UG-R22 Curriculum
With effective from 2022-23

Chemical Engineering

Scheme of Instruction and Syllabi of
B.Tech I to IV Semester of
Four Year Degree Course

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
(An Autonomous Institute | Affiliated to Osmania University)
Accreditated by NBA & NAAC (A++)
Kokapet Village, Gandipet Mandal, Hyderabad -500075, Telanagana.
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Phone No. : 040-24193276 / 277 / 279

SCHEME OF INSTRUCTION AND SYLLABI
Of
B.E. / B.TECH. I to IV SEMESTERS

FOR

B.TECH. – CHEMICAL ENGINEERING

(Inline with AICTE Model Curriculum with effect from AY 2022-23)

(R–22 Regulation)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Affiliated to OU, Approved by AICTE, Accredited by NBA, NAAC (A++)

Kokapet Village, Gandipet Mandal, Hyderabad– 500 075. Telangana

E-Mail: principal@cbit.ac.in; Website: www.cbit.ac.in;

Phone Nos.: 040-24193276 / 277 / 279

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMUS)

DEPARTMENT OF CHEMICAL ENGINEERING

VISION & MISSION OF THE INSTITUTE

Institute Vision

To be a center of excellence in Technical Education and Research

Institute Mission

To address the emerging needs through quality technical education and advanced research

DEPARTMENT VISION & MISSION

Department Vision

To become the most sought center of excellence engaged in training and shaping students as professionals for higher education and process industries bothin India and abroad and allow the students to do R & D projects and publish samein the reputed journals.

Department Mission

Imparting contemporary technical education and training manpower to createa skilled human resource talent pool to serve, manage the process industries globally with a sense of responsibility towards society and the environment.

Program Educational Objectives (PEOs)

PEO1: To train the students for identifying problems relevant to design and general practice of chemical engineering field.

PEO2: To provide experience in the three significant design areas of equipment, process and plant operation of chemical industries.

PEO3: To educate the students in understanding the multifaceted aspects of chemical engineering and in applying the various computational methods studied, for problemanalysis and solution.

PEO4: To prepare the students to pursue post graduate studies or to succeed in industry / technical profession through global technical education

Program Outcomes (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, andengineering specialization for solving complex engineering problems
PO2	**Problem analysis**: Identify, formulate, research literature, and analyse complex engineering problemsreaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components orprocesses that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling to complex engineering activities, with anunderstanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professionalengineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal andenvironmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and normsof the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with t h e society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principlesand apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent andlife-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

PSO1	Undertake research activities in the area of heat and mass transfer, separation processes, Reaction engineering, related to Green Chemical Engineering.
PSO2	Undertake real life projects in process industries and allied fields.

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**

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.

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.

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.

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).

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

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

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.

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

22CYC02

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.

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.

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).

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.

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.

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

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.

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**

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**.**

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.

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.

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.

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.

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

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.

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.

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

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.

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.

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

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.

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.

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

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

(In line with AICTE Model Curriculum with effect from AY 2023-24)

B. Tech (Chemical Engineering)

SEMESTER– III

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE In Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22CSC35	Data Structures using Python	2	-	-	3	40	60	2
2	22MTC10	Partial Differential Equations and Statistics	3	1	-	3	40	60	4
3	22CHC01	Chemical Engineering Thermodynamics-I	3	-	-	3	40	60	3
4	22CHC02	Fluid Mechanics	3	1	-	3	40	60	4
5	22CHC03	Mechanical Unit Operations	3	-	-	3	40	60	3
6	22CHC04	Material and Energy Balance Calculations	3	–	-	3	40	60	3
PRACTICAL									
7	22CSC36	Data Structures using Python Lab	-	-	2	3	50	50	1
8	22CHC05	Fluid Mechanics Lab	-	-	3	3	50	50	1.5
9	22CHC06	Mechanical Unit Operations Lab	-	-	3	3	50	50	1.5
10	22CHI01	MOOCs/Training/ Internship	2-3weeks/ 90 hours			-	50	-	2
TOTAL			**17**	**2**	**8**	**-**	**440**	**510**	**25**
Clock Hours Per Week: 27									

L: Lecture T: Tutorial P: Practical CIE-Continuous Internal Evaluation SEE - Semester End Examination NC- Non-Credit

22CSC35

DATA STRUCTURES USING PYTHON

(Common to BioTech, Chemical, Civil and Mechanical Engineering)

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

COURSE OBJECTIVES: This course aims to

1. Introduce object-orientation concepts in python.
2. Familiarize students with asymptomatic analysis of various functions and implement different sorting techniques.
3. Examine various linear and non-liner data structures.
4. Explore various string functions and hash functions.

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

1. Understand classes, objects, linear data structures, nonlinear data structures, time complexity.
2. Use python packages to work with datasets.
3. Implement sorting, searching algorithms and analyse their performance.
4. Build solutions for problems using linear, nonlinear data structures and hashing.
5. Apply pattern matching algorithms for real time problems.

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

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

UNIT-I

Overview of Python, Concept of Class, and objects; NumPy: The Basics of NumPy Arrays, Aggregations; Pandas: Pandas Objects, Data Indexing and Selection; **Visualisation:** Simple Line Plots, Simple Scatter Plots, Histograms, Binnings, and Density.

UNIT - II

Introduction: Data Structures, Abstract Data Types, Algorithm, Analysis of Algorithms, Running Time Analysis, Commonly Used Rates of Growth, Big O Notation, Omega Notation, Theta Notation, Guidelines for Asymptotic Analysis.

Sorting: Introduction, Classification of Sorting Algorithms, Selection Sort, Merge Sort, Quick Sort, Radix sort, Comparison of Sorting Algorithms.

UNIT-III

Linked Lists: Linked List ADT, Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists; **Stacks:** Stack ADT **Queues:** Queue ADT.

UNIT-IV

Trees: Introduction, Binary Trees, Types of Binary Trees, Properties of Binary Trees, Binary Tree Traversals, Binary Search Trees (BSTs); **Graph:** Introduction, Applications of Graphs, Graph Representation, Graph Traversals

UNIT-V

String Algorithms and Hashing: Introduction, String Matching Algorithms:Brute Force Method, Rabin-Karp. Hash Table ADT, Components of Hashing, Hash Table, Hash Function, Load Factor, Collisions, Collision Resolution Techniques

TEXTBOOKS:

1. Narasimha Karumanchi,"Data Structures and Algorithmic Thinking With Python", Career Monk Publications, 2016
2. Tony Gaddis, “Starting out with Python”, 4th Edition, Global Edition, Pearson Education Limited, 2019
3. Jake Vander Plas, “Python Data Science Handbook”, OReilly, 2017

SUGGESTED READING:

1. Wes McKinney, “Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython”, 2nd
2. Ed, OReilly, 2018
3. Michael T.Goodrich, Roberto Tamassia, Michael H. Goldwasser, “Data Structure and Algorithms in Python”, Wiley, 2013.
4. Kenneth A. Lambert, "Fundamentals of Python: Data Structures", Cengage Learning,2018.

ONLINE RESOURCES:

1. https://visualgo.net/en
2. https://jakevdp.github.io/PythonDataScienceHandbook/
3. https://www.coursera.org/specializations/data-structures-algorithms
4. https://nptel.ac.in/courses/106/106/106106182/
5. https://www.cs.usfca.edu/~galles/visualization/Algorithms
6. https://www.edx.org/course/algorithms-and-data-structures

22MTC10

PARTIAL DIFFERENTIAL EQUATIONS AND STATISTICS

(CHEMICAL)

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

COURSE OBJECTIVES: This course aims to

1. To explain the expansion of functions in sine and cosine series.
2. To form PDE and to find its solution.
3. To know the model of wave and heat equations.
4. Able to analyze random phenomena using basic probability.
5. To learn fitting of distribution and predicting the future values.

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

1. Calculate the Euler's coefficients for Fourier series expansion of a function.
2. Solve Linear and Nonlinear PDEs.
3. Solve One-Dimension Wave and Heat equations and Two Dimensional Laplace equations.
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 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	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	3
CO2	2	2	2	2	-	-	-	-	-	-	-	1	2	2
CO3	2	2	2	2	-	-	-	-	-	-	-	1	3	-
CO4	2	2	2	1	-	-	-	-	-	-	-	1	0	2
CO5	2	2	2	1	-	-	-	-	-	-	-	1	2	2

UNIT-I

Fourier series: Periodic functions, Euler's formulae, Conditions for a Fourier series expansion, Fourier series of Functions having points of discontinuity, Change of interval, even and odd functions, Half range Sine & Cosine Series.

UNIT-II

Partial Differential Equations: Formation of Partial Differential Equations, Linear Equations of First Order (Lagrange's Linear Equations), Solution of First Order Nonlinear Partial Differential Equations (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 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 and exponential curves.

TEXT BOOKS:

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, 2014.

22CHC01

CHEMICAL ENGINEERING THERMODYNAMICS-I

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

Prerequisites: Material & Energy Balance Computations, Engineering Physics

COURSE OBJECTIVES: This course aims to

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

1. Understand the fundamental concepts of thermodynamics to engineering applications.
2. Apply mass and energy balances to closed and open systems and study the PVT behavior of pure substances.
3. Apply the laws of thermodynamics and estimate the heat and work requirements for Industrial Processes.
4. Evaluate thermodynamic properties of ideal and real mixtures and the efficiency of flow processes.
5. Analyze liquefaction, refrigeration and different power cycles.

CO-PO-PSO Matrix

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

UNIT I

Introduction: The scope of thermodynamics, Dimensions and units, temperature and Zeroth Law of Thermodynamics, Force, volume, pressure, work, heat, Energy classifications- energy in transit, thermodynamic state and state functions, reversible and irreversible processes, equilibrium, The phase rule.

UNIT-II

The first law and other basic concepts: Joules Experiments; The first law of thermodynamics and Internal Energy; Energy balance for closed systems; enthalpy; constant-V and constant- P processes; heat capacity; Mass and energy balance for open systems.

Volumetric properties of pure fluids: The PVT behaviour of pure substances; the ideal gas; virial equations of state; applications of the virial equations; Cubic equations of state; generalized correlations for gases; generalized correlations for liquids.

UNIT-III

The second law of thermodynamics: Statements of the second law; heat engines; thermodynamic temperatures scales, Carnot Engine with Ideal-Gas-State Working Fluid, Entropy; Entropy changes of an ideal gas; mathematical statement of the second law; Entropy balance for open systems; calculation of ideal work and lost work; the third law of thermodynamics; entropy from the microscopic view point.

UNIT-IV

Thermodynamic properties of fluids: Property relations for homogeneous phases; residual properties; Residual properties from the virial equations of state; generalized property correlation for gases, two phase systems; thermodynamic diagrams; tables of thermodynamic properties.

Application of thermodynamics to flow processes: Duct flow of compressible fluids - pipe flow, nozzles, throttling process; turbines; compression processes – compressors and pumps.

UNIT-V

Production of power from heat: The steam power plant-the Rankine cycle; Internal combustion Engines- the Otto engine, the diesel engine.

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

TEXTBOOKS:

1. Smith, J.M., Van Ness, H.C., Abbott, M.M and Swihart, M.T., "Introduction to Chemical Engineering Thermodynamics ", 8thed, Tata McGraw Hill., 2018.

SUGGESTED READINGS:

1. Gopinath Halder., "Introduction to Chemical Engineering Thermodynamics", 2nd Edition, PHI Learning Pvt Ltd, 2014
2. M J Moran, H P Shapiro, D Boettner, and M B Bailey., "Principles of engineering Thermodynamics", 8th Ed, Wiley, 2015.
3. Kyle, B.G., "Chemical and Process Thermodynamics", 3rd ed. "Pearson, Prentice Hall of India Pvt. Ltd., 1999.
4. K.V. Narayanan., "Chemical Engineering Thermodynamics", Prentice Hall of India Pvt Ltd., 2009
5. Hougen, O.A., Watson, K.M and Ragatz, R.A., "Chemical Process Principles, Part II ", Thermodynamics, 2nd Edition, CBS Publications New Delhi, 2004.
6. Y.V.C. Rao., "Chemical Engineering Thermodynamics", University Press Hyderabad, 2005.

22CHC02

FLUID MECHANICS

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

Pre-requisites: Engineering Physics, Differential Equations

COURSE OBJECTIVES: This course aims to

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: After the completion of this course, the student 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 and Identify equipment to be used to measure fluid flow.

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

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, streamlines 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.

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

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, 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- Venturimeter, orifice meter, Pitot tube, Rotameter, Notches and Weirs, Compressors and blowers.

TEXTBOOKS:

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.

22 CHC03

MECHANICAL UNIT OPERATIONS

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

Prerequisites: Mathematics, Physics, Chemistry

COURSE OBJECTIVES: This course aims to

1. Principles of size reduction using various equipment.
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: After the completion of this course, the student will be able to

1. Choose the suitable size reduction and transportation equipment for solids based on their properties
2. Select equipment for industrial application with respect to size separation techniques.
3. Design equipment for industrial application with respect to separation of solid-fluid operations.
4. Apply the different filtration techniques for industrial application.
5. Identify the suitable technique for blends 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

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.

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. 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.

TEXTBOOKS:

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 Readings:

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

22CHC04

MATERIAL ENERGY BALANCE CALCULATIONS

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

COURSE OBJECTIVES: This course aims to

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. Properties and laws for analyzing vapors and liquids
5. Energy balance calculations and its importance.

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

1. Convert physico-chemicalquantitiesfromonesystemofunitstoanotherandexpress composition of systems on different basis of calculation.
2. Solve material balance problems without chemical reactions for single and multi-unit systems.
3. Solve material balance problems with chemical reactions
4. Solve energy balance problems for non-reactive systems
5. Estimation heat of reaction for reactive systems.

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

UNIT-I

Introduction to process calculations: Units and Dimensions-Conversion of Units – Dimensional homogeneity; Process and process variables – process flow sheet, process unit, process streams, density, specific gravity, specific gravity scales, mass and volumetric flow rates, mole concept and mole balance, molecular and equivalent weights; Composition of streams on different basis; Gases, Vapors and Liquids: Equations of state, mixture of ideal gases-Dalton's and Amagat's laws, Vapor pressure, Clausius- Clapeyron equation, Cox chart, Duhring's plot, Raoult's law.

UNIT-II

Solving material balance problems without chemical reaction: Basic laws of conservation; Process classification; Material balance equation, general steps for solving material balance problem, M.B for single unit and multi-unit systems; Degrees of freedom analysis and significance; M.B problems of various unit operations – mixing, splitter, absorption, distillation, evaporation, crystallization, leaching, extraction, drying, Solubility, dissolution and crystallization under steady state conditions.

UNIT-III

Material Balance with Chemical Reaction: Material Balance with chemical reaction, Concept of stoichiometry and mole balances, limiting and excess reactant, % conversion, % excess, yield and selectivity; examples; Combustion calculations -Proximate and ultimate analysis of coal and analysis of flue gas. Material balances for by-pass, recycle and purge Operations; problems on multi-unit systems.

UNIT-IV

Energy Balances on non-reactive processes: Thermophysics–Energy balance equation for open and closed system, Procedure, Heat Capacity, changes in pressure and temperature; Calculation of enthalpy changes without and with phase change, Heat of solution and mixing.

UNIT-V

Energy balances on reactive processes: Thermo chemistry - Standard heat of reaction, formation and combustion, Hess Law, Effect of temperature; Kirchoff"s equation; Energy balances on reactive systems; combustion and fuels – Adiabatic flame temperature; Simultaneous material and energy balances.

TEXTBOOKS:

1. Felder,R.M.; Rousseau, R.W. "Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons, 2000.
2. Himmelblau, D.M., iggs, J.B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., Pearson India Education Services.
3. 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.

22CSC36

DATA STRUCTURES USING PYTHON LAB

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

COURSE OBJECTIVES: This course aims to

1. Introduce data structures in python.
2. Familiarize with visualization techniques and tools in python.
3. Implement ADT for linear and non linear structures.
4. Analyze the performance of sorting and searching techniques
5. Gain knowledge on applying data structures in real world problems.

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

1. Demonstrate Classes, Objects, linear data structures, nonlinear data structures.
2. Store, retrieve and visualize datasets using Python built-in packages.
3. Evaluate the performance of sorting techniques.
4. Build optimal solutions using linear data structures, nonlinear data structures and hashing.
5. Apply pattern matching algorithms for real time problems.

CO-PO-PSO Matrix

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

LIST OF EXPERIMENTS:

1. Demonstration of class and objects.
2. Read a dataset, describe, visualize and provide inference.
3. Implement the Sorting algorithms: Selection Sort, Merge Sort, Quick Sort, Radix Sort.
4. Define Single Linked List ADT: Insertions, Deletions, Display
5. Define Doubly Linked List ADT and perform all standard operations.
6. Define Stack and Queue ADTs and implement standard operations
7. Implementation of Binary Search Tree: Insertion, Deletion, Traversal
8. Implementation of Graph traversal techniques.
9. Implementation of Hashing.
10. Implementation of Rabin-Karp algorithm

TEXTBOOKS:

1. Narasimha Karumanchi, "Data Structures and Algorithmic Thinking with Python", Career Monk Publications, 2016
2. Jake VanderPlas, Python Data Science Handbook, OReilly, 2017

SUGGESTED READING:

1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, “Data Structure and Algorithms in Python”, Wiley, 2013.

2. Kenneth A. Lambert, "Fundamentals of Python: Data Structures", Cengage Learning,2018.
3. Narasimha Karumanchi, “Data Structures and Algorithms for GATE”, Career Monk Publications,2011.
4. Wes McKinney, “Python for Data Analysis Data Wrangling with Pandas, NumPy, and IPython”,2nd Ed, O Reilly, 2018

Online Resources:

1. https://www.geeksforgeeks.org/data-structures/
2. https://www.coursera.org/specializations/data-structures-algorithms3.
3. https://nptel.ac.in/courses/106/106/106106182/
4. https://www.cs.usfca.edu/~galles/visualization/Algorithms

22CHC05

FLUID MECHANICS LAB

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

COURSE OBJECTIVES: This course aims 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, the student 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

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

LIST OF EXPERIMENTS: Minimum of 10 experiments in the list are to be performed

1. Determination of discharge coefficient for Orifice meter and Venturimeter and their variation with Reynolds number
2. Determination of weir meter constant K for V notch / rectangular notch
3. Determination of discharge coefficient for Mouthpiece 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
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

TEXTBOOKS:

1. 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:

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

22CHC06

MECHANICAL UNIT OPERATIONS LAB

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

Prerequisites: Mathematics, Physics, Chemistry

COURSE OBJECTIVES: This course aims to

1. Provide the opportunity to acquire practical skills in mechanical unit operations.
2. Introduce the principles, importance 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: After the completion of this course, the student will be able to

1. Assess the nature of solids, their characterization, handling and the processes involving solids
2. Analyze the performance of size reduction equipment and calculate the power and efficiency requirements
3. Identify the principle, construction and operation of various classification equipment
4. Select the suitable Solid -Liquid industrial separation equipment based on settling, density and centrifugal force
5. Estimate the cake properties in a filtration operation

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

LIST OF EXPERIMENTS: Minimum of 10 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.
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.
12. Study of the sedimentation characteristics of a thickener and design of a continuous thickener

TEXTBOOKS:

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. Foust A.S, Wenzel L.A., "Principles of Unit Operations", 2nd Ed., John Wiley and sons, NewYork, 1981.

Suggested Readings:

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

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

(In line with AICTE Model Curriculum with effect from AY 2023-24)

B. Tech (Chemical Engineering)

SEMESTER IV

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22CHC07	Chemical Engineering Thermodynamics-II	3	-	-	3	40	60	3
2	22CHC08	Chemical Technology	3	-	-	3	40	60	3
3	22CHC09	Heat Transfer	3	-	-	3	40	60	3
4	22CHC10	Instrumentation and Material Characterization	2	-	-	3	40	60	2
5	22CHC11	Mass Transfer Operations- I	3	1	-	3	40	60	4
6	22CHEXX	Professional Elective I	3	-	-	3	40	60	3
7	22EGM01	Indian Constitution and Fundamental Principles	2	-	-	2	--	50	NC
PRACTICAL									
8	22CHC12	Heat Transfer Lab	-	-	3	3	50	50	1.5
9	22CHC13	Instrumentation and Material Characterization Lab	-	-	3	3	50	50	1.5
TOTAL			**19**	**01**	**06**	**-**	**340**	**510**	**21**
Clock Hours Per Week: 26									

L: Lecture T: Tutorial P: Practical CIE-Continuous Internal Evaluation

SEE - Semester End Examination NC- Non-Credit

Professional Elective I	
22CHE01	Energy Engineering
22CHE02	Food Processing Technology
22CHE03	Material Science for Chemical Engineers
22CHE04	Pulp and Paper Technology

22CHC07

CHEMICAL ENGINEERING THERMODYNAMICS – II

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

COURSE OBJECTIVES: This course aims to

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: After the completion of this course, the student 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	1	1	1	0	0	1	1	0	1	3	3
2	3	2	1	0	0	0	1	0	0	0	0	1	3	3
3	3	1	1	1	0	0	0	0	1	1	0	1	3	3
4	3	3	2	0	0	1	0	0	0	0	0	0	3	3
5	3	3	1	0	0	0	1	0	0	1	0	1	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 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).

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, Liquid-liquid equilibrium, VLLE, SLE, SVE, 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 Multireaction Equilibria

TEXTBOOKS:

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.

SUGGESTED READINGS:

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. Y.V.C. Rao., “Chemical Engineering Thermodynamics”, University Press Hyderabad, 2005.
4. Kyle B.G., Chemical and Process Thermodynamics, 3rd Edition, Pearson, 1999

22CHC08

CHEMICAL TECHNOLOGY

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

COURSE OBJECTIVES: This course aims to

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

1. Differentiate between unit operation and unit processes.
2. Estimate the chemical industry growth and opportunities.
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.

CO-PO-PSO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	2	2	2	0	0	0	0	0	1	2	1
2	3	1	3	2	2	0	0	0	0	0	0	0	1	2
3	3	1	3	1	1	0	0	0	0	0	0	1	2	2
4	3	0	2	2	3	1	0	0	0	0	0	0	1	1
5	0	0	1	2	2	2	0	0	0	0	0	0	0	1

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, Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry).Overview of Pharmaceutical industry and classification of pharmaceutical chemical forms.

UNIT-II

Production of Green Hydrogen. Manufacturing of Ammonia. Urea manufacturing by various processes. Manufacturing of Mono ammonium Phosphate, Di ammonium Phosphate. Manufacturing of Single super Phosphate and Triple super Phosphate.

UNIT-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.

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, By products of sugar industries.

TEXTBOOKS:

1. 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.
2. George T. Austin, ―Shreve's Chemical Process Industries‖, 5th edition. McGraw Hill Book Company, 1984.

SUGGESTED READINGS:

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, New Delhi, 2009.

22 CHC09

HEAT TRANSFER

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

Prerequisites: Material and Energy Balance Calculations, Mechanical Unit Operations, Fluid Mechanics

COURSE OBJECTIVES: This course aims to

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

1. Understand the different modes of heat transfer, conduction heat transfer through the different geometries under steady & unsteady state conditions
2. Calculate the heat transfer coefficients under the forced, natural convection and understand the concepts of heat exchangers and its design
3. Analyze the heat transfer phenomena in fluids involving phase changes
4. Identify the type of evaporator required for a specific purpose and its design
5. Understand the concept of radiation, laws of radiation and the impact of radiation shields

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

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.

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

TEXTBOOKS:

1. W.L.Mc Cabe, 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 READINGS:

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

22CHC10

INSTRUMENTATION AND MATERIAL CHARACTERIZATION

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

Prerequisites: Engineering Chemistry, Engineering Physics

COURSE OBJECTIVES: This course aims to

1. The components and characteristics of industrial measurement systems
2. Different types of temperature and pressure measuring instruments and their industrial applications
3. Different types of flow meters and level measuring instruments
4. Different types of microscopic analysis
5. Different types of spectroscopic and chromatographic analysis

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

1. Understand the measurement techniques of different process variables
2. Select temperature, pressure, level, and flow measuring instruments based on their operation
3. Explain the morphological and crystallographic characterization techniques
4. Infer the characterizations associated with spectroscopy
5. Explain the concepts of rheology and chromatographic analysis

CO-PO-PSO Matrix

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

UNIT- I

Introduction to Instrumentation: Elements of instruments, static and dynamic characteristics, 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.

UNIT- II

Importance of industrial instrumentation: Need, significance, applications and classifications. Familiarization with temperature, pressure, level and flow measuring instruments.

UNIT- III

Morphology, surface and Crystallographic Analysis: Theory, working principles, applications of X-ray diffraction (XRD), optical microscopy, scanning electron microscope (SEM), transmission electron microscopy (TEM), BET analysis.

UNIT- IV:

Spectroscopy: Theory, working principles, applications of UV-Vis absorption spectroscopy, fluorescence spectroscopy, Fourier Transform Infra Red (FTIR) spectroscopy, Raman spectroscopy.

UNIT- V:

Chromatography and Rheology: Basic concepts of chromatographic techniques (High-performance liquid chromatography, ion exchange chromatography, gel chromatography, and gas chromatography), viscometer, and tensiometer.

TEXTBOOKS:

1. Characterization of Materials, 2 Volume Set by Elton N. Kaufmann-Wiley-Interscience 2003.
2. Principles of Instrumental Analysis by D.A. Skoog, F.J. Holler, and T.A. Nieman, 7th edition, Cengage Learning, 2018.
3. Principles of industrial instrumentation, D. Patranabis, 2nd ed., Tata McGraw Hill Edu. (India) Pvt. Ltd., New Delhi, 2013.

SUGGESTED READINGS:

1. Instrumental Method of Chemical Analysis by G.R. Chatwal, and S.K. Anand, Himalaya Publishing House, 2005.
2. Chromatographic Methods by A. Braithwaite, and F.J. Smith, 5th edition, Blackie Academic and Professional, London, 1996.

22CHC11

MASS TRANSFER OPERATIONS-I

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

Prerequisite: Knowledge of differential and partial differential equations and MEBC.

COURSE OBJECTIVES: This course aims 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: After the completion of this course, the student will be able to

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

CO-PO-PSO Matrix

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

UNIT-I

Diffusion Mass Transfer: Introduction of Mass transfer operations & their applications, Choice of separation methods, Concept of driving force and flux, 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).

UNIT – II

Mass Transfer Coefficient & Interphase Mass Transfer: Mass transfer coefficients, 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. Correlations for mass transfer coefficients and Reynolds & Colburn analogies.

UNIT – III

Absorption and Stripping: Introduction to absorption, Equilibrium in gas-liquid system, and minimum liquid rate, Design of packed column 27 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. Kremer – 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 moisture, 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.

TEXTBOOKS:

1. R.E. Treybal, "Mass Transfer operations", 3rd Edition, McGraw Hill Book Co., 1981
2. B. K. Datta "Principles of Mass Transfer and Separations Processes" PHI Learning Private Limited, New Delhi, 2009.

SUGGESTED READINGS:

1. Christie John Geonkoplis "Transport Processes and Separation Process Principles", 4th edition. PHI, New Delhi.
2. J Coulson and Richardson,"Fluid Flow, Heat and Mass Transfer", Volume 1, 6th Edition, Pergoman Press, 2009
3. W.L.McCabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition, 2005.

22CHE01

ENERGY ENGINEERING

(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 aims to

1. Gain knowledge on various energy sources and their applications
2. Know emerging technologies viz., fuel cells, biofuels 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: After the completion of this course, the student will be able to

1. Explain the conventional and non-conventional energy sources and discuss the characterization and production methods of non-conventional energy sources.
2. Illustrate the principles and applications of solar energy and photovoltaic cells.
3. Summarize the basic principles of wind energy, hydropower and tidal Energy
4. Explain the importance of bio fuels and classify them
5. Demonstrate the need for energy auditing and conservation, identify strategies for reducing energy consumption and increasing efficiency.

CO-PO-PSO Matrix

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

UNIT-I

Introduction:Introduction to conventional and non-conventional energy sources, alternative energy sources, their significance and availability

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-II

Non-conventional Energy Sources:Solar Energy: Basics, Types of Solar Energy Collectors, Applications-Solar Distillation, pumping, production of hydrogen.

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

UNIT-III

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-IV

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 biodiesel, bio-butanol and bio-ethanol, Second generation bio-fuel feed stocks

UNIT-V

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

TEXTBOOKS:

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 READINGS:

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 Butterwolfer and Co. Ltd.,2001

22CHE02

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 aims to

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

1. Understand food demand scenario with respect to world and India
2. Explain heat effects and food processing on sensory and nutritional characteristics of food
3. Analyze various techniques of raw material preparation and design process equipment to achieve the desired quality of food.
4. Develop novel food processes that have a minimal effect on food quality.
5. Know different types of packaging and packaging materials for effective food packaging.

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	2	2	2	1	1
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	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 – components of food technology, Quality and nutritive aspects, Product and Process development – stages of new product development process, 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.

UNIT – III

Ambient Temperature Processing: Raw material preparation - cleaning, sorting, grading, peeling; Size reduction of solid and liquid foods; Mixing and forming; Separation and concentration of food components - Centrifugation, filtration, expression, extraction, 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 – purpose, functions, characteristics, types of packaging - Theory and Types of packaging materials; Coating or enrobing, Printing, Interactions between packaging and foods, Environmental considerations.

TEXTBOOKS:

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, 2000

22CHE03

MATERIAL SCIENCE FOR CHEMICAL ENGINEERS

(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 aims to

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.

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

1. Classify different engineering materials as ferrous and non-ferrous alloys.
2. Compare mechanical, thermal and optical properties of engineering materials
3. Select materials for high and low temperature applications.
4. Identify new or alternate materials for development and operation of process industry.
5. Understand the significance of Biomaterials in engineering

CO- PO and PSO Correlation Matrix

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

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 propertiesand applications of engineering materials like Refractories, Ceramics, Super alloys, Composites;

UNIT-IV

New materials: Nano-materials: nanosensors, nanocomposites, role of reinforcement-matrix interface strength on composite behaviour. Smart materials: Piezoelectrics, Magneto-strictive, shape memory alloys, electro- rheological materials, 3D printing.

UNIT-V

Biomaterials: Biomaterials: Biocompatibility, advantages, properties, uses, Types- Nearly inert ceramics, surface active ceramics, resorbable ceramics.

TEXTBOOKS

1. Materials Science and Engineering an Introduction, William D. Callister, Jr. 10th Ed., John Wiley and Sons, Inc. 2017.

SUGGESTED READINGS:

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

22CHE04

PULP AND PAPER 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 aims to

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

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

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

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.

UNIT IV

Bleaching operations: Objective of bleaching – Elemental chlorine free and Total chlorine free bleaching; Bleaching agents – form, function, advantages and 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 & news print specifications; BIS and ISO standards of paper. Paper properties dependence on paper making processes.

Paper recycling process, Effluent treatment processes with environmental considerations.

TEXTBOOKS:

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 READINGS:

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, Ultra structure, 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

22EGM01

INDIAN CONSTITUTION AND FUNDAMENTAL PRINCIPLES

(BE/B.Tech - Common to all branches)

Instruction	2 L Hours per week
Duration of Semester End Examination	2 Hours
Semester End Examination	50 Marks
CIE	-
Credits	0

Prerequisite: Basic Awareness of Indian Constitution and Government.

COURSE OBJECTIVES: The course will introduce the students to:

1. Understand the history of framing of the Indian Constitution.
2. Awareness on Fundamental Rights, Duties and Directive Principles of State Policy.
3. Explore the organization of Union Government, and functions of President and Prime Minister.
4. Gain an insight into the inter-functionality of Union Legislature and Judiciary
5. Educate on the local governance and problems in development of rural and urban areas.

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

1. Understand the history of framing of the Indian Constitution and its features.
2. Assess the realization of Fundamental Rights and Directive Principles of State Policy.
3. Analyze the challenges to federal system and position of the President and the Prime Minister in the Union Government.
4. Underline the role of the Legislature and the Judiciary in Union Government and their mutual relations.
5. Evolve the development of the local governments in India and assess the role of Collector in district administration.

CO-PO Articulation Matrix

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

UNIT-I

Constitutional History and Framing of Indian Constitution: East India Company rule (1757-1857): Social, Economic, Political and Administrative impact of Company rule in India. British Rule (1858-1947): Indian National Movement, Government of India Acts 1909, 1919 and 1935, and Indian Independence Act 1947. Framing of the Indian Constitution: Constituent Assembly, Preamble and Salient Features.

UNIT-II

Fundamental Rights, Duties and Directive Principles of State Policy: The Fundamental Rights**:** Features and significance of Rights. Fundamental Duties: Importance and the legal status of Duties. Directive Principles of State Policy: Socialist, Gandhian and Liberal-intellectual principles, importance and relevance.

UNIT-III

Union Government and its Administration: Federalism: Division of legislative and financial powers between the Union and the State. Union Executive: Role and position of President, Prime Minister and Council of Ministers. Emergency Provisions: National Emergency, Constitutional Emergency and Financial Emergency.

UNIT-IV

Union Legislature and Judiciary: Union Legislature: Parliament of India-Composition and functions of Parliament, and Parliamentary Committees. Union Judiciary: Supreme Court of India-Composition and Functions.

UNIT-V

Local Self Governments: Rural Local Governments: Zilla Parishad- CEO and functions of Zilla Parishad, Mandal Parishad- Role of Elected and Officials, Gram Panchayat- Sarpanch, Secretary and Gram Sabha. Urban Local Governments: Structure and functions of Municipalities and Municipal Corporations. District Collector: Powers and functions of Collector.

TEXT BOOKS:

1. Sastry Ravindra, (Ed), "Indian Government & Politics", Telugu Akademy, 2nd edition, 2018.
2. "Indian Constitution at Work", NCERT, First edition 2006, Reprinted in 2022.

SUGGESTED READING:

1. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. Granville Austin, "The Indian Constitution: The Cornerstone of a Nation", OUP, 2nd Edition, 1999.
4. M.V. Pylee, "India"s Constitution", S. Chand Publishing, 16th Edition, 2017.
5. Rajeev Bhargava (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.

22CHC12

HEAT TRANSFER LAB

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

Prerequisites: Material and Energy Balance Calculations, Mechanical Unit Operations, Fluid Mechanics

COURSE OBJECTIVES: This course aims 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: After the completion of this course, the student will be able to

1. Evaluate the heat transfer rate through the solids and to determine thermal conductivity of different materials of varying geometries under the steady state conditions.
2. Estimate heat transfer coefficients and determine effectiveness of pin fin for free and forced convection
3. Determine surface emissivity of a test plane and Stefan-Boltzmann's constant and compare with theoretical values
4. Determine critical heat flux in pool boiling.
5. 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	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

LIST OF EXPERIMENTS

(Minimum of 10 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

TEXTBOOKS:

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

22CHC13

INSTRUMENTATION AND MATERIAL CHARACTERIZATION LAB

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

COURSE OBJECTIVES: This course aims to

1. Principles of different process instruments
2. Working principle of microscopes
3. Working principles and analysis processes of spectroscopic techniques
4. Working principles and analysis processes of characterization processes related to rheology and interfacial tension
5. Working principles and analysis processes of Chromatographic techniques

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

1. Calibrate different process instruments.
2. Analyze and calculate the dimensions of microparticle
3. Estimate material concentrations in solutions
4. Identify functional groups and the composition of the materials
5. Determine viscosity and surface tension of liquids

CO-PO-PSO Matrix

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

LIST OF EXPERIMENTS

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

1. Calibration of flow measuring instrument-Rotameter
2. Calibration of temperature measuring instrument-Mercury in glass thermometer
3. Estimation of the dimension of microparticles using Optical microscopy
4. Calculation of Dye concentration using UV-Vis spectroscopy
5. Calculation of Dye concentration using Fluorescence spectroscopy.
6. Identification of functional groups using FTIR Spectroscopy.
7. Calculation of heavy metal concentration using Atomic Absorption microscopy
8. Determination of viscosity using Viscometer/Rheometer
9. Determination of surface tension using Tensiometer
10. Estimation of gas composition using Gas chromatography
11. Calculation of alcohol concentration using High Pressure Liquid Chromatography
12. Estimation of Contact angle using contact angle goniometer

TEXTBOOKS:

1. Characterization of Materials, 2 Volume Set by Elton N. Kaufmann -Wiley-Interscience 2003.
2. Principles of Instrumental Analysis by D.A. Skoog, F.J. Holler, and T.A. Nieman, 7th edition, Cengage Learning, 2018.
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