CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

CHEMICAL ENGINEERING
B. Tech I – Year

I - Semester

THEORY						
S.No	**Code**	**Subject**	**L**	**T**	**P/D**	**Credits**
1	EG 111	English - I	2	0	0	2
2	MT 111	Mathematics – I	3	1	0	3
3	PY 112	Physics - I	3	0	0	3
4	CY 112	Inorganic Chemistry	4	1	0	3
5	CS 113	Programming and MATLAB Computing	3	1	0	3
6	CE 112	Environmental Studies	3	1	0	3
PRACTICALS						
7	EG 112	English Language Laboratory – I	0	0	2	1
8	PY 115	Engineering Physics Lab	0	0	3	2
9	CY 115	Inorganic Chemistry Lab	0	0	3	2
10	CS 115	Programming & MATLAB Computing Lab	0	0	3	2
11	ME 115	Workshop Practice	0	0	3	2
TOTAL			**18**	**04**	**14**	**26**

II – Semester

THEORY						
S.No	**Code**	**Subject**	**L**	**T**	**P/D**	**Credits**
1	EG 121	English – II	2	0	0	2
2	MT 121	Mathematics – II	3	1	0	3
3	PY 123	Physics – II	3	0	0	3
4	CY 122	Organic Chemistry	4	1	0	3
5	CS 121	Object Oriented Programming through C++	3	1	0	3
6	CH 121	Introduction to Chemical Engineering	4	0	0	3
PRACTICALS						
7	EG 122	English Language Laboratory – II	0	0	2	1
8	CY 124	Organic Chemistry Lab	0	0	3	2
9	CS 122	Programming Lab – II	0	0	3	2
10	ME 122	Engineering Drawing	0	0	3	2
TOTAL			**19**	**03**	**11**	**24**

EG 111

ENGLISH –I
(common to all branches)

Instruction	2L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

To enable the students to

- To understand the role and importance of communication and to develop their basic communication skills in English.
- To enable the students to communicate through listening, speaking, reading and writing.
- To achieve a sound foundation and acquaint the students in the basics of grammar.
- To develop vocabulary and to use appropriate idiomatic expressions, one word substitutes etc,.
- To ensure students use learning materials prescribed, and to inculcate the habit of reading for pleasure.
- To enhance imaginative creative and critical thinking through literary texts.
- To enable students to write composition and draft different kinds of letters.

UNIT-I

Effective Communication: Role and importance of communication, process of communication, types of communication , barriers to communication, Verbal communication and non verbal communication , formal versus informal communication.

UNIT-II

Review of Grammar: 1.Tense and aspect 2.Articles 3.Prepositions 4.Voice 5.Concord 6. Direct and indirect speech
Vocabulary Enhancement: 1.Synonyms2.Antonyms

UNIT-III

Reading comprehension and reading strategies.
Lessons Prescribed: 1. Barack Obama: A Trendsetter 2. Rendezvous with IndraNooyi
Text based exercises
Vocabulary Enhancement:1. Homonyms 2. Homophones 3. Homographs 4. Words often confused

UNIT-IV

Writing Skills: Paragraph writing, Essay writing , Letter of application, Resume writing, Complaint letter with response.
Vocabulary Enhancement: Idiomatic expressions and one word substitutes.

UNIT-V

Soft skills - Introduction to soft skills, soft versus hard skills, professional etiquette in formal and semi formal situations, telephonic etiquette, E-mail etiquette.

Text Books:

1. "Essential English"- E Suresh Kumar et al**.**(Orient Balck Swan PVT Ltd.)
2. "Communication Skills and Soft Skills: An Integrated Approach"- E Suresh Kumar et al**. (**Pearson Publications)

Suggested Reading:

1. "English Vocabulary in Use" - Michael McCarthy (Cambridge University Press)
2. "Developing Communication Skills" – Krishna Mohan &Meera Banerjee (Macmillan)
3. "Murphy's English grammar" (Cambridge University Press)
4. "English Phrasal Verbs in use" - Michael McCarthy (Cambridge University Press)
5. "Written Communication in English" –Sarah Freeman (Orient Longman)
6. "Model Business letters, E-Mails and Other Business Documents" - Shirley, Taylor (Pearson) "Effective Technical Communication" – M. Ashraf Rizvi (Tata- McGraw Hill)
7. "Business Correspondence and Report Writing – R.C Sharma and Krishna Mohan (Tata McGrawHill)
8. Soft Skills, Alex , Publishers S. Chand

MT 111

MATHEMATICS – I
(common to all branches except Bio-Tech)

Instruction	3L + 1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT-I: Matrices: Rank of a matrix, Echelon form-Normal form-Consistency of a linear system of equations. Eigen values, Eigen vectors- properties (without proofs). Cayley- Hamilton Theorem (statement only) inverse and powers of a Matrix by Cayley-Hamilton Theorem. Reduction of Quadratic form to Canonical form by linear transformation, rank, positive, negative, definite, semi-definite, index and signature.

UNIT-II: Sequences and Series: Convergence and divergence, ratio test, Comparison test, integral test, Cauchy's root test, Raabes's test-Alternating series, Absolute and conditional convergence, Leibniz's Test (tests without proofs).

UNIT-III: Differential Calculus:
Mean value theorems (statements only) - Rolle'sTheorem, Lagrange's theorem, Cauchy's theorem, and generalized mean value theorem (Taylor's Theorem), Geometrical interpretations. Curvature and Radius of curvature, center of curvature, circle of curvature.Evolutes,involutes and Envelopes. Functional dependence, Jacobian, Taylors series in two variables, Maxima and Minima for function of two variables with and without constraints.

UNIT-IV:Integral Calculus: Curve tracing – Cartesian, polar and parametric curves (standard curves only). Double and triple integrals change of order integration, applications of integration, rectification, areas, volumes and surfaces of solids of revolution in Cartesian and polar coordinates.

UNIT-V: Beta and Gamma Functions: Definitions of Beta and Gamma functions-elementary Properties of both Beta and Gamma functions, Relation between Beta and gamma functions, differentiation under the integral sign.

Text Books:

1. Advanced Engineering by Kreyszig, john wiley&sons -publishers.
2. Mathematical Methods of science and engineering, Aided with MATLAB, Kanti.B.Datta. Cengage Learning India Pvt.Ltd,418 Pratapgang,New Delhi.
3. Mathematics for Engineers and Scientists by AlenJaffery , 6th edition 2013 CRC press, Taylor & Francis Group.(Elsevier)
4. Advanced Engineering Mathematics by Michael Greenburg, Second Edition –Pearson Education.

Suggested Reading:

1. Mathematics for Engineers-a modern interactive approach by A.Craft and Robert Davison-Willey
2. Applied Mathematics and physicists by Loius Pipes-McGraw Hill pubulishers.
3. Advanced Engineering Mathematics by R.K.Jain&S.R.K.Iyenger, 3rd edition, Narosa Publications
4. Matrices for Engineering Dynamics by AR Collar and A. Simpson-John Willey & sons
5. Essential Mathematics for Engineers by W.Bolton-Betterworth and Heineman
6. Mathematics for Physicists and Engineers- L F Landoviz, Publishers- Rienfold Book Corporation.
7. Higher Engineering Mathematics by B.S.Grewal, Khanna Publishers.
8. Engineering Mathematics by B.V.Ramana
9. Calculus by Smith and Minton
10. Applications of Linear Algebra by David.C Lay

PY 112

PHYSICS – I
(Chemical Engg)

Instruction	3L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT – I

Waves and Oscillations: Simple harmonic motion – Differential equation and its solution – Torsional pendulum – Superposition of two mutually perpendicular linear SHMs of same frequency – Lissajous figures – Damped vibrations – Differential equation and its solution – Logarithmic decrement - Relaxation time – Quality factor – Forced vibrations – Differential equation and its solution – Amplitude resonance.

Ultrasonics: Introduction – Production of ultrasonics by piezoelectric and magnetostriction methods – Detection of utrasonics– Determination of ultrasonic velocity in liquids – Engineering applications.

UNIT – II

Interference: Introduction – Division of amplitude & division of wavefront – Interference in thin films (reflected light) – Newton's rings – Fresnel's biprism.

Diffraction: Introduction – Distinction between Fresnel and Fraunhoffer diffraction – Diffraction at single slit & double slit – Diffraction grating (N Slits).

UNIT – III

Polarization: Introduction – Brewster's law – Malus's law – Double refraction – Nicol's prism – Quarter & Half wave plates – Optical activity – Laurent's half shade polarimeter.

Lasers &Holography: Introduction – Characteristics of lasers – Spontaneous & stimulated emission of radiation – Einstein's coefficients – Population inversion – Ruby laser – He-Ne laser – Semiconductor laser – Applications.

Basic principle of Holography – Recording & Reconstruction of hologram – Applications

UNIT - IV

Black Body Radiation: Introduction – Qualitative treatment of Kirchoff's law, Stefan-Boltzmann's law, and Wien's displacement law – Spectrum of black body radiation – Wien's law – Rayleigh Jean's law – Planck's law of black body radiation – Photoelectric effect – Compton effect.

UNIT – V

Elements of Statistical Mechanics: Introduction – Ensembles – Phase space – Thermodynamical probability – Boltzmann theorem on entropy – Maxwell-Boltzmann statistics – Partition function and thermodynamical quantities (Entropy, Helmholtz free energy, Total energy, Enthalpy, Gibb's potential, Pressure of gas, Specific heat at constant volume) – Bose-Einstein statistics – Fermi-Dirac statistics.

Text Books:

1. M.N. Avadhanulu and P.G. Kshirsagar, *A Text BookEngineering Physics*, S. Chand Publications, 2014
2. S.L. Gupta and Sanjeev Gupta, *Modern Engineering Physics*, DhanpatRai Publications, 2011
3. V. Rajendran, *Engineering Physics*, McGahill Education Publications, 2013

Suggested Reading:

1. R. Murugeshan and KiruthigaSivaprasath, *Modern Physics*, S. Chand Publications S. Chand Publications, 2005
2. M. Arumugam, *Materials Science*, Anuradha Publications, 2002.
3. Satyaprakash and Agarwal, *Statistical mechanics*, Kedannath Publications
4. P.K. Palanisamy, *Engineering Physics*, Scitech Publications, 2012
5. Hitendra K Malik and A.K. Singh, *Engineering Physics*, Tata McGahill Education Publications, 2011

CY 112

INORGANIC CHEMISTRY
(Chemical Engg)

Instruction	4L + 1T Periods per week
Duration of University Examination	4 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	4

UNIT – I

Chemical Bonding : Introduction to molecular orbital theory, Linear combination of atomic orbital (LCAO) Method, Pictorial representation of combination of Atomic orbitals to form molecular orbitals, conditions for the combination of Atomic orbitals, energy level diagram for molecular orbitals, mixing of orbitals, bond order molecular orbital diagram for simple diatomic molecules of H_2, He_2^+, N_2, O_2, O^-_2ion, NO and CO.

UNIT – II

Electordepotentials : Oxidation – Reduction reactions Principle of electrode potential, standard electrode potential, Electro chemical series-applications.

Corrosion : Definition of Corrosion, Oxidation corrosion-mechanism, Electrochemical corrosion–Mechanism. Types of corrosion – Galvanic corrosion, differential aeration corrosion, pitting corrosion, water line corrosion. Corrosion control – Cathodic protection.

UNIT – III

Water chemistry : Hardness of water-Types, units of hardness, disadvantages of hard water, estmtion of hardness of water by EDTA method, alkalinity of water and its determinations, numerical problems. Boiler troubles-scale and sludge formation, caustic embrittlement, boiler corrosion, priming and foaming-causes and effects. Specifications of potable water – treatment of water for drinking purpose – by boiling, sedimentation, coagulation, filtration, by ozone, concept of breakpoint chlorination of water, industrial requirements of water-Microbial testing.

UNIT – IV

Organometallic compounds: Introduction-Types of Metal-carbon bonds, preparation of organo metallic compounds of lithium and magnesium, synthetic uses of organometallic compounds, other uses of organometallic compounds.

Hard and soft acids and bases, pearsons HSAB principle and its applications.

UNIT V

Fuels: Classification of fuels, characteristics of a good fuel. Calorific value: gross calorific value, net calorific value, determination of calorific value – bomb calorimeter.

Solid Fuels: Coal, analysis of coal – proximate analysis, ultimate analysis.

Liquid Fuels: Characteristics of liquid fuels, petroleum – fractional distillation of crude petroleum, octane number, cetane number, cracking of petrol – fixed bed catalytic cracking.

Gascous Fuels: Advantages of gaseous fuels, liquid petroleum gas, CNG. Combustion- calculation of air required for combustion, analysis of flue gases – orsat apparatus.

Text Books :

1. Concise inorganic Chemistry; JD LEE
2. Engineering chemistry: Jain and Jain

Suggested reading

1. Principles of Inorganic Chemistry: B.R. Puri, L.R. Sharma & K.C. Kalia
2. Advanced Inorganic Chemistry: Cotton F.A. &Willikinson G.
3. Inorganic Chemistry: P.L. Sony & Mohan Sultan Chand & Sons.
4. Engineering Chemistry: B.K. Sharma

CS 113

PROGRAMMING AND MATLAB COMPUTING
(Chemical Engg)

Instruction	3L + 1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

UNIT-I

Introduction to computers: Components, Block diagram, Operating Systems, programming languages, Assembler, Interpreter, Compiler, loader, linkers, Number systems (Binary, Octal, Decimal and Hexa),
Representation of numbers (fixed and floating point), Problem Solving: Algorithm, Flow Charts.

Types: Operators and Expressions: Variable Names, Data Types and Sizes, Constants, Declarations, Type Conversions, Operators, Precedence and Order *of* Evaluation.

UNIT-II

Control Flow and Behavior Flow Charts: Statements and Blocks, If-Else, Switch, loops: While, For, Do-While Break; Continue, Go to and labels.

UNIT-III

Functions: Basics of Functions, Parameter Passing Techniques, Functions returning non-integers, Recursion.
Storage Classes, External Variables, Scope Rules, Header Files, Static and auto Variables, Register Variable, Block Structure, Initialization. C Preprocessor. Arrays: One, Two and Multi-dimensional arrays. Search: Linear and Binary, Sort: Selection and Bubble.
Pointers: Pointers and Addresses, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, Command line arguments.

UNIT-IV

Structures and Unions: Basics, Structure and functions, array of structures, Pointers to structures, Self referential structure, Union. Files: Basics and File Handling functions: Copy file and display file.

UNIT-V

MAT LAB C Programming, built-in functions, Creating Arrays, mathematical operations with Arrays, Two and three dimensional plots, user defined functions and function files, Relational and logical operators, Conditional statements-if-end, if-else-end, if – else if-else-end. Loops: for-end loop and while-end loop.
Nested loops and nested conditional statements, Break and continue commands.

Text Books:

1. Kernighan B.W. and Ritchien.M., "The C Programming language" 2nd Edition,Prentice-Hall of India, 2006.
2. Amos Gilat, "MATLAB: An Introduction with Application" 3rd Edition, John Wiley& Sons.

Suggested Reading:

1. ForouzanEichard B.A., Gilberg F, "A Structured Programming Approach Using *C"* 2nd Edition, Thompson, 2003.
2. Rajaraman V. "The Fundamentals of Computers" 4th Edition, Prentice Hall of India, 2006.

CE 112

ENVIRONMENTAL STUDIES
(common to all branches)

Instruction	3L + 1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To equip the students with inputs on the environment, natural resources, ecosystems and Bio-diversity.
2. To enable the students become aware of environmental pollutions, causes, effects and control measures.
3. To make the students contribute for capacity building of nation for arresting and/or managing environmental disasters.

UNIT – I

Environmental Studies Definition, Scope and importance, need for public awareness. Natural resources: Water resources, use and over utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Effects of modern agriculture, fertilizer pesticide problems, water logging salinity.Energy resources; growing energy needs, renewable and non-renewable energy sources. Land resources; land as a resource, land degradation, soil erosion and desertification.

UNIT – II

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in ecosystem, food chains, ecological pyramids, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries).

UNIT – III

Biodiversity: Genetic species and ecosystem diversity, biogeographical classification of India. Value of biodiversity, threats to biodiversity, endangered and endemic species of India, conservation of biodiversity.

UNIT – IV

Environmental Pollution: Cause, effects and control measures of air pollution, water pollution,
soil pollutions, noise pollution, thermal pollution and solid waste management. Environment protection act: Air, water, forest & wild life acts, issues involved in enforcement of environmental legislation.

UNIT – V

Social issues and the environment: Water conservation, watershed management, and environmental ethics. Climate change; global warming, acid rain, ozone layer depletion, Environmental protection act, population explosion.
Disaster Management: Types of disasters, impact of disasters on environment, infrastructure and development, Basic principles of disaster mitigation, disaster management, and methodology disaster management cycle and disaster management in India

Text Books:

1. Y. Anjaneyulu, Introduction to Environmental Science, B.S. Publications, 2004
2. S.S.Dara, A Text book of Environmental Chemistry & Pollution Control, S.Chand&Comp. Ltd, 2000.

Suggested Reading:

1. De A.K. *Environmental Chemistry*, Wiley Eastern Ltd., 1989.
2. Odum E.P. *Fundamentals of Ecology,* W.B. Saunders Co., USA, 1975.
3. Rao M.N. and Datta A.K., *Wastewater treatment*, Oxford & IBH publishing Co., 1987.
4. Miller T.G. Jr. Environmental Science, Wordsworth Publishing Co., 1984.
5. Benny Joseph, Environmental Studies, Tata Mc. Graw Hill education Pvt. Ltd., 2000
6. Raman Siva Kumar, Introduction to environmental Science and Engineering, Tata Mc. Graw Hill education Pvt. Ltd., 2010.

EG 112

ENGLISH LANGUAGE LABORATORY – I
(common to all branches)

Instruction	2 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	1

Computer Assisted Language Learning Lab (CALL)

Introduction:
The language lab focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations and contexts.
The following are the **objectives** of the course:

1. To make students recognize the sounds of English through audio – visual aids and computer software.
2. To help them overcome their inhibitions and self consciousness while speaking in English and to build their confidence. The focus shall be on fluency rather than accuracy.
3. To enable them to speak English correctly with focus on stress and intonation.
4. To expose the students to a variety of self instructional, learner friendly modes of communication.

Syllabus:
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. Aspects of connected speech: Strong forms, weak forms, contracted forms, elision.

Interactive Communication Skills Lab (ICS LAB)

Introduction:
The objective of the course is to enrich interpretation skills, problem solving skills, interpersonal skills, analytical skills and leadership skills of the students, the most essential requirement of communication skills for Engineering students. The course lays emphasis on the language integrated skills in simple and comprehensive manner.
The following are the **objectives** of the course:

1. To expose the students to a team environment and how best one works with teams while adapting themselves to a corporate environment and to make business presentations.
2. Use proper body language expressions in presentation and speeches.
3. Depict situations in the dialogue that are relevant and useful to the learner, retain the truth value in the dialogue.
4. Public speaking is to be shown in action by incorporating narrative examples and extracts from speeches relating directly to students actual life experiences.

Syllabus:
1. Situational dialogues &role plays.
2. Group discussions: Objectives of a GD, types of GD's, initiating, continuing and concluding of GD.
3. Public speaking: Advantages of public speaking, essentials of an effective speech,rehearsal techniques, planning and delivering speeches.

Suggested Reading:

1. E Suresh Kumar et al**. English for Success** (with CD), Cambridge University Press India Pvt. Ltd. 2010.
2. T Balasubramanian**. A Textbook of English Phonetics for Indian Students**, Macmillan, 2008.
3. KavitaTyagi and Padma Misra. **Professional Communication**, PHI Learning Pvt. Ltd, 2011
4. J Sethi et al. **A Practical Course in English Pronunciation** (with CD), Prentice Hall India, 2005.
5. Meenakshi Raman and Sangeeta Sharma**. Technical Communication**, Oxford University Press 2009.

PH 115

ENGINEERING PHYSICS LAB
(Chemical Engg)

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

1. Compound Pendulum – Determination of 'g' by Compound pendulum
2. Helmholtz Resonator – Determination of resonating volume of air and neck correction
3. 'μ' of the Lenses – Determination of refractive index of given lenses
4. 'μ' of the Prism – Determination of refractive index of given prism
5. Newton's Rings – Determination of wavelength of given monochromatic source
6. Diffraction Grating – Determination of wavelengths of two yellow lines of mercury light
7. Malus's Law – Verification of Malus's law
8. Polarimeter– Determination of specific rotation of glucose
9. R.P. of Telescope – Determination of resolving power of given telescope
10. Energy Gap – Determination of energy gap of given semiconductor
11. Hall Effect – Determination of Hall coefficient, carrier concentration & mobility of charge carrier of given semiconductor specimen
12. B-H Curve – Determination of hysteresis loss of given specimen
13. M & H Values – Determination of magnetic moment given bar magnet & horizontal component of Earth's magnetic field
14. Solar Cell – Study I-V characteristics of given solar cell and calculation of fill factorefficiency and series resistance
15. Dielectric Constant – Determination of dielectric constant of given PZT sample
16. Planck's Constant –Determination of Planck's Constant using photo cell

CY 115

INORGANIC CHEMISTRY LAB
(Chemical Engg)

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

I. Systematic semi micro qualitative analysis of mixture containing two anions (non interfering) and two cations : $CO^{-2}_{3,}$ $C1^{-1}$, B_r^{-1}, I^{-1}, CH_3COO^{-1}, NO_3^{-1}, SO_4^{-2}, PO_4^{-3}, Pb^{+2} ,Bi^{+3}, Cd^{+2}, Fe^{+3}, Al^{+3}, Zn^{+2}, Mn^{+2}, Ca^{+2}, Sr^{+2}, Ba^{+2}, Mg^{+2}, NH_4^+.

II. Volumetric Analysis

1. Estimation of Fe^{2+} by Permanganometric titration.
2. Estimation of Copper by Iodometry
3. Estimation of Hardness of water by EDTA method.

CS 115

PROGRAMMING AND MATLAB COMPUTING LAB
(Chemical Engg)

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

C-Programming:

1. Finding the maximum and minimum of given set of numbers.
2. Finding Roots of a Quadratic Equation.
3. Sin x and Cos x values using series expansion.
4. Conversion of Binary to Decimal, Octal, Hexa and vice versa.
5. Generating a Pascal triangle.
6. Recursion: Factorial, Fibonacci, GCD.
7. Matrix addition and multiplication using arrays.
8. Bubble Sort, Selection Sort.
9. Linear Search and Binary Search.
10. Functions for string manipulations.
11. Finding the No. of characters, words and lines of given text file.
12. File Handling programs.

MATLAB Computing:

1. Roots of a Polynomial.
2. Curve fitting using polyfit function.
3. Solving equation with one variable.
4. Finding minimum and maximum of a function.

ME 115

WORKSHOP PRACTICE
(Chemical Engg & Bio-Tech)

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

Trades for Practice

1. Carpentry	2. Plumbing	3. House Wiring	4. Welding and demonstration of lathe operations

Exercises in Carpentry

1. To plane the given wooden piece to required size
2. To make a cross lap joint on the given wooden piece according to the given dimensions.
3. To make a Tee lap joint on the given wooden piece according to the given dimensions.
4. To make a dove tail-joint on the given wooden piece according to the given dimensions.
5. To make a bridle joint on the given wooden piece according to the given dimensions.

Exercises in Plumbing

1. To make external threads for GI pipes using dies.
2. To connect the GI pipes as per the given diagram using taps, couplings & bends.
3. To connect the GI pipes as per the given diagram using, couplings, unions, reducer & bends.
4. To connect the GI pipes as per the given diagram using shower, tap & valves
5. Demonstration of above exercise by giving water connection.

Exercises in House Wiring

1. Wiring of one light point controlled by one single pole switch, a three pin socket controlled by a single pole switch, and wiring of one buzzer controlled by a bell push.
2. Wiring of two light points connected in series and controlled by single pole switch. Verify the above circuit with different bulbs.
3. 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. Go-down wiring.

Exercises in Welding

1. To make a butt joint using arc welding on the given MS work pieces
2. To make a lap joint using arc welding on the given MS work pieces
3. To make a T-fillet joint using arc welding on the given MS work pieces.
4. To make a corner joint using arc welding on the given MS work pieces.
5. To join two thin sheets of GI material using Electric Resistance welding.

Demonstration of operations on lathe

Facing, turning, taper turning, grooving, knurling and boring operations over a cylindrical mild steel bar

Note: A minimum of 12 exercises from the above need to be done

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
CHEMICAL ENGINEERING
B. Tech. II – Year

I – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P/D**	**Credits**
1	MT 211	Fourier Analysis and Partial Differential Equations	4	0	0	3
2	CH 211	Chemical Technology	4	0	0	3
3	CH 212	Material and Energy Balances	4	0	0	3
4	CY 211	Physical Chemistry	4	0	0	3
5	ME 219 / EE 216	Basics of Mechanical and Electrical Engineering	4	0	0	3
PRACTICALS						
6	CH 213	Chemical Technology Lab	0	0	3	2
7	CY 212	Physical Chemistry Lab	0	0	3	2
8	ME 210 / EE 218	Mechanical and Electrical Engineering Lab	0	0	3	2
TOTAL			**20**	**0**	**9**	**21**

II – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P/D**	**Credits**
1	MT 221	Complex Variables and Probability Statistics	4	0	0	3
2	CH 221	Fluid Mechanics	4	0	0	3
3	CH 222	Chemical Engineering Thermodynamics - I	4	0	0	3
4	CH 223	Mechanical Unit Operations	4	0	0	3
5	CH 224	Chemical Reaction Engineering - I	4	0	0	3
6	CH 225	Material Science for Chemical Engineers	4	0	0	3
PRACTICALS						
7	CH 226	Mechanical Unit Operations Lab	0	0	3	2
8	CH 227	Fluid Mechanics Lab	0	0	3	2
TOTAL			**24**	**0**	**6**	**22**

MT 211

FOURIER ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS
(common for all branches except Biotech)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:
1. Introduce the concepts of Fourier analysis & z-transforms in engineering applications.
2. Introduction of boundary value problems and their applications in Heat Transfer and wave propagation.

Course Outcomes:
1. Students must be able to apply mathematical concepts of Fourier series, Fourier Transforms in solving one dimensional wave equation, Heat equation and the two dimensional Laplace equations.

UNIT– I
Fourier Series
Dirichlet's conditions - expansion of a given function in Fourier series. Expansion of even and odd functions in Fourier series. Change of interval, half range sine and cosine series. Complex form of Fourier series

UNIT– II
Fourier Transforms
Fourier integral (statement only)-Fourier transform, Inverse Fourier transform, Fourier sine and cosine transform, definitions and properties.

UNIT– III
Partial Differential Equations
Formation of Partial differential equations by elimination of arbitrary constants and by elimination of arbitrary functions. Partial differential equations of First Order- Lagrange's Linear equation and its solution. Partial differential equations of First order but of any degree-Standard types: I- $f(p,q)=0$, $II-f(z,p,q)=0$, III- $f(x,p)=f(y,q)$ and IV- $z=px+qy+f(p,q)$ .General Method of solution: Two independent variables - Char pit's Method; three or more independent variables - Jacobi's method.

UNIT– IV
Applications of Partial Differential Equations
Solutions of Partial differential equations by the method of separation of variables- boundary value problems. One dimensional Wave equation, one dimensional Heat equation- related problems. Laplace equation

UNIT – V
Z- Transforms
Introduction, Basic theory of Z-transforms. Z-transforms of some standard sequences, Existence of z-transform. Properties of z-transforms: Linearity, Translation, scaling properties. Initial and final vale theorems. Differentiation of Z-transforms, convolution theorem, Solution of difference equations using Z-transforms.

Text Books:
1. Kanti B Datta "Mathematical Methods of Science and Engineering (Aided with MATLAB)" CENGAGE Learning
2. B.S.Grewal "Higher Engineering Mathematics", Khanna Publishers 42nd Edition, 2013
3. M.D.Raisinghania , Text Book of ODE and PDE , S Chand Publishers 4th Edition, 2012

CH 211

CHEMICAL TECHNOLOGY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Introduction to Chemical Industry
2. Application of unit operations and processes in manufacturing inorganic chemical products
3. Understanding qualitative/ quantitative flow diagrams in converting raw material to finished product
4. Evaluating process limitations and optimizing Raw materials / utilities consumption

Course Outcomes:

1. Students will be able to identify the various unit operations and processes involved in different chemical industries
2. Students will be in a position to know the process technology to achieve the finished product.

UNIT – I

Classification of Indian Chemical Industry, Introduction to unit operations and unit processes. Metallurgical Industry overview – classification of metals, manufacturing of pig Iron by blast furnace, methods of steel making – steel alloys.
Manufacturing of copper & types of copper alloys
Manufacturing of Aluminum & types of alloys
Manufacturing of graphite and its applications

UNIT – II

Manufacturing of H_2 by steam reforming of hydro carbons. NH_3 Synthesis - methods and manufacturing. Urea manufacturing by total recycle. Manufacturing of Diammonium Phosphate. Manufacturing of Triple super Phosphate, Mixed and Bio Fertilizers

UNTI – III

Ceramic industry overview, ceramic raw materials manufacturing of porcelain ware. Manufacturing of refractory's & 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, PVC, PVA,
Synthetic fibers Manufacturing of Nylon–6-6, Polyester Fiber
Classification of rubbers and Manufacturing of SBR

UNIT V

Pulp and Paper Industry: Methods of pulping production. Recovery of chemicals from black liquor. Production of paper.
Oils, Soaps, 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

Text Books:

1. Charles E.Dryden , Outlines of Chemical Technology, Willy Eastern 2001
2. Shreve, Chemical Process Industries – IV Edition, Tata Mc Graw Hill

Suggested Reading:

1. Hand Book of Fertilizer Technology, Indian Journal of Fertilizers

CH 212

MATERIAL AND ENERGY BALANCES

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Students will learn the fundamental aspects of Chemical engineering problem solving.
2. Teaching of the subject will provide the foundation for subsequent courses in Chemical engineering.
3. Students will be familiar with data which will be useful later in the course.

Course Outcomes:

1. Students will be adapted to deal with the complex material and energy balances of the Operations in the industry.
2. Students will be able to identify the losses in gas, liquid and solid effluents in industries and solve the pollution problem.
3. The subject will be helpful in the final year project work.

UNIT – I

Basic concepts - Mass and volume relations, Stoichiometric and composition relations - Ideal gas law, partial pressure - Vapor pressures of pure components, Raoult's law and Henry's law, Vapor pressure of miscible and immiscible liquids and solutions, p-x-y and t-x-y diagrams for ideal solutions.

UNIT – II

Material Balance Without Chemical Reaction

Psychometry – Solubility and crystallization (single solute systems) – Material balance in Unit Operations like absorption, distillation, evaporation, crystallization, leaching, extraction, drying and mixing units under steady state conditions.

UNIT – III

Material Balance With Chemical Reaction

Material balances over units involving reactions including combustion- Proximate and ultimate analysis of coal and ultimate analysis of coal and analysis of flue gas.

UNIT – IV

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

UNIT-V

Energy Balances

Heat capacity, sensible and latent heat – Heat balances in operations involving phase change – Heat balance over heat exchangers, dryers and simple evaporation systems / Heat balances calculation in processes without chemical reaction- Heat of reaction, Heat of formation, Heat of combustion- Heat balance in reactions, Adiabatic reaction, temperature of products-Heating values of fuels.

Text Books:

1. B.I Bhatt and S.B.Thakone, Stoichiometry –5th Ed. Tata Mc.Graw Hill, 2010
2. O.A.Hougen, K.M Watson and R.A Ragatz, Chemical Process Principles, Part – I, 2nd Ed,John Wiley & Sons, 2004

Suggested Reading:

1. David M.Himeldlau & James B Riqqs, Basic Principles and Calculations in Chemical Engineering", 7th Ed, PHI, 2003
2. K.V.Narayanan & B.Lakshmikutty, Stoichiometry & Process calculations, Prentice Hall of India

CY 211

PHYSICAL CHEMISTRY
(Chemical)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To enable student to quantify chemical phenomenon and to understand chemical reactions as sources of energy
2. To realize the industrial importance of chemical processes and optimize the processes to make it industrially viable
3. To control speed of chemical process and introduce to instruments in structure elucidation of chemical compounds

Course Outcomes:

1. Efficient management of industrial processes
2. Discovers new processes and creates newer materials
3. Devise instruments for studying the structure of chemical compounds

UNIT – I

Electrochemistry: Fugacity and activity, chemical potential and its criterion for spontaneity and equilibrium. Conductance of electrolytes, laws of electrolysis and its applications, specific and equivalent conductances and their determinations, kohlrausch's law and its applications, transport number and its determination, the interionic attraction theory.

UNIT – II

Electromotive Force: Electromotive force and its determination by Pogendorf's compensation method, reversible and irreversible cells, various types of electrodes, cell notation, cell reactions, standard electrode potentials, electrochemical series and its applications, derivation of Nernst equation, numericals, fuel cells, chemical concentration cells with and without transference, over voltage and polarization.

UNIT – III

Dilute Solutions: Colligative properties, Raoult's law, lowering of vapour pressure, elevation of boiling point, depression of freezing point and osmotic pressure. Experimental methods for determination of each of colligative properties, van'thoff theory of dilute solutions- abnormal colligative properties, determination of degree of dissociation of weak electrolytes.

UNIT – IV

Chemical Kinetics: The scope of chemical kinetics, rate, rate laws, order and molecularity, determinations of order, derivation of rate laws, Arrhenius equations, determination of activation energy of reaction. Theories of reaction rates, collision theory, transition state theory, determination of activation parameters of chemical reaction, mechanisms of reactions. General principles of homogeneous and heterogeneous catalysis, mechanism of homogeneous acid base catalysis.

UNIT – V

Physical Properties And Molecular Structures: Molar polarisation, dipole moment and its determination and applications, rotational spectrum, vibrational-rotational spectrum, applications of I.R. spectrum, Raman spectrum.

Text Books:

1. Physical Chemistry by G.M.Barrow, McGraw Hill (2008)
2. Principles of Physical Chemistry by Puri, Sharma and Pathania (2013)
3. A text book of Physical Chemistry by K.L.Kapoor, volume 1, 2, 3 & 4 Macmillan (2001)
4. Principles of Physical chemistry by Prutton and Maron, Oxford & IBH Publishing company, New Delhi. (2012)

Suggested Reading:

1. P.W.Alkies, Physical Chemistry (3rd Ed.), Oxford University Press, (2012)
2. Physical Chemistry by W.J.More, Prentice Hall. (2012)
3. Problems in Physical Chemistry by T. Navneeth Rao and others Mac Millan

ME 219 / EE 216

BASICS OF MECHANICAL AND ELECTRICAL ENGINEERING
(Chemical)

MECHANICAL ENGINEERING

Instruction	2L Periods per week
Duration of University Examination	1 ½ Hours
University Examination	38 Marks
Sessionals	12 Marks
Credits	1.5

Course Objectives:

1. The students will understand the basic principles related to the behavior of engineering materials.
2. The students will learn the significance of different types of stresses and strains.
3. The students will be introduced to the concept of shafts and how power is transmitted through belts.
4. The students will be introduced to the different types of boilers used in the field of engineering.

Course Outcomes:

1. The learning outcomes are assessed through mid sessionals, assignments and final exam.
2. This course is a pre-requisite for design of process equipment.
3. This course helps to design shafts and thin cylinders.
4. The course is helpful for understanding the working principle of fire tube and water tube boilers.

UNIT – I

Stresses and Strains: Kinds of stress–strains, elasticity and plasticity, Hooks law, stress – strain diagram, modules of elasticity, Poisson's ratio, linear and volumetric strain, relation between Young modulus, Bulk modulus and Rigidity modulus, bars of uniform strength. Compound bars and temperature stresses.

UNIT – II

Thin Cylindrical Shells: Stress in cylindrical shells due to internal pressures, circumferential stress, longitudinal stress, design of thin cylindrical shells, spherical Shells, change in dimension of the shell due to internal pressure, change in volume of the shell due to internal pressure.

Shafts: Torsional stress and strains, strength of a solid shaft, power transmitted by shaft strength of a hollow shaft.

UNIT – III

Steam Boilers: Classification of boilers, Cochran boiler, Locomotive boiler, Lancashire boiler, Babcock and Wilcox boiler, boiler mountings and accessories. Working principle of four-stroke diesel / petrol engines.

Belts: Velocity ratios, slip, length of belt, open belt and cross belt drives. Ratio of tensions, centrifugal tension in belt, power transmitted by bells, initial tensions in the belt and simple problems.

Text Books:

1. S Ramamrutham, Strength of Materials, Dhanpath and Sons, 10th Edition, 2005
2. S.S Rattan, Theory of Machines, Tata McGraw Hill Publishers, 2009
3. Mahesh M Rathor, Thermal Engineering, Tata McGraw Hill Publishers, 2013

Suggested Reading:

1. S.S. Rattan, Strength of Materials, Tata McGraw Hill Education, 2011
2. Thomas Bevan, Theory of Machines, CBS Publishers, 2009
3. A.S. Sarao, Thermal Engineering, Satya Prakasham, 5th Edition, 2005

ME 219 / EE 216

BASICS OF MECHANICAL AND ELECTRICAL ENGINEERING [continued]
(Chemical)

ELECTRICAL AND ELECTRONICS ENGINEERING

Instruction	2L Periods per week
Duration of University Examination	1 ½ Hours
University Examination	37 Marks
Sessionals	13 Marks
Credits	1.5

Course Objectives:

1. To know the fundamentals of DC, AC circuits and AC machines.
2. To understand the concepts basic electronic devices.

Course Outcomes: The student will be able to:

1. Comprehend DC circuits & AC machines in respect of concepts and applications
2. Identify the characteristics of diode and transistor.

UNIT – I

D.C. Circuits: Kirchhoff's laws, Mesh current and node voltage analysis. Electromagnetic induction: Faraday's law, Direction of emf and current. Energy stored in a magnetic field, Hysteresis and eddy current losses.
AC circuits: generation of alternating voltage and currents, Average and rms value of sinusoidal quantities.

UNIT – II

Single Phase Transformer: Constructional details, Working principle, EMF equation, practical transformers. Equivalent circuits, voltage regulation, losses and efficiency, open circuit and short circuit test.
Three Phase Induction Motors: construction, principle, advantage and disadvantages, working principle. Torque – slip characteristics, losses and efficiency.

UNIT – III

Electronic Devices and Circuits: P-N junction, semiconductor diode, characteristics of diode, diode as rectifier, half wave & full wave rectifiers, bridge rectifier, filter circuits.
Transistor: construction, action, symbols, as an amplifier in CE arrangement, characteristics of common base connection.

Text Books:

1. Principles of Electrical Engineering and Electronics by V.K.Mehta

Suggested Reading:

1. Electrical Technology, B.L.Teraja, A.K Teraja, S.Chand & Co.

CH 213

CHEMICAL TECHNOLOGY LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

Cycle – I

1. Analysis of Iron Ore
2. Analysis of Copper Ore
3. Estimation of Borax
4. Estimation of carbonates and Bicarbonates ions
5. Estimation of Dissolved Oxygen in Water
6. Estimation of Chlorine in Water Sample
7. Estimation of Calcium Ions in Natural Water

Cycle – II

1. Estimation of Urea
2. Estimation of Acid Value of oils
3. Estimation of Formaldehyde in formalin solution
4. Estimation of Glucose
5. Preparation of Nitro benzene
6. Preparation of Meta-dinitro benzene
7. Preparation of Acetanilide

Note: Minimum **of 8** experiments in the list is to be performed selecting at least **4 from each cycle**.

CY 212

PHYSICAL CHEMISTRY LAB
(Chemical)

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives: To give hands on experience in application of theoretical concepts in experimentation

Course Outcomes: Gains ability in handling experiments and creating new experiments

List of Experiments:

1. Determination of molecular state of Acetic acid by studying the distribution of acetic acid between n-butanol and water
2. Determination of molecular state of benzoic acid by studying the distribution of benzoic acid between benzene and water
3. Determination of order of the reaction of hydrolysis of methyl acetate in dilute hydrochloric acid
4. Determination of order of the reaction between potassium persulphate and potassium iodide
5. Conductometric titration of strong acid vs. strong base and weak acid vs. strong base
6. Conductometric titration of mixture of acids vs. strong base
7. Verification of Beer-Lambert's Law and determination of concentration of Potassium dichromate OR Potassium permanganate
8. Titration of HCl against NaOH using P^H-meter
9. Potentiometric redox titration between Fe^{2+} and $K_2Cr_2O_7$
10. Kinetics of inversion of sucrose by polarimeter

Text Books:

1. Senior practical physical chemistry by B.D.Khosla, V.C.Garg and AdarshKhosla., R.Chand& company, New Delhi
2. Laboratory manual in engineering chemistry by S.K.Bhasin and Sudha Rani., Dhanpathrai Publishing Company

Suggested Books:

1. Vogel's text book of quantitative chemical analysis by J.Mendham and Thomas, Pearson Education Pvt. Ltd. New Delhi, 6^{th} edition, 2002

Note: Minimum **of 8** experiments to be performed.

ME 210 / EE 218

MECHANICAL AND ELECTRICAL ENGINEERING LAB
(Chemical)

I. MECHANICAL ENGINEERING LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	25 Marks
Sessionals	13 Marks
Credits	1

Course Objectives:

1. Students will acquire basic knowledge in determining the properties of materials like modulus of elasticity and modulus of rigidity
2. Student is exposed to the concept of determination of various hardness of material
3. Student can evaluate the performance of four-stroke diesel/petrol engine with varied engine parameters
4. Student can understand the working principle of fire tube and water tube boilers

Course Outcomes:

1. Student can estimate the strength of materials from the knowledge of mechanics of materials.
2. Student can demonstrate knowledge in evaluating mechanical properties of material by determining the hardness of the material.
3. Student can estimate the power and thermal efficiency developed by an IC engine
4. The knowledge about fire tube boiler and water tube boiler is useful for power plants and pressure vessel industry.

List of the Experiments

Note: Minimum **of FOUR** experiments should be conducted in the semester selecting **at least TWO from each cycle**

Cycle-1:

1. Determination of Modulus of Elasticity (E) and salient point on stress – strain curve of given material by direct tension on universal Testing Machine (UTM)
2. Determination of rigidity modulus of a shaft by torsion test
3. Brinell's hardness Test of material
4. Determination of rigidity modulus of a leaf spring
5. Determination of the Compressive strength of bricks on compression testing Machine/.

Cycle-2:

1. To evaluate the performance of four-stroke single cylinder Diesel Engine.
2. Study of Boiler – Cochran boiler, Lancashire boiler, Wilcox boiler
3. To conduct heat balance on four-Stroke single cylinder Diesel Engine.
4. Determination of the valve time diagram for a four-Stroke Vertical Diesel Engine

Text Books:

1. S.Ramamrutham, *Strength of Materials*, Dhanpath and Sons, 10th Edition, 2005
2. S.S Rattan, *Theory of Machines*, Tata McGraw Hill Publishers, 2009
3. Mahesh M Rathor, *Thermal Engineering*, Tata McGraw Hill Publishers, 2013

Suggested Reading:

1. S.S. Rattan, *Strength of Materials*, Tata McGraw Hill Education, 2011
2. Thomas Bevan, *Theory of Machines*, CBS Publishers, 2009.
3. A.S. Sarao, *Thermal Engineering*, Satya Prakasham, 5th Edition, 2005

II. ELECTRICAL ENGINEERING LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	25 Marks
Sessionals	12 Marks
Credits	1

List of Experiments:

1. Verification of Ohm's law
2. Verification of KVL & KCL
3. Verification of Voltage and current division rules
4. Power factor measurement of and R-L series circuits
5. Calibration of single phase energy meter
6. Brake test on induction motor
7. Open circuit & short circuit tests on single phase transformer
8. Static characteristics of junction diode
9. Static characteristics of a common base transistor circuit
10. Static characteristics of common emitter transistor circuit

Note: At least **four** Experiments should be conducted in the semester

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
CHEMICAL ENGINEERING
B. Tech. II – Year

II – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P/D**	**Credits**
1	MT 221	Complex Variables and Probability Statistics	4	0	0	3
2	CH 221	Fluid Mechanics	4	0	0	3
3	CH 222	Chemical Engineering Thermodynamics - I	4	0	0	3
4	CH 223	Mechanical Unit Operations	4	0	0	3
5	CH 224	Chemical Reaction Engineering - I	4	0	0	3
6	CH 225	Material Science for Chemical Engineers	4	0	0	3
PRACTICALS						
7	CH 226	Mechanical Unit Operations Lab	0	0	3	2
8	CH 227	Fluid Mechanics Lab	0	0	3	2
TOTAL			**24**	**0**	**6**	**22**

MT 221

COMPLEX VARIABLES AND PROBABILITY STATISTICS
(common to all branches, except ECE & Biotech)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 marks
Sessionals	25 Marks
Credits	3

Course Objectives:
1. Extension of Laplace transforms in solving the Integral equations
2. Introduction of the Concept of analyticity of complex functions and contour Integrations and conformal Mapping.
3. Introduction of Basic Probability, Probability distributions and sampling theory.

Course Outcomes:
1. Students must be able to apply the concepts learned in potential Theory, electromagnetic theory.
2. Students must realize the Probability & Statistics and its wide applications in various Branches of Engineering and science. Students must be able to analyze the Random phenomena of any Physical system.

UNIT-I

Applications of Laplace transforms to Integral equations:

Laplace transforms of special functions-Bessel function and error functions. Definitions of Integral transforms, kernel of the transform. Solution of Integral equations; Abel's integral equation, Integral equation of the convolution type and Integro-differential equations. Solutions of partial differential equations- Boundary value problems.

UNIT- II

Complex Variables:

Analytic function, Cauchy Riemann equations (Cartesian and polar forms) - construction of Analytic functions. Harmonic function, derivatives of Analytic functions.

Complex line integrals, Cauchy's Integral theorem, Cauchy's Integral formula and its derivatives and problems related to the above theorems.

UNIT-III

Complex Variables:

Taylor's and Laurent's expansions-zeros, types of singularities and residues. Cauchy's Residue theorem. Evaluation of real definite integrals by Cauchy's residue theorem.

Elementary transformations and conformal Mapping.

UNIT-IV

Statistics and Basic Probability

Correlation -Correlation coefficient between two variables, Rank correlation and Regression- lines, random variables, distributions-probability mass function and probability density function. Conditional distributions-Bayes' Theorem-Mathematical expectation-expected values- moments and moment generating function- Characteristic function.

UNIT-V

Probability Distributions: Binomial, Poisson, and Uniform (rectangular), Normal, exponential, Gamma and Beta distributions. Test of hypothesis using Chi-square test for goodness of fit, t-test, F-test.

Text Books:

1. Mathematical Methods of Science and Engineering (Aided with MATLAB) By KantiB.Datta CENGAGE Learning.
2. Fundamentals of Mathematical Statistics by Gupta and Kapoor
3. Higher Engineering Mathematics by B.S.Grewal

CH 221

FLUID MECHANICS

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To understand the fluid flow phenomena for incompressible and compressible fluids
2. To provide conservation of momentum principles to fluid flow
3. To provide an understanding about flow past immersed bodies
4. To understand the fluidization phenomena and to steady the methods for transporting the fluids

Course Outcomes:

1. The student will be able to design the piping for flow of gases and liquids under different conditions useful for industry
2. The student will be able to apply the phenomena of fluidization applications in petroleum, chemical and allied industries
3. The student will be in a position to decide the type and nature of pump to be used for different fluids under different conditions such as toxic, acidic, slurry etc

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

UNIT – II Basic Equations of Fluid Flow: path lines, stream lines and stream tube, Mass balance –equation of continuity, one dimensional flow, mass velocity, differential momentum balance- equations of motion, coquette 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 & 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, Mody's friction factor chart. Pipes and valves, fittings. Friction losses due to sudden expansion and contraction, Effects of fittings and valves, form frictional losses in the Bernoulli Equation. Dimensional analysis and Buckingham π-theorem and Rayleigh theorem– its applications and limitations.

UNIT – IV Compressible Fluids and Non Newtonian fluids (with Differential Pressure estimation) Flow past immersed bodies and Fluidization: Motion of particles through fluids – Free settling and hindered settling, Drag and drag coefficient, Flow through packed beds of solids – Kozeny-Carman equation, Burke-Plummer equation and Ergun equation. Fluidization and conditions for fluidization, Minimum fluidization velocity, particulate and bubbling fluidizations, Expansion of fluidized beds, Applications of fluidization.

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

Text Books:

1. Warren L. Mc Cabe, Julian C. Smith and Peter Harriott , Unit Operations of Chemical Engineering , 7th Edition, McGraw Hill International Edition , 2005

Suggested Reading:

1. C.J.Geankopolis ,Transport process and unit operations , PHI New Delhi., 2004
2. James O. Wilkes, **Fluid** Mechanics for Chemical Engineers with Microfluidics and CFD, 2/E ,University of Michigan, Prentice Hall Int., 2006

CH 222

CHEMICAL ENGINEERING THERMODYNAMICS – I

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: Engineering thermodynamics gives the fundamental approach to a process using first law of Thermodynamics for fluids used in chemical industries. The importance of second law of Thermodynamics, its advantages over first law and its Principle, Introduction of Entropy applications gives about availability and efficiency of second law. Concepts of refrigeration give knowledge on refrigeration aspects in chemical industries.

Course Outcomes: This subject serves as a basis for understanding chemical reaction engineering, Mass Transfer operations etc. The student gets knowledge in thermodynamic properties of fluids, principles of entropy, heat engines and the energy balances in different flow processes.

UNIT – I

The first law of the thermodynamics- system, surroundings, property, energy, thermodynamic equilibrium, stability of equilibrium states, criterion for stability of equilibrium states, process, work, modes of work, heat, Zeroth law of thermodynamics.

UNIT – II

Joule's Experiments, reversible process, irreversible process, constant volume and constant pressure processes, equation of states (Vanderwall, RK,Peng Robinson). Thermodynamic properties of fluids: - pure fluids, Concept of phase, graphical representation of PVT data, compressibility charts. First law analysis of processes: control mass analysis, control volume analysis, limitations of first law of the thermodynamics.

UNIT – III

Second law of the thermodynamics; definition & necessity, heat engine, Carnot cycle, Carnot Principle, Rankine Cycle, Clausius inequality, Entropy; calculation of entropy change, principles of entropy increase, Temp- Entropy diagram, second law analysis of a control volume.

UNIT – IV

Availability & Refrigeration: Available energy, loss in available energy, availability function, irreversibility, second law efficiency, Refrigeration- liquefaction; COP, vapor-compression cycle, comparison of refrigeration cycles, heat pump, various processes for liquefaction.

UNIT – V

Thermodynamic flow Processes: Energy balances for steady state flow process; adiabatic and isothermal flow of compressible fluids through pipes of constant cross section with and without friction; expansion process involving flow through nozzles and turbines; throttling process calculations for real fluids; thermodynamics of compression process for compressible and incompressible fluids; compressors and pumps; calculation of ideal work and lost work for flow processes.

Text Books:

1. Y V C Rao, An Introduction to Thermodynamics ,New Age International (P) Ltd.Revised Edition

Suggested Reading:

1. J M Smith and H.C Van Ness, Introduction to Chemical Engineering Thermodynamics, McGraw Hill Book Company
2. J C Smith, Unit Operations of Chemical Engineering, Mc Graw Hill

CH 223

MECHANICAL UNIT OPERATIONS

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To study the principles of size reduction using various equipments
2. To know the techniques of separating solids based on size by different methods
3. To study the different kinds of filtration units
4. To study the various aspects of Mixing and Agitation of solids and liquids.

Course Outcomes: The student will be able to:

1. Decide the usage of equipment for industrial application with respect to size reduction.
2. Decide the necessary equipment to screen different particles
3. Apply the knowledge of different blends and mixing techniques to liquids and solids.

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

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

Text Books:

1. W.L.McCabe, J.C.Smith and P.Harriot, Unit Operations of Chemical Engineering 5th Edn., McGraw Hill Chem. Engg.Book Co. Series, 1993

Suggested Reading:

1. Coulson & Richardson's. Chemical Engg Vol. 2 Pergamon Press Oxford, 1962, 4th Edition.
2. Foust A.S, Wenzel L.A., Clump, C.W. Maks and Andersen L.B. Principles of Unit Operations Wiley NewYork
3. C M Narayanan and B C Bahattacharya, Mechanical Unit Operation for Chemical Engineers Khanna Publishers, 3rd Ed, 1999

CH 224

CHEMICAL REACTION ENGINEERING – I

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Analyze experimental kinetic data to determine reaction mechanisms.
2. Design different types of chemical reactors (Batch, Tube, and CSTR).
3. Assess the advantages and disadvantages of reactor types.
4. To understand the concepts of non ideal reactors

Course Outcomes:

1. Ability to analyze chemical reactors and reaction systems
2. Designing experiments involving chemical reactors, and analyzing and interpreting data
3. Design and sizing of industrial scale reactor on the basis of kinetic data obtained at lab scale

UNIT – I

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

UNIT – II

Interpretation of Batch Reactor Data: Constant volume batch reactor: Analysis of total pressure data, conversion. Integral method of Analysis of data for single reaction, multiple reactions, Homogeneous catalyzed reactions, Auto catalytic reactions, Reversible reactions, and Reactions of shifting orders. Half life method, Partial analysis of the rate equation. Differential method of analysis of data. **Variable Volume Batch Reactor:** Fractional change in volume of the system, Differential method of analysis, Integral method of analysis.

UNIT – III

Introduction to Reactor Design, Ideal Reactors for a Single Reaction: Ideal batch reactor, Space time – space velocity, Steady state mixed flow reactor, Steady state plug flow reactor, Holding time and space time for flow reactors. Design for single reactions, Size comparison of single reactors, Multiple reactor systems, Recycle reactor, Auto catalytic reactions – optimum recycle operation, Reactor combinations.

UNIT – IV

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

UNIT – V

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

Text Books:

1. Octave Levenspiel, Chemical reaction Engineering, 3rd Ed, Wiley India Pvt.Ltd, New Delhi, 2006.

Suggested Reading:

1. J.M. Smith, Chemical Engineering Kinetics, Mc Graw – Hill , Third Edition, 1981
2. H.Scott Fogler, Elements of Chemical Reaction Engineering, Prentice Hall, Third Edition, 2002.

CH 225

MATERIAL SCIENCE FOR CHEMICAL ENGINEERS

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. Students will understand the criteria involved in identifying materials for chemical engineers.
2. Students will learn the significance of different properties required for selecting types of material under different combinations of process conditions.
3. The students will be introduced to the concept of phase-transformations that occur during material manufacture and vis-à-vis the effect of material properties.
4. The students will learn possible and latest alternatives available for standard engineering materials.

Course Outcomes:

5. The learning outcomes are assessed through mid semester sessionals, quiz, and final exam.
6. This course is an opportunity to apply the basic fundamentals of physics, chemistry and basics of mechanical engineering acquired in previous subjects in order to understand material selection and properties.
7. This course is a prerequisite for the subject: process equipment design that will be offered during the later years of the course where selecting the right materials for design and fabrication of process and non-process equipment required in the field of chemical engineering is demanded.
8. The course is helpful for identifying new or alternate materials required during operation and development of existing process industry.

UNIT – I Introduction to Engineering Materials: Classification – metals, non-metals, alloys; Introduction to metallic materials: Ferrous metals and alloys – Iron and steel, types of steels like mild steel, carbon steel and stainless steel, Common grades of steel (304, 316); Non-Ferrous metals and alloys of Aluminum, Copper and Nickel; Introduction to non-metallic materials: Polymers, Ceramics, Refractories and Composites; Criteria for material selection.

UNIT – II Phase Diagrams: Phase rule, Definition and construction of phase diagrams, Basic types of binary phase diagrams: Cu-Au, Al-Si, Al-Cu, Mg-Sn, Cu-Zn. Iron-Iron carbide equilibrium diagram. Applications of Phase Equilibrium Diagrams: Time–Temperature–Transformation (T-T-T) relations of steels, Zone refining, Heat treatment of steels.

UNIT – III General Properties of Engineering Materials

Mechanical Properties: Stress-strain diagram, Elastic, Plastic, Anelastic and Viscoelastic behavior, Hardness, testing, Deformation – hot and cold working, 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 fibers. Magnetic Behavior: Magnetism, Susceptibility, Anisotropy and Hysteresis, Ferro-, Para- and Dia-magnetism, soft and hard magnetic materials.

UNIT – IV Materials for High and Low Temperature Applications

Ceramics and Refractories – Classification, advantages, general properties and engineering applications. Introduction to Superalloys. Electrical Materials – Different types like conductors, semiconductors and superconductors; general properties and engineering applications. Polymers and Elastomers – Classification, advantages, general properties and engineering applications.

UNIT–V New Materials: Composite materials - Classification, advantages over alloys, general properties and applications. Nano-materials: Introduction, Carbon nanotubes, Nanosensors. Biomaterials: Need of ceramics, Interaction with bioenvironment, Biocompatibility, Types of biomaterials- Nearly inert ceramics, surface active ceramics, resorbable ceramics.

Text Books:

1. A Textbook of Material Science and Engineering, R.K.Rajput, 2nd ed., S.K.Kataria and Sons, 2002
2. Engineering Materials, A.K.Bhargava, 2nd ed., PHI learning pvt. Ltd., 2012.

Suggested Reading:

1. Materials Science and Engineering-An Introduction, Callister W.D, 5th ed, John Wiley & Sons. Inc., 2002
2. Material Science, Dr. M. Armugam, 3rd ed., Anuradha Publications, Chennai, 2002
3. Elements of Materials Science and Engineering - A First Course, V Raghavan, 5th Ed, PHI learning pvt. Ltd., 2006

CH 226

MECHANICAL UNIT OPERATIONS LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. Verification of crushing laws with the actual power ratio using hammer mill
2. Verification of the communition laws and critical speed of a ball mill
3. Calculation of the effectiveness of screen in horizontal and inclined position (vibrating screens)
4. Verification of the laws of size reduction using Rod mill or jaw crusher
5. Verification of the stokes law range and study the characteristics of different particles in single medium
6. Determination of the specific cake resistance and medium resistance in a vacuum filter or plate and frame filter press.
7. Study of the sedimentation characteristics of a thickener and design of a continuous thickener
8. Determination of specific cake resistance and medium resistance of leaf filler
9. Determination of the froth flotation characteristics in mineral concentration
10. Determination of the settling rates of particles in hydro cylcones
11. Determination of separation factors of air and hydraulic classifiers
12. Analysis of various sizes of given material by sieve analysis and determination of cumulative and differential analysis
13. Verification of the laws of crushing using drop weight crusher and determination of work index
14. Determination of the size distribution of a given powder sample by air elutriation method.
15. Study of hindered settling and sedimentation characteristics of solids in liquid suspension
16. Determination of thickener cross sectional area using kynch theory
17. Determination of laws of crushing of a given sample in a pulveriser

Note: Minimum **of 8** experiments to be performed.

CH 227

FLUID MECHANICS LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. Determination of discharge coefficient for orifice meter and venturimeter and their variation with Reynolds number
2. a) Determination of weir meter constant K for v-notch and rectangular notch
   b) Calibration of rotameter and study of variation of flow rate with tube to float diameter.
3. Determination of viscosity of Glycerol – water solution at different temperatures
4. Determination of friction factor for flow of water through annulus using Fanning's and Darcy's equations.
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 clearance volume and efficiency of an air compressor
8. Determination of characteristic curves for centrifugal pumps
9. a) Determination of friction factor for packed beds
   b) Determination of minimum fluidization of velocity
10. Determination of pressure drop through helical coils
11. Determination of velocity profile of air in pipe by pitot tube
12. Determination of critical velocity by Reynolds Experiments

Note: Minimum **of 8** experiments to be performed

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
CHEMICAL ENGINEERING
B.Tech III – Year

I – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	CH 311	Chemical Reaction Engineering – II	4	0	0	3
2	CH 312	Mass Transfer Operations – I	4	0	0	3
3	CH 313	Process Dynamics and Control	4	0	0	3
4	CH 314	Process Heat Transfer	4	0	0	3
5	CH 315	Process Instrumentation	4	0	0	3
6	CE 444	Human Values and Professional Ethics	2*	0	0	0
PRACTICALS						
7	CH 316	Chemical Reaction Engineering Lab	0	0	3	2
8	CH 317	Process Heat Transfer Lab	0	0	3	2
9	EG 221	Soft Skills and Employability Enhancement	0	0	2	1
TOTAL			**22**	**00**	**08**	**20**

L: Lecture, T: Tutorial, D: Drawing, P: Practical
* 21 periods per semester

II – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	CH 321	Bio Chemical Engineering	4	0	0	3
2	CH 322	Chemical Engineering Thermodynamics - II	4	0	0	3
3	CH 323	Energy Engineering	4	0	0	3
4	CH 324	Process Modeling Simulation and Optimization	4	0	0	3
5	CH 351 CH 352	**Elective – I** Surface Coatings Technology Technology of Vegetable oils and Fats	4	0	0	3
PRACTICALS						
6	CH 325	Process Dynamics and Control Lab	0	0	3	2
7	CH 326	Process Modeling Simulation And Optimization Lab	0	0	3	2
8	CH 355 CH 356	**Elective - I Lab** Surface Coatings Technology Lab Technology of Vegetable Oils and Fats Lab	0	0	3	2
9		Industrial Visit	0	0	0	0
TOTAL			**20**	**00**	**09**	**21**

CH 311

CHEMICAL REACTION ENGINEERING – II

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To understand various models in non-ideal reactors
2. Develop rate laws for reactor design based on reaction data from a reactor or set of reactors in heterogeneous systems.
3. Predict reactor performance in situations where the observed reaction rate is significantly influenced by internal mass transfer in porous heterogeneous catalysis

Course Outcomes:

1. Should be able to predict conversions in non-ideal reactors using various models.
2. Describe the steps in a catalytic mechanism and to derive a rate law, mechanism, and rate-limiting step that are consistent with experimental data.

UNIT - I

Analysis of Non ideal Reactors - Basic concepts. Compartment models - hints, suggestions and possible applications. Dispersion number from C and F curves, Conversion using dispersion and tanks in series models for the first order irreversible reaction

UNIT - II

Solid Catalysts - Adsorption, adsorption isotherms, surface area, void volume and solid density, pore volume distribution. Theories of heterogeneous catalysis, classification of catalysts, catalyst preparation, promoters and inhibitors.(to the extent covered in J.M. Smith only)

UNIT - III

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

UNIT - IV

Catalyst deactivation- Mechanisms of catalyst deactivation, the rate and performance equations: The rate equation from experiment, determining the rate for batch solid in contact with fluid in batch, mixed flow and plug flow modes for independent deactivation. Effect of pore diffusion resistance.

UNIT - V

Kinetics of fluid - fluid reactions. The rate equation for straight mass transfer of A (absorption). The general rate equation and the rate equation for reaction with mass transfer.

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

Text Books:

1. Octave Levenspiel,"Chemical Reaction Engineering", John Wiley & Sons - Third edition , 1999
2. J.M.Smith, "Chemical Engineering kinetics",McGraw - Hill, Third Edition , 1981

Suggested Reading:

1. H.ScottFogler," Elements of Chemical reaction Engineering", Prentice - Hall, Fourth edition , 2005

CH 312

MASS TRANSFER OPERATIONS – I

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand
1. The rate equations, Mass transfer coefficients, Interphase Mass transfer
2. Various unit operations viz., absorption, humidification, drying & crystallization.

Course Outcomes: At the end of the course, the students will be able to
1. Write rate equations for any mass transfer operations
2. Design Absorber/Stripper by equilibrium methods
3. Design Cooling towers, dryers and crystallizers.

UNIT - I

Diffusion and Mass Transfer – Mass transfer operations & their applications. Molecular diffusion –Fick's first law – steady state molecular diffusion in binary mixtures of gases, liquids and solids – Determination of diffusivity in gases by Steffan-Maxwell method – estimation of diffusion coefficients in binary mixtures of liquids and gases by correlation.
Eddy diffusion – Basic concepts of mass transfer theories – Film mass transfer coefficients for the cases of equimolar counter diffusion and diffusion of one component (**A**) in stagnant component (**B**) - Correlation's for mass transfer coefficients and Reynolds & Colburn analogies.

UNIT - II

Interphase Mass Transfer – overall mass transfer coefficients – Two resistance theory – Gas phase and liquid phase controlled situations.
Gas – liquid contact: Description of Continuous and stage wise contact equipment, packing for packed columns – Liquid distribution.
Mass transfer coefficients in packed columns, Flooding in packed and plate columns, Ideal stage, Murphree, point and overall column efficiency, Comparison of packed and plate columns.

UNIT - III

Absorption and Stripping: counter current and co-current isobaric absorption and stripping of single component – Operating Lines – Minimum flow rates – Determination of number of plates – absorption factor.
Determination of number of transfer units and height of a continuous contact packed absorbers. Kremser – Brown equation for tray towers and packed towers

UNIT - IV

Humidification: Vapour, gas mixtures – Humidity and relative saturation. Dew point adiabatic saturation and wet bulb temperatures – psychometric charts – Enthalpy of gas vapor mixtures.
Humidification and Dehumidification – Operating lines and design for cooling towers and dehumidifiers. Construction and working of Spray chambers

UNIT - V

Drying: moisture contents of solids – equilibrium, bound and unbound moisture.
Design conditions – Rate of batch drying under constant drying conditions – Mechanism of batch drying – total time for batch drying, Description of batch and continuous dryers.
Crystallization: Principles – primary and secondary nucleation, equipment – construction and working,

Text Books:

1. R.E. Treybal, "Mass Transfer operations", 3rd Edition, McGraw Hill Book Co., 1981

Suggested Reading:

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.

CH 313

PROCESS DYNAMICS AND CONTROL

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: To provide a conceptual and methodological framework to
1. Analyze the transient behavior of simple chemical processes (using mathematical modeling from first principles and Laplace transforms)
2. Feedback control of processes - concepts, terminology, methods, and performance
3. Advanced control strategies with industrial examples.

Course Outcomes: The student will be able to:
1. Characterize and analyze the dynamic behavior of linear systems (1^{st} and 2^{nd} order)
2. Construct block diagrams for simple chemical processes
3. Analyze stability, speed of response, frequency response, of simple feedback control systems
4. Analyze and tune process controllers to achieve desired performance
5. Empirically identify process dynamics

UNIT – I

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

UNIT – II

Response of Second Order Systems: Transient response of under damped, critically damped, over damped systems to step, impulse and sinusoidal forcing functions. Transportation lag

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

UNIT – III

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

UNIT – IV

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

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

UNIT – V

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

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

Control valves: Construction, sizing, Characteristics and valve Positioner

Dynamics and control of Heat Exchangers (Lumped and Distributed parameter systems) and pH Process

Text Books:

1. Donald R. Coughanowr , Steven E LeBlanc, "Process Systems Analysis and Control", 3^{rd} edition, McGraw Hill Inc, 2009

Suggested Reading:

1. George Stephanopoulos , "Chemical Process Control: An Introduction to Theory and Practice", Prentice-Hall of India, 1984
2. Peter Harriott , "Process Control", Tata McGraw Hill Ltd.
3. Seborg, Edgar, Mellichamp& Doyle, "Process Dynamics and Control", 3^{rd} Edition, Wiley India Pvt. Ltd., 2014

CH 314

PROCESS HEAT TRANSFER

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To provide an overall view of different modes of heat transfer applicable to process industries.
2. To analyze an evaporator.
3. To impart the concept and functioning of different heat exchangers.

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

1. Distinguish between different types of heat transfer
2. Find out the rate of heat transfer with and without change of phase.
3. Decide the type of evaporator required for a specific purpose
4. Analyze the concepts of heat exchanger

UNIT - I

Modes of Heat Transfer – derivation of heat conduction equation in rectangular co-ordinates – one dimensional heat conduction without heat generation through plane, cylindrical and spherical walls – Resistance concept - situations involving conduction and convection – critical and optimum insulation thickness – Numerical problems on unsteady heat conduction through semi-infinite slab, infinite slab and cylinder – lumped capacity systems.

UNIT - II

Heat Transfer to Fluids Without Phase Change – forced convection in laminar flow over plates and in tubes – dimensional analysis. Correlations for heat transfer in turbulent flow, natural convection, Agitated vessels, packed beds – Analogy between heat and momentum transfer – Reynolds, Prandtl and Colburn analogies.

UNIT - III

Heat Transfer to Fluids With Phase Change – heat transfer from condensing vapors – Drop wise and Film wise condensation – Derivation and practical uses of Nusselt equation. Boiling of saturated liquid – maximum heat flux and critical temperature drop, minimum flux and film boiling. Typical heat exchange equipment – counter and parallel flows, energy balances, log-mean temperature difference and correction for mixed and cross flow – Rating of single and multiple heat exchangers – Description of extended surface heat exchangers.

UNIT - IV

Evaporators - Types– capacity and economy of evaporators – material and energy balances in evaporation – multiple effect evaporation and methods of feeding – Barometric leg, steam traps – heat transfer coefficients in evaporators – Description and working of crystallizers

UNIT - V

Radiation - Fundamentals of radiation heat transfer, laws of black body radiation, radiating heat exchange between non-black surfaces, combined heat transfer by conduction, convection and radiation, radiation shields

Text Books:

1. W.L.McCabe, ,J.C. Smith and P. Harriot, "Unit Operations Of Chemical Engineering", 7thEdition, Mc-Graw Hill, 2005

Suggested Reading:

1. Donald Q.Kern, "Process Heat Transfer", MGH publishers 1st Edition, 2001
2. J.P .Hollman, "Heat Transfer", 10th edition MGH publishers, 2011
3. J. Coulson and R.S Richardson, "Fluid Flow, Heat and Mass Transfer", Volume 1, 6th Edition , Pergoman Press, 2009
4. B.K.Dutta, "Heat Transfer Principles and applications", PHI publishers, 2004

CH 315

PROCESS INSTRUMENTATION

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To give fundamental concepts about different instruments in chemical process industries.
2. Detailed study of instruments and their applications that leads to safety of employee and industry.

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

1. Understand he working mechanism of important instruments used in process industry.
2. Learn the applications of various instruments in the required fields.

UNIT - I

Introduction: Importance of instrumentation, applications & their significance in chemical process industries

Instruments for analysis: Recording instruments, indicating and signaling instruments, instrumentation diagram.

Qualities of measurement: Elements of instruments, static and dynamic characteristics, basic concepts of response of first and second order type instruments.

UNIT - II

Flow Measurement: Head flow meters, open channel meters, area flow meters, flow of dry materials, viscosity measurement, level measurement, direct measurement of liquid level, level measurement in pressure vessels, measurement of interface level, level of dry materials.

UNIT - III

Expansion Thermometers: Mercury in glass thermometer, bimetallic thermometer, bimetallic, pressure spring thermometer, static accuracy and response of thermometers.

Temperature Measurement: Industrial thermocouples, thermocouple lead wires, thermocouple wells industrial resistance and digital thermometers, heat flux sensors fiber-optic sensors. Radiation receiving elements, radiation, photoelectric and optical pyrometers. Response of thermocouples

UNIT - IV

Pressure Measurement: Pressure, vacuum and head manometers, measuring elements for gauge pressure and vacuum, measuring pressure in corrosive liquids, static accuracy and response of pressure gauges.

UNIT - V

Composition Analysis: Spectroscopic analysis by absorption, infrared, UV and X-ray. Emission spectroscopy, Mass spectroscopy, color measurement by spectrometers. Gas analysis by thermal conductivity. Analysis of moisture in gases, wet bulb and dry bulb thermometer, dew point method, polarograph, gas & liquid chromatography, refract meter.

Text Books:

1. Donald P. Eckman. "Industrial Instrumentation", Wiley Eastern Ltd. 2004
2. Patranabis D. "Principles of Industrial Instrumentation", 2nd Edition, Tata McGraw-Hill Publishing Company, New Delhi, 1999

Suggested Reading:

1. William C. Dunn, "Fundamentals of Industrial Instrumentation and Process Control", 1st Edition, Tata McGraw-Hill Education Private Limited, 2009

CE 444

HUMAN VALUES AND PROFESSIONAL ETHICS
(common to all branches of B.E/B.Tech)

Instruction	21L Periods per semester (7 *3)
Duration of University Examination	2 Hours
University Examination	50 Marks
Sessionals	-
Credits	-

Course Objectives:
1. To develop the critical ability among students to distinguish between what is of value and what is superficial in life
2. To enable the students understand the values, the need for value adoption and prepare them meet the challenges
3. To enable the students develop the potential to adopt values, develop a good character and personality and lead a happy life
4. To motivate the students practice the values in life and contribute for the society around him and for the development of the institutions /organization around they are in.
5. To make the students understand the professional ethics and their applications to engineering profession

Course Outcomes:
1. Students develop the capability of shaping themselves into outstanding personalities, through a value based life.
2. Students turn themselves into champions of their lives.
3. Students take things positively, convert everything into happiness and contribute for the happiness of others.
4. Students become potential sources for contributing to the development of the society around them and institutions / organizations they work in.
5. Students shape themselves into valuable professionals, follow professional ethics and are able to solve their ethical dilemmas.

UNIT-1 Concepts and Classification of Values – Need and challenges for value Adoption

Definition of Values - Concept of Values - Classification of Values - Hierarchy of Values - Types of Values -Espoused and Applied Values - Value judgement based on Culture - Value judgement based on Tradition - Interdependence of Values

Need for value education - Findings of Commissions and Committees- Corruption and illegal practices - Science and Technology without values- Exploitation of nature - Increasing use of violence and intoxicants - Lack of education in values - Implications of education in values - Vision for a better India. Challenges for Value adoption - Cultural, Social, Religious, Intellectual and Personal challenges

UNIT – 2 Personal Development and Values in Life

Personal Development: Enlightened self-interest - Accountability and responsibility - Desires and weaknesses - Character development - Good relationships, self-restraint, Spirituality and Purity - The quest for Character - Tests of Character - The key to good character

Values in Life: Building an ethical policy - Integrating values in everyday life - Archaic Social Values - Parenting practices - Critical Thinking - Analyzing and Prioritizing values - Practicing Yoga and Meditation

UNIT – 3 Practicing Values for the Development of Society

Resentment Management and Self-analysis - Positive Thinking and Emotional Maturity - The importance of Women , Children and Taking care of them - Helping the poor and needy - Fighting against addictions and atrocities - Environmental awareness - Working for the Sustainable development of the society

Values in Education system: Present Scenario- Engineering education –Current trends- Need for quality improvement- Adoption of value education – Principles of Integrity-Institutional Development.

UNIT – 4 Basic Concepts of Professional Ethics

Ethics, Morals and Human life , Types of Ethics, Personal Ethics, Professional ethics, Ethical dilemmas, Indian and Global thoughts on ethics, Profession, Professional and Professionalism, Ethical role of a professional Basic ethical principles, Some basic ethical theories, use of ethical theories. Science, Religion Ethics, Genders and ethics, Media and ethics, Computer Ethics, Case Studies on Professional Ethics, Exemplary life sketches of prominent Indian personalities

UNIT-5 Ethics in Engineering Profession

Engineering profession-Technology and Society-Engineering as Social Experimentation-Engineering ethics-Ethical obligations of Engineering Professionals-Role of Engineers-Engineers as Managers-Professional responsibilities of Engineers- Engineers Responsibility for Safety- A few Case Studies on Risk management

Conflicts of Interest- Occupational Crimes- Plagiarism-Self plagiarism-Ethics Audit-Consideration for ethics audit-Ethics Standards and Bench Marking

Text Books:
1. Subramanian R., " Professional Ethics " , Oxford University Press , 2013
2. Nagarajan R.S., " A Text Book on Human Values and Professional Ethics " New Age Publications , 2007
3. Dinesh Babu S., " Professional Ethics and Human Values " , Laxmi Publications , 2007

Suggested Reading:
1. Santosh Ajmera and Nanda Kishore Reddy " Ethics , Integrity and Aptitude " ,Mc Graw hill Education Private Limited , 2014
2. GovindaRajan M., Natarajan S., Senthil Kumar V.S." Professional Ethics and Human Values " PHI Private Limited , 2012
3. Course Material for Post Graduate Diploma In "Value Education & Spirituality " Prepared by Annamalai University in Collaboration with Brahma Kumaris , 2010

CH 316

CHEMICAL REACTION ENGINEERING LABORATORY

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

LIST OF EXPERIMENTS

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

1. Studies in Batch Reactor: To find the Arrhenius form of temperature dependency of reaction.
2. Studies in Mixed Flow Reactor (CSTR) : To find kinetics from reactor performance of CSTR
3. Studies in Tubular Reactor: To determine the rate constant and to verify the order of reaction from performance of the reactor.
4. Studies in Tubular Reactors in series: To verify the performance of the reactor sections connected in series.
5. Mass Transfer with Chemical Reaction: (Liquid – Liquid Reaction System) To find out the mass transfer coefficient in a stirred cell: With chemical reaction and without chemical reaction.
6. Mass Transfer with Chemical Reaction: (solid – Liquid Reaction System)
7. To find the mass transfer co-efficient without chemical reaction and with chemical reaction.
8. R.T D Studies in Packed bed reactor: To determine the axial mixing (axial dispersion) in the packed column.
9. R T D Studies in Tubular Column To determine the variance of residence time distribution and the dispersion number in a tubular column
10. Studies in Batch Reactor: With Equimolar Feed (M = 1) : To determine the rate constant and to verify the order of reaction by differential method of analysis.
11. Studies in Batch Reactor: With Equimolar Feed (M = 1) : To determine the rate constant and to verify the order of reaction by integral method of analysis
12. Studies in Batch Reactor: With feed of Initial molar ratio (M) $\neq 1.0$: To determine the rate constant and to verify the order of reaction by differential method of analysis.
13. Studies in Batch Reactor: With feed of Initial molar ratio (M) $\neq 1.0$: To determine the rate constant and to verify the order of reaction by integral method of analysis
14. Studies in Batch Reactor for Partial method of analysis for a reversible reaction with effect of excess reactant on forward reaction
15. Studies in Batch Adiabatic Reactor: to determine the kinetics of an exothermic reaction from the Temperature of the reaction system.
16. Studies in Mixed Flow Reactors in series: To compare the actual & ideal performances of a Reaction system.
17. Studies in Packed bed: To determine the rate constant and to verify the order of reaction from performance of the reactor.

CH 317

PROCESS HEAT TRANSFER LABORATORY

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

LIST OF EXPERIMENTS

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

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

EG 221

SOFT SKILLS AND EMPLOYABILITY ENHANCEMENT
(common to all branches of B.E and B.Tech)

Instruction	2 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	1

Course Objectives: To help the students

1. Participate in group discussions with confidence and to make effective presentations. Also to learn the art of communication.
2. With- resume packaging, preparing and facing interviews.
3. Build an impressive personality through effective time management & goal setting, self confidence and assertiveness.
4. Understand what constitutes proper grooming and etiquette in a professional environment. Also to understand academic ethics and value systems.

Course Outcomes: The students will be able to

1. Be effective communicators and participate in group discussions with confidence. Also be able to make presentations in a professional context.
2. Write resumes, prepare and face interviews confidently.
3. Be assertive and set short term and long term goals. Also learn to managetime effectively and deal with stress.
4. Make the transition smoothly from campus to corporate. Also use media with etiquette and know what academic ethics are.

Exercise 1

Communicative Competence – The Art of Communication, basic grammar, Indianisms, Effective listening skills, using English in different situations

Exercise 2

Group Discussion – dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and coherence

Elements of effective presentation – Structure of presentation – Presentation tools – Body language

Creating an effective PPT

Exercise 3

Interview Skills – Resume‟ writing – structure and presentation, planning, defining the career objective, projecting ones strengths and skill-sets

Interview Skills – concept and process, pre-interview planning, opening strategies, answering strategies, mock interviews

Exercise 4

Personality Development – Effective Time Management, setting realistic goals, self confidence and assertiveness, stress management, moral values.

Exercise 5

Corporate Culture – Grooming and etiquette, communication media etiquette

Academic ethics and integrity

Suggested Reading:

1. Madhavi Apte , “A Course in English communication”, Prentice-Hall of India, 2007
2. Leena Sen , “Communication Skills”, Prentice-Hall of India, 2005
3. Dr. ShaliniVerma, “Body Language- Your Success Mantra”, S Chand, 2006
4. Edgar Thorpe and ShowickThorpe , “Objective English”,2nd edition, Pearson Education, 2007
5. Ramesh, Gopalswamy, and Mahadevan Ramesh, “The ACE of Soft Skills”, New Delhi: Pearson, 2010
6. Gulati and Sarvesh, “ Corporate Soft Skills”, New Delhi: Rupa and Co. , 2006
7. Van Emden, Joan, and Lucinda Becker, “Presentation Skills for Students”, New York: Palgrave Macmillan, 2004
8. Covey and Stephen R, “The Habits of Highly Effective People”, New York: Free Press, 1989

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
CHEMICAL ENGINEERING
B.Tech III – Year

I – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	CH 311	Chemical Reaction Engineering - II	4	0	0	3
2	CH 312	Mass Transfer Operations - I	4	0	0	3
3	CH 313	Process Dynamics and Control	4	0	0	3
4	CH 314	Process Heat Transfer	4	0	0	3
5	CH 315	Process Instrumentation	4	0	0	3
6	CE 444	Human Values and Professional Ethics	2*	0	0	0
PRACTICALS						
7	CH 316	Chemical Reaction Engineering Lab	0	0	3	2
8	CH 317	Process Heat Transfer Lab	0	0	3	2
9	EG 221	Soft Skills and Employability Enhancement	0	0	2	1
TOTAL			**22**	**00**	**08**	**20**

L: Lecture, T: Tutorial, D: Drawing, P: Practical
* 21 periods per semester

II – Semester

THEORY						
S. No	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	CH 321	Bio-Chemical Engineering	4	0	0	3
2	CH 322	Chemical Engineering Thermodynamics - II	4	0	0	3
3	CH 323	Energy Engineering	4	0	0	3
4	CH 324	Process Modeling Simulation And Optimization	4	0	0	3
5	CH 351 CH 352	**Elective - I** Surface Coatings Technology Technology of Vegetable oils and Fats	4	0	0	3
PRACTICALS						
6	CH 325	Process Dynamics and Control Lab	0	0	3	2
7	CH 326	Process Modeling Simulation And Optimization Lab	0	0	3	2
8	CH 355 CH 356	**Elective - I Lab** Surface Coatings Technology Lab Technology of Vegetable oils and Fats Lab	0	0	3	2
9		Industrial visit	0	0	0	0
TOTAL			**20**	**00**	**09**	**21**

CH 321

BIO-CHEMICAL ENGINEERING

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:
1. To apply the principles of Chemical Engineering to bioprocesses.
2. Conduct an analysis on the biological factors that are important in the design, operation, performance, and/or monitoring of a biological process

Course Outcomes: On successful completion of this module, students should be able to
1. Describe the basic structure and function of cells & Relate cell function to products and processes useful to man
2. Identify and explain the basic features of bioreactors
3. Describe the principles of the various separation procedures involved in the downstream processing of products

UNIT – I

Introduction to Biochemical Engineering, Molecular Biology& Bio Chemistry

Biochemical Engineering Principles, Biophysics and cell doctrine: Atomic Theory and Cell Theory,Important cell types, structure and functions of a typical cell and their components,Transport across cell membranes: Passive and facilitated diffusion, Active transport. Structure and functions of Bio Molecules: Carbohydrates, lipids, Nucleotides to Nucleic Acids - R N Aand DNA, Amino acids to Proteins - the building blocks of biochemical life.Biosynthesis and Metabolic Pathways: Biosynthesis of Small and Macro Molecules Introduction ofmetabolic pathways and end products of glucose metabolism.

UNIT – II

Introductory Microbiology

Introduction to Microbiology: Classification and Industrial uses of MicroorganismsGrowth and Reproduction of Microbes: Growth cycle phases for batch cultivation. Monod's growthkinetics – Growth Rate dependant classification of Microorganisms.Microbial Genetics: Recombinant DNA technology and mutant populations. Multiple Interacting Microbial populations: Neutralism, Mutualism, Commensalism, Amesanalism, Predatism and Parasitism

UNIT – III

Enzyme Technology

Enzymology: Enzymes as Biocatalysts - The enzyme substrate complex and enzyme action and Classification of Enzymes based on Functions. Kinetics of Enzyme Catalyzed Reactions: Simple enzyme kinetics with one and two substrates. Determination of rate constants, substrate activation and inhibition, modulation and regulation of enzyme activity / effect of PH and temp on enzyme activity. Immobilized Enzyme Technology: Types of Enzyme immobilization, Immobilized enzymes in industrial processes, Cofactors, Apo-enzymes and Coenzymes utilization and regeneration

UNIT – IV

Bioreactors and Down Stream Techniques - Introduction

Design and Analysis of Biological Reactors: Batch and CSTR reactors, Enzyme reactors Ideal Reactors for kinetic measurements: The ideal batch reactor / The ideal continuous flow stirred tank reactor - Alternate bio-reactor configurations Separation Processes: Filtration, Centrifugation, Adsorption, Reverse osmosis, Dialysis, Electrophoresis, Sedimentation and Extraction Purification Processes: Precipitation, Crystallization, and Chromatography

UNIT – V

Bioprocess Technology

Fermentation Technology: Types of Fermentation - Anaerobic and Aerobic Fermentation process. Surface and Submerged Fermentation process Medium formulation and Culture Propagation: Media composition and Sterilization, Inoculum's culture development under aseptic conditions of transfer. Environmental biotechnology: Effluent treatment. Industrial Biotechnology: Commercial enzymes, Antibiotics and single cell protein

Text Books:

1. James, E.Bailey and David F Ollis, "Biochemical Engineering fundamentals", 2ndEdition, McGraw-Hill Internal Edition.1986

Suggested Reading:

1. Michael L. Shuler and FikretKargi, "*Bioprocess Engineering: Basic Concepts"*. Second Edition Prentice Hall, 2002

CH 322

CHEMICAL ENGINEERING THERMODYNAMICS – II

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand

1. VLE for binary mixtures.
2. To generate T-x-y and P-x-y, from the fundamentals of equilibrium and properties of fluid.

Course Outcomes: The students will be able to

1. Generate VLE data for binary mixtures for ideal and non- ideal systems
2. to determine equilibrium constant and composition of product mixture at given temperature and pressure

UNIT - I

Criterion of Phase Equilibrium: Fundamental property relations, Chemical potential, Partial Properties, Relation between Partial Properties and Molar properties, Fugacity, Fugacity Coefficients, Determination of Fugacity Coefficient by equations of states (Virial, Van der Waal, R.K. equation.)

UNIT - II

Solution Thermodynamics: Fugacity of pure liquids, Fugacity for Mixtures, Poynting factor, Residual Properties, Excess Properties, Lewis Randall Rule, Activity Coefficients, Heat Effects of mixing.

UNIT - III

The Nature of Phase Equilibrium: The Phase Rule, Duhem's Theorem, Models to calculate Activity Coefficients (Margules Equation, Van-laar, Wilson), Introduction to UNIQUAC, UNIFAC. Method to get activity coefficients (Margules and Van laar) by using Excess Gibbs Free Energy models

UNIT - IV

Application of Phase Equilibrium: To get T-x-y, P-x-y, Using Raoult's law, Modified Raoult's law for binary mixtures, following methods of BUBBL-T, Dew-T, BUBBL-P, DEW-P. Algorithm to find VLE by Peng- Robinson, R-K- Equation

UNIT - V

Chemical Reaction Equilibrium: Reaction Coordinate, Equilibrium criteria for chemical reactions, equilibrium constant and effect of temperature , temperature and pressure effects on conversion, Calculation of equilibrium conversion for single reactions in homogenous and heterogeneous systems, Duhem's Theorem for reacting systems, simple examples of multi-reaction equilibrium

Text Books:

1. J M Smith and H C VanNess, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill, International Edition, Fourth edition, 1987

Suggested Reading:

1. Pradeep Ahuja, "Chemical Engineering Thermodynamics" , PHI Publishers, EEE, 2009
2. YVC Rao, "Chemical Engineering Thermodynamics" Universities Press , 2003

CH 323

ENERGY ENGINEERING

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:
1. Introduce the importance of energy sources
2. To explore the challenges facing and solutions found by energy engineers.
3. To introduce students to energy efficiency and renewable energy resources and how to develop a sustainable energy plan.

Course Outcomes: On successful completion of this module, students should be able to:
1. Understand scope of energy engineering
2· Quantify how much energy is available from renewable sources
3. Understand how deep energy efficiency improvements may be achieved

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

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

UNIT – III
Non conventional Energy Sources:
Selective surfaces for solar Energy Conversion: Introduction. Heat balance. Physical Characteristics of Selective Surfaces
Use of Selective Solar Energy Collectors, Anti-Reflection Coatings,
Solar Reflector Materials, Selective and Non-Selective Surfaces. Types of Selective coatings, Intrinsic Solar Selective Materials
Photo Voltaic Cells: Introduction: Types of Solar Cells. Applications, Electrical Storage. Future developments
Wind-power: Introduction. Basic principles of wind energy conversion. Types of wind machines
Wave power: Introduction, advantages and disadvantages, energy and power from the waves. Wave energy conversion devices

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, biobutanol, bioethanol
Second generation biofuel feed stocks
Fuel Cells: Working principle, Types, Advantages, Current and Future Applications.

UNIT - V
Nuclear Energy: Nuclear fission fuels processing, nuclear reactions and nuclear reactors
Energy Storage and Distribution: Mechanical Energy Storage, Hydroelectric Storage, Compressed Air Storage and Energy Storage via Flywheels. Electric Storage , Chemical Storage ,Thermal Energy Storage.

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

Suggested Reading:
1. Om Prakash Gupta, "Fundamentals of Nuclear Power Reactors", Khanna Publishers,
2. S Srinivasan, "Fuel Cells: From Fundamentals to Applications", Springer, 2006

CH 324

PROCESS MODELING SIMULATION AND OPTIMIZATION

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. This course is helpful to learn the formulation of a mathematical process model through the application of material and energy balance.
2. Students are introduced to mathematical solution procedures like numerical methods and optimization techniques to solve the formulated process models**.**
3. The course is helpful to provide know-how on process simulation software required in chemical engineering field.

Course Outcomes:

1. The students gain the ability to analyze, formulate and apply the basic fundamentals of mathematics like numerical methods & programming languages to solve problems related to chemical processes
2. The course helps the students to understand the steps involved in applying process simulation software packages for design, solution and optimization that are a prerequisite for the development of process flowsheets

Note: The Programs are to be written in "MATLAB"

UNIT – I Formulation of Process Models

Definition of mathematical models, introduction to process models, types, uses, scope of coverage, principles of formulation, conservation principles of mass and energy laws.

Application of fundamental laws to develop: Total and component continuity equations, energy equation, momentum equation, chemical kinetic rate expressions.

UNIT – II Numerical Solutions of Linear and Non-linear process models

Uses, comparison and computational significance for problem solving in chemical engineering for:

Set of linear simultaneous equations by Gauss-Elimination, Gauss-Jordan and Gauss-Seidel methods.

Set of non-linear equations by Bi-section, Reguli-falsi and Newton Raphson methods.

UNIT – III Curve-fitting and Numerical Solutions of Ordinary Differential Process Models

Computational features and problem solving in chemical engineering for:Curve-fitting by Linear and nonlinear least square analysis,

Set of ordinary differential equations by Euler's modified Euler's and RungeKutta methods.

UNIT – IV Chemical Process Optimization

Nature and organization, basic concepts and elements of Optimization, single variable functions, direct, indirect and random search methods – with and without acceleration

Elimination methods for unrestricted and exhaustive search, Fibonacci search, Dichotomous search, Golden-section (gradient) search methods

UNIT – V Simulation of Chemical Processes

Process modeling, MATLAB programming and use of Process Simulator like CHEMCAD on:Gravity flow tank, Batch reactor, Three CSTRs in series, Gas-pressurized CSTRs, Two-heated tanks, Heat-exchangers, Distillation columns, Packed-bed columns.

Text Books:

1. William L Luyben, "Process Modeling, Simulation and Control for Chemical Engineers", McGraw Hill Publishing Company,2nd edition, 1990
2. Edger T.E., and Himmelbau D.M., "Optimization of chemical processes", McGraw Hill international edition, 1988

Suggested Reading:

1. Steven C. Chapra and Raymond P Canale, "Numerical methods for Engineers", McGraw Hill International, 2nd edition, 1988
2. S.S. Rao, "Engineering Optimization"
3. Mickley H.S., Sheerwood T.K., Reed C.E., "Applied mathematics in Chemical Engineering", McGraw Hill, New York, 1957

CH 351

SURFACE COATING TECHNOLOGY
(Elective - I)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:
To give fundamental concepts in pigments, extenders, binders, solvents, paint formulation, paint applications, manufacturing of different paints, special type paints, paint tests and paint defects.

Course Outcomes:
The students will be able to distinguish the differences between various types of paints and their composition.
The applicability of different paints for industrial purposes can be decided.

UNIT-I
Introduction: Surface coatings- Scope, properties, applications & uses. Major components of surface coatings. Fundamentals of film formation
Classification of Paints: Air drying paints, stoving paints, their properties and uses. Liquid paints & powder paints, their properties & uses. Varnishes, Lacquers, resin their properties & uses.
Manufacture of Paints: Distempers- Manufacture, properties & uses. Powder Paints- Manufacture, properties & uses. Enamel - Manufacture, properties & uses.

UNIT – II
Pigments: Importance of pigments - their basic properties, uses & their applications.
Classification of pigments: Inorganic & organic pigments.
Special properties of pigments: Criteria for selection of color, tinting strength, fastness to light, bleeding, hiding power, refractive index, particle size & anti-corrosive properties.
Manufacture of Pigments: Titanium di-oxide, Zinc Oxide, Carbon black, red lead, Ultramarine blue, Prussian blue, Zinc chrome.

UNIT – III
Extenders: Importance, properties & significance.
Manufacture of Extenders: Blanc fixe, China clay, Gypsum, Mica & talc.
Solvents: Importance, uses & their properties,
Manufacture of solvents: Turpentine, di-pentene, pionoid, alcohols.
Natural Resins: Resin &shallock. Synthetic Resins: Alkyd resins, phenolic resins, amino resins.

UNIT – IV
Application methods of paints: Air drying paints, industrial liquid stoving paints & industrial stoving powder paints. Brush application, spray application, electrostatic spray application. Dip coating, Roller coating & electro deposition coating.
Testing of Paints: Wet paint & dry paint testing film thickness, adhesion & resistance coverage. Defects in paints & paintings & their remedies: defects in grinding skinning, sagging, bleeding, flooring, floating, brushing, orange peel, fish eye, brush marks, lifting.

UNIT – V
Special Coatings: Importance, Significance & their applications.
Powder Coatings, Water soluble coatings, Water Borne coatings, heat resistant coatings, automatic coatings, fire retardant coatings, space & air craft coatings & swimming pool coatings.

Text Books:
1. W.M. Morgans, “Outline of Paint Technology”, Edward Arnold Publishers, London, 1990
2. R. Lambourne& T A Strivens, “Paint & Surface coatings”, Second edition, 1999

Suggested Reading:
1. Patton Temple, “C Pigment Flow & Pigment Dispersion”, Wiley Inter science, 1979
2. Swaraj Paul, “ Surface Coatings science and technology” , 1995

CH 352

TECHNOLOGY OF VEGETABLE OILS AND FATS
(ELECTIVE – I)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To impart knowledge about sources, types and composition of oils and fats
2. To comprehend the physicochemical characteristics
3. To familiarize the students about extraction and processing
4. To study the production of value added products from oils and fats

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

1. Analyze the various properties of fats and oils to determine their use in food, soap and other industries
2. Identify unit operations involved in extraction and refining processes
3. Will know about the degradation occurring during storage of oils and fats and prevention methods

UNIT – I

Introduction: Position of Oils & Oilseeds in India & world, definition, structure, composition of oils and fats, distinction between oils and fats

Glycerides: Definition and types – Simple, mixed triglycerides, mono and diglycerides, Distribution of fatty acids in glyceride molecule

Fatty Acids: Saturated fatty acids, unsaturated fatty acids (Fatty acids with one, two, three and more double bonds) Fatty acids of unusual structure: Hydroxyl and di-hydroxy acids - Acetylene acids – Epoxy acids and keto acids

Non-glyceride Components: Phosphatides, sterols, pigments, tocopherols, tocotrienols, oryzanol, β-carotene, squalene

UNIT – II Classification of Oils and Fats

Classification of Oils and Fats with Examples, Physical and chemical properties (structure indices – iodine value, saponification value, hydroxyl value) of oil and fats, detailed glyceride composition

Industrial Utilization of the following oils – palm, palm kernel, coconut, cotton seed, peanut, sunflower, safflower, sesame, rice bran, rapeseed and mustard, linseed (flax seed), soya been, Tung, castor oil, lard, tallow and fish

Nontraditional oils like neem, karanja and jatropafor industrial applications

UNIT– III Chemical Reactions of Oils and Fats

Reactions in the fatty acid chain - Hydrogenation, Oxidation reactions.Esterification andInteresterificationSopanification, formation of metal soaps ,Hydrogenolysis, formation of fatty amines, fatty amides and fatty chlorides, Halogenation, Addition of maleic anhydride, sulfation, sulfonation Chemical oxidation(hydroxylation), atmospheric oxidation (rancidity), Polymerization, Isomerisation and Reaction of hydroxyl groups

UNIT – IV Storage, Pretreatment and Extraction of Oil Seeds: Mechanical expression of oil – extruder expander, Solvent extraction, Fat Splitting (chemical and enzymatic methods)

UNIT – V Chemical and Physical Refining: De-gumming, neutralization, refining losses, Miscella refining, Bleaching, dewaxing, Deacidification and Deodorization

Partial and Total Hydrogenation: Mechanism, selectivity, continuous process, preparation of Raney Nickel catalyst. Products of hydrogenation - anaspati, Margarine and Shortening

Soap Manufacture: Raw materials required , selection of raw materials – Full boil process

Concepts about surfactants, detergents, cosmetics, lubricants, biodiesel, Regulations of FSSAI related to oils and fats

Text Books:

1. Ed. D Swern, "Bailey's Industrial Oils and Fats Products" , Wiley Inter Science publication, N.Y. John Wiley and Sons ,6th Edition, 2006

Suggested Reading:

1. M M Chakrabarty , "Chemistry and Technology of Oils and Fats", Allied Publishers Pvt.Ltd., 1st Edition, 2007
2. O P Narula, "Treatise on fats,Fatty acids and Oleochemicals", Vol I and II, Industrial Consultants (India), 1994
3. R J Hamilton , "Recent Advances in Chemistry and Technology of Fats and Oils", Elsevier Applied Science 1987

CH 325

PROCESS DYNAMICS AND CONTROL LABORATORY

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. Determination of order, time constant, and dynamic lag of a first order system
2. Determination of frequency response of a first order system
3. Determination of Bode plot from dynamic studies of first order system
4. Study the effect of PID controller parameters on closed loop servo response
5. Feedback controller tuning by Zeigler-Nicolas and Cohen Coon Methods
6. Determination of order, time constants, interaction effective time constant of interacting liquid level system
7. Determination of order, time constants of two tank non-interacting liquid level system
8. Determination of order, time constants, interaction, effective time constants and dynamic lag of a second order system
9. Determination of second order under damped characteristics from the dynamics of second order system (manometer)
10. Determination of pneumatic valve characteristics
11. Study of Cascade control system
12. Evaluation of model based nonlinear control on continuous bioreactor with input multiplicities
    a. Calculation of overall heat transfer coefficient and effectiveness of the given heat exchanger
    b. Study of dynamics of heat exchanger

Note: 1. Experiments (1 to 5) can be designed on any of the following computer controlled systems.
   a. Liquid-Level
   b. Flow
   c. Temperature
   d. Pressure
   e. Jacketed stirred tank

2. Minimum of 8 experiments have to be performed

CH 326

PROCESS MODELING SIMULATION AND OPTIMIZATION LABORATORY

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. The laboratory sessions equip the students in computer aided problem solving. The sessions are further helpful in interpreting the results and to write technical reports in the form of lab records.
2. The course aims to provide the students with opportunity to run simple process simulators for the study of design and analysis of processes or equipment in chemical plant operation.
3. The lab sessions aim to provide an opportunity for team work in solving chemical engineering related simple problems.

Course Outcomes:

1. The students are able to express the experimental data in the form of suitable mathematical correlations and estimate the coefficients involved.
2. In the lab, the students are exposed to process simulation of common chemical engineering unit operations.
3. The students are able to work as a team and develop process models as well as apply their mathematical skills to solve them.

Note: The Programs are to be written in "MATLAB"

PART – A: INTRODUCTION

Basics of theoretical modeling, and Numerical solutions for Process Calculations:

1. Solution of ordinary differential equations by Euler`s, Modified Euler`s, Runge-Kutta methods
2. Solution of set of linear simultaneous equations by Gauss-elimination, Gauss-Jordan and Gauss-Seidel methods
3. Solution of non-linear equations by bisection, Regular-Falsi and Newton Raphson methods
4. Linear and Non-linear Least square analysis

PART – B: APPLICATION

(A minimum of 4 process systems to be simulated)

1. Series of isothermal, constant holdup CSTRs
2. Two heated Tanks
3. Gas-Phase Pressurized CSTR
4. Batch Reactor - Adiabatic or Isothermal
5. Ideal Binary distillation
6. Vapor Liquid Equilibrium : Bubble Point and Dew Point Calculations

PART – C: PROCESS SIMULATORS

Application of process simulation software packages like ChemCAD for:
understanding the basic concepts, steps involved for developing process flowsheet

Suggested Reading:

1. William L Luyben, “Process Modelling, Simulation and Control for Chemical Engineers”, McGraw Hill, 2nd edition 1990
2. B Wayne Bequette, “Process Modelling Analysis and Simulation”, Prentice Hall International Series, 1998
3. Steven C Chapra and Raymond P Canale, “Numerical methods for Engineers”, McGraw Hill, 2nd edition, 1988

CH 355

SURFACE COATING TECHNOLOGY LAB
(ELECTIVE - I LAB)

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives

To understand the theoretical concepts of organic surface coating technology (Paints) the experimental procedure were designed like preparation of M.S. panels for painting, viscosity tests, adhesion tests, impact tests, gloss tests, thickness tests, paint spreading capacity tests and corrosion tests.

Course Outcomes:

With the conceptual experimental procedures, analysis with theoretical and experimental values and with good evaluation procedures, the students are made to be perfect in analytical skills and then these skills are useful to them in industries.

LIST OF EXPERIMENTS
(Minimum of 8 experiments are to be performed)

1. Preparation of panels for painting
2. Determination of apparent viscosity of paints, varnished lacquers and viscous products
3. Using B-4 ford cup (type I S . 101/IS 3944/BS 3900) - Determination of resistance to scratching under a specified load of a dried film of paint (as Per IS . 101)
4. Measurement of paint film thickness using dry film thickness gauge of a first coat (primer Paint) and second coat (finish paint)
5. Determination of flexibility and adhesion of the paints (as per 101 BS 3960 m and size ¼)
6. Determination of impact resistance of the painted panel
7. Measurement of hardness of magnesium phosphate coating
8. Measurement of gloss of painted film at 45 degree angle
9. Determination of drying consistency of different paints and varnishes
10. Determination of coverage or spreading capacity of different paints

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CH 356

TECHNOLOGY OF VEGETABLE OILS AND FATS LABORATORY
(ELECTIVE – I LAB)

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

List of Experiments:

1. Determination of Acid value of given oil sample
2. Determination of percentage of free fatty acid present in given sample and its acid value
3. Determination of iodine value of given oil sample
4. Determination of saponification value of given oil sample
5. Determination of the hydroxyl value of given oil sample
6. Determination of unsaponifiable matter of given oil sample
7. Determination of oil content in oil seeds
8. Determination of slip melting point of Fats (Ex: vanaspati, tallow)
9. Determination of the percentage of moisture and any materials volatile under the conditions of test
10. Determination of Total Fatty Matter (TFM) in soaps

Note: Minimum of 8 experiments have to be performed

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)
SCHEME OF INSTRUCTION AND EXAMINATION
B.Tech – IV YEAR
CHEMICAL ENGINEERING

SEMESTER - I

S.No	Syllabus ref. no.	Subject	Scheme of Instruction			Scheme of Examination			
			Periods per week			Duration in Hours	Maximum Marks		Credits
			L	T	P/D		End exam	Sessionals	
THEORY									
1.	CH 411	Chemical Process Safety	4	0	0	3	75	25	3
2.	CH 412	Mass Transfer Operations -II	4	0	0	3	75	25	3
3.	CH 413	Petrochemical Engineering	4	0	0	3	75	25	3
4.	MB 216	Principles and Practice of Management	4	0	0	3	75	25	3
5.	CH 414	Process Equipment Design	4	0	0	3	75	25	3
6.		**Elective – II**	4	0	0	3	75	25	3
PRACTICALS									
7.	CH 415	Equipment Design and Drawing	0	0	3	3	50	25	2
8.	CH 416	Mass Transfer Operations Laboratory	0	0	3	3	50	25	2
9.	CH 417	Project Seminar	0	0	3	–	–	25	1
Grand Total (Theory + Practicals)			**24**	**0**	**9**	–	**550**	**225**	**23**

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

S.No	Syllabus ref. no.	**Elective – II**
1.	CH 461	Fertilizer Technology
2.	CH 462	Membrane Separation Processes
3.	CH 463	Mineral Processing Technology
4.	CH 464	Polymer Technology
5.	CH 465	Pulp and Paper Technology

SEMESTER – II

S.No	Syllabus ref. no.	Subject	Scheme of Instruction			Scheme of Examination			
			Periods per week			Duration in Hours	Maximum Marks		Credits
			L	T	P/D		End exam	Sessionals	
THEORY									
1.	CH 421	Plant Design and Economics	4	0	0	3	75	25	3
2.	CH 422	Transport Phenomena	4	0	0	3	75	25	3
3.		**Elective – III**	4	0	0	3	75	25	3
4.		**Elective – IV [Open Electives]**	4	0	0	3	75	25	3
PRACTICALS									
5.	CH 423	Seminar	0	0	3	–	–	25	1
6.	CH 901	Project	0	0	6	Viva	100	50	9
Grand Total (Theory + Practicals)			**16**	**0**	**9**	–	**400**	**175**	**22**

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

S.No	Syllabus ref. no.	**Elective – III**	S.No	Syllabus ref. no.	**Elective – IV**
1.	CH 471	Corrosion Engineering	1.	CE 422	Disaster Mitigation and Management
2.	CH 472	Fluidization Engineering	2.	ME 464	Entrepreneurship
3.	CH 473	Pollution Control in Process Industries	3.	PE 484	Nano Materials and Technology
4.	CH 474	Sugar Technology	4.	CH 481	Nuclear Engineering

CH 411

CHEMICAL PROCESS SAFETY

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand the:
1. importance of safety culture in process industry.
2. disregard for ethical decision making based on numerous case studies.
3. interaction and implementation of trade-offs concept in chemical plant operation.
4. examples of problems that can occur with inadequate process design, improper process modification.

Course Outcomes: At the end of the course, the students will be able to:
1. evaluate effect of chemical hazards and risks of toxicants.
2. analyze chemical incidents and possible consequences to plant facilities, workers, and the general public.
3. apply the technique of safe process design.
4. analyze fire and explosion hazards.
5. integrate safety concepts into chemical plant design.
6. follow the ethics during process plant operation.

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

Fires and explosions: Definition of fire, fire triangle, Classification of fires as Class - A, B, C and D. Reaction of fires.
Fire extinguishers: Portable fire extinguishers − applications and their uses, Construction and working of water, Mechanical foam, CO_2, stored powder, ABC powder. Automatic multiple CO_2 extinguishers in chemical process industries.

UNIT – V

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

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

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

CH 412

MASS TRANSFER OPERATIONS - II

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand the
1. distillations methods - batch, semi continuous, continuous distillation for binary miscible systems.
2. various Methods to design distillation columns.
3. concepts of solvent extraction methods using Triangular diagrams for ternary systems and binary immiscible system along with design.
4. concepts of various leaching methods and leaching equilibriums with design.
5. concepts of Absorption, Adsorption equilibrium / Isotherms and design.

Course Outcomes: At the end of the course, the students will be able to
1. differentiate the application of various types of distillation processes.
2. design and estimate the number of theoretical stages of distillation column using McCabe- Thiele method and Ponchan-Savarit method.
3. design and estimate the number of theoretical stages for Liquid-Liquid extraction.
4. design and estimate the number of theoretical stages for Solid-Liquid extraction.
5. design and estimate the number of theoretical stages for Adsorber.
6. design of equipment for Mass Transfer Operations.

UNIT – I: Distillation:
VLE Phase diagrams – Tie lines and mixture rule – Flash vaporization and differential distillation for binary mixtures – Steam distillation. Batch distillation with reflux for binary mixtures.

UNIT-II: Continuous fractionation
Continuous fractionation of binary mixtures, Ponchan – Savarit method, McCabe – Thiele method for determination of ideal plates for binary mixtures, Optimum reflux ratio, Use of total and partial condensers.
Use of open steam. Packed bed distillation. Principles of Azeotropic and Extractive distillation.

UNIT–III: Liquid – Liquid Extraction:
Solubilities of ternary liquid systems. Triangular and solvent free coordinate systems. Choice of solvent. Extraction with insoluble and partially soluble systems – single stage, multistage cross-current and multistage counter-current extraction without reflux and Continuous contact extraction (packed beds). Equipment's for liquid – liquid extraction operation.

UNIT–IV: Leaching:
Preparation of solid, Unsteady state operation, in-place leaching, heap leaching, percolation leaching, Shanks system, agitated vessels, percolation in closed vessels, Percolation Vs Agitation. Steady state continuous operation–equipment-methods of calculation, stage efficiency and practical equilibrium. Single stage leaching, multistage cross current leaching, multistage counter current leaching.

UNIT-V: Adsorption:
Principles of Adsorption and their applications – Types of adsorption – Adsorbents – Adsorption equilibrium – Adsorption Isotherms for vapor and dilute solutions. Single stage and multistage adsorption, Adsorption wave and breakthrough curve and fixed bed adsorption. Equipment for Adsorption operation.

Text Books:

1. R.E.Treybal, "Mass Transfer Operations", 3rd Edition, McGraw Hill Book Company, 2002.
2. Geankoplis, "Transport Processes and Separation Processes Principles", 4th Edition, Prentice Hall, 2003.

Suggested reading:

1. Richardson and Coulson, "Chemical Engineering", Volume 1, Tata McGraw Hill Publications, 2000
2. Binay.K. Dutta, " Principles of Mass Transfer & Separation Processes", Eastern Economy Edition, PHI learning Pvt, ltd, 2015.
3. Warren McCabe and Julian Smith and Peter Harriott, "Unit Operations of Chemical Engineering", 7 th ed., McGraw Hill Book Company, 2005.

CH 413

PETROCHEMICAL ENGINEERING

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

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

Course Outcomes: At the end of the course, the students will be able to
1. grade the crude oil, its composition and applications based on formation theories.
2. know refining process of crude oil.
3. apply the techniques of catalytic and non-catalytic cracking methods.
4. design the manufacture of derivative products.
5. design the safety and pollution control techniques in petroleum refining industries.
6. find the suitable refining technology for maximizing gasoline yield.

UNIT−I

O**rigin and formation of petroleum**:- Organic theories, Inorganic theories and biological methods for explaining the formation of Crude oil. **Definition of refining terms :-** API Gravity, Aniline point, Octane number, Cetane number, Smoke point, Fire point, Flash point, Diesel Index, Naphtha, Types of Naphtha etc. Composition and applications of crude oil. **Petroleum Refining: -** Overall refining of crude petroleum. Production of gasoline, kerosene and lubricating oils.

UNIT− II

Rebuilding of Hydrocarbons and techniques involved: **Naphtha cracking:** Definition, types, reactions, fluidized bed cracking, description of the reactors. **Alkylation:-** Hydrofluoric acid process and sulphuric acid process
Isomerization: - Aluminum chloride process and isomerization with platinum catalyst. **Polymeriztion: -** Types of polymerizations, mechanism of polymerization, polymerization in presence of sulphuric acid, polymerizations in presence of phosphoric acid.

UNIT− III

Ethylene Derivatives: - various products with ethylene as the starting materials. **Manufacturing of the following:-** Vinyl Chloride Monomer, Perchloroethylene − pyrolysis of carbon tetra chloride, chlorination and pyrolysis method, Ethyl alcohol by direct hydration and liquid phase hydration methods, Vinyl acetate monomer, Ethylene oxide and its applications , Polyethylene, Styrene.

Unit− IV

Propylene derivatives: - list of propylene derivatives. **Manufacturing of the following:-** Isopropyl alcohol, Acetone by catalytic dehydrogenation, Propylene oxide, Glycerine by Acrolein, allyl chloride and by isomerization of propylene oxide methods. **Derivatives of C_4 Hydrocarbons:** List of butadiene derivatives, Manufacturing of butadiene from n-butylene and by oxidative dehydrogenation., Purification of butadiene

UNIT −V

Derivative of Higher Paraffins:- Manufacturing of Isoprene, olefins of C_5 , C_6, long chain and straight chain Olefins. **Derivatives of Aromatics**: - Sources of aromatic compounds, production of aromatics. Effect of temperature, pressure and catalyst on dehydrogenation process. Separation of aromatics from Non-aromatics and separation of aromatics into individual streams

Text Books:

1. W.L.Nelson, “Petroleum refinery engineering” 4th ed., McGraw Hill company, 2013.
2. B.K.Bhasker Rao, “Modern petroleum refining process”, 5th ed., Oxford and IBH, 2008.

Suggested Reading

1. N.K.Sinha, “Petroleum Refining and Petro Chemicals”, 1st edition, Umesh publications , 2003.
2. Kirk-Othmer, “Encyclopedia of Chemical Technology”, 3rd Ed..John Wiley and sons.Inc, 2004.
3. Meyers Robert, “Hand Book of Petroleum Refining Processes”, 3rd edition McGraw Hill, 2003.

MB 216

PRINCIPLES AND PRACTICE OF MANAGEMENT

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand:
1. basic principles, concepts and functions of management in industry.
2. key competencies and skills required for problem-solving and decision-making in managerial situations.
3. the different organizational designs and structures.
4. materials, operations and marketing management.
5. the role and functions performed by HR managers.

Course Outcomes: At the end of the course, student will be able to apply the
1. managerial skills for managing a Unit / Branch.
2. the different operations / functional areas to process industry as an organization.
3. assess the situations in an organization by critical examination and provide better decisions.
4. dynamics of business and sense to formulate the direction of change.
5. purchasing objects and principles to material management
6. concept of marketing management to a global scenario.

UNIT - I

Management definition, Administration Vs Management Principles and Functions of Management, levels of management - System and Contingency approach to management - steps in Planning - Decision making process - organization: Definition, Line, staff, functional and matrix type organization, span of control (Graicuna`s Formulae), Centralization Vs Decentralization.

UNIT - II

Communication - Process, Grapevine, Networks and Barriers of communication - Managerial grid, Theory of X, Y and Z; Job Enrichment Vs Job enlargement - Control process - Introduction to Personnel Management: Functions, staffing process, need for HRD, Training & Development (TWI Programme)

UNIT - III Measurement of Morale - Job Design -Industrial Relations: Human relation Vs Industrial relations, Trade Unionism, Industrial Unrest, Wage and Incentive concepts - Role of ILO - MIS in industry - Management of public enterprises.

UNIT - IV Introduction to Financial Management : Sources of Finance, Capital & its Structure (CFS & FFS) Financial statements, cost sheet - Introduction to Purchase & Material management Purchasing objects and principles, types of purchasing, Vendor selection, rating, evaluation & Development - Inventory control, ABC analysis, stores organization and pricing of issues - concept of Warehousing.

UNIT - V Production and marketing Management: Types of Production, Quality control (Tools used), PPC, Maintenance management - Marketing management ; Definition and concept of marketing, functions of marketing, market research, Types of markets, Sales Forecasting, Promotion mix - Pricing - Product Identification - A brief note on International Marketing.

Text Books:

1. Harold Koontz and Heinz Weihrich, "Essentials of Management-An International Perspective", 9th Ed., Tata McGraw-Hill Edu Pvt. Ltd, 2012.
2. Khan & Jain, "Financial Management", 7th Ed., Tata McGraw-Hill Edu Pvt. Ltd, 2014.

Suggested Readings:

1. David A. DeCenzo, David A, Robbins, Stephen P, "Fundamentals of Human Resource Management", 11th Ed, John Wiley and Sons Inc, 2015.
2. Elwood S Buffa, Rakesh K. Sarin, "Modern Production/Operations Management", 8th Ed, Wiley India Pvt. Ltd., 2007.
3. Jennifer George and Gareth Jones "Understanding and Managing Organizational Behavior", Published by Pearson Education Inc., 2013.
4. I. M. Pandey, "Financial Management", 10th Ed. Vikas Publishing House, 2013.
5. Gary Dessler, "Human Resources Management", 11th Eastern Economy Ed., 2011.

CH 414

PROCESS EQUIPMENT DESIGN

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course objectives: This course helps the students to understand the:
1. classification of unfired pressure vessels observed in process industries.
2. design needs for process equipment of any chemical plant.
3. mechanical design of process vessels for shells, domes and other significant component parts.
4. process design of reactors based on their operation.
5. sieve-tray hydraulics and downcomer design of distillation columns.

Course outcomes: At the end of the course, the students will be able to:
1. identify the design needs for process equipment based on operating conditions of chemical plant operation.
2. calculate the dimensions of shell and domes of process vessels.
3. select appropriate component parts for any process vessel and calculate the dimensions of flanges, nozzles.
4. apply the calculation procedures for design of significant process equipment like storage vessels, reactors.
5. apply McCabe- Thiele method and design continuous distillation with multiple feeds or side streams.
6. apply the calculation procedures for hydraulics and downcomer design for trays of a distillation column.

UNIT – I: Design of Pressure Vessels

Classification of equipment, types of pressure vessels, General design considerations for process equipment like pressure, temperature, codes and standards, stresses, welding categories, material of construction, corrosion allowance, major and minor constraints.

Design and calculations for thin-walled vessels under internal pressure: cylindrical and spherical shells, domes – flat plates, torispherical, elliptical, hemispherical, conical heads.

Design of thin-walled vessels under external pressure: cylindrical shells, vessel heads, need and types of stiffeners.

UNIT – II: Design of Vessel Components

Significant component parts of process vessels. Flanges – classification, types, design calculations for loose type non-standard flanges. Equipment supports – types, selection criteria.

Nozzles – design calculations for deciding the compensation requirements for openings and branches. Jackets for process vessels – Types, selection criteria, comparison with immersion coils.

UNIT – III: Design of Reactors

Reactors – classification basis, types, selection criteria, application, comparison. Process design – significance of mass and energy balances, reaction rates. Calculations to estimate volume of reactor.

Impellers – types, dimensions and selection criteria based on nature of material to be mixed, power requirement. design calculations to estimate shaft dimensions for impellers.

UNIT – IV: Design of Continuous stage-wise Distillation Column

Design of tall columns under combined loading – source of loads, stress balance – pressure, wind and weight loads. Prediction of plate efficiency of distillation columns – types and design methodology.

Application of McCabe-Thiele method for design calculations of continuous distillation with multiple feeds and with removal of side streams.

UNIT – V: Design of Plate contactors

Sieve-plate hydraulic design – performance, construction, area considerations, flooding, liquid-flow arrangement, weir dimensions, entrainment, weep-point. Plate pressure drop – dry plate, residual and total drop. Design of downcomer back-up – clear liquid, weir crest, head loss, residence time.

Text Books:

1. J.M.Coulson, J.F.Richardson, R.K. Sinnott, "Chemical Engineering Design", Vo1. 6, Ed 3, Butterworth – Heinemann publishers, New York, 2000.
2. Dr. Shrikanth D. Dawande, "Process Design of Equipments" Vol. 1 & 2, Central Techno Publications, Nagpur, 2000.

Suggested Reading

1. M.V. Joshi, "Process Equipment Design", 2nd Ed., McMillan Co. of India Limited, Madras,1976.
2. Ernest E. Ludwig, "Applied process design for chemical and petrochemical plants", Vol 3, Elsevier Inc., 2001.
3. Bachurst, J.R. and Harker, J.H, "Process Plant Design", American Elsevier Pub. Co., London, 1973.

CH 461

FERTILIZER TECHNOLOGY
(Elective II)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course objectives: This course helps the students to understand:
1. the use of fertilizers to improve soil productivity and crop yield
2. the different types of the nitrogenous, phosphatic and potash fertilizers
3. various fertilizer application methods
4. different organic fertilizer production methods

Course outcomes: At the end of the course, the students will be able to:
1. identify the raw materials required for manufacture of fertilizers.
2. process description and flowsheet involved in the manufacture of various fertilizers.
3. significant unit operations involved in manufacture of various fertilizers.
4. characterize fertilizers on the basis of their properties.
5. Identify engineering problems in fertilizer manufacturing.
6. Select appropriate synthetic fertilizers.

UNIT – I:
Introduction: Fertilizer Technology, Plant Nutrients, Role of essential elements for plant growth. Availability of feed stocks.
Nitrogen Fertilizers: Feed stocks for the production of Ammonia, Ammonia synthesis by – Haber and Kellogg processes. By-product ammonia recovery by direct and indirect methods.

UNIT - II
Manufacture of Urea, Manufacture of other nitrogenous fertilizers such as ammonium sulfate, ammonium nitrate, calcium ammonium nitrate, ammonium chloride. Manufacture of nitric acid.

UNIT - III
Phosphorous fertilizers– manufacture of single and triple super phosphate.
Production o f ammonium phosphates – mono-, Di- and nitro phosphates, Manufacture of phosphoric acid by wet process and thermal process.

UNIT - IV
Potassium fertilizers, mixed and NPK fertilizers.
Introduction to new variety of fertilizers – liquid fertilizers. Bio fertilizers – introduction, advantages over chemical fertilizers, types and uses.

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

Text Books:
1. Brahma Mishra, " Fertilizer Technology and Management", IK International Publishing House Pvt. Ltd., 2012
2. FAO, "Fertilizers and their use", 4th Edition, Scientific Publisher, New Delhi, 2015
3. Dr. Shalini Suri, "BioFertilizers and Biopesticides", APL publishing Corporation, 2011.

Suggested Reading:
1.UNIDO, " Fetilizer Manual", 3rd edition, Kluwer Academic Publishers,1998.

Web Resources :
1. www.webpages.uidaho.edu
2. www.wiley-vch.de

CH 462

MEMBRANE SEPARATION PROCESES
(Elective - II)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: To enable the students to understand
1. The fundamental principles and applications of different membrane processes
2. Types of membranes and preparation
3. Selection criteria for membrane processes
4. Various installations for Membrane Processes and simple design considerations

Course Outcomes: At the end of the course, students will be able to
1. Understand different types of membrane processes
2. Identify a membrane process for a specific application
3. Understand the types and preparation of membranes
4. Calculate performance factors for various membrane processes
5. Acquire knowledge about membrane modules
6. Write design equations for simple membrane modules

UNIT – I Introduction to Membrane Separation Processes: Classification of separation processes - Separating agents - principles of gas permeation, reverse osmosis, ultra-filtration, pervaporation, dialysis, Electro-dialysis.
Applications of membranes - for the separation of gases, waste water treatment, pulp and paper, electroplating and Electro-coating industries, food industry - denaturing of liquid foods, cheese making and whey processing

UNIT – II Preparation of Membranes: Basic introduction to different types of membrane materials. Basics of preparation of synthetic membranes - Sintering, Stretching, Track-Etching, Template Leaching, Phase-inversion, Coating, Sol-gel process

UNIT – III Ideal Separation on Capabilities of Membrane Processes: Separation factor, rejection factor, expressions for ideal separation factors in various membrane processes.
Secondary Phenomena in Membrane processes: Secondary physical and transport phenomena in membrane processes, concentration polarization in membrane processes.

UNIT – IV Equipment for Membrane Processes: Flat sheet, tubular, spiral wound and hollow fiber membrane modular designs for various membrane processes, single entry and double entry separating elements, separation stage. Flow configuration in membrane systems.

UNIT – V Design of Membrane Systems: Design equations for perfect mixing and cross flow configuration, separation stages for gas permeation, reverse osmosis and ultra filtration. Design equations for perfect mixing and parallel flow dialyze. Simple design equations for Electro-dialytic stacks

Text Books:
1. Kaushik Nath, “Membrane Separation Processes”, PHI Learning, 2008
2. Marcel Mulder, “Basic Principles of Membrane Technology”, Kluwer Academic Publishers, 2nd Ed., 1996

Suggested Reading:
1. Membrane Technology Lecture series of Winter School conducted at College of Tech, O.U., December, 1987
2. W L McCabe, J C Smith and P Harriot, “Unit Operations of Chemical Engineering”, 7th Ed., Mc-Graw Hill, 2005
3. Christie John Geonkoplis “Transport Processes and Separation Process Principals”, Pearson New Intl. Ed., 2013

CH 463

MINERAL PROCESSING TECHNOLOGY
(Elective II)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand:
1. the unit operations in mineral processing technology and mineral concentration processes.
2. the importance and principles of material handling in mineral processing plant with special emphasis on feeding and conveying of bulk material.
3. acquire practical skills in concentrates handling, grade determination, recovery and loss calculations.

Course Outcomes: At the completion of this course, students will be able to:
1. identify the principles governing a range of processes applied in mineral industry.
2. describe typical unit processes and flowsheets for production of a number of metals.
3. design the movement techniques of solids in fluids during processing.
4. design the slurry transport of materials and their separation.
5. apply basic engineering principles to develop flowsheets.
6. produce conceptual designs for simple extraction processes.

UNIT – I: **Introduction**
Scope and importance of Mineral Processing, Properties and Types of Minerals. Pretreatment of ores: removal of harmful materials, sampling of ores, moisture sampling, assay sampling, sampling systems, sample division methods, online analysis.

UNIT – II:
Mineral liberation: degree of liberation, concentration, measures of assessing metallurgical performance namely recovery, ration of concentration, grade, enrichment ratio.
Laboratory sizing: particle size and shape, sieve analysis, sub sieve techniques, microscopic sizing, centrifugal methods (Warman cyclosizer), online particle size analysis

UNIT – III:
Movement of solids in Fluids and classification: principles, types of classifiers, Gravity concentration − principles, concentration in vertical surren (Jigging), Jigs, types of Jigs viz., Harz Jig, circular and radial jigs, coal jigs (Baumb and Batac jigs). Gravity concentration in streaming currents, pinched sluice, cones, spirals, shaking tables.

UNIT –IV:
Slurry transport of materials: composition of slurry, online instrumentation for mass flow measurement, pumping equipment and piping for slurry transport. Heavy medial separation: principles, liquids and suspension for heavy media separation, separation vessels. Gravitational vessels, Wemco separator, drum separator, centrifugal separators, DMS cyclone, Vorsyl separator, LARCODEMS, Dyna whirlpool separator; DMS circuits.

UNIT – V:
Flotation – History and theory: contact angle, work of adhesion; Floatation Reagents: collectors, frothers, regulators; and their action – Floatation practice: ore and pulp preparation, reagents and conditioning.
Machines: pneumatic (Davcra cell, flotation column, Jameson cell, froth separators) and mechanical (Denver cell, Wemco cell). Electro flotation, skin flotation and table flotation.

Text Books:
1. B. A. Wills "Mineral Processing Technology" Maxwell International, 8th Ed., 1987.(Copyrights 2015).
2. S. K. Jain "Ore Processing" Oxford and IBH Publishing Co. (P) Ltd.,1st Ed., India, 1986.

Suggested Reading:
1. Warren L. McCabe, Julian C. Smith, Peter Harriott, "Unit Operations of Chemical Engineering" McGraw Hill Chemical Engineering Series, 7th Ed., 2005.
2. Maurice C. Fuerstenau, "Principles of Mineral Processing "Published by SME, 3rd Ed., 2003.
3. Robert Hallowell Richards, "A Textbook of Ore Dressing " MGH.3rd Ed., reprint 2015.

CH 464

POLYMER TECHNOLOGY
(Elective II)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course enables the students to understand the
1. different types and properties of polymers
2. various polymerization mechanisms
3. significance of polymer blends and their applications
4. techniques for polymerization
5. basics of polymer composites.

Course Outcomes: At the end of the course, students will be able to
1. identify polymers of industrial significance based on their properties.
2. distinguish various techniques for polymerization.
3. select polymer materials for industrial applications.
4. prefer polymer blends and alloys based on techno-economical consideration.
5. differentiate between different polymer composites based on their structural properties.
6. identify the importance of polymer nano-composites.

UNIT −I INTRODUCTION:
Polymers − definition, bonding, functionality, molecular weights and classification. Significant properties and applications of polymeric materials in process industries. Transition in polymers. Selection of Polymers for high and low temperature applications for process industries. Growth of polymer industry in India. Thermodynamics of polymer solutions, solubility parameter and its determination − Flory Huggins theory.

UNIT− II POLYMERIZATION MECHANISM:
Kinetics of polymerization mechanism. Types of polymerization − chain-polymerization, free radical, Step polymerization, anionic & cationic co-ordination polymerization, Poly-condensation.
Mechanism of ring opening, poly-addition and condensation polymerization.

UNIT −III POLYMER BLENDS:
Polymer blends and alloys, definition, reasons for blending, types of blends. Compatibilization, methods of blending, Techno-economical consideration for blending. Polymer rheology, recent applications of polymers, Electro-active polymers and biomedical applications.

UNIT− IV POLYMERIZATION TECHNIQUES:
Manufacture of polymers, different techniques practised, merits and demerits along with examples.
Bulk Polymerization – PET and PBT manufacture. Solution polymerization – Polypropylene manufacture. Suspension polymerization − PS and PMMA. Emulsion polymerization − SBR;
Processing of polymers − Compounding, moulding − Injection, rotational, compression, Extrusion, blow moulding.

UNIT −V POLYMER COMPOSITES:
Introduction, constituent materials, applications, polymers matrices. Polymer resins − epoxy, vinyl ester, silicone. Structural aspects influencing properties − Intermolecular and Intra molecular structures.
Manufacturing techniques of polymer composite materials − hand layup process, bag moulding process, filament winding, pultrusion. Introduction to polymer nano-composites.

Text Books:
1. P . Ghosh, " Polymer Science & Technology", TMH Publishing, New Delhi, 2002.
2. B.T. Astron, " Manufacturing of Polymer Composites", Chapman & Hall, 1997

Suggested Reading
1. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, "Polymer Science", New Age International, 1986.
2. Harry R. Allcock & Frederick W Lampe & James E. Mark, " Contemporary Polymer Chemistry", Prentice Hall, New Jersey, 2003.
3. L.A. Utraclci, "Polymer Blends & Alloys", Hanser Publishers, 1988
4. J.R. Fried, " Polymer Science & Technology", Prentice Hall Publications, 1999.

CH 465

PULP AND PAPER TECHNOLOGY
(Elective II)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

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

1. Basic concepts of Pulp and Paper making processes
2. Details of physical and chemical characteristics of fibrous raw materials and black liquor.
3. Varios types of cooking and bleaching methodologies.
4. Recovery of energy and chemicals used in pulping processes with due techno-economic and environmental considerations.

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

1. design the operation, maintenance and safety aspects for paper making.
2. identify the factors that drive industry trends.
3. grade paper and boards based on different testing methods.
4. select appropriate bleaching technique for required paper quality.
5. differentiate the important wood and fiber properties that affect paper quality.
6. identify, formulate and solve design problems pertaining to pulp digesters.

UNIT – I: Introduction

Importance of Paper , Definitions of Pulps

Wood Parts & Types: Ultra structure of Cell Wall, Wood cell types, Early & Latewood, Softwoods, Hardwoods & Non-woods.

Comparison of different raw materials.

Distribution of Wood Constituents – Cellulose, Hemi-cellulose, Lignin, Extractives and Inorganic components.

UNIT – II: Overview of pulping process

Mechanical Pulping: Pressurized ground pulping, Refiner Pulping, Chemo(thermo) mechanical pulping processes.

Kraft Pulping: Description of Kraft Cooking Process, Kraft recovery, Composition & Analysis of white liquor, Chemical reactions & process variables. Pulp yield, End uses of kraft pulps.

UNIT – III: Pulp and black liquor characterization

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

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

UNIT- IV: Bleaching operations

Objectives of bleaching – Elemental chlorine free and total chlorine free bleaching; Bleachability and its measurement, bleaching reactions, reaction kinetics and operating variables for different bleaching agents like ClO_2, O_2, O_3, hypochlorite, H_2O_2.

Stages of bleaching – Oxygen delignification, Chlorination, Extraction, Hypochlorite bleaching, Ozone bleaching, Peroxide bleaching, Operating variables for different bleaching stages; ECF and TCF bleaching systems for chemical pulps; bleaching systems for mechanical and high yield pulps.

UNIT – V: Paper Making and its Properties

Paper Testing Methods – Flowsheet of complete pulp and paper making process, Strength properties, Surface properties, Optical properties & Absorption properties. Different grades of paper, boards & newsprint specifications; BIS and ISO standards of paper. Paper properties dependence on paper making processes, Calibration of instruments.

Paper recycling process, Effluent treatment processes with environmental considerations.

Text Books:

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

Suggested Reading:

1.Hakan Karlsson, "Fiber Guide-Fiber analysis and process applications in the pulp & paper industry", Ab Lorentzen and Wetre, 1st Ed., 2006.
2.EIRI Board ., "Handbook of Pulp & Paper, Paper board and Paper based Technology", Engineers India Research Institute, 2nd Ed., 2015.

CH 416

EQUIPMENT DESIGN AND DRAWING

Instruction	3L Periods per week
Duration of University Examination	3 Hours
University Examination	50Marks
Sessionals	25 Marks
Credits	2

LIST OF EXERCISES

1. Symbols for Piping and Instrumentation.
2. Flowsheet symbols for unit operations.
3. Types of Heat transfer equipment and their representation symbols.
4. Process fluid transport equipment symbols.
5. Development and drawing of few flowsheets.
6. Typical layout, mechanical design and elevation drawings of storage vessels.
7. Design and elevation drawings of Reactor kettles.
8. Layout, design and elevation drawings of heat exchangers.
9. Elevation drawings and design of plate distillation column.

Suggested Reading:

1. Vilbrandt, C.T. and Dryden, C.E., "Chemical Engineering plant design", 4th Ed., Kogakusha, 1979.
2. Joshi, M.V. "Process Equipment Design", 2nd Ed., McMillan Co. of India Limited, Madras,1976.
3. Bachurst, J.R. and Harker, J.A. "Process Plant Design", Heiman Education Books, London, 1973.
4. Evans, F.L., "Equipment Design Hand Book for refineries and Chemical Plants", Vol .I, 1979, Vol. II, 1980, Gulf Publishing Co., Houston, Texas.

CH 417

MASS TRANSFER OPERATION LABORATORY

Instruction	3L Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

LIST OF EXPERIMENTS
(Minimum of 8 experiments to be performed)

1. Determination of concentration profile for the given system
2. Estimation of diffusivity coefficient for the gaseous system (CCl_4 - Air)
3. Estimation of diffusivity coefficient for the liquid system (H2SO4 - water)
4. Determination of vapor - liquid equilibrium data for the given system.
5. Estimation of vaporization efficiency and prediction of steam distillation temperature.
6. Verification of the Rayleigh`s equation for the system of methanol and water.
7. Determination of the capacity coefficient of the packed column under total reflux conditions and calculation of height equivalent to theoretical plate.
8. Development of the solubility curve for the given system
9. Prediction of Liquid - Liquid equilibrium data for the given system and determination of the plait point.
10. Calculation for percentage of extraction of solute from solid mixture using a solvent (Solid-Liquid extraction).
11. Estimation of the mass - transfer coefficient k_G for Air- Water system and plotting the variation of k_G with Reynolds's number.
12. Developing the drying curve by using tray drier and estimation and composition of time required for drying the given solid.

Suggested Reading:

1) Christie John Geankoplis, " Transport Processes and Separation Process Principles" , 4th Ed., Prentice Hall India, 2003.
2) McCabe and Julian Smith and Peter Harriott, " Unit Operations of Chemical Engineering", 7 th Ed., McGraw Hill Book Company, 2005.
3) R.E.Treybal, " Mass Transfer Operations", 3rd Edition, McGraw Hill Book Company 1981.

CH 418

PROJECT SEMINAR

Instruction	3L Periods per week
Sessionals	25 Marks
Credits	1

The objective of the project seminar is to actively involve the student in the initial work required to undertake the final year project. Dealing with a real time problem should be the focus of the under graduate project.

It may comprise of

- Problem definition and specifications.
- A broad understanding of the available techniques to solve a problem of interest.
- Presentation (Oral & written) of the project.

The department should appoint a project coordinator who will coordinate the following.

- Grouping of students as project batch(a maximum of 3 in group)
- Allotment of projects and project guides
- Project monitoring at regular intervals.

Each project group/batch is required to

1. Submit a one page synopsis of the seminar to be delivered for display on notice board.
2. Give a 30-40 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write up on the talk delivered.

Three (3) teachers will be associated with the evaluation of the project seminar for the award of the sessional marks which should be on the basis of performance on all the three items stated above.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)
SCHEME OF INSTRUCTION AND EXAMINATION
B.Tech – IV YEAR
CHEMICAL ENGINEERING

SEMESTER - I

S.No	Syllabus ref. no.	Subject	Scheme of Instruction			Scheme of Examination			
			Periods per week			Duration in Hours	Maximum Marks		Credits
			L	T	P/D		End exam	Sessionals	
THEORY									
1.	CH 411	Chemical Process Safety	4	0	0	3	75	25	3
2.	CH 412	Mass Transfer Operations -II	4	0	0	3	75	25	3
3.	CH 413	Petrochemical Engineering	4	0	0	3	75	25	3
4.	MB 216	Principles and Practice of Management	4	0	0	3	75	25	3
5.	CH 414	Process Equipment Design	4	0	0	3	75	25	3
6.		**Elective – II**	4	0	0	3	75	25	3
PRACTICALS									
7.	CH 415	Equipment Design and Drawing	0	0	3	3	50	25	2
8.	CH 416	Mass Transfer Operations Laboratory	0	0	3	3	50	25	2
9.	CH 417	Project Seminar	0	0	3	–	–	25	1
Grand Total (Theory + Practicals)			**24**	**0**	**9**	–	**550**	**225**	**23**

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

S.No	Syllabus ref. no.	**Elective – II**
6.	CH 461	Fertilizer Technology
7.	CH 462	Membrane Separation Processes
8.	CH 463	Mineral Processing Technology
9.	CH 464	Polymer Technology
10.	CH 465	Pulp and Paper Technology

SEMESTER – II

S.No	Syllabus ref. no.	Subject	Scheme of Instruction			Scheme of Examination			
			Periods per week			Duration in Hours	Maximum Marks		Credits
			L	T	P/D		End exam	Sessionals	
THEORY									
7.	CH 421	Plant Design and Economics	4	0	0	3	75	25	3
8.	CH 422	Transport Phenomena	4	0	0	3	75	25	3
9.		**Elective – III**	4	0	0	3	75	25	3
10.		**Elective – IV [Open Electives]**	4	0	0	3	75	25	3
PRACTICALS									
11.	CH 423	Seminar	0	0	3	–	–	25	1
12.	CH 901	Project	0	0	6	Viva	100	50	9
Grand Total (Theory + Practicals)			**16**	**0**	**9**	–	**400**	**175**	**22**

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

S.No	Syllabus ref. no.	**Elective – III**	S.No	Syllabus ref. no.	**Elective – IV**
5.	CH 471	Corrosion Engineering	5.	CE 422	Disaster Mitigation and Management
6.	CH 472	Fluidization Engineering	6.	ME 464	Entrepreneurship
7.	CH 473	Pollution Control in Process Industries	7.	PE 484	Nano Materials and Technology
8.	CH 474	Sugar Technology	8.	CH 481	Nuclear Engineering

CH 421

PLANT DESIGN AND ECONOMICS

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

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

1. fundamentals of investments and engineering economics.
2. flowsheet synthesis and integrate with process equipment design.
3. design concepts with principles of process economics.
4. methods to quantify concepts such as fixed capital investment, cash-flow analysis, profitability analysis and decision making.

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

1. calculate the time value of money and depreciation.
2. estimate fixed and working capitals and operating costs for process plants.
3. calculate the Rate of return and payout time for design of any process plant.
4. evaluate the profitability of process industry projects using measures such as ROI, NPV and DCF
5. identity and apply the selection criteria for design of flowsheets, equipment and material.
6. design the piping specifications as per standards.

UNIT – I

Economic equations. Present and future worth. Equivalence and value for money. Nominal and effective interest rates. Capitalized cost, sinking fund, definition of bond and problems. Types of depreciation and problems.

UNIT - II

Capital requirements by Chilton and Lang, Schweyer, Cost indices methods. Total investment schedule. Sources of capital. Balance sheet and problems. Economic charts. Problems on break even, variable cost, fixed cost. Estimation of profit and capital ratios.

UNIT - III

Selection of alternative equipment or plants by annual cost. Present cost and Capitalized cost methods. Replacement of existing equipment. Rate of return and payout time methods and problems.

UNIT – IV

Process evolution. Stages of process design. Types of flowsheets. Selection criteria of process equipment - material handling (solids, liquids & gases) - separation equipment (solid - solid sold - liquid, liquid - solid etc), Size reduction equipment, agitators, drying equipment filtration equipment, reactors. Procedure for material selection.
Introduction to Design and Automation of process plants. Examples.

UNIT – V

Piping and tube specifications, pipe fabrication methods, piping material, principles of piping layout, piping stresses, stress design and supports. Pressure drop in pipe lines, piping friction factor, design of pipe lines for natural gas, selection of valves. Introduction to P & ID Diagrams.

Text Books:

1. Max. Peters, K Timmerhaus and Ronal West, "Plant Design and Economics for Chemical Engineers", 5th Ed., McGraw Hill Publications, 2003.
2. C.Vilbrandt and Dryden C.E, "Chemical Engineering Plant Design", 4th Ed, MGH Book Co., Reprints 2015..

Suggested Reading:

1. Seider W.D., Seader J.D. & Lewin D.R., "Product and Process Design principles: Synthesis, Analysis and Evaluation", John Wiley & Sons, Inc., 2nd ed., 2010
2. J.M. Coulson and J.F Richardson, "Chemical Engineering", Vol.6, 5th ed. Pergamon and ELES, 2003.
3. H.E.Schweyer., "Process Engineering Economics", MGH Book Co, NewYork, 2001.

CH 422

TRANSPORT PHENOMENA

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: Introduces the students to

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

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

1. Apply the first principles to solve various chemical engineering problems.
2. Compare various flow phenomena
3. Develop expressions for steady state velocity, temperature and concentration profiles using shell balance method
4. Apply equations of change to solve flow problems.
5. Develop expressions for unsteady state isothermal and non-isothermal flows
6. Time smooth equations of change.

UNIT – I

Introduction – Mechanism of molecular transport of momentum, heat and Mass Transfer. Flux equations – Newton's, Fouriers' and Fick's laws - Similarities and differences

Non-Newtonian fluids, transport properties – estimation, temperature and pressure dependence, estimation of transport properties of binary gaseous mixtures

Velocity distributions in laminar flow – shell momentum balances – Flow of falling film – flow of fluids through circular tubes, annulus and Immiscible fluids between parallel plates. Creeping flow around sphere

UNIT – II

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

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

UNIT – III

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

UNIT – IV

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

UNIT – V

Unsteady state problems in momentum, energy and Mass Transfer operations; Turbulence - Time smoothing of equations of change of momentum, energy and Mass Transfer; Eddy properties - Intensity of turbulence Reynolds stresses; Semi empirical expressions for turbulent –Momentum – energy and mass fluxes

Text Books:

1. R.B.Bird, W.E.Stewart, and E.N.Lightfoot , "Transport Phenomena", John Wiley & sons, 1960
2. R.B.Bird, W.E.Stewart, and E.N.Lightfoot , "Transport Phenomena", John Wiley & Sons. Inc. 2002

Suggested Reading:

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

CH 471

CORROSION ENGINEERING
(ELECTIVE − III)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

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

1. definition and classification of corrosion.
2. principles of corrosion, common corrosion forms,
3. different corrosion testing methods.
4. corrosion control methods and material selection for cost reduction.
5. modern theories to explain corrosion

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

1. identity the type of corrosion.
2. correlate the damage with the cause of corrosion.
3. identify the correct method of testing any corrosion.
4. select the appropriate preventive method to avoid corrosion.
5. select the significant coating for corrosion prevention.
6. apply modern method of corrosion measurement.

UNIT− I: Introduction:
Definition, corrosion environments, damage, classification of corrosion. Principles and corrosion rate expressions. Environmental effects such as velocity, temperature, galvanic coupling. Metallurgical and other aspects

UNIT− II: Different forms of corrosion:
Uniform attack, galvanic corrosion, crevice corrosion, fitting corrosion, inter– granular corrosion, selective leaching, erosion corrosion, stress corrosion and hydrogen damage.
Pitting: pit shape and growth, velocity, metallurgical variables, evaluation of pitting damage, prevention.

UNIT− III: Corrosion testing methods:
Classification, purpose, surface preparation, measuring and weighing, duration, plant interval test, NACE test methods, slow – strain rate test and paint test.
Composites testing: Exposure techniques, Huey test, Sea water test, Stress corrosion, Corrosion of palstics, Invivo corrosion.

UNIT −IV: Corrosion prevention methods:
Selection of metals and alloys–Cast iron, steel, Al, Mg, Ti, Composites and Refractory metals.
Non-metallics: Thermosetters, laminates and reinforced plastics, Rubbers, Wood, Ceramics, Carbon and Graphite. Alteration of environment such as changing mediums, lowering temperature, design rules, design of cathodic and anodic protection, selected coating techniques to prevent corrosion; Failure analysis. High temperature corrosion.

UNIT −V: Advanced techniques:
Modern theory–principles and applications, electrode kinetics, predicting corrosion behavior, corrosion prevention, Corrosion rate measurements in Petroleum Industry with examples.

Text Books:

1. Pierre R. Roberge, " Handbook of Corrosion Engineering", 2nd edition, MCGraw-Hill, Newyork, 2012
2. Zaki Ahmad, "Principles of Corrosion Engineering and Corrosion Control", Butterworth-Heinemann, 2006.

Suggested Reading

1. Pierre R Roberge, "Corrosion Engineering – Principles and Practice, MCGraw-Hill, 2008
2. Pierre R. Roberge, Corrosion Basics: An Introduction, NACE International, 2006.

Web resources :

1. www.academia.edu/5491377/corrosion_engineering_mars_g._fontana

CH 472

FLUIDIZATION ENGINEERING
(ELECTIVE − III)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credit	3

Course Objectives: This course helps the students to understand:

1. Basic fundamentals of fluidization and fluidized bed behavior.
2. Minimum fluidization and pressure drop across the bed.
3. Various models to analyze the behavior and mixing patterns.
4. Heat and mass transfer aspects of fluidized bed.
5. Concepts of fluidized bed combustion chamber.

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

1. Calculate the minimum fluidization velocity and optimum operating fluidization velocity.
2. Design the cooling tube length for required heat transfer area.
3. Design the complete fluidized bed in terms of pressure drop across the bed a
4. Design the distributors, TDH, height, diameter, power consumption of compressor for air.
5. Distinguish between boiler and furnaces, methods of starting up.
6. Calculate the amount of chemicals required to control the emission like SO2.

UNIT – I INTRODUCTION:

Processes involving contact between solid particles and a Fluid, Packed Beds, Fluidized Beds advantages and disadvantages of fluidized beds for industrial applications. Fundamental fluidized bed behavior, Fast fluidization, circulating fluidized beds.

Particles and Fluidization: Physical properties of solid particles, size and sharp, size range, surface area of particles in a bed, Bed voidage, classification of particles according to Fluidization characteristics, pressure drop across packed beds, minimum fluidization velocity and its determination.

UNIT – II TWO – PHASE THEORY OF FLUIDIZATION:

Bubbles and Fluidization Regimes, Bubble rise velocity, Bed expansion, Bubble growth and slugging, Mixing, Elutriation and Transport of solids, General mechanism of mixing of particles, mixing and segregation of particles, Terminal velocity of particles, Elutriation, transport disengaging height, solids transport. Davidson's Model, Diffusion model, Bubbling bed model ideal mixing stage model, two regime models.

UNIT – III FLUIDIZED BED HEAT TRANSFER:

Heat Transfer in Beds of Particles, Gas -to- particle heat transfer, Bed – to- surface heat transfer, particle convection component, interphase gas connective component, Radioactive component, Estimation of Bed–to surface Heat Transfer coefficient, Heat Transfer between the Bed-Distributor, side walls, immersed tubes or components, Heat Transfer to surfaces located above the Bed, Free surface, Design for physical operation, Batch and continuous operation for Mass & Heat Transfer and Drying of solids.

UNIT IV DESIGN OF SIMPLE FLUIDIZED BEDS:

Introduction, Estimation of Bed Dimensions and Fluidizing velocity, Transport disengaging Height, Distributors, Heat removal from fluidized beds from cooling tubes in the bed, optimum size of a fluidized bed reactor. Power consumption.

UNIT – V FLUIDIZED BED COMBUSTION:

Introduction, combustion systems for solid fuels combustors and the first law of thermodynamics, fluidized Bed combustion of solid fuels, pressurized fluidized bed combustion, size of fluidized bed combustion system, size of inert particles in the bed, turndown efficiency of fluidized bed combustion, Equipment, combustion of fuel particles in a fluidized bed, Distinguish between boiler and furnaces, methods of starting up, circulating or 'fast' fluidized bed combustion systems, control of emission of SO2.

Text Books:

1. J.R. Howard Adam Hilger, "Fluidized Bed Technology -Principles & Applications", IOP, Pub Ltd., NY. 1989.

Suggested Reading

1. Diazo Kuni & Octave Levenspiel, " Fluidization Engineering", 2nd Edition, John Wiley and Sons, 2002.
2. John M. Matsen, Grace John R , "Fluidization", Springer-Verlag New York Inc., 1980.

CH 473

POLLUTION CONTROL IN PROCESS INDUSTRIES
(ELECTIVE − III)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course objectives: This course helps the students to understand:

1. effects of pollution on environment and ecosystems
2. types and sources of pollution from process industries,
3. measurement of air and water pollution in process industries
4. the essential principles and equipment used in industrial pollution abatement

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

1. differentiate the types of wastes generated in an industry, their effects on living and non-living things
2. analyze the effect of climate changes, atmospheric dispersion of air pollutants, and operating principles.
3. design and calculate the required particulate control devices.
4. quantify and analyze industrial wastewater and its treatment.
5. identify appropriate unit operations & unit processes for conversion of polluted water to bearable standard limits.
6. analyze the hazardous and nonhazardous solid wastes and select the treatment and disposal methods.

UNIT - I Introduction:

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

UNIT – II Air Pollution:

Meteorological aspects of pollution dispersion, adiabatic and environmental lapse rate, Turbulence and stability of atmosphere. Indoor air pollution - smoke and hydrocarbons. Richardson Number, Plume raise, plume behavior and characteristics, effective stack height.

General Control Methods and Equipment**:** removal of sulphur dioxide, oxides of nitrogen and carbon, organic vapors from gaseous effluents. Removal of particulate matter - principle and working of settling chambers cyclone separators solid traps, fabric and fiber filters, electro-static precipitators.

UNIT – III: Water pollution

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

UNIT - IV Solid waste management:

Industrial solid wastes − Types, classification, properties, management and general disposal methods. Hazardous industrial solid wastes – environmental effects and disposal methods commonly practiced.

Methods practiced in chemical, paper and textile industries.

UNIT - V Pollution control practices in Process Industries

Principle, working mechanism and application of tertiary treatment methods like carbon adsorption, Ion-exchange, Reverse Osmosis, Ultra Filtration in process industries.

Sludge treatment and disposal methods like Incineration and land filling. Pollution control in petroleum and fertilizer industries

Text Books:

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

Suggested Reading

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

CH 474

SUGAR TECHNOLOGY
(ELECTIVE – III)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand:
1. the performance measures of different types of unit operations in sugar processing
2. applications, advantages and limitations of the processing procedure
3. the competence and optimization of advanced technology in sugar processing.
4. the possible byproducts of any sugar industry and production of salable derivatives.

Course Outcomes: At the end of the course, student will be able to apply the
1. principles and skills of work in sugar cane milling, processing and refining in practical settings.
2. analyze the composition of different types of sugars by volumetric and gravimetric determination.
3. different unit operations for effective processing of cane juice.
4. batch and continuous methods for an efficient operation of sugar industry.
5. concepts of quality assurance and control in industry as per Indian regulations and practices.
6. methods to reclaim byproducts.

UNIT - I

Importance of sugar industry. Different raw materials for sugar manufacturing, composition of raw materials, history, origin and distribution of sugarcane, production and productivity of sugarcane in India. Indian sugar industry on global screen. Manufacturing processes of raw sugar and crystalline white sugar. Reducing sugars - composition, volumetric and gravimetric determination methods.

UNIT - II

Conveying of raw materials - cane carrier and feeding table working principles. Cane preparation – objective, sieving, preparation index, cane knives, crushing and shredding applications. Extraction of cane juice by milling operation - basic concept of roller mills, working principles, conditions for good milling operation, milling efficiency, maceration and imbibitions – importance, effect, method, objective and efficiency. Cane juice clarification – simple, compound and neutral defaction procedures. Sulphitation and carbonation - batch and continuous methods. Single and double carbonation process, De-Hans' process, comparison of different clarification modern techniques.

UNIT - III

Juice heaters - construction and working principles. Juice filtration - plate and frame filter presses, RVDF, types of filter cake washing. Evaporation- multiple effect evaporators - construction and operation. Steam economy and capacity. Vacuum pan boiling - construction, types of pans, speed of circulation, heating surface to volume ratio, pan boiling techniques, different boiling schemes.

UNIT - IV

Crystallization – nucleation, graining methods, advantages and disadvantages of graining. Theory of crystallization, crystallization zone, crystal growth. centrifuge –construction & working, factors influences on time of curing. Advantages and disadvantages of batch / continuous centrifugal machine. Separation of molasses-different molasses conditioning methods, precautions during molasses conditioning.

Sugar drying -various aspects regarding drying and cooling, rotary dryer. Packing of sugar -types of sugar grader, dilution indicator, quality and safety factors, location and stalking of sugar bags.

UNIT - V

Sugar byproducts: bagasse, pressmud and molasses- their composition and applications. Production of bio-gas, fibre board, furfurol filter mud, extraction of cane wax, manure, industrial alcohol and rectified spirit. Sugar scales and normal weight.

Text Books:

1. Meade and Chen, " Hand of book of cane sugar", 11th Ed , Wiley Interscience, New York, 2001.
2. James C.P Chen, "Cane Sugar Hand book", 12th Ed, Elsevier Pub. Co., New York, 1993.

Suggested Reading:

1. R B L Mathur, Hand Book of Cane Sugar Technology", 2nd Ed, Oxford & IBH, 1978.
2. John H. Payne, "Unit operation in cane sugar production", Sugar series book 4, Elsevier Pub. Co., New York, 1982.

CE 422

DISASTER MITIGATION AND MANAGEMENT
(ELECTIVE – IV)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives:

1. To equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities including natural, climatic and human induced factors and associated impacts.
2. To impart knowledge in students about the nature, mechanism causes, consequences and mitigation measures of the various natural disasters including hydro metrological and geological based disasters.
3. To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters including chemical, biological and nuclear warfare agents.
4. To equip the students with the knowledge of various chronological phases in the disaster management cycle.
5. To create awareness about the disaster management framework and legislations in the context of national and global conventions.
6. To enable students to understand the applications of geospatial technologies like remote sensing and geographical information systems in disaster management.

Course Outcomes:

1. Ability to analyse and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at local level
2. Ability to choose the appropriate activities and tools and set up priorities to build a coherent and adapted disaster management plan.
3. Ability to understand various mechanisms and consequences of natural and human induced disasters for the participatory role of engineers in disaster management.
4. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans
5. Ability to understand various participatory approaches/strategies and their application in disaster management
6. Ability to understand the concepts of remote sensing and geographical information systems for their effective application in disaster management.

UNIT-I:

Introduction to Natural, human induced and human made disasters – Meaning, nature, types and effects; International decade of natural disaster reduction (IDNDR); International strategy of natural disaster reduction (ISDR)

UNIT-II:

Natural Disasters– Hydro meteorological disasters: Causes, impacts, Early warning systems, structural and non-structural measures for floods, drought and cyclones; Tropical cyclones: Overview, cyclogenesis, drought monitoring and management.; Geographical based disasters: Earthquakes and Tsunami- Overview, causes, impacts, zoning, structural and non-structural mitigation measures; Tsunami generation; Landslides and avalanches: Overview, causes, impacts, zoning and mitigation measures. Case studies related to various hydro meteorological and geographical based disasters.

UNIT III:

Human induced hazards: Risks and control measures in a chemical industry**,** Causes, impacts and mitigation measures for chemical accidents, chemical disaster management, current status and perspectives; Case studies related to various chemical industrial hazards eg: Bhopal gas tragedy; Management of chemical terrorism disasters and biological disasters; Radiological Emergencies and case studies; Case studies related to major power break downs, fire accidents and traffic accidents .

UNIT IV:

Use of remote sensing and GIS in disaster mitigation and management; Scope of application of ICST (Information, communication and space technologies in disaster management, Critical applications& Infrastructure; Potential application of Remote sensing and GIS in disaster management and in various disastrous conditions like earthquakes, drought, Floods, landslides etc.

UNIT V:

Concept of Disaster Management: Introduction to disaster management, Relationship between Risk, vulnerability and a disaster, Disaster management cycle, Principles of disaster mitigation: Hazard identification and vulnerability analysis, Early warning systems and forecasting; Infrastructure and development in disaster management; Disaster management in India: National disaster management framework at central, state, district and local levels. Community based disaster management.

Text Books:

1. Rajib, S and Krishna Murthy, R.R, "Disaster Management Global Challenges and Local Solutions" Univ. Press Hyd., 2012.
2. Notes / Reading material published by National Disaster Management Institute, Ministry of Home Affairs, Govt. of India.

Suggested Reading:

1. Navele, P & Raja, "C.K. Earth and Atmospheric Disasters Management, Natural and Manmade". B.S. Pub., Hyd., 2009.
2. Fearn-Banks, K, "Crises computations approach: A case book approach", Route ledge Pub., Indian Edu., New York 2011.
3. Battacharya, T., "Disaster Science and Management", Tata McGraw Hill Company, New Delhi, 2012.

ME 464

ENTREPRENEURSHIP
(ELECTIVE – IV)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. To understand the essence of Entrepreneurship
2. To know the environment of industry and related opportunities and challenges
3. To know the concept a procedure of idea generation
4. To understand the elements of business plan and its procedure
5. To understand project management and its techniques
6. To know behavioral issues and Time management

Outcomes: After completing this course, students will be able to:

1. Apply the entrepreneurial process
2. Analyze the feasibility of a new business plan and preparation of Business plan
3. Evaluate entrepreneurial tendency and attitude
4. Brainstorm ideas for new and innovative products or services
5. Use project management techniques like PERT and CPM
6. Analyze behavioural aspects and use time management matrix

UNIT-I

Indian Industrial Environment: Competence, Opportunities and Challenges, Entrepreneurship and Economic growth, Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries, Types of enterprises, Corporate Social Responsibility.

UNIT-II

Identification and characteristics of entrepreneurs: First generation entrepreneurs, environmental influence and women entrepreneurs, Conception and evaluation of ideas and their sources, Selection of Technology, Collaborative interaction for Technology development.

UNIT-III

Business plan: Introduction, Elements of Business Plan and its salient features, Technical Analysis, Profitability and Financial Analysis, Marketing Analysis, Feasibility studies, Executive Summary.

UNIT-IV

Project Management: During construction phase, project organization, project planning and control using CPM, PERT techniques, Human aspects of project management, Assessment of tax burden

UNIT-V

Behavioral aspects of entrepreneurs: Personality, determinants, attributes and models, Leadership concepts and models, Values and attitudes, Motivation aspects, Change behavior

Time Management: Approaches of time management, their strengths and weaknesses. Time management matrix and the urgency addiction

Text Books:

1. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997.
2. Prasanna Chandra, "Project-Planning, Analysis, Selection, Implementation and Review", Tata Mcgraw-Hill Publishing Company Ltd. 1995.
3. S.S. Khanka, "Entrepreneurial Development", S. Chand & Co. Pvt. Ltd., New Delhi

Suggested Reading:

1. Robert D. Hisrich, Michael P. Peters, "Entrepreneurship", Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005
2. Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster Publication, 1994.
3. Sudha G.S., "Organizational Behavior", National Publishing House, 1996.

PE 484

NANO MATERIALS AND TECHNOLOGY
(ELECTIVE – IV)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Objectives:

1. Students are able to understand the nanotechnology approach and challenges
2. To give the student familiarities about materials of nanotechnology
3. Students are able to understand the nano structurers
4. Students are able to learn nano fabrication
5. Students are able to understand special nano materials
6. Students are able to understand bio materials

Outcomes: At the end of the course

1. Understand the developments and challenges in nano technology
2. Understand synthesis and properties of nanostructured materials
3. Analyze magnetic and electronic properties of nano materials
4. Analyze nano fabrication methods and their applications
5. Understand the characterization of nano and bio materials and their use
6. Analyze the synthesis and characterization of nano wires and tubes

Unit I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nanotechnology, Bottom-up and Top-down approaches, challenges in nanotechnology, proximal probe technologies.

Unit II

Materials of Nanotechnology: Introduction, Si-based materials, Ge-based materials, Ferroelectric materials, Polymer materials, GaAs& InP (HI-V) group materials, Nanotribology and materials, characterization using Scanning Probe Microscope, AFM, FFM

Unit III

Nano Structures: Zero dimensional Nanostructure (Nano particles), synthesis procedure, characterization techniques, properties and applications of Nano particles

One dimensional Nanostructures (Nano Wires, Nano Tubes), various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes

Unit IV

Nano Fabrication: Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping), MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques).

Unit V

Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal-ceramics and Polymer-ceramics), Characterization procedures, applications, Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications

Text Books:

1. A.K. Banopadyay, 'Nano Materials', New Age Publications
2. T. Pradeep, 'Textbook of Nanoscience and Nanotechnology', McGraw Hill Edu. (India) Pvt Ltd., New Delhi
3. Dieter Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications,Wiley, 2013

Suggested Reading:

1. Carl C. Koch, 'Nano Materials Synthesis, Properties and Applications', Jaico Publishing House
2. Willia Tllsey Atkinson, 'Nano Technology', Jaico Publishing House
3. George W. Hanson, 'Fundamentals of Nanoelectronics', Pearson Education, 2009
4. T. Pradeep, 'Nano: Essentials-understanding Nano Science and Technonology', TMH, 2007
5. Sabu Thomas, Nandakumar Kalarikkal, A. Manuel Stephan, B. Raneesh, "Advanced Nanomaterials: Synthesis, Properties, and Applications", Apple Academic Press

CH 481

NUCLEAR ENGINEERING
(ELECTIVE − IV)

Instruction	4L Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	3

Course Objectives: This course helps the students to understand:

1. fundamentals of nuclear fission reactions and products.
2. types of nuclear fuel materials, properties, characteristics.
3. nuclear fuel separation and enrichment methods along with flowsheets.
4. non-fuel materials required for design of the reactor structure, cladding and for moderation.
5. different types of reactors, concepts of heat removal, control and safety systems.
6. spent fuel management.

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

1. identify the various radioactive elements based on the mechanism of fission process.
2. processing and handling techniques for enrichment of fuel materials.
3. properties and radiation effects of materials for design of cladding structure.
4. concepts of fuel source, heat removal, control and safety needs for operation of nuclear reactors .
5. design and working of fast breeder reactors.
6. techniques practiced for handling, storage and reprocessing of spent fuel.

UNIT – I: Nuclear fission

Atomic structure and isotopes of radioactive material, nuclear elements, nuclear binding energy, radioactive nuclides and nuclear stability, radioactivity, radioactive decay - alpha decay, beta decay, gamma rays.

Neutron reactions, fission cross-sections, fission rate and reactor power, prompt and delayed fission neutrons, fission products.

UNIT – II: Nuclear fuel materials

Types of fuel materials, properties and significant characteristics, fuel cycle, pre-reactor fuel operations, isotopic enrichment, isotopic separation requirements. Nuclear fuel utilization – breeding ratio, Uranium, Thorium and Plutonium utilization.

UNIT – III: **Non-fuel reactor materials**

Classification, mechanical properties, radiation effects of materials, corrosion of metals, structural and cladding materials, moderator and reflector materials.

UNIT – IV: Nuclear fission reactors

General features, classification, reactor development for power production. Design features, concepts of heat removal, control and safety systems for: pressurized water reactors (PWR), boiling water reactors (BWR). Heavy water moderated reactors (HWMR) and Fast breeder reactors (FBR).

UNIT – V: Spent fuel management

Characteristics of spent fuel, storage, disposal, reprocessing of spent fuel, solvent extraction separation process, other possible separation processes.

Text Books:

1. Samuel Glasstone and Alexander Sesonske, "Nuclear Reactor Engineering", 3rd Ed, CBS Publishers and distributors, New Delhi, 1986.

Suggested reading:

1. Benjamin M. MA, "Nuclear reactor materials and applications", Van Nostrand Reinhold Co., New York, 1975.
2. John R. Lamarsh, "Introduction to Nuclear Engineering", Addison-Wesley publishing Co., Philippines, 1975.
3. Raymond L. Murray, "Nuclear Energy", Pergamon Press, New York, 1975.

CH 423

SEMINAR

Instruction	3L Periods per week
Sessionals	25 Marks
Credits	**1**

Oral presentation is an important aspect of engineering education. The objective of the seminar is to prepare the student for a systematic and independent study of state of the art topics in a broad area of his /her specialization.

Seminar topics may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

- Literature survey
- Consolidation of available information
- Power point Preparation
- Technical writing

Each student is required to:

1. Submit a one page synopsis of the seminar talk for display on the notice board.
2. Give twenty(20) minutes presentation through OHP/ PPT/ Slide Projector followed by Ten(10) minutes discussion
3. Submit a report on the seminar topic with list of references and hard copy of the slides.

Seminars are to be scheduled from 3rd week to the last week of the semester and any change in schedule should be discouraged.

For the award of sessional marks students are judged by three (3) faculty members and are based on oral and written presentations as well as their involvement in the discussions during the oral presentation.

Note: Topic of the seminar should be from any peer reviewed recent journal publications.

CH 901

PROJECT

Instruction	6L Periods per week
University Examination	Viva-voce
University Examination	100 Marks
Sessionals	50 Marks
Credits	9

Dealing with a real time problem should be the focus of under graduate project.

All projects will be monitored at least four times in the II-semester through individual presentations (Project batch wise).

Every student should maintain a project dairy, wherein he/she needs to record the progress of his/her work and get it signed at least once in a week by the guide(s). If working outside and college campus, both the external and internal guides should sign the same.

Sessional marks should be based on the marks, awarded by a project monitoring committee of faculty members as well as the marks given by the guide.

Common norms are established for final documentation of the project report, the students are directed to download from the website regarding the guidelines for preparing the project report and the project report format.

The project report shall be evaluated for 100 Marks by the External Examiner.

If the project work found inadequate in the end examination, the candidate should repeat the project work with a new problem or improve the quality of work and report it again.

Break up for 100 Marks in the end examination:

1. Power point presentation 20 Marks
2. Thesis/Report preparation 40 Marks
3. Viva-voce 40 Marks