B. Tech. Degree
in
CHEMICAL ENGINEERING

SYLLABUS
FOR
CREDIT BASED CURRICULUM
(For students admitted in 2013-14)

DEPARTMENT OF CHEMICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015
TAMIL NADU, INDIA
CURRICULUM
The total minimum credits required for completing the B. Tech. Programme in Chemical Engineering is 182 (45+137)

SEMESTER III

<table>
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<tr>
<th>CODE</th>
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LIST OF ELECTIVES

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ELECTIVE 2&3

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ELECTIVE 4&5

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Any other electives from other department.

ELECTIVE 6,7&8

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LIST OF ADVANCED LEVEL COURSES OFFERED TO OBTAIN B. Tech. HONOURS

(A student with consistent academic record of GPA ≥ 8.5 from I to IV semesters, and applied for B. Tech Honours can opt to study any 3 of the listed advanced level courses from V semester)

(A student who has consistently obtained a minimum GPA of 8.5 in the first 4 semesters and desires to apply for B. Tech. Honours should maintain the same minimum GPA in the subsequent semesters AND opt to study any 3 of the listed advanced level courses approved to be offered by the department concerned to such applicants from V semester)
### LIST OF ADVANCED LEVEL COURSES OFFERED TO OBTAIN B. Tech. HONOURS

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(SYLLABUS)

MA 201  TRANSFORMS, SPECIAL FUNCTIONS AND PARTIAL DIFFERENTIAL EQUATIONS  L  T  P  C
3  1  0  4

COURSE OBJECTIVES
(i) To understand the basic principle of contents of Mathematics
(ii) Mathematics is a tool in the hands of engineers to make it effective it is imperative to
   a. know clearly how tool works
   b. To build the logic of students
   c. To increase the computational skill of student
(iii) Mathematics leads to creative thinking
(iv) To prepare students for their respective branches

COURSE CONTENT
Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform – Convolution theorem – Periodic functions – Application to ordinary differential equation and simultaneous equations with constant coefficients and integral equations.


Bessel’s Equation – Bessel Functions – Recurrence relations – Generating function for Bessel functions – Legendre’s equation – Legendre polynomials – Rodrigue’s formula-generating function and recurrence relations for Legendre polynomials – orthogonality property of Legendre polynomials.


Applications of Partial Differential Equations – Solution of one-dimensional heat flow equation and two dimensional heat flow equation (Cartesian and Polar form) in steady state by the method of separation of variables using Fourier series.

COURSE OUTCOME
i. The ability to derive and apply solutions from knowledge of Mathematics.
ii. Graduate will have confidence to apply science & Engg. Solutions in global & social context using Mathematics.
iii. Graduate can participate & attend to succeed in competitive exams like GATE, TOFEL, and GRE etc.
iv. Graduates will be capable of pursuing higher studies, Research and development activities.
v. Graduates will have ability to identify, to formulate and solve engineering problems.

REFERENCES:

B.Tech. Chemical Engineering
COURSE OBJECTIVES
(i) To impart the basic concepts of organic chemistry.
(ii) To develop understanding about concepts on organic reactions for analysis of unit processes.

COURSE CONTENT
Unit I: Fundamentals of Photochemistry, Qualitative introduction about different transitions, Cis-Trans isomerization, Paterno-Buchi reaction, Norrish type I and II reactions, photo reduction of ketones, di-pi-methane rearrangement, photochemistry of arenas.

Unit II: Pericyclic reactions, Classification, electrocyclic ring opening and closure, Cope & Claisen rearrangement, 2+2 and 4+2 cycloaddition and ene reactions, Woodward-Hoffmann rules, and FMO theory. Coal Tar distillation separation of aromatics. Theory of orientation in aromatic electrophilic substitution in benzenoid and heterocyclic compounds.


Unit IV: Identification of organic compounds by using combined Mass, IR and NMR spectral analysis. Index of hydrogen deficiency. Mass spectroscopy: Methods of desorption and ionization (EI, CI, MALDI, ESI), study of fragmentation pattern. Basics of IR spectroscopy, applications. Basic Principles of $^1$H & $^{13}$C NMR, Applications of $^1$H and $^{13}$C NMR (DEPT) to organic chemistry, Case studies and combined problems

Unit V: Carbohydrates: Structure of ribose, glucose, fructose, sucrose, starch & cellulose and cyclodextrins, inter conversions of sugars. Dye industry, Synthesis and applications of Azodyes, Vat dyes, triphenyl methane dyes, Mordant Dyes, Leuco Dyes, Eco Friendly Dyes, Environmental hazards from dying industry, Waste treatment in dye industry, Oils and Fats, Analysis.

COURSE OUTCOME
i. Ability to understand the basic reactions required for chemical unit operations
ii. Ability to understand carbon chemistry.
iii. To understand the synthesis of organic compounds

TEXT BOOKS:

REFERENCES:

B.Tech. Chemical Engineering
COURSE OBJECTIVES:
- To provide the key concepts about Transformers, DC and AC motors and thereby able to choose the appropriate drives for various applications.
- To equip students to understand and apply the basic concepts of Combinational logic circuits and INTEL 805 Microprocessor.

Prerequisites: Basic Electrical and Electronics Engineering
DC motors - Characteristics - Starting and speed control – Testing - Applications.
Transformers: (Single phase only) - equivalent circuit and regulation - losses and efficiency - Testing.

Three-phase induction motor - Cage and slip ring motors -torque slip characteristics –starting and speed control of induction motors - single phase induction motors and universal motors.
Synchronous motors - starting and applications.

Electric drive for general factory, textile mill, cement mill - pump, blowers, hoists, traction etc. - group and individual drives.

Combinational logic - representation of logic functions – SOP and POS forms K-map representations – minimization using K maps - simplification and implementation of combinational logic – multiplexers and demultiplexers – code converters, adders, subtractors, memory and its types.

Microprocessor – Architecture of INTEL 805 – Instruction set – addressing modes - Basic assembly language programming

TEXT BOOKS:

REFERENCE BOOKS:

COURSE OUTCOMES:
Upon completion of the course, the student will be able to
1. Analyze the performance of DC Motors and Transformers under various operating conditions using their various characteristics.
2. Describe different types AC motors and their characteristics.
3. Select appropriate drive for any industrial application.
4. Design and analyze combinational logic circuits.

Understand the architecture and instruction set of 8085.
**COURSE OBJECTIVE:**

(i) To impart the basic concepts of chemical technology.
(ii) To develop understanding about unit process and unit operations in various industries.
(iii) To learn manufacturing processes of organic and Inorganic Chemicals and its applications.

Natural Products Processing: Production of pulp, paper and rayon, Manufacture of sugar, starch and starch derivatives, Gasification of coal and chemicals from coal.

Industrial Microbial Processes and Edible Oils: Fermentation processes for the production of ethyl alcohol, citric acid and antibiotics, Refining of edible oils and fats, fatty acids, Soaps and detergents.


Fertilisers: Nitrogen Fertilisers; Synthetic ammonia, nitric acid, Urea, Phosphorous Fertilisers: Phosphate rock, phosphoric acid, super phosphate and Triple Super phosphate

**COURSE OUTCOME:**

i. Able to understand the manufacturing process organic and Inorganic materials
ii. To understand the unit operation in process.
iii. To understand various chemical reaction in the process

**TEXT BOOK:**


**REFERENCES:**

CL 205  MOMENTUM TRANSFER  L T P C  3 0 0 3

COURSE OBJECTIVES
i. To impart the fundamental concepts of fluid statics, pressure distribution and dimensional analysis
ii. To nurture the students to solve fluid dynamics problems using Newton's laws of motion.
iii. To enable students to compute velocity profile, friction factor and head loss in pipes and fittings
iv. To impart the knowledge of metering and transportation of fluids and fluid moving machinery performance

COURSE CONTENT


COURSE OUTCOME
The students would have
1. the Knowledge of fundamental concepts in fluids statics and to use dimensional analysis for scaling experimental results
2. the ability to solve hydrostatic and fluid flow problems using Newton's laws of motion.
3. the ability to analyze frictional flow in pipes and piping networks and to compute the head loss and power requirements for chemical process equipments
4. the ability to select the metering equipments and fluid moving machinery for an appropriate chemical engineering operations
TEXT BOOKS:

REFERENCE:
COURSE OBJECTIVES
1. To nurture students to observe and understand the need of material balance and energy balance in chemical process industries
2. To impart strong fundamental and technical knowledge among students to pursue various mathematical techniques to solve material balance and energy balance problems
3. To provide students experience in data analysis to formulate, solve and interpret the solutions to various unit operation problems by writing material balance
4. To enable students to analyze and solve material balance and energy balance problems by applying basic principles of Chemical Engineering and Mathematics

COURSE CONTENT
Stoichiometry: Introduction - Units and Dimensions - Stoichiometric principles -composition relations, density and specific gravity.


Energy Balance: Thermo chemistry - Hess's law of summation - heat of formation, reaction, combustion and mixing - mean specific heat - Theoretical flame Temperature.

COURSE OUTCOME
1. The students will have the capability to find out need of writing mass and energy balance for various unit operations in chemical process industries.
2. The students will have the capability to use mathematical knowledge for solving mass and energy balance problems.
3. The students will learn to integrate the data, formulate the mass and energy balance problems and to solve them.
4. Students will learn to use various mass and energy balance writing techniques in process design in chemical process industries.

TEXT BOOKS:

REFERENCES:

B.Tech. Chemical Engineering
COURSE OBJECTIVES

To enable the students to perform various analytical instruments for water and chemicals.

CONTENT

1-6 Analysis of water, oil, soap, cement, sugar, bleaching powder, fertilizer, drugs and vegetables, tannins, ores, alloys, cellulose

7-12 Analysis of products by colorimeter, polarimetry, potentiometric titration, Conductometric titrations, pH meter, gas chromatograph, flame photometer Turbidity meter, conductivity meter, refractometer, etc.

COURSE OUTCOME

Ability to undergo analysis for water and metal compositions.
List of Experiments

1. Load Test on DC Shunt Motor
2. Speed Control of DC Shunt Motor
3. Load Test on DC Series Motor
4. Open Circuit and Short Circuit Test on Single-Phase Transformer
5. Load Test on three phase induction motor
6. Combinational Logic circuit I
7. Combinational Logic circuit II
8. Arithmetic operation using 8085

COURSE OUTCOME
Understanding on usage of ammeter, voltmeter and other calibrations techniques would be enhanced.
COURSE OBJECTIVES
(i) The use of probability models and statistical methods for analyzing data has become common practice in virtually all scientific disciplines.
(ii) Two modules of this course attempt to provide a comprehensive introduction to those models and methods most likely to be encountered and used by students in their careers in engineering.
(iii) A broad introduction to some important partial differential equations is also included to make the student get acquainted with the basics of PDE.
(iv) To impart the basic concepts of numerical analysis.
(v) To impart understanding about numerical solutions for engineering problems.

COURSE CONTENT

Solution of nonlinear equation – Bisection method – Secant method – Regula falsi method – Newton - Raphson method for f(x) = 0 and for f(x, y) = 0, g(x, y) = 0 – Order of convergence – Horner’s method – Graeffe’s method – Bairstow’s method.


Numerical solution of Laplace equation and Poisson equation by Liebmann’s method – solution of one dimensional heat flow equation – Bender – Schmidt recurrence relation – Crank – Nocolson method – Solution of one dimensional wave equation.

COURSE OUTCOME
1. To learned all types of numerical methods problem
2. The students were able to solve the problems individually.
3. Understand usage of numerical methods the chemical engineering problem application

TEXT BOOKS:

COURSE OBJECTIVES
i. Understand object-oriented concepts and how they are supported by C++
ii. Gain some practical experience of C++
iii. Understand implementation issues related to object-oriented techniques
iv. Build good quality software using object-oriented techniques
v. This course is to introduce computational and numerical techniques that may be used to solve a variety of chemical engineering problems

COURSE CONTENT
Objects and Classes: Concepts in object-oriented programming, classes and objects, C++ programming basics, object-oriented analysis, object-oriented design methods.


Class Inheritance: Derived classes, the protected access specifier, Derived class constructors, overriding member functions, Class hierarchies, Public and Private inheritance, Multiple inheritance.

Polymorphism: Virtual functions, Abstract base classes and pure virtual functions.

Files and Streams: Introduction to object-oriented database - case studies.

COURSE OUTCOME
i. Ability to solve Chemical engineering problems
ii. Select a computational tool that is capable of solving a particular chemical engineering problem. Such tools include, EXCEL, POLYMATH, Visual Basic, Metlab, Aspen, polymath, and Scilab
iii. Ability to identify, formulate, and solve engineering problems
iv. An ability to communicate effectively
v. Able to do modeling and simulation for unit operations and process in chemical engineering
vi. Able to solve various mathematical problems via programming

TEXT BOOK:

REFERENCES:
TR 204 PHYSICAL CHEMISTRY

COURSE OBJECTIVES
(i) To impart the basic knowledge on different theories of chemical reaction.
(ii) To expose the students to understand the basic concepts of different isotherms and surface theories.

COURSE CONTENT


Phase Equilibria: Phase rule: Application - to one components system (water, sulphur and carbon dioxide), Two component systems (Eutetic, Intermediate compound formation and solid solutions) and simple three component systems.


Electrical Conductance: Debye - Huckell Onsager theory; Ostwald's dilution law - solubility of electrolytes and solubility product – Applications, common ion action - acids, bases - definitions a) based on proton transference, dissociation constant, amphoteric electrolyte - pH - Buffer solutions. Hydrolysis of salts. Decomposition potential, over voltage, definitions of current density, current efficiency, energy consumption; oxidation - reduction redox couple; e.m.f. and energy relations. Conductometry, Potentiometry, Voltammetry, their applications. Fuel cells.


COURSE OUTCOME
Able to understand all the basic laws and equations involved in any type of chemical reactions.

TEXTBOOKS:

REFERENCES:

B.Tech. Chemical Engineering
COURSE OBJECTIVES
i. Study scope and limitations of thermodynamics
ii. Study laws of thermodynamics
iii. Understand equations of state and various processes
iv. Study fundamentals of heat effects
v. Derive Maxwell’s equations, and relations for enthalpy, entropy and Gibb’s energy
vi. Know applications of thermodynamic flow processes
vii. Know power cycles, refrigeration and liquefaction processes

COURSE CONTENT
Fundamentals of Thermodynamics: Laws of thermodynamics as applied to open and closed system - reversible and irreversible processes - state and point function - Absolute entropy - Thermodynamic property changes for ideal gas.


Thermodynamic Relations: Thermodynamic relations - Maxwell’s relations - Jacobian algebra - estimation of thermodynamic properties.


Chemical equilibria - heat effects, industrial reactions - Free energy calculations - Homogeneous and heterogeneous reactions - Industrial reactions like NH₃ synthesis, SO₃ production etc.

COURSE OUTCOME
i. Students will have fundamental knowledge of temperature, force, pressure, energy, heat and work.
ii. Students will be able to identify the types of processes and know the applications of phase rule and first law of thermodynamics with limitations
iii. Students are expected to have ability to determine volumetric properties of non-ideal fluids using virial and cubic equations of state
iv. Students will have the ability to calculate heat of formation, heat of combustion and heat of reaction
v. Students will have knowledge of second law of thermodynamics, third law of thermodynamics and their scope of applications
vi. Students should be able to determine thermodynamic properties of fluids using Maxwell’s relation and equations of state
vii. Students will have knowledge of application of thermodynamic flow processes
viii. Students will be able to convert heat into work by power cycles
ix. Students will be aware of refrigeration and liquefaction processes

TEXT BOOKS:

REFERENCE:
B.Tech. Chemical Engineering
COURSE OBJECTIVES

i. Understand many basic principles in various Chemical Engineering operations such as Size Reduction, Filtration, Sedimentation, Mixing and Agitation etc. and their mathematical relationships
ii. Understand basic principles of particle preparation and their characterization
iii. Study various methods for storage of solids and conveyors available for their transportation
iv. Understand the performance of different equipments for separation of solids and size reduction

COURSE CONTENT

Characteristics of Particulate Material: Properties and characterisation of particulate solids, analysis and technical methods for size and surface area distribution of powder; Flow properties of particulates.

Synthesis Methods: Introduction to synthesis of composite material by spray technique, aerosol generation, Introduction to size reduction equipment, energy and power requirement in milling operations, computer simulation techniques for mill performance.

Particulate Processes: Gas-liquid separation methods, Classification by size, agitation of liquids and mixing of solids, Fluidization, encapsulation etc.

Handling of Particulate Material: Conveying methods, Storage methods and design of silo, selection of feeders and elevators.

COURSE OUTCOME

i. Students are expected to understand the basic principles of particles preparation and their characterization
ii. Students are expected to have an understanding of solid storage and their conveying in chemical process industries.
iii. Students are expected to have an understanding of design of sedimentation tanks and other solid fluid separation equipments
iv. Students are expected to have knowledge about different size reducing equipments and power requirements during size reduction
v. Students should have an ability to design chemical engineering processes while including economic safety, environment and ethical consideration

TEXT BOOKS:

REFERENCES:

B.Tech. Chemical Engineering
CL 210  ENVIRONMENTAL ENGINEERING  L  T  P  C
3   0   0   3

COURSE OBJECTIVES
i. To impart the basic concepts of environmental engineering.
   ii. To understand the problems of pollution, loss of forest, solid waste disposal, degradation of
       environment, loss of biodiversity and other environmental issues and create awareness
       among the students to address these issues and conserve the environment in a better way.
   iii. To develop understanding about pollution and its treatment methodology.
   iv. To impart the basic concepts of water treatment technology.

COURSE CONTENT
Environment, Environmental quality and degradation, description of environment setting and
procedure for environment impact assessment policies and acts.

Sources of air pollution - effects of air pollution on the environment, on materials, on human
health, on animals. Analytical methods. Equipments for control of air pollution.
Measurements of air pollution.

Sources of water pollution – Effects of water pollution - control of water pollution and
treatment methods for effluent water. Measurements of COD & COD.

Sources of noise pollution. Noise pollution measurements - controlling methods of noise
pollution. Effects on human being.

Sources and classification public health aspects, methods of collection, disposal methods.

COURSE OUTCOME
   i. Able to understand the effects of pollutants to the environment.
   ii. Understand the various treatment technologies for water/wastewater, air effluents and solid
       waste released from chemical industries.
   iii. Understand the development of various unit operation

TEXT BOOKS/REFERENCES:

   Ltd., 2003.
Course Objective:
Understand and application of the principles & concepts of learned in momentum transfer theory course

Pre requisite:
Momentum Transfer course

List of Experiments
Flow Through Straight Pipe
Flow Through Pipe Fittings
Flow Through Helical Coil
Flow Through Spiral Coil
Flow Through Packed Bed
Flow Through Fluidized Bed
Flow Through Flow Meters (Orifice & Venturi)
Centrifugal Pump
Flow Of Non-Newtonian Fluid

REFERENCES:
1. Lab Manual

Course Outcome:
After completion of the course, student can able to
1. understand and application of the concept of manometers
2. understand and analyse the laminar and turbulent flow
3. understand apply and analyse the friction factor
4. understand and apply the concept
COURSE OBJECTIVES
To impart the basic concepts of physical and analytical chemistry.

1 and 2 Molecular weight Determination
   a  Rast's method.
   b  B.Pt Depression.
   c  B.Pt elevation and
   d  Transition temperature methods.

3 and 4 partition experiments.
   (a) Partition coefficient of iodine between two immiscible Solvents.
   (b) Eq. constant of KI + I = KI
   (c) Association factor of an organic acid
   (d) Curramorium couples.

5. and 6. Phase rules
   (a) Two component system
   (b) Three component system
   (c) Phenol - water system.

7  Optical experiments.
   a  polarimetry
   b  Refractometry.

8  Conductivity experiments.
   a  Cell constant.
   b  Ostwald Dilution law.
   c  Basicity of an organic acid.
   d  Conductometric titration.

9  Kinetics.
   a  First order reaction.
   b  Second order reaction

10 EMF
   a  Single electro potentials.
   b  Concentration cells.
   c  Titrations
   d  pH determination.

11 Miscellaneous.
   a  Surface tension.
   b  Viscosity
   c  Adsorption.

COURSE OUTCOME
Able to understand the application of various laws and their importance for physical and chemical analysis.
COURSE OBJECTIVES
i. Introduce basic concepts of chemical kinetics like homogeneous and heterogeneous reactions, rate of reaction, order and molecularity of reaction, concentration and temperature dependency of rate of reaction
ii. Build up the concepts to analyze kinetic data and determine the rate expression for a reaction
iii. This course will guide students to make use of key concepts and techniques of chemical kinetics to design single reactor and multiple reactors
iv. Analyze multiple reactions to determine selectivity and yield
v. Work together in same-discipline teams to solve engineering problems

COURSE CONTENT


Heat Effects: Temperature and pressure effects on single and multiple reactions.


COURSE OUTCOME
i. Classify reactions and identify the factors affecting the rate of reaction
ii. Predict effect of temperature on rate of reaction
iii. Analyze laboratory data for determining the order of reaction and reaction rate constant
iv. Ability to relate rate of reaction with design equation for reactor sizing
v. Make comparisons of ideal reactor types (batch, plug flow, mixed flow, etc.) and select the most suitable one.
vi. Determine optimal ideal reactor design for multiple reactions for yield or selectivity.
vii. Solve reaction engineering problems through logic rather than memorization

TEXT BOOK:

REFERENCE:

B.Tech. Chemical Engineering
COURSE OBJECTIVES

i. To impart the basic concepts of material science.

ii. To develop understanding about selection based on properties for various applications.

COURSE CONTENT


COURSE OUTCOME

i. To provide experience in the process of Material

ii. To understand the handling material in chemical engineering in the areas of equipment design

iii. To understanding execute the design and evaluating its performance of materials including economic considerations.

TEXT BOOKS:


REFERENCES:

1. V. Raghavan, Materials Science and Engineering, Prentice Hall
CL 305  MASS TRANSFER  L T P C 3 0 0 3

COURSE OBJECTIVES
i. To understand mass Transfer Operations
ii. To learn concept of diffusion in gas, liquid & solid
iii. To learn fundamental mass transfer coefficient
iv. To understand basic of interphase mass transfer
v. To learn application of gas liquid operation

COURSE CONTENT

Equilibria, Mass transfer coefficients - Individual and overall with relations, Theories of mass transfer, Analogies between momentum, heat and mass transfer to predict mass transfer coefficients.

Absorption – Solubility, theory of gas absorption, Design of absorption towers, Concept of Equilibrium and operating lines. Mass Transfer Equipments- Batch and continuous Stage wise contactors and Differential contactors, Concept of HTU and NTU, Tower packings and packing characteristics, Non-isothermal absorbers, Absorption with chemical reactions.

Humidification Theory, Psychometric Chart, Adiabatic Saturator, Wet Bulb Theory, Methods of Humidification and dehumidification, Cooling tower theory, Design of cooling towers, Industrial cooling towers, Air conditioning process, Recirculating water gas humidification system.

Drying Theory and Mechanism, Drying Characteristics, Estimation of Drying time, drying rate curve, Classification of Driers, Through circulation driers design, Design of driers, Description and Application of Driers, Analysis of continuous driers.


COURSE OUTCOME
i. Have demonstrated knowledge of the mathematical, science, and engineering principles fundamental to the practice of chemical engineering
ii. Have a broad enough education to understand the impact of engineering solutions in a global and societal context
iii. Indicate a motivation to continue developing knowledge and skills after graduation
iv. Have knowledge of contemporary issues related to chemical engineering
v. Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

B.Tech. Chemical Engineering
TEXT BOOKS:

REFERENCE:
COURSE OBJECTIVES

i. To introduce the fundamental concepts of momentum and heat transfer as well as their use in typical engineering applications

ii. To emphasize on analogies between the balance equations of fluid flow and heat flow, on dimensional analysis, and the prediction of friction losses

COURSE CONTENT

Basic modes of heat transfer and the laws governing them. Steady state conduction through plane and composite walls general heat conduction equation, concepts of thermal diffusivity and equivalent thermal conductivity. Radial Heat conduction through thick cylindrical and spherical vessels, Transient heat conduction.

Convection – Dimensional analysis and empirical correlations, critical insulation thickness for cylindrical and spherical surfaces, Hydrodynamic and thermal Boundary layers, physical significance of the dimensionless groups.

Thermal Radiation laws, spectrum of electromagnetic radiation, Black and Gray bodies, and configuration factor – typical examples. Boiling and condensation.

Heat Exchangers – classification and design, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger, NTU and efficiency of Heat exchangers, use of efficiency charts.

Evaporation, single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Duhrin’gs rule, effect of liquid head, illustrative examples.

COURSE OUTCOME

i. To Apply the Fourier law of heat conduction to homogeneous and heterogeneous objects of various shapes

ii. To Estimate transient and steady state heat transfer rates from/to object such as tanks, pipes, buildings, etc

iii. To Apply the macroscopic balances of mass, momentum, and energy, as well as the differential continuity equation and the equations of motion to simple systems using both Cartesian and polar coordinate

TEXT BOOKS:

REFERENCES:

B.Tech. Chemical Engineering
COURSE OBJECTIVES
1. To impart the basic concepts of biochemical engineering
2. To develop understanding about biochemistry and bioprocesses

COURSE CONTENT

Functioning of Cells and Fundamental Molecular Biology: Metabolism and bio-energetics, Photosynthesis, carbon metabolism, EMP pathway, tricarbocyclic cycle and electron transport chain, aerobic and anaerobic metabolic pathways. Synthesis and regulation of biomolecules, fundamentals of microbial genetics, role of RNA and DNA.


COURSE OUTCOME
An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

TEXT BOOKS:

REFERENCE:
PARTICULATE SCIENCE AND TECHNOLOGY
LABORATORY

COURSE OBJECTIVES
i. To impart hands on experience on different unit operation equipments.
ii. Apply principles developed in chemical engineering courses to the analysis of chemical engineering processes and unit operations.
   1. Sphericity factor on friction losses.
   2. Agitated vessel
   3. Settling studies
   4. Drag studies
   5. Filtration (constant rate)
   6. Filtration (constant pressure)
   7. Screening
   8. Elutriation
   9. Jaw crusher
  10. Ball mill
   11. Particle size distribution
   12. Storage of Solids

COURSE OUTCOME
Ability to operate different unit operations and their calculations involved have improved.
Course Objective:
Understand the principles & concepts learned in Chemical Engineering thermodynamics theory course

Pre requisite:
Chemical Engineering thermodynamics course

List of Experiments
1. Excess property determination
2. Heat of solution by solubility method
3. Equilibrium constant determination
4. Liquid-liquid equilibrium
5. Vapor compression refrigeration test rig
6. Boiling point apparatus – VLE Data (Txy diagram)
7. Test for thermodynamic consistency (Estimation of thermodynamic model constants using Othmer still)
8. Air water heat pump
9. Bomb calorimeter
10. Gas calorimeter

REFERENCES:
1. Lab Manual
HM 302  HUMAN PSYCHOLOGY & ORGANISATIONAL BEHAVIOUR

COURSE OBJECTIVES
To impart the students with human behavior, teamwork skills and leadership qualities in industries.

COURSE CONTENT
Introduction: a. Principles of management, functions of organisations, organisational system - technology, process, design, structure and culture and their impact on the people at work. b. Definition - development of psychology as scientific discipline - methods and applications of psychology in human at work in industry.


Motivation, Leadership, Teamwork, Communication: Concept of. Motivation; why to people work; theories on motivation, (Maslow, Herzberg , achievement orientation, expectancy theory, theory x, y, z); techniques of motivating employees, Leadership - role of leader, qualities of a leader; styles of leadership (blake and mouton managerial grid, Frid Fiedler’s contingency approach, Rensis Likert’s four styles), determinants of leadership style to be adopted, Power, authority and accountability; delegation, Dynamics of groups; work groups, Mentoring, teamwork, Communication - Channels of communication, feedback, Barrier to communication; Non-verbal communication, grapevine, Transactional analysis

Human Engineering: Human and Engineering Factors influencing each other - Ergonomics, Effect of Physical environment - illumination, temperature, noise etc; Social economic and political responsibilities of an engineer.

Psychological aspects Expounded by Thirukural: Realisation of truth, power of speech (utterances of pleasant words) and Action, Mutual desire, human effort, inconsistent conduct, possession of Decorum manly effort, energy.

COURSE OUTCOME
The students have understood the importance of psychology and how organize a task in industries.

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES
i. To train students to analyze performance of real reactors with single chemical reactions and reactors operating at steady state
ii. To train students to derive rate expressions and mechanisms for elementary heterogeneous chemical reactions
iii. To train students to analyze rate data in order to derive rate expressions and mechanisms for heterogeneous catalytic reactions and design heterogeneous reactors
iv. To train students to appreciate the importance of both external and internal mass transfer effects in heterogeneous systems

COURSE CONTENT
Modes of contacting different phases: Self mixing of single fluids, mixing of two miscible fluids, Introduction. Design for heterogeneous reacting systems.

Design of reactor for non catalytic reactions: Fluid-particle systems: Models for non-catalytic heterogeneous reactions, their limitations, selection and their applications to design.


COURSE OUTCOME
i. Students will be able to determine performance of real flow reactor and compare it with ideal flow reactor
ii. Students will be able to classify heterogeneous reactions and to determine the catalyst properties such as surface area and pore volume
iii. Students will be able to analyze and interpret kinetic data to determine the rate controlling step, model and to design a reactor for various heterogeneous reactions
iv. Students will be able to design a reactor for a given chemical engineering process

TEXT BOOKS:
COURSE OBJECTIVES
i. To impart the basic concepts of mass transfer in distillation, extraction, leaching and membrane operations.
ii. To develop understanding about design and analysis of distillation, extraction, leaching and membrane operation units.

COURSE CONTENT
Principle, theory, Vapour Liquid Equilibria calculations, Effect of Pressure and temperature on VLE, Methods of distillations, batch, continuous, flash, steam, vacuum, molecular distillations. Design of single stage flash and simple distillation columns.

Stage-wise and continuous Differential contact operations, Design calculations using Ponchon-Savarit and Mc-Cabe Thiele Methods, Efficiency interrelations. Reboilers and condensers. Open steam Distillation, Multicomponent Distillation- Azeotropic distillation and Extractive distillation, Multi component Flash and differential distillation.

Liquid - Liquid Equilibria for Different systems, Effect of Pressure and Temperature on LLE, Solubility criteria, Design of Batch and continuous extraction towers for miscible and immiscible systems. Industrial Applications, Design of Extractors with reflux.

Theory, Mechanism, Types of leaching, Solid - Liquid equilibria, Design of Batch and continuous extractors. Equipments and industrial applications.

Types of adsorption, nature of adsorbents, Adsorption isotherms, Operation of adsorption columns. Batch and continuous operations, Design of adsorbers.

COURSE OUTCOME
1. An ability to design the systems and find the number of stages required for the separation of the components involving different phases.
2. An ability to apply diffusion concepts in analyzing all the transfer processes to meet the required specifications.

TEXT BOOKS:

REFERENCES:

B.Tech. Chemical Engineering
COURSE OBJECTIVES

i. To introduce students to the terminology, concepts and practices of input/output modeling and automatic process control.

ii. To impart knowledgeable in the design of control systems and controller tuning for chemical processes.

COURSE CONTENT

Introduction - Control system, components of a feed back control system, Lags in the control system – transfer lag, transportation lag, pneumatic PID controller, control valve – valve characteristics.

Laplace transforms - properties of Laplace transform, solution of linear differential equations using Laplace transform techniques, piecewise continuous functions.

Dynamic behaviour of systems - derivation of transfer functions for first and second order systems, liquid level, temperature, pressure, flow and concentration control processes, linearization of nonlinear systems, interacting and non-interacting systems.

Transient response of first and second order systems, natural frequency, damping factor, overshoot, decay ratio, rise time and settling time.

Transient analysis of control systems - block diagram algebra, overall transfer function of closed loop control systems, regulator and servo problems, transient response of first and second order systems with P, PI and PID controller.

Definition of stability of control systems, Routh test, limitations of Routh test, Pade’s approximation of time delay systems.


COURSE OUTCOME

i. To write balance equations using first principles modeling and determine the response for various forcing functions.

ii. To configure simple feedback control loops, and identify the components of those loops.

iii. To use the P-only control equation to compute gains, proportional bands and to describe the action of ON-OFF, proportional, and proportional-integral controllers.

iv. To describe the different types of control valves and can identify the types by their inherent flow curves.

v. To gain the knowledge of various controller designs, and methods of controller tuning.
TEXT BOOKS / REFERENCE BOOKS:
CL 310    HEAT TRANSFER LABORATORY L T P C
                      0  0  3  2

COURSE OBJECTIVES
To provide experience on testing, and analysis of heat transfer equipments in various approaches.
1. Shell and Tube Heat exchanger
2. Condenser (Vertical)
3. Condenser (Horizontal)
4. Natural convection
5. Radiation
6. Transient heat conduction
7. Agitated vessel heat transfer
8. Heat Transfer in Jacketed Kettle
9. Thermal Conductivity of metal rod
10. Plate Heat Exchanger

COURSE OUTCOME
The students have understood how heat transfer occurs for different equipments and worked out the parameters studied in theory.

CL 312    CHEMICAL REACTION ENGINEERING L T P C
                              LABORATORY  0  0  3  2

COURSE OBJECTIVES
To provide experience on analysis of process control and reaction engineering.
1. Reversible reaction in a batch reactor
2. Irreversible reaction in a batch reactor
3. Plug flow reactor
4. Mixed flow reactor
5. Adiabatic reactor
6. Combined reactor: Mixed flow -plug flow
7. Combined reactor: Plug flow -mixed flow
8. Heterogeneous catalytic reactor
9. Biochemical reactor
10. RTD studies
11. Photochemical reactor
12. Segregated flow reactor
13. Semibatch reactor
14. Gas-solid reaction

COURSE OUTCOME
The students could independently calculate the reaction kinetics of various reactors used for manufacturing of chemicals in industries.
CL 401 SAFETY IN CHEMICAL INDUSTRIES

COURSE OBJECTIVES
To create awareness about the hazards that can happen in various industries and methods of preventing them.

COURSE CONTENT
Introduction: Industrial safety principles. Site selection and plant layout. Legal Aspects. Emergency response systems for hazardous goods, basic rules and requirements which governs the chemical industries.

Hazards: Chemical hazards classification. Hazards due to fire, explosion and radiation. Hazard analysis, Reduction of process hazards by plant condition monitoring, Materials Safety Data sheets and National Fire protection agency’s classifications.

Diseases: Dangerous occupational diseases, poisoning, dust effect, biomedical and engineering response to health hazards.

Control of Hazards: Engineering control of plants instrumentation, accident prevention signs and labels, Colour codes for pipe lines, Safety aspects of reactive chemicals.


COURSE OUTCOME
Students will be familiar with hazard analysis and prevention techniques, scope for entrepreneurship by consultancy, safety audit.

TEXT BOOKS:

REFERENCES:
CL 403 CHEMICAL PROCESS DESIGN

COURSE OBJECTIVE:
(i) To apply the basic principles/concepts learned in yester semesters in the design of chemical process equipment
(ii) To develop the skill to select and design appropriate process equipment for the required operation
(iii) To analyse and evaluate the performance of existing equipments

PREREQUISITE:
Courses on Particulate science and technology, Heat transfer, Mass transfer and Equilibrium staged operations, Reaction engineering, Strength of materials

CONTENT:
Design of Pressure Vessels: Design of vessels and its components under internal pressure, external pressure and combined loadings, design of heads/closures, design of supports and design of high pressure vessels
Design of Storage tanks, Agitated vessels and Reaction vessels.
Design of Phase Separation Equipment: Design of physical separation equipments
Design of Heat Transfer Equipments: Design of Heat Transfer Equipments such as heat exchangers with and without phase change, evaporators, crystallizers.
Design of Mass Transfer Equipments: Design of mass transfer equipments such as distillation columns, absorption columns, extraction columns.

TEXT BOOKS:

REFERENCES:

COURSE OUTCOME:
After completing the course, A student can able to
1. understand the role of different types of loads on the vessels and its auxiliaries
2. perform the mechanical design of vessel and its auxiliaries
3. integrate the knowledge acquired from core chemical engineering subjects for design of chemical process equipments (pressure vessels, storage tanks, reactor vessels, phase separation equipments)
4. Carry out chemical process design of heat transfer equipments, mass transfer and simultaneous heat and mass transfer equipments
5. address the process equipment problems and provide suitable alternate solutions.
COURSE OBJECTIVES
i. To provide basic knowledge on chemical engineering research.
ii. For enabling the students to gain experience in organisation and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year.
   i. To gain knowledge on cost analysis when it comes to start up a new industry after undergoing all major subjects of chemical engineering.
   ii. To make the students to understand all the facility required for starting up a new industry apart from various unit operation/mass/heat transfer equipments.
   iii. To make the students to gain all the knowledge in terms of financial analysis for starting up a new chemical industry.
   iv. To give a clear linkage between technical knowledge and commercial aspects of the major chemical engineering unit operations and design.

COURSE CONTENT
Plant location and site selection, plat layout, factors affecting plant location, project planning and scheduling of projects, procurement operations, office procedures, project financing

Process utilities, process water, boiler feed water, water treatment & disposal, steam, steam distribution including appropriate mechanical valves and instrumentation, Furnaces, process pumps, compressors, vacuum pumps, pressurized air distribution systems, Refrigeration plant

Process auxiliaries, piping design, layout, Support for piping insulation, plant constructions, start up and commissioning.

Capital Requirements for process Plants: Project implementation steps, Feasibility studies, Capital requirements for process plants, Cost indices, Equipment cost, Service facilities. Capital requirements for complete plants, Balance sheet.

Market analysis: Situational analysis and specification of objectives, collection of secondary information, conduct of market survey, characterization of the market, demand forecasting, uncertainties in demand forecasting and market planning.


Economics of Selecting Alternates: Annual cost method, Present worth method, Equivalent alternates, Rate of return and Payout time. Cash flow analysis.

COURSE OUTCOME
i. The students have understood how a project has to be started, their pre-requirements, flow chart preparation, economic calculation and so on.

ii. The students were able to work out the balance sheet and Income statement for a particular concern.

iii. The students have gained a good knowledge on when to run a industry in a profitable or without loss/gain of a particular concern.

iv. The students are able to choose between the equipments/instruments of the same function based on both technical and commercial point of view.

v. The students were able draw a complete flowchart of a plant with complete cost analysis.

TEXT BOOKS:

REFERENCES:
1. Rase and Barrow, Project Engineering of Process Plants, John Wiley, 1964
COURSE OBJECTIVES
i. Understand theory and basic principles of momentum, heat and mass transport
ii. Understand theory of velocity distribution for various systems.
iii. Understand Macroscopic balances for isothermal systems
iv. Understand theory of thermal conductivity energy transport
v. Understand diffusivity and mechanism of mass transport for homogeneous and heterogeneous systems.

COURSE CONTENT

Equation of Motion: Equation of change for isothermal process - One dimensional equation of motion and continuity - Euler and Navier - Stokes equation. Dimensional analysis of equation of change.


Heat Transfer analysis: Temperature distribution in solids and fluids in laminar flow - Equations of change for multi component systems.

Mass Transfer analysis: Concentration distribution in solids and in fluids laminar flow - Equations of change for multi component systems.

COURSE OUTCOME
i. To identify, formulate, and solve problems isothermal systems particularly in the context of momentum, heat and mass transfer.
ii. Use shell balance for diffusion with homogenous and heterogeneous systems
iii. Apply shell balance for different systems like flow through tube, annulus, along sphere, etc.

TEXT BOOKS:

REFERENCE:

COURSE OBJECTIVES
To examine the knowledge acquired by the student during the B.Tech. course, through an oral examination

COURSE OUTCOME
The students were able to know the status of their learning on all the core chemical engineering subjects they have studied and helped them to improve their knowledge.
### CL 411  MASS TRANSFER LABORATORY

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**COURSE OBJECTIVES**

To provide experience analysis of mass transfer operations.

1. Simple Distillation
2. Steam Distillation
3. Surface evaporation
4. Leaching
5. Batch adsorption
6. Diffusion
7. Air drying
8. Wetted wall column
9. Vacuum drying
10. H.E.T.P
11. Continuous adsorption
12. Extraction

### CL 413  PROCESS DYNAMICS AND CONTROL LAB

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**COURSE OBJECTIVES**

To impart hands on experience on various process control instruments for various unit operations.

1. Analog Simulator.
2. Process trainer
3. Interacting & non interacting Systems
4. Control of a thermal system
5. Flapper - Nozzle system
6. Control valve characteristics
7. Level control system
8. Transducer characteristics
9. I & II Order System Dynamics
10. Pressure control system
11. Frequency Response

### COURSE OUTCOME

The thorough understanding of usage and employability of devices for determining the separation factors and efficiencies for the systems.

The students were able to apply the theoretical knowledge while performing experiments and different process control technologies for different chemical engineering processes.
HM 402  INDUSTRIAL ECONOMICS & MANAGEMENT  L  T  P  C
        3  0  0  3

COURSE OBJECTIVES
i. To impart the basic concepts of economics and management.
ii. To impart the basic concepts of management.

COURSE CONTENT

COURSE OUTCOME
The students have understood how to lead a group of people in a concern and how to manage provided a task is undertook in an industry.

TEXT BOOKS:

REFERENCE:

CL 406  PROJECT WORK  L  T  P  C
        0  0  0  6

COURSE OBJECTIVES
i. To provide students with an opportunity to apply the knowledge and skills acquired in previous coursework to solve a specific problem and/or acquire in-depth knowledge on a specific topic.
ii. To provide experience in carrying out a literature search.
iii. To work in a team in a planned manner on a chosen engineering topic based on the knowledge gained throughout the engineering programme.
LIST OF ELECTIVES

CL 315  PETROLEUM AND PETROCHEMICAL ENGINEERING  L T P C
        3 0 0 3

COURSE CONTENT
Primary Processing of Crude Oil: Classification of crude oil, Atmospheric distillation, Vacuum distillation of residue-Products and distillation practice.
Secondary Processing of Crude Oil: FCCU, Hydro cracking, Visbreaking, Thermal cracking, Coking, Reforming, Alkylation, Polymerisation and Isomerisation process.

Treatment Techniques: Treatment techniques for removal of objectionable gases, Odours, to improve performance, Storage stability, Extraction of aromatics, Olefins and recovery operations from petroleum products.

Environmental and Safety aspects in Refinery and Petrochemicals: Waste water and effluent gases treatment from alkylation units and petrochemical units, safety aspects in the above industries.

TEXT BOOKS:

REFERENCES:
COURSE CONTENT
Principles of nuclear power generation, nuclear fission and fusion, energy from fission and fuel burn up.

Radioactivity, neutron energies, thermal neutrons, nuclear cross sections, Fission reactor types, reactor control, fuel arrangements in a thermal reactor.

Pressurized water reactor, PWR power plant, Boiling water reactor, BWR power plant, Gas cooled reactor, high temperature gas cooled reactor.

Concept of breeding, fast breeder reactors, Liquid metal fast breeder reactor and accessories.

Thermal pollution by nuclear power plants, Radio-active pollution of environment by nuclear power plants, radio-active waste disposal.

TEXT BOOKS / REFERENCES:
1. Glasstone, "Nuclear Reactor Engineering".
2. M.N. El Vakil, "Nuclear Power Engineering".
3. Arora and S. Domkundwar, "Power Plant Engineering", Dhanpat Rai & Sons
COURSE CONTENT
Introduction to Chemical Fertilizers: Chemical inorganic Fertilizers and Organic manures.
Types of fertilizers: Mixed, complex and Granulated, plant nutrients.

Processes for Raw Materials: Processes for manufacture of ammonia, nitric acid, phosphoric acid and sulphuric acid.


Complex Fertilizers: Processes for nitro - phosphates and complex NPK fertilizers liquid fertilizers

Phosphatic Fertilizers and Indian Fertilizer Industry: Single and Triple Superphosphate, biofertilizer. Fertilizer Industry in India.

TEXT BOOKS:

REFERENCES:
CL 316  BIOTECHNOLOGY  L  T  P  C  3 0 0 3

COURSE CONTENT
Rates and Patterns of Changes in cell cultures: Kinetics of substrate utilization, biomass and product formation in cellular cultures. Stoichiometry of growth and product formation


Sensors, Monitoring and control systems in Bioprocesses: Instrumentation and process control in Bioprocesses.


Fermentation Technology and R-DNA Technology: Bio-process Technology and Genetic Engineering.

TEXT BOOKS:

REFERENCE:
COURSE CONTENT
Coal: Coal and Coal derived fuels; Characteristics, production methods and uses. Coal combustion technology, waste heat recovery.

Oil and Gases: Fuels from oil and gases: Characteristics, production methods and uses. Technology for combustion of fuels derived from oil and gas.

Solar Energy: Solar energy utilization, Thermal application and photovoltaic applications; wind, geothermal and hydro energy utilization.

Bio Energy: Biomass conversion for fuels; production methods based on thermochemical and bioconversion. Characteristics and uses; Design of digestors.

Nuclear Energy: Nuclear Energy; Nuclear fission fuels processing, Nuclear reactions and nuclear reactors, Nuclear Engineering.

TEXT BOOKS:

REFERENCE:
COURSE CONTENT

Characteristics of Measurement System - Elements of instruments, static and dynamic characteristics, basic concepts and qualities of measurement, basic concepts of response of first order type instruments, mercury in glass thermometer

Pressure measurement: Pressure, Methods of pressure measurement, Manometers, Elastic pressure transducers, Measurement of vacuum, Force-balance pressure gauges, Electrical pressure transducers, Pressure switches, Calibration of pressure measuring instruments, Maintenance and repair of pressure measuring instruments, Troubleshooting

Temperature measurement: Temperature, Temperature scales, Methods of temperature measurement, Expansion temperature, Filled-system thermometers, Electrical temperature instruments. Pyrometers: Radiation and optical

Flow Measurement: Methods of flow measurement, Inferential flow measurement, Quantity flowmeters, Mass flowmeters, Calibration of flowmeters, Selection of flowmeters.
Level measurement: Methods of liquid level measurement, Direct methods, level measurement in pressure vessels, measurement of interface level, level of dry materials.
Instruments for Analysis - recording instruments, indicating and signaling instruments, instrumentation diagram.

Methods of composition analysis: Spectroscopic analysis, Absorption spectroscopy, Emission spectroscopy, Mass spectroscopy

REFERENCE BOOKS

COURSE CONTENT

Polymer material structure and Properties: Deformation, flow and melt characteristics. Morphology and order in crystalline polymers. Rheology and the mechanical properties of polymers. Polymer structure and physical properties.

Polymer synthesis and reaction engineering: Condensation polymerization. Addition polymerization. Ionic and coordination polymerization. copolymerisation. polymerization conditions and polymer reactions.


TEXT BOOK:

REFERENCES:
COURSE CONTENT

Sorption Techniques: Types and choice of adsorbents, Normal Adsorption techniques, chromatographic techniques, types and Retention theory mechanism Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

Membrane Separation Processes: Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators, Dialysis, Reverse Osmosis, Ultra filtration, Concentration Polarization in Membrane and Economics of Membrane operations.

Ionic Separation: Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion - Exchange, Commercial processes.


TEXT BOOKS:

REFERENCES:
COURSE CONTENT

Formulation of physical problems: Mathematical modelling of chemical engineering processes based on first principles.

Analytical solutions of equations: Separable forms, homogeneous equations, exact solutions, singular solutions.


Optimization: Types of optimization problems, optimization of a function of single variable, unconstrained minimization, constrained minimization.

TEXT BOOKS:


REFERENCES:


COURSE CONTENT
Introduction – Global warming, Green house gases, Coal thermal power plant efficiency, Kyoto protocol, Carbon credits, Renewable Energy.

Renewable Energy – Quality, quantity, availability, advantageous and limitations.


Solar passive concepts. Solar photo Voltaic energy – silicon cell, VI characteristics, PV plant layout, efficiency improvement in PV cell.


Geothermal energy.


REFERENCES:

COURSE CONTENT
Supramolecular Chemistry. Definition and examples of the main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supramolecular structures.

Physical Chemistry of Nanomaterials. Students will be exposed to the very basics of nanomaterials; A series of nanomaterials that exhibit unique properties will be introduced.

Methods of Synthesis of Nanomaterials. Equipment and processes needed to fabricate nanodevices and structures such as bio-chips, power devices, and opto-electronic structures. Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.

Biologically-Inspired Nanotechnology Basic biological concepts and principles that may lead to the development of technologies for nanoengineering systems. Coverage will be given to how life has evolved sophisticatedly; molecular nanoscale engineered devices, and discuss how these nanoscale biotechnologies are far more elaborate in their functions than most products made by humans.

Instrumentation for Nanoscale Characterization. Instrumentation required for characterization of properties on the nanometer scale. The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nanometer range.

TEXT BOOKS:
1. Supramolecular Chemistry by Jean-Marie Lehn,
2. Supramolecular Chemistry by Jonathan Steed & Jerry Atwood
3. Intermolecular and Surface Forces by Jacob Israelachvili.
COURSE CONTENT


Heat transfer between Fluidised beds and surfaces - Entrainment & Elutriation: Heat transfer between fluidised beds and surfaces: Experiment finding theories of bed heat transfer comparison of theories. Entrainment of or above TDH, model for Entrainment and application of the entrainment model to elutriation.

TEXT BOOK:
<table>
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<th>COURSE CONTENT</th>
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<tr>
<td>Introduction to Physical Pharmaceutics: Metrology and Calculations, Molecular structure, properties and States of Matter, Solutions, Phase Equilibria, Micromeritic and Powder Rheology, Surface and Interfacial Phenomena, Dispersion Systems, Diffusion &amp; Dissolution, Kinetics and drug stability, Viscosity &amp; Rheology, and Polymer Science and Applications.</td>
</tr>
<tr>
<td>Materials of Pharmaceutical Plant Construction, Good Manufacturing Practice (GMP’s) Guidelines</td>
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**TEXT BOOKS:**

1. *Physical Pharmacy by Alfred Martin.*
2. *Remington's Pharmaceutical Sciences*

**REFERENCES:**

1. *Bentley's Pharmaceutics by E A Rawlins*
2. *Cooper and Gunn's Tutorial Pharmacy*
COURSE CONTENT
General: Functions of single and multiple variables - optimality criteria, direct and indirect search methods.

Linearisation: Constraint optimality criteria, transformation methods based on linearisation.

Quadratic And Geometric Programming: Quadratic and geometric programming problems, calculus of variations.


Artificial Intelligence In Optimization: Introduction to Artificial Intelligence in optimization.

TEXT BOOK:

REFERENCE:
Electives for B.Tech. Honours

CL 601 PROCESS DYNAMICS AND CONTROL - II  L T P C
3 0 0 3

COURSE OBJECTIVES
Expose students to the advanced control methods used in industries and research. This course prepares the student to take up such challenges in his profession.

COURSE OUTCOMES
Upon completing the course, the student should have understood
- controller tuning
- type of controller that can be used for specific problems in chemical industry
- design of controllers for interacting multivariable systems
- design of digital control systems

COURSE CONTENT


Special Control Techniques: Advanced control techniques, cascade, ratio, feed forward, adaptive control, Smith predictor, internal model control.

Multivariable Control Analysis: Introduction to state-space methods, Control degrees of freedom analysis and analysis, Interaction, Bristol arrays, Niederlinski index - design of controllers, Tuning of multivariable controllers.

Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems. Design of digital controllers. Introduction to PLC and DCS.

TEXT BOOKS:

REFERENCES:
COURSE OBJECTIVES
Fluidization finds extensive application today in Process Industry and also in combustion. Objective of this course is to make the student aware of fundamentals of Fluidization and understand the design aspects of fluidized bed systems.

COURSE OUTCOME
The student at the end of the course will be in a position to design a fluidized bed system for different applications.

COURSE CONTENT
Applications of fluidized beds: Introduction, Industrial application of fluidized beds, Physical operations and reactions.


Elutriation and entrainment: TD and also distribution of solid in a fluidized bed. Circulation systems.

Design of fluidized bed systems: design of fluidization columns for physical operations, catalytic and non-catalytic reactions, three phase fluidization.

CA: 2 Tests each for 20 marks + Assignment/seminar for 10 marks 50 marks for end semester examination.

TEXT BOOK:

REFERENCE:
CL 603 PROCESS MODELLING AND SIMULATION

COURSE OBJECTIVES
To give an overview of various methods of process modeling, different computational techniques for simulation. The focus shall be on the techniques themselves, rather than specific applications so that the student can take up modeling and simulation challenges in his profession.

COURSE OUTCOMES
Upon completing the course, the student should have understood
- Development of process models based on conservation principles and process data
- Computational techniques to solve the process models
- How to use simulation tools such as MATLAB/SCILAB

COURSE CONTENT
Introduction to process modeling - a systematic approach to model building, classification of models. Conservation principles, thermodynamic principles of process systems.

Development of steady state and dynamic lumped and distributed parameter models based on first principles. Analysis of ill-conditioned systems. Models with stiff differential equations.


Solving the problems using MATLAB/SCILAB.

TEXT BOOKS:


REFERENCES:


B.Tech. Chemical Engineering
PINCH ANALYSIS & HEAT EXCHANGER NETWORK DESIGN


COURSE OBJECTIVES

COURSE OUTCOME
After the course, you are able to appreciate the pinch concept and process thermodynamics, able to identify minimum energy targets, identification of different choices and constraint during heat exchange networking, strategies for retrofitting existing process plant, integration of energy demands of multiple processes.

COURSE CONTENT
Thermodynamical review of the process, Pinch Concept, significance of pinch, pinch in grid representation, Threshold problems, capital cost implication of the pinch.

Targeting: Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, continuous targeting.


Pinch Design and Optimization: Networks for maximum energy recovery, Pinch design method, Flexibility criteria of the pinch, cp table, the tick of heuristic, case studies, optimization of heat exchanger network optimality for a minimum area network, Sensitivity analysis.

Energy and Resource Analysis of various processes, Batch process, flexible process, distillation process, evaporation process, reaction process, process using mass separating agent. Heat pipes and Heat pumps,

TEXT BOOKS:
1. V. Uday Shenoy "Heat Exchanger network synthesis" Gulf Publishing Co, USA, 1995

REFERENCES:
CL 605 DESIGN AND ANALYSIS OF EXPERIMENTS

L T P C
3 0 0 3

PREREQUISITES: Fundamental statistics

COURSE OBJECTIVES
The aim of the course to give competences in the field of applied statistical methods for work concerning planning and analysis of experiments, regression analysis, optimization of processes and multivariate analysis.

COURSE OUTCOME
- Plan experiments according to a proper and correct design plan.
- Analyse and evaluate experimental results (statistically), according to chosen experimental design (ANOVA, regression models).
- Control and properly use fundamentals such as hypothesis testing, degrees of freedom, ANOVA, fractional design and other design methods/techniques and so on.
- Know the fundamentals of multivariate analysis and chemometric methods (PCA and PLS) with simple applications.

COURSE CONTENT
- Statistics
- Simple Comparative Experiments
- Experiments of a single factor, analysis of variance.
- Randomized blocks
- Latin squares
- The 2k factor design
- Blocking and confounding
- Two level fractional Factorial design.
- Three level and mixed level factorial and fractional factorial design.
- Fitting regression methods. LS method.
- Robust parameter design
- Experiment with random factors.
- Nested design
- Response surfaces, EVOP.
- Multivariate data analysis

COURSE ORGANISATION
The course contains lectures mixed with calculation examples showing practical applications of basic theories. The assignments and calculation are based on realistic industrial examples taken from literature and research projects. The projects are problem based with active learning activities. This part has been a very successful part in terms of life-long learning for the students and highly appreciated among students for many years.

Textbook:
COURSE CONTENT
Transient Heat conduction, Extended surfaces and generalized expressions for fins or spines. Effectiveness of fins and spines, Temperature - time response of thermocouples and use of transient heat conduction charts.

Convection - Theory and practice. Energy equation for thermal boundary layer over a flat plate. Data analysis for forced and free convection problems, Analogy between heat, mass and momentum transfer.

Heat Transfer with phase change, Boiling and condensation, Boiling Regimes and types of condensation processes, effect of pressure, turbulence and other factors on boiling and condensation heat transfer.


TEXT BOOKS:

REFERENCES:
Courses offered from other departments

MT 403 CORROSION ENGINEERING  L  T  P  C
3  0  0  3

COURSE CONTENT
Electrochemical and thermodynamic principles, Nernst equation and electrode potentials of metals, EMF and galvanic series, merits and demerits; origin of Pourbaix diagram and its importance to iron, aluminium and magnesium metals

Exchange current density, polarization - concentration, activation and resistance, Tafel equation; passivity, electrochemical behaviour of active/passive metals, Flade potential, theories of passivity

Atmospheric, pitting, dealloying, stress corrosion cracking, intergranular corrosion, corrosion fatigue, fretting corrosion and high temperature oxidation; causes and remedial measures

Purpose of testing, laboratory, semi-plant and field tests, susceptibility tests for IGC, stress corrosion cracking and pitting, sequential procedure for laboratory and on-site corrosion investigations, corrosion auditing and corrosion map of India

Corrosion prevention by design improvements, anodic and cathodic protection, metallic, non-metallic and inorganic coatings, mechanical and chemical methods and various corrosion inhibitors

TEXT BOOKS:

REFERENCES:
COURSE CONTENT
Brief survey of methods of power generation-hydro, thermal, nuclear, solar and wind power –
Introduction to thermal power plant processes – building blocks - ideal steam cycles – Boiler
– types, Boiler - turbine units and its range systems, feed water systems, steam circuits,
combustion process, products of combustion process, fuel systems, treatment of flue gases,
steam turbine, condensate systems, alternator, feed water conditioning, turbine bypass valves.
Importance of instrumentation in power generation – details of boiler processes, P & I
diagram of boiler – combined cycle power plant, power generation and distribution.

Measurement in boiler and turbine: Metal temperature measurement in boilers, piping system
for pressure measuring devices, smoke and dust monitor, flame monitoring. Introduction to
turbine supervising system, pedestal vibration, shaft vibration, eccentricity measurement.
Installation of non-contracting transducers for speed measurement, rotor and casing
movement and expansion measurement.

Controls in boiler: Problems associated with control of multiple pulverizers. Draught plant:
Introduction, natural draught, forced draught, induced draught, power requirements for
draught systems. Fan drives and control, control of air flow. Combustion control: Fuel/Air
ratio, oxygen, CO and CO2 trimming, combustion efficiency, excess air, parallel and cross
limited combustion control, control of large systems.

Controls in boiler: Boiler drum level measurement methods, feedwater control, soot-blowing
operation, steam temperature control. Coordinated control, boiler following mode operation,
turbine following mode operation, sliding pressure mode operation, selection between boiler
and turbine following modes. Distributed control system in power plants-interlocks in boiler
operation. Turbine control: Shell temperature control-steam pressure control – lubricant oil
temperature control – cooling system.

Nuclear power plant instrumentation: Piping and instrumentation diagram of different types
of nuclear power plant, Nuclear reactor control loops, reactor dynamics, excess reactivity,
pulse channel and logarithmic instrumentation, control and safety instrumentation, reliability
aspects.

TEXT BOOKS:
3. P.C Martin, I.W Hannah, “Modern Power Station Practice”, British Electricity

REFERENCE BOOKS:
COURSE OBJECTIVES
The course aims to enable engineering students perform better in corporate world by providing insights into human values through literature.

COURSE DESCRIPTION
This course intends to initiate non-literature students to the intricacies of “the written word”. Covering representative works by diverse writers, this course while providing an overview of the formal properties of literature will also emphasize on the social, moral, emotional, political and cultural mores of literary works. Further, the course will acquaint the students to contextualize and historicize literary works, to interpret and evaluate literature and finally, to appreciate figurative/ expressive nature of language. At the end of the course, the students shall demonstrate familiarity by being able to read and write critically about one of the literary forms/genres. All these will enable the students’ to understand people better.

Definitions of Literature. Role and Purpose of literature. Literary language and scientific language. Author/Text/Reader.
Genres of literature (eg. Novel/Short Story/ Poetry/ Drama etc.) and tools of literary study.
Critical/Creative/Lateral thinking. Close reading techniques.
Writing about Literature. Major theories governing the appreciation of literature.
Dissertation

REFERENCES:
COURSE OBJECTIVE
Finding one’s voice is the primary objective for any creative writing program. The course will enable the participant to give shape to his/her creative ideas that can be published.

COURSE DESCRIPTION
This course is meant for the students of engineering who have the talent for creative writing. The course provides a dynamic forum to engage a variety of literary texts. Through such engagements a keener sense about the process of creative writing can be developed. To this end the course is designed with well-considered exercises meant to enable appreciation of literary texts. Further, these exercises would provide a prospect into the demands of creative writing. The student gets an opportunity to make a realistic assessment of his/her abilities in the field. At the end of the program the student will be sufficiently motivated to transform himself/herself from having, merely, a talent for writing to becoming a published writing talent.

Course content
With this in mind, the student is expected to involve in a series of classroom activities and extra-classroom assignments that provide the impetus to discover one’s actual talent. There are FIVE compulsory units which are to be completed through lectures, discussions and individual read-aloud sessions.

Understanding literary forms

Thinking about texts: Role-playing the Reader, the Author, and the Individual as both the Reader-Author.

Intensive reading of a poem, short story, a novel, a bestseller, a film, a drama, an essay, a news story, an Ad-campaign, an interview.

Designing the individual reading list. Pursing one’s own competence

Dissertation: Performance in the chosen genre

REFERENCES: