energy management, energy managementtechniques, importance of energy management, managing the energy consumption, energy crisis, environmental aspects

UNIT-III

Energy Management-II: Energy management approach, understanding energy costs, bench marking, energyperformance, matching energy use to requirement, optimizing the input, energy requirements, energy audit instruments, material and energy balance diagrams, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, restructuring of the energy supply sector, energy strategy for the future

UNIT-IV

Energy Efficient Technologies-I: Importance of energy efficiency for engineers, Energy efficient technology in mechanical engineering: Heating, ventilation and air-conditioning, boiler and steam distribution systems Energy efficient technology in civil engineering: future of roads, harnessing road and transport infrastructure;

UNIT-V

Energy Efficient Technologies-II: Energy efficient technology in electrical engineering: Electricity billing,electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors; Energy efficient technology in chemical engineering: green chemistry, low carbon cements, recycling paper

Text Books:

1. Umesh Rathore, 'energy management', Kataria publications, 2nd ediiton, 2014.
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects
3. Hargroves, K., Gockowiak, K., Wilson, K., Lawry, N., and Desha, C. (2014) An Overview of Energy

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Efficiency Opportunities in Mechanical/civil/electrical/chemical Engineering, The University of Adelaide and Queensland University of Technology.

Suggested Reading:

1. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)
2. K V Shama, P Venkataseshaiah, "Energy management and conservation", I. K. International Publishing agency pvt ltd., 2011, ISBN: 978-93-81141-29-8

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18ME O 03 **RESEARCH METHODOLOGIES**

(Open Elective II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To make the students to formulate the research problem.
2. To identify various sources for literature review and data collection.
3. To prepare the research design.
4. To equip the students with good methods to analyze the collected data.
5. To explain how to interpret the results and report writing.

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

1. Define research problem.
2. Review and assess the quality of literature from various sources.
3. Understand and develop various research designs.
4. Analyze problem by statistical techniques: ANOVA, F-test, Chi-square.
5. Improve the style and format of writing a report for technical paper/Journal report.

UNIT – I

Research methodology: Objectives and motivation of research, types of research- descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical, research approaches, significance of research, research methods vs. methodology, research process, criteria of good research, problems encountered by researchers in India, technique involved in defining a problem.

UNIT–II

Literature survey: Importance of literature survey, sources of information-primary, secondary, tertiary, assessment of quality of journals and articles, information through internet.

UNIT – III

Research design: Meaning of research design, need of research design, feature of a good design important concepts related to research design, different research designs, basic principles of experimental design, steps in sample design.

UNIT – IV

Data collection: Collection of primary data, Secondary data, measures of central tendency-mean, mode, median, measures of dispersion- range, mean deviation, standard deviation, measures of asymmetry (skewness), important parametric tests -z, t, F, Chi-Square, ANOVA significance.

UNIT – V

Research report formulation and presentation: Synopsis, dissertation, technical paper and journal paper, writing research grant proposal, making presentation with the use of visual aids, writing a proposal for research grant.

Text Books:

1. C.R Kothari, "Research Methodology Methods & Technique", New Age International Publishers,2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011.
3. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand &Company Ltd., New Delhi, 2009.

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Suggested Reading:

1. G. Nageswara Rao, “Research Methodology and Quantitative methods”, BS Publications, Hyderabad, 2012.
2. Naval Bajjai, “Business Research Methods”, Pearson Education, 2011.

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18CE O 02 **DISASTER MITIGATION AND MANAGEMENT**

(Open Elective-II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course aims to,

1. Equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities.
2. Impart knowledge in students about the nature, causes, consequences and mitigation measures of the various Hydro-meteorological disasters.
3. Introduce the concepts of causes, consequences and mitigation measures of the various Geographical disasters.
4. Enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters.
5. Equip the students with the knowledge of the impacts of disaster, chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of Central and State Level Authorities

Course Outcomes: Upon completion of this course, the student will be able to,

1. Identify and understand the fundamental terminologies in disaster management.
2. Distinguish between the Hydro-meteorological disasters and apply the concepts of structural and non-structural mitigation measures.
3. Categorize different Geographical Disasters and apply the knowledge in utilizing the early warning systems.
4. Analyze various mechanisms and consequences of human induced disasters.
5. Develop an awareness of disaster management phases and formulating effective disaster management plans, ability to understand various participatory roles of stakeholders- Central and State Government bodies at different levels.

UNIT- I:

Introduction: Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster- Natural and manmade; Introduction to Disaster management cycle; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).

UNIT- II:

Natural Disasters:

Hydro meteorological disasters:

Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Applications. Case studies related to various hydro-meteorological disasters.

UNIT- III:

Geographical based disasters: Causes, zoning, Early warning systems- monitoring and management, structural and non-structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various geographical based disasters.

UNIT- IV:

Human Induced Disasters: Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; Case studies related to various chemical industrial hazards eg: Bhopal gas leakage; Management of chemical terrorism disasters and biological disasters; Case studies related to power break downs, fire accidents, traffic accidents, oil spills and stampedes, building failure disasters.

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UNIT- V:

Concept of Disaster Impacts and Management:

Disaster impacts- environmental, physical, social, ecological, economical, political, etc.; health, psycho-social issues; demographic aspects, gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

Disaster management cycle and its phases, risk analysis, vulnerability and capacity assessment; Post-disaster environmental response water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

Text Books:

1. Pradeep Sahni, "Disaster Risk Reduction in South Asia", Prentice Hall, 2003.
2. B. K. Singh, "Handbook of Disaster Management: Techniques & Guidelines", Rajat Publication, 2008.

Suggested Reading:

1. Ministry of Home Affairs, Government of India, "National Disaster Management Plan, Part I and II",
2. K. K. Ghosh, "Disaster Management", APH Publishing Corporation, 2006.
3. http://www.indiaenvironmentportal.org.in/files/file\disaster_management_india1.pdf
4. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs)
5. Hazards, Disasters and your community: A booklet for students and the community, Ministry of Home Affairs.
6. Disaster Medical Systems Guidelines, Emergency Medical Services Authority, State of California, EMSA no.214, June 2003.
7. Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings, Geneva: IASC.
8. http://ndma.gov.in/ (Home page of National Disaster Management Authority)

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18CS O 10 **MACHINE LEARNING USING PYTHON**
(Open Elective II)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The main objectives of this course are:

1. Get an idea of Machine Learning algorithms to solve real world problems.
2. Study various machine learning algorithms.
3. Analyze data using machine learning techniques.

Course Outcomes: Upon completion of this course, the student will be able to:

1. Define the basic concepts related to Python and Machine Learning.
2. Describe the feature engineering methods, regression techniques and classification methods.
3. Apply Python packages for data visualization. Text and time series data analysis using NLP toolkit.
4. Evaluate and interpret the results of the various machine learning techniques.
5. Solve real world problems using deep learning framework

UNIT - I

Introduction to Machine Learning: Introduction, Machine Learning process. Introduction to Python: Features, sources and installation of Python, IDEs, Basics of Python, Data Structures and loops.

UNIT - II

Feature Engineering: Introduction to Features and need of feature Engineering, Feature extraction and selection, Feature Engineering Methods, Feature Engineering with Python. Data Visualization: Various charts, histograms, plots.

UNIT - III

Regression: Simple and multiple regressions, Model assessment, various types of errors, errors, ridge regression, Lasso regression, non-parameter regression. Classification: Linear classification, logistic regression, Decision Trees, Random Forest, Naïve Bayes.

UNIT - IV

Unsupervised Learning: Clustering, K-Means clustering, Hierarchical clustering. Text Analysis: Basic text analysis with Python, regular expressions, NLP, text classification. Time Series Analysis: Date and time handling, window functions, correlation, time series forecasting.

UNIT - V

Neural Network and Deep Learning: Neural network- gradient descent, activation functions, parameter initialization, optimizer, loss function, deep learning, deep learning architecture, memory, deep learning framework. Recommender System: Recommendation engines, collaborative filtering.

Text Books:

1. Abhishek Vijavargia "Machine Learning using Python", BPB Publications, 1st Edition, 2018
2. Tom Mitchel "Machine Learning", Tata McGraWHill, 2017
3. Reema Thareja "Python Programming", Oxford Press, 2017.

Suggested Reading:

1. Yuxi Liu, "Python Machine Learning by Example", 2nd Edition, PACT, 2017

Online Resources:

1. https://www.guru99.com/machine-learning-tutorial.html
2. https://www.tutorialspoint.com/machine_learning_with_python/index.htm
3. https://www.tutorialspoint.com/python/
4. https://docs.python.org/3/tutorial/
5. https://www.geeksforgeeks.org/machine-learning/

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18CH C 24 **PROCESS INSTRUMENTATION AND CONTROL LAB**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	25 Marks
Credits	1.5

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

1. **Evaluate** the performance of a U-tube manometer
2. **Assess** the discharge efficiency of an orifice meter
3. **Analyze** step response of simple feedback control systems
4. **Determine** frequency response of control systems
5. **Analyze** the behavior of a control system using different modes of control when subjected to a permanent disturbance
6. **Apply** closed loop and open loop techniques to tune process controllers

List of Experiments

Part I: Process Instrumentation

1. Introduction to basics of control system components, signals and standards
2. Pressure measuring instruments/sensors
3. Level measurement
4. Flow measuring instruments
5. Temperature measuring devices
6. Humidity, density, viscosity and pH measuring devices
7. Pressure controllers: regulators, safety valves
8. Flow control actuators: different types of valves
9. Electrical and pneumatic signal conditioning and transmission
10. Computer process control, PLC, DCS,SCADA

Part II: Process Control

1. Control Valves
2. Flow-level cascade control Trainer
3. Viscosity Measuring Device
4. Level and Flow Measuring Devices
5. Temperature and Pressure Measuring Device
6. Temperature, level, and pressure control trainers
7. Open loop systems: lagged thermometer
8. Transmitters and transducers

Text Books:

1. Donald R Coughanowr , Steven E LeBlanc ,Process Systems Analysis and Control, 3rd edition, McGraw Hill Education (India) Edition2013
2. D Patranabis, Principles of Industrial Instrumentation, , 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi,2013

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18CH C 25 **PROCESS MODELING AND SIMULATION LAB**

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	25 Marks
Credits	1.5

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

1. **Develop** chemical engineering process models based on fundamental laws of mass and energy transfer
2. Dynamically simulate and **interpret** two heated tanks, using MATLAB
3. Dynamically simulate and **analyze** continuous reactors in Series using MATLAB
4. **Adapt** ASPEN software to perform steady state simulation of valves
5. **Apply** ASPEN software for simulation of batch Distillation
6. **Utilize** ASPEN software to design Plug flow reactor

List of Experiments

Part I

1. Introduction to Software Packages. Understanding the basic concepts and steps involved for developing process flow sheet.

Part II

i. Setting up models for simulation

Part III: Dynamic simulation using MATLAB

1. Two-heated Tanks in series
2. Three CSTRs in series at isothermal, constant holdup condition
3. Batch Reactor
4. Vapor Liquid Equilibrium
5. Ideal Binary distillation
6. Gas-Phase Pressurized CSTR

Part IV: Steady State simulation using ASPEN

1. Simulation of reactor systems
2. Simulation of simple units like valves, pumps, flash columns, Heat exchangers
3. Simulation of Distillation columns
4. Flow-sheeting of chemical process.

Text Books:

1. Manjeet KaurBedi, Prof. Vikram Singh, A Textbook Of Simulation And Modeling, Laxmi Publications, 2011

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18CH C 26 **PROJECT: PART I**

Instruction	4 Hours per week
CIE	50 Marks
Credits	2

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

1. Summarize the literature review to identify and formulate engineering problems
2. Design the experiments/ process /mathematical model by selecting the engineering tools/components for solving the identified problem
3. Develop skills of problem solving, interpreting analysis and evaluation
4. Illustrate written and oral communication skills through project report and presentation
5. Demonstrate the knowledge, skills, attitude and ethics of a professional engineering graduate
6. Adapt to the working environment of Industry/Institute by working as a team

The objective of Project Part -1 is to enable the student take up investigative study in the broad field of Engineering / Technology, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) towards R&D. The work shall include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility;
4. Preparing a Written Report on the Study conducted for Presentation to the Department;
5. Final Seminar, as oral Presentation before a departmental Committee.

Guidelines for the award of Marks:
Max. Marks: 50

Evaluation by	Max.Marks	Evaluation Criteria / Parameter
Supervisor	20	Project Status / Review
	5	Report
Department Committee	5	Relevance of the Topic
	5	PPT Preparation
	5	Presentation
	5	Question and Answers
	5	Report Preparation

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18CH E 16 **CHEMICAL PROCESS SAFETY**

(Core Elective VI)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. Importance of safety culture in process industry.
2. Disregard for ethical decision making based on numerous case studies.
3. Interaction and implementation of trade-offs concept in chemical plant operation.
4. Examples of problems that can occur with inadequate process design, improper process modification.
5. Different case studies related to industrial processes

Course outcomes: At the completion of this course, students will be able to

1. Evaluate effect of chemical hazards and risks of toxicants.
2. Analyze chemical incidents and possible consequences to plant facilities, workers, and the general public.
3. Analyze fire and explosion hazards.
4. Integrate safety concepts into chemical plant design.
5. Apply ethics during process plant operation

UNIT – I

Introduction: Process industrial safety –definition, importance. Safety awareness – Safety aspects of site selection, plant planning and layout, check list, inline arrangement of tower drums, exchangers, pumps and main pipelines.

Case studies of major disasters due to safety violations: Chernobyl disaster, Bhopal disaster, recent oil spills. Chemical hazards and workers safety, industrial process case studies.

UNIT – II

Organized labor interest in safety: Involvement of unions in accident prevention, recommendation of occupational health committees. Work Policy of MCA in accident prevention at process industries. Risk assessment procedures (HAZOP) and typical operational practices. Necessary precautionary measures (OSHA). Hazards: Identification and operability studies. Involvement of chemical criminals in process industries and their prevention. DOW Fire and explosion index, calculation of the DOW Fire and EI. Chemical safety data sheets and guides.

UNIT – III

Safety education and training: Training of personnel, on- the- job and job instructed training, meeting and instructional presentations. Effects of toxic Agents, chemicals and smoke on skin, eyes, respiratory tract, digestive tract. Primary protection equipment (PPE) – types, significance and applications. Measuring safety effectiveness: criteria for effective measurement, disabling (Lost-time) injuries, frequency rate, severity rate. Problem related safe-t-score. Involvement of inspector of factories in accident prevention. The technique of safe process design, separation sections, materials handling, storage sections, flow sheet review.

UNIT – IV

Fires and explosions: Definition of fire, fire triangle, Classification of fires as Class-A, B, C and D. Reaction of fires. Fire extinguishers: Portable fire extinguishers applications and their uses, Construction and working of water, Mechanical foam, CO_2, stored powder, ABC powder. Automatic multiple CO_2 extinguishers in chemical process industries.

UNIT – V

Emergency preparation and accident investigation: On-site and off-site emergency plan and infrastructure, learning from accidents, layered investigation, equipments aiding in diagnosis. Safety audit: Introduction,

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essentials, requirements, programs and procedures

Text Books

1. D. A. Crowl and J.F. Louvar, "Chemical Process Safety", Prentice Hall, New Delhi, 2011.
2. Howard H. Fawcett and W. S. Wood, "Safety & Accident prevention in chemical operations", 2nd Ed., John Wiley and Sons Inc, 1982.

Suggested Reading:

1. Coulson and Richadson, "Chemical Engineering Design", 3rd ed., Vol 6, TMH, 1999.
2. Fulekar M.H, "Industrial Hygiene and Chemical Safety", I.K. International Publisher, 2006.
3. Sanders R.E., "Chemical Process Safety: Learning from case Histories", Butterworth-Heinemann (Elsevier) pub, 2005.

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18CH E 17 **FERTILIZER TECHNOLOGY**
(Core Elective VI)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: This course will help the students to understand the

1. Use of fertilizers in improving soil productivity and crop yield.
2. Different types of the nitrogenous, phosphatic and potash fertilizers.
3. Various fertilizer application methods.
4. Different organic fertilizer production methods.
5. Environmental impact of fertilizer plants

Course outcomes: At the completion of this course, students will be able to

1. Identify the different nutrients and significance of feed stocks for the production of various nitrogenous fertilizers.
2. Apply different manufacture methods for various phosphorous fertilizers.
3. Explain production methods for potassium and mixed complex fertilizers
4. Explain the need, application techniques and uses of new variety of fertilizers.
5. Summarize effluent treatment methods and impact of fertilizers on environment.

UNIT – I:

Introduction: Fertilizer Technology, Plant Nutrients, Role of essential elements for plant growth. Availability of feed stocks. Nitrogen Fertilizers.

Feed stocks for the production of Ammonia, Ammonia synthesis by Haber and Kellogg processes. By-product ammonia recovery by direct and indirect methods.

UNIT –II

Manufacture of Urea: Manufacture of urea and other nitrogenous fertilizers such as ammonium sulphate, ammonium nitrate, calcium ammonium nitrate, ammonium chloride. Manufacture of nitric acid.

UNIT – III

Phosphorous fertilizers: manufacture of single and triple super phosphate. Production of Mono ammonium phosphate, Di ammonium phosphate and nitro phosphates, Manufacture of phosphoric acid by wet process and thermal process.

UNIT –IV

Introduction to new variety of fertilizers: Potassium fertilizers, mixed and NPK fertilizers. Liquid fertilizers. Bio fertilizers – Introduction, advantages over chemical fertilizers, types and uses.

UNIT –V

Fertilizer application techniques: different soil controlled release fertilizers. Effluent treatment methods for various fertilizer plants. Environmental impact of fertilizer plants on Ecosystem. Indian Fertilizer industry – production Economics and future plans.

Text Books

1. Brahma Mishra, "Fertilizer Technology and Management", IK International Publishing House Pvt. Ltd., New Delhi, 2012.
2. Dr. ShaliniSuri, "Bio Fertilizers and Bio pesticides", 1st Ed., APH publishing Corporation, New Delhi, 2011.

Suggested Reading:

1. Fertilizer Association of India, "Fertilizer Handbook", 2nd Ed., Scientific Publisher, New Delhi, 2009.
2. UNIDO, "Fertilizer Manual", 3rd edition, Kluwer Academic Publishers, New Delhi,1998.

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18CH E 18 **CHEMICAL PROCESS SYNTHESIS**

(Core Elective VI)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course objectives: This course helps the students to

1. Understand chemical process flow sheet and equipment synthesis
2. Understand heuristics for process synthesis
3. Learn optimization of process flow sheet for a given product
4. Learn to design and evaluate project profitability
5. Understand trouble-shooting analysis of equipment

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

1. Analyze alternative processes and equipment
2. Synthesize a chemical process flow sheet that would approximate the real process
3. Design best process flow sheet for a given product
4. Perform economic analysis related to process design
5. Evaluate project profitability

UNIT – I

Synthesis of steady state flow sheet: Introduction, Flow sheets, General semantic equation of equipment, Generalization of the method of synthesis of process flow sheet, Recycle structure of the flow sheet, separation systems.

UNIT – II

Heuristics for process synthesis: Raw materials and Chemical reactions, Distribution of chemicals, Separations, Heat exchangers and furnaces, pumping pressure reduction and conveying of solids, Reactor design.

UNIT – III

Optimization of flow sheet with respect to heat exchanger: Introduction, Network of heat exchanger, Some necessary conditions for the existence of an optimal heat exchanger network, Maximum heat transfer in a single exchanger, Hot and cold utilities.

UNIT- IV

Safety in Chemical plant design: Introduction, Reliability of equipment, prevention of accidents, Flammability of chemicals, Safety considerations in plant layout, Classification of chemicals and handling problem, Safety consideration in reactor design, Design of safety valves

UNIT- V

Trouble-shooting analysis of equipment and chemical plants, Fault tree analysis of accidents. Reliability consideration in maintenance policies of a chemical plant. Economic evaluation: Methods for Profitability evaluation, Discounted cash flow analysis.

Text Books:

1. Seider W. D., Seader J.D. and Lewin D. R., Product and Process Design Principles: Synthesis, Wiley, 2005.
2. Robin Smith, Chemical Process Design and Integration, John Wiley & Sons Ltd., 2005.

Suggested Reading:

1. Bieglar L.T, Grossman E.I and Westerberg A.W., Systematic Methods of Chemical Process Design, Prentice Hall Inc.,1997
2. Douglas J. M., Conceptual Design of Chemical Processes, McGraw Hill International, 1988.

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18 PY O 01 **HISTORIES OF SCIENCE AND TECHNOLOGY**

(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The objectives of the course is to make the student

1. Gains the knowledge about origin of science in the Stone Age and its progress during Antiquity period.
2. Familiar with scientific views in the Medieval period and during the Industrial revolution..
3. Aware of modern scientific developments from 19th century onwards.

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

1. Demonstrate the process of beginning of science and civilization, knowledge acquisition and philosophical approach of science and its advancements in the Stone Ages and Antiquity period.
2. Illustrate the advancements in science and technology in the medieval period across Asia and Arab countries and decline and revival of science in Europe.
3. Explain the scientific approach and its advances of the Europeans and how the role of engineer during the industrial revolution and the major advancements.
4. Make use of the advancements in the field of science and technology by adopting new philosophies of 19th and first half of 20th century in finding ethical solutions to the societal problems.
5. Interpret the changes in specializations of science and the technology and build the relation between information and society from second half of 20th century onwards.

Unit-I

Science - The Beginning (through 599 BCE): The Stone Ages, Knowledge among hunter gatherers, Agricultural Revolution and other revolutions, Civilization, Major advances.

Science in Antiquity (600 BCE- 529 CE): Philosophy- a precursor to science, Hellenistic world and the Roman Empire, Other cultures of the period, Major advances.

Unit-II

Medieval Science (530 CE - 1452 CE): The decline of science in Europe, Science in China, Science and mathematics in India, Arab science, Revival of science in Europe, Technology revolution of the Middle ages, Major advances.

The Renaissance and the Scientific Revolution (1453 CE – 1659 CE): Renaissance, Scientific Revolution, Technology, Major advances.

Unit-III

Scientific Method: Measurement and Communication (1660 CE – 1734 CE): European domination, The scientific method, Major advances.

The Industrial Revolution (1735 CE – 1819 CE): Industrial Revolution, Rise of the engineer, Major Advances.

Unit-IV

Science and Technology in the 19th Century (1820 CE – 1894 CE): Philosophical basis of 19th-century science, Science and the public, Science and technology, Major advances.

Rise of Modern Science and Technology (1895 CE – 1945 CE): The growth of 20thcentury science, New philosophies, Quantum reality, Energy sources, Electricity: a revolution in technology, Major advances.

Unit-V

Big Science and the Post-Industrial Society (1946 CE – 1972 CE): Big science, Specialization and changing categories, Technology changes society, Major advances.

The Information Age (1973 CE – 2015 CE): Information and society, Globalization, The post-industrial society, Problems of the Information age, Major Advances

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Text Books:

1. Bryan Bunch and Alexander Hellemans, “The History of Science and Technology”, Houghton Mifflin Company (New York), 2004
2. JD Bernal, “Science in History”, 4 Volumes, Eklavya Publishers, 2012

Suggested Reading:

1. “The 100 Most Influential Scientists of All Time”, Edited by Kara Rogers, Britannica Educational Publishing, 2010
2. Alberto Hernandez, “A Visual History of Science and Technology”, The Rosen Publishing Group, 2016

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18EG O 02 **GENDER SENSITIZATION**

(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives This course will introduce the students to:

1. Sensibility regarding issues of gender in contemporary India.
2. A critical perspective on the socialization of men and women.
3. Popular debates on the politics and economics of work while helping them reflect critically on gender violence.

Course Outcomes After successful completion of the course the students will be able to**:**

1. Understand the difference between "Sex" and "Gender" and be able to explain socially constructed theories of identity.
2. Recognize shifting definitions of "Man" and "Women" in relation to evolving notions of "Masculinity" and "Femininity".
3. Appreciate women's contributions to society historically, culturally and politically.
4. Analyze the contemporary system of privilege and oppressions, with special attention to the ways gender intersects with race, class, sexuality, ethnicity, ability, religion, and nationality.
5. Demonstrate an understanding of personal life, the workplace, the community and active civic engagement through classroom learning.

UNIT – I

Understanding Gender:

Gender: Why Should We Study It? (*Towards a World of Equals*: Unit -1)

Socialization: Making Women, Making Men (*Towards a World of Equals*: Unit -2)

Introduction. Preparing for Womanhood. Growing up Male. First lessons in Caste. Different Masculinities.

UNIT – II

Gender And Biology:

Missing Women: Sex Selection and Its Consequences (*Towards a World of Equals*: Unit -4)

Declining Sex Ratio. Demographic Consequences.

Gender Spectrum: Beyond the Binary (*Towards a World of Equals*: Unit -10)

Two or Many? Struggles with Discrimination.

UNIT – III

Gender and Labour:

Housework: the Invisible Labour (*Towards a World of Equals*: Unit -3)

"My Mother doesn't Work." "Share the Load."

Women's Work: Its Politics and Economics (*Towards a World of Equals*: Unit -7)

Fact and Fiction. Unrecognized and Unaccounted work. Additional Reading: Wages and Conditions of Work.

UNIT-IV

Issues Of Violence

Sexual Harassment: Say No! (*Towards a World of Equals*: Unit -6)

Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading:"*Chupulu".*

Domestic Violence: Speaking Out (*Towards a World of Equals*: Unit -8)

Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Additional Reading:

New Forums for Justice.

Thinking about Sexual Violence (*Towards a World of Equals*: Unit -11)

Blaming the Victim-"I Fought for my Life…." - Additional Reading: The Caste Face of Violence.

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UNIT – V

Gender: Co - Existence

Just Relationships: Being Together as Equals (*Towards a World of Equals*: Unit -12)
Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers.
Additional Reading: Rosa Parks-The Brave Heart.

Textbook:

1. Suneetha, Uma Bhrugubanda, DuggiralaVasanta, Rama Melkote,VasudhaNagaraj, AsmaRasheed, GoguShyamala, DeepaSreenivas and Susie Tharu **"Towards a World of Equals: A Bilingual Textbook on Gender"** published by Telugu Akademi, Hyderabad, Telangana State, **2015**.

Suggested Reading:

1. Menon, Nivedita. Seeing like a Feminist. New Delhi: Zubaan-Penguin Books, 2012
2. Abdulali Sohaila. **"I Fought For My Life…and Won."**Available online at:
3. http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdulal/

Web Resources:

1. https://aifs.gov.au/publications/gender-equality-and-violence-against-women/introduction
2. https://theconversation.com/achieving-gender-equality-in-india

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

18EG O 01 **TECHNICAL WRITING SKILLS**

(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: The course will introduce the students to:

1. Process of communication and channels of communication in general and technical writing.
2. Technical Writing and also contextual use of technology specific words.
3. Business letters and technical articles.
4. Technical reports and technical proposals.
5. Transferring data from verbal to graphic and vice versa and making technical presentations.

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

1. Understand the channels of communication and define nature and aspects of Technical communication
2. Compare and contrast technical communication to that of general communication while constructing error free sentences applying features of technical writing.
3. Analyze data, draw inferences to write Journal articles and conference papers and to compose business letters.
4. Evaluate data to draft technical reports and technical proposals.
5. Design a technical presentation by understanding the nuances of presentation skills and also transfer data from verbal to graphic and vice versa

Unit I

Communication – Nature and process.

Channels of Communication – Downward, upward and horizontal and lateral communication. Barriers to communication.

Technical Communication – Definition; oral and written communication. Importance and need for Technical communication. Nature of Technical Communication. Aspects and forms of Technical communication. Technical communication Skills – Listening, Speaking, Reading & Writing.

Unit II

Technical Writing – Techniques of writing. Selection of words and phrases in technical writing. Differences between technical writing and general writing. Abstract and specific words. Sentence structure and requisites of sentence construction. Paragraph length and structure.

Unit III

Business correspondence – Sales letters, letters of Quotation, Claim and Adjustment letters.

Technical Articles: Nature significance and types of technical articles. Writing an abstract. Journal articles and Conference papers. Elements of technical articles.

Unit IV

Technical Reports: Types, significance, structure, style and writing of reports. Routine reports, Project reports.

Technical Proposals: Definition, types, characteristics, structure and significance.

Unit V

Information Transfer – Graphic to verbal (written) and verbal to graphic.

Technical Presentations: Important aspects of oral and visual presentations.

Text Books :

1. Meenakshi Raman & Sangeeta Sharma, **"Technical Communications-Principles and Practice",** Oxford University Press, Second Edition, 2012.
2. 1.M Ashraf Rizvi, **"Effective Technical Communication",** Tata McGraw Hill Education Pvt Ltd, 2012.

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Suggested Reading:

1. Kavita Tyagi & Padma Misra, **"Basic Technical Communication",** PHI Learning Pvt Ltd, 2012.
2. R.C Sharma & Krishna Mohan, **"Business Correspondence and Report Writing",** Tata McGraw Hill, 2003

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18_mg13/preview
2. https://www.technical-writing-training-and-certification.com/
3. https://academy.whatfix.com/technical-writing-skills

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18CSO 03 **IoT AND APPLICATIONS**

(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Pre-requisites: Programming Basics.

Course Objectives: The main objectives of this course are:

1. Impart necessary and practical knowledge of components in Internet of Things.
2. Understand working of IoT Systems.
3. Develop skills required to build IoT based systems in the field of biotechnology.

Course Outcomes: On Successful completion of this course, student will be able to

1. Understand Internet of Things and its hardware and software components.
2. Interface I/O devices, sensors & communication module.
3. Remotely monitor data and control devices.
4. Hypothesizing real time IoT based projects.
5. Advance towards research based IoT in the field of biotechnology

UNIT – I

Introduction to IoT: Sensors, Types of sensors and Transducers, Actuators and Types of Actuators.

UNIT – II

Basics of Networking: Functional Components of IoT , IoT interdependencies, IoT Service oriented architecture, IoT categories, IoT gateways, IoT and associated technologies, Key technologies for IoT, IoT challenges.

UNIT – III

IoT Hardware Components: Computing (Arduino/ Raspberry Pi), Communication, Sensors, Actuators, I/0interfaces, Programming API's (for Arduino/Raspberry Pi).

UNIT – IV

IoT Application Development: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, Authorization of devices

UNIT – V

IoT Systems and Applications: Smart Lighting, Weather Monitoring System, Weather Reporting Bot, Forest Fire Detection, Alcohol Detection System, Smart Parking Environment., Drip-irrigation, Biological water treatment system, Work flow Automation in Industries, Smart Intrusion Detection System, monitoring space risks and hazardous conditions in industrial regions like underground tanks , trap door margins.

Text Books:

1. Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases",CRCPress,2017.
2. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi, 2018.
3. ArshdeepBahgaand Vijay Madisetti, "Internet of Things: A Hands- on Approach",Universities Press,2014.

Suggested Reading:

1. Dr. SRN Reddy, RachitTirnkraland Manasi Mishra, "Introduction to Internet of Things: A practical

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Approach", ETILabs,2018.
2. Adrian Mc Ewen, "Designing the Internet of Things", Wiley, 2013.
3. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill, 2017.
4. CunoPfister,"GettingStartedwiththeInternetofThings",0Reilly Media,2011.
5. O.Vermesan, P. Friess, "Internet of Things– Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers, SeriesinCommunications,2013.

Online Resources / Weblinks / NPTEL Courses:

1. LiDaXu, WuHe, and ShancangLi, "Internet of Things in Industries: A Survey ", IEEE Transactions on Industrial Informatics, Vol.10,No. 4, Nov.2014.
2. Gotovtsev, Pavel M., and Andrey V. Dyakov. "Biotechnology and Internet of Things for green smart city application." 2016 IEEE 3rd World Forum on Internet of Things (WF-IoT). IEEE, 2016.
3. Yanjing, Sun,etal. "Research and design of agriculture informatization system based on IOT." Journal of Computer Research and Development 48(2011):316-331.
4. Somov, Andrey, etal."Bacteria to power the smart sensor applications: Yanjing, Sun, etal. "Research and design of agriculture informatization system based on IOT." Journal of Computer Research and Development 48(2011):316-331.
5. Han, Shuqing, etal. "Analysis of the frontier technology of agricultural IoT and its predication research. "IOP Conference Series: Materials Science and Engineering.Vol.231.No.1.IOP Publishing, 2017.

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18CSO 04 **BASICS OF DATA SCIENCE USING R**

(Open Elective III)

Instruction	3 Hours per week
Duration of SEE	3 Hours
SEE	70 Marks
CIE	30 Marks
Credits	3

Pre-requisites: Probability and Statistics, basics of programming languages.

Course Objectives: The main objectives of this course are:

1. Understand R programming language.
2. Explore the programming skills needed to use R tool for statistical analysis of Biological data.
3. Analyze biological data.

Course Outcomes: On Successful completion of this course, student will be able to

1. Summarize the basics of R and in-built data visualization packages.
2. Describe the data analysis using Bayesian and stochastic modeling.
3. Relate Gibbs, Z- sampling distributions and compare the binomial, chi-square, wilcoxon and Fisher's exact tests in hypothesis testing.
4. Explore the ANOVA in Regression analysis and classify the multivariate data.
5. Experiment with the biological data using R tool and apply clustering algorithms to biological data.
6. Identify R commands for data manipulation and database technologies for datasets of bioinformatics

UNIT - I

Basics of R: Introduction, R features, setting up and exploring R environment, loading packages, types of data objects in R, working with R data objects, Controlling work space, importing files. Programming with R: Variables and assignment, operators, control structures, Functions-built-in, writing own functions, package creation.

UNIT - II

Data Analysis and Graphics: Data summary functions in R, Graphics technology in R, saving graphics, additional graphics packages. Bayesian Data Analysis: Need of Bayesian approach, Application of Bayes rule, Priors, Likelyhood functions, evaluating the posterior, Applications of Bayesial Statistics in Bioinformatics. Stochastic Modeling: Stochastic process and Markov Processes, Classification of Stochastic processes, modeling a DNA sequence with Markov Chain, Characteristics of Markov Chain.

UNIT - III

MCMC using Brugs: ABO blood type example. Gibbs sampling. Statistical Inference: Sampling distributions, Parameter estimation, interval estimation, bootstrapping, R packages for bootstrapping. Hypothesis Testing: Package ctest, Binomial test, comparing variances, Wilcoxon tests, Chi-Square test, Fisher's Exact tests, Likelihood Ratio tests.

UNIT - IV

ANOVA and Regression: ANOVA table, perforating ANOVA using R, graphical analysis of ANOVA comparison, Regression: Correlations, linear regression model, fitting and testing of regression model, generalization of the model. Working with Multivariate Data: Multivariate data, sample statistics, display of multivariate data, outliers and principal components. Classification of discriminate analysis- classification with two population and more than two populations, cross validation classification trees.

UNIT - V

Clustering methods: measures of dissimilarities, K-means clustering, K-Medoid clustering, Hierarchical clustering-Agglomerate and divisive. R Packages: Bio-conductor and Seqin R.

Data Technologies: R for Data manipulation, example, Database technologies, Bioinformatics resources on the WWW.

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Gandipet, Hyderabad-75.

Text Books:

1. Kim Seefeld, Ernest Linder, “Statistics using R with Biological examples”, 2007 (https://cran.r-project.org/doc/contrib/Seefeld_StatsRBio.pdf).
2. Robert Gentleman, “R Programming for Bioinformatics”, 1st Edition, CRC Press, 2008.

Suggested Reading:

1. ArvilCohhlan “A Little Book of R for Bioinformatics”, Release 1.0, CC ver 3.0

Online Resources:

1. https://epdf.tips/r-programming-for-bioinformatics.html
2. https://epdf.tips/r-programming-for-bioinformatics.htmlhttps://www.cyclismo.org/tutorial/R/object Oriented.html
3. https://www.w3schools.in/r/object-oriented/

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18CH C 27 **TECHNICAL SEMINAR**

Instruction	2 Hours per week
CIE	50 Marks
Credits	1

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

1) Summarize the literature review in order to identify and formulate the engineering problem
2) Show preparedness to study independently and apply acquired technical skills to variety of real time problem scenarios
3) Develop the required critical thinking ability and analytical skills for evaluation of the selected problem
4) Illustrate the written and oral communication skills through a seminar report and presentation
5) Demonstrate the required knowledge, skills, attitude and ethics as a professional engineering graduate
6) Work in a team by adapting to the working environment

The goal of a seminar is to introduce students to critical reading, understanding, summarizing, explaining and preparing report on state of the art topics in a broad area of his/her specialization. Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.
2. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
3. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the department.

Seminars are to be scheduled from 3rd week to the last week of the semester and any change in schedule shall be discouraged.

For the award of sessional marks students are judged by three (3) faculty members and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

Note: Topic of the seminar shall be preferably from any peer reviewed recent journal publications.

Guidelines for awarding marks		
Sl No.	Description	Max Marks
1.	Contents and relevance	10
2.	Presentation skills	10
3.	Preparation of PPT slides	05
4.	Questions and answers	05
5.	Report in a prescribed format	20

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18CH C 28 **PROJECT: PART II**

Instruction	20 Hours per week
CIE	100 Marks
SEE	100 Marks
Credits	10

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

1. Summarize the literature review to identify and formulate engineering problems
2. Design the experiments/ process /mathematical model by selecting the engineering tools/components for solving the identified problem
3. Develop skills of problem solving, interpreting analysis and evaluation
4. Illustrate written and oral communication skills through project report and presentation
5. Demonstrate the knowledge, skills, attitude and ethics of a professional engineering graduate
6. Adapt to the working environment of Industry/Institute by working as a team

The object of 'Project: Part-2' is to enable the student extend further the investigative study taken up, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/ Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar presentation before Departmental Committee

Guidelines for the award of marks in CIE: (Max. Marks: 100)

Evaluation	Max .Marks	Evaluation Criteria / Parameter
Department Review Committee	10	Review 1
	15	Review 2
	25	Submission
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Report Preparation
	10	Analytical / Programming / Experimental Skills

Guidelines for awarding marks in SEE: (Max. Marks: 100)

Evaluation	Max .Marks	Evaluation Criteria / Parameter
External and InternalExaminers together	20	Power Point Presentation
	40	Thesis Evaluation
	20	• Quality of the project • Innovations • Applications • Live Research Projects • Scope for future study • Application to society
	20	Viva-Voce

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