UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR
V SEMESTER
CHEMICAL ENGINEERING
<table>
<thead>
<tr>
<th>Course No</th>
<th>Name of subject</th>
<th>Credits</th>
<th>Weekly load, hours</th>
<th>CA Marks</th>
<th>Exam Duration Hrs</th>
<th>U E Max Marks</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.501</td>
<td>Engineering Mathematics IV (BCHMPSU)</td>
<td>4</td>
<td>3 1 D/P</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.502</td>
<td>Heat Transfer Operations I (H)</td>
<td>4</td>
<td>3 1 D/P</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.503</td>
<td>Particle Technology (H)</td>
<td>4</td>
<td>3 1 D/P</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.504</td>
<td>Chemical Reaction Engineering I (H)</td>
<td>4</td>
<td>3 1 D/P</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.505</td>
<td>Chemical Engineering Thermodynamics (H)</td>
<td>4</td>
<td>2 2 D/P</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.506</td>
<td>Elective I</td>
<td>3</td>
<td>2 1 D/P</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.507</td>
<td>Particle Technology and Mineral Processing Lab (H)</td>
<td>3</td>
<td>- - D/P</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.508</td>
<td>Fluid Mechanics Lab (H)</td>
<td>3</td>
<td>- - D/P</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>29 16 7 6</td>
<td>400</td>
<td>800</td>
<td>1200</td>
<td></td>
</tr>
</tbody>
</table>

13. 506 Elective I

- 13.506.1 Biochemical Engineering (H)
- 13.506.2 Fertilizer Technology (H)
- 13.506.3 Mathematical Methods in Chemical Engineering (H)
- 13.506.4 Process Optimization (H)
- 13.506.5 Entrepreneurship and Management of Process Industries (H)
- 13.506.6 Corrosion Engineering (H)
- 13.506.7 Nuclear Engineering (H)
- 13.506.8 Technical English and Communication Skills (H)
Course Objective:

- To provide a basic understanding of random variables and probability distributions.
- Mathematical programming techniques are introduced as a part of this course. These techniques are concerned with the allotment of available resources so as to minimize cost or maximize profit subject to prescribed restrictions.

Module – I

Random Variables - Discrete and continuous random variables and their probability distributions - Probability distribution (density) functions - Distribution functions - mean and variance - simple problems - Binomial distribution, Poisson distribution, Poisson approximation to Binomial, Uniform distribution, Exponential Distribution, Normal distribution - mean and variance of the above distributions (derivations except for normal distribution) - Computing probabilities using the above distributions.

Module – II

Curve fitting - Principle of least squares - Fitting a straight line - Fitting a parabola - Linear correlation and regression - Karl Pearson’s coefficient of correlation - Sampling distributions - Standard error - Estimation - Interval estimation of population mean and proportions (small and large samples) - Testing of hypothesis - Hypothesis concerning mean - Equality of means - Hypothesis concerning proportions - Equality of proportions.

Module – III


Module – IV


References:


**Internal Continuous Assessment (Maximum Marks-50)**

- 50% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
- 20% - Regularity in the class

**University Examination Pattern:**

- Examination duration: 3 hours
- Maximum Total Marks: 100

The question paper shall consist of 2 parts.

- **Part A (20 marks)** - Five Short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

- **Part B (80 Marks)** - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

**Course Outcome:**

After successful completion of this course, the students will be familiar with the large scale applications of linear programming techniques which require only a few minutes on the computer. Also they will be familiar with the concepts of probability distributions which are essential in transportation engineering.
Course Objectives:

The course introduces the fundamental concepts of various modes of heat transfer. It will further elaborate these concepts with theories and applications to the solutions of practically relevant chemical engineering problems. The course further offers a prefatory on the principle and application of heat. Emphasis has been given to the fundamental theory, analysis and applications of heat transfer using the principle all the modes of heat transfer. To present a physical picture of the convection process, heat transfer in boundary layer flows will also be addressed. Adequate emphasis has been given to the industrial applications by explicating case studies pertaining to all process heat transfer equipments used in industries.

Module – I

Basic Concepts: Overview of applications of heat transfer in different fields of engineering, modes of heat transfer- conduction, convection and radiation, heat transfer with and without change of phase. Material properties of importance in heat transfer, Thermal conductivity, Specific heat capacity, Isotropic and anisotropic materials.

Conduction Heat Transfer: General heat conduction equation in Cartesian, cylindrical and spherical coordinates (derivation is required only for Cartesian geometry). Reduction of general equation to Laplace, Poisson, heat diffusion and Fourier equations. Different Boundary conditions applied in heat transfer problems. Formulation of heat transfer problems with and without generation of heat (uniform and non uniform heat generation) at steady and unsteady state for different boundary conditions.

One dimensional steady state heat conduction without generation of heat: Fourier heat conduction equation, thermal conductivity measurement; thermal conductivity of solids, liquids and gases- comparison between them, thermal conductivity measurement of solids and liquids, effect of temperature on thermal conductivity; thermal diffusivity. Steady state heat conduction through a variable area

Conduction through systems of constant thermal conductivity :- conduction through plane, cylindrical and spherical wall, combined boundary condition systems (conduction-convection systems), conduction through composite slab:- multilayered plane, cylindrical and spherical shells. Electrical analogy to heat flow. Numerical problems of practical importance based on the above topics.

Thermal insulation: Analysis of Critical radius of insulation for cylindrical and hollow spheres; optimum thickness of insulation. Industrial Insulating materials-cold and hot temperature insulating materials, refractories- examples. Concept of optimum thickness of
insulation. Concept of thermal contact resistance Numerical problems based on the above aspects.

**Module – II**

**Steady state heat conduction in systems with uniform generation of heat** (Constant thermal conductivity): Expression for temperature distribution for one dimensional heat conduction in solids in flat, cylindrical and spherical solid walls. Numerical problems based on the above aspects.


**Unsteady State heat Conduction**: Analysis of transient heat flow with negligible internal resistance-lumped capacity analysis, concept of Biot Modulus and Fourier number- Numerical problems of practical importance.


**Heizler and Grober Charts for transient one-dimensional Heat Flow for infinite and semi-infinite solids**: Heisler charts for infinite and semi-infinite flat walls and cylinders without generation of heat for boundary conditions of practical importance. Solution of numerical heat conduction problems based on the above categories for boundary conditions of practical importance using Heisler Charts.

**Module – III**

**Convection**: Mechanism, overview of continuity, momentum and energy balance equation, boundary layer concepts- thermal and velocity boundary layers, boundary layer thickness, relationship between hydrodynamic and thermal boundary layer thickness for flow over flat plates, the convective heat transfer coefficient, reference temperatures, thermal boundary layers for the cases of flow over a flat plate and flow through pipe, dimensionless numbers in heat transfer and their significance, dimensional analysis- Rayleigh and Buckingham’s pi theorem, its limitations, principle of similarity, application of dimensional analysis to forced convection.

**Forced Convection**: General methods for estimation of convection heat transfer coefficient, Correlation equations for heat transfer in laminar and turbulent flow for external and internal flows for constant heat flux and wall temperature conditions- flow in a circular tube (both developing and developed flows with constant wall temperature-its analysis and constant heat flux conditions) and non-circular tubes, flow over flat plates, flow over

**Natural Convection:** Dimensional analysis, natural convection from vertical and horizontal surfaces under laminar and turbulent conditions for plates, cylinders under constant heat flux and wall temperature conditions, physical significance of Grashoff and Rayleigh numbers. Numerical problems of practical interest.

**Module – IV**

**Analogy between momentum and heat transfer:** Development of Reynold’s and Prandtl, analogy (Derivation is required). Overview of Colburn and Von-Karman analogies (No derivation required). Comparison of different analogy expressions. Numerical problems.

**Heat transfer by radiation:** Introduction- theories of radiation, electromagnetic spectrum, thermal radiation, spectral emissive power, surface emission- total emissive power, emissivity. Radiative properties- Emission, irradiation, radiosity, absorptivity, reflectivity and transmissivity. Concept of black and grey body, radiation intensity, Laws of black body radiation, non-black surfaces- Grey, white and real surface, Lambert’s cosine law., radiation between black surfaces and grey surfaces, radiation shape factor, reciprocity theorem, radiation between large parallel gray planes-derivation of expression for rate of radiant energy exchange, concentric cylinders and spheres (no derivation required), radiation between a small gray body and a large gray enclosure. Radiation shields.

Electrical Network analogy- radiation heat transfer between black surfaces; radiation heat exchange between grey bodies. Radiation in gases. Errors in the measurement of temperature in a thermowell.

**References:**


**Internal Continuous Assessment** *(Maximum Marks-50)*

- 50% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
- 20% - Regularity in the class

**University Examination Pattern:**

- Examination duration: 3 hours  
  Maximum Total Marks: 100

The question paper shall consist of 2 parts.

**Part A** (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from modules I and II, and two questions each from modules III and IV.

**Part B** (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

**Note:** Part B questions should have at least 60 % numerical problems. There could be numerical problems in part A also.

Reference No. 10 indicated in the group of references given above is allowed in the examination hall, which may be mentioned along with the directions to be provided on the facing sheet of the question paper. Steam tables are also permitted in the examination hall. No other charts, tables and codes are permitted in the Examination hall. Necessary relevant data shall be given along with the question paper by the question paper setter.

**Course Outcome:**

Upon successful completion of this course, the students shall become familiar with the fundamental principles and applications of heat transfer in diverse process industries. The knowledge gained through the course coupled with the concepts of the Part II of this course shall equip them to design heat transfer equipments, suiting diverse process needs.
13.503 PARTICLE TECHNOLOGY (H)

Teaching Scheme: 3(L) - 1(T) - 0(P) Credits: 4

Course Objectives:

The course introduces the fundamental concepts of various methods and equipments for handling materials in process industries. The broad class of operations include size reduction, separation and size analysis. Design methods for some of the important materials handling equipments are also introduced.

Module – I


Module – II


Module – III


Module – IV

Mineral beneficiation – Ore Sorting- electronic sorting, assay sampling, recovery, liberation, locked particles. Classification as a means of concentration - Heavy media separation - Jigging - Wilfly table - froth flotation - magnetic separation - high voltage separation. Gas
cleaning methods: Bag filters, cyclone separation, electrostatic separation, scrubbing
Storage of solids, liquids and gases. Transportation of bulk solids - different methods of
transportation - type of conveyors and selection.

References:

Internal Continuous Assessment *(Maximum Marks-50)*
50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

*Examination duration: 3 hours  Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

**Part A (20 marks)** - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

**Part B (80 Marks)** - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

*By doing this course the students will be able to perform size analysis of given substance and present the results in useful form. They will be able to estimate the energy requirements for a specified reduction in size of a given material. Will be familiar with reduction equipments used in industries. They will be able to design clarifiers, thickeners, filters etc.*
Course Objective:

*In this course, the students will be introduced to the basic concepts of chemical reaction kinetics and engineering. In particular they will be introduced to the basics of reactions, determination of kinetics by analyzing reactor experimental data. Design of various commonly used types of reactors and reactor configurations.*

**Module – I**

An overview of chemical reaction engineering. Brief outline of reactor design procedure and types of industrial reactors. Basic concepts of chemical kinetics. Classification of chemical reactions with examples. Rate equations, rate constant, temperature dependency- Arrhenius law, collision theory, transition state theory, comparisons and predictions. Concentration dependency-non-elementary homogeneous reactions: Active intermediates, pseudo steady state hypothesis (PSSH), searching for a mechanism, General considerations, hydrogen bromide reaction, polymerisation - steps in free radical polymerisation. Other examples of non-elementary reactions.

**Module – II**


**Module – III**

Ideal reactors, concept of ideality, design equations for batch, tubular and stirred tank reactors. Space time and space velocity, steady state mixed flow, plug flow and laminar flow reactors. Multiple reactor systems, Plug flow reactor in series and parallel, equal sized mixed reactors in series, mixed flow reactors of different sizes in series, determination of the best system for a given conversion. Advantages and limitations of series combinations. Recycle reactors, optimum recycle ratio, plug flow and mixed flow reactors for an autocatalytic reaction. Reactor Scale-up.
Module – IV


References:


Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

On doing this course, the students will be able to carry out analysis of process reactor data, obtain the kinetics information and carry out process design of reactor systems including biochemical reactor systems.
Course Objectives:

To develop a fundamental understanding of the basic principles of chemical engineering thermodynamics. To examine and select pertinent thermodynamic data, and solve thermodynamics problems on the application, analysis and synthesis of the data. To impart knowledge in the area of solution thermodynamics to the students and make them solve problems in process engineering.

Module – I


Thermodynamic properties of pure fluids- Reference properties, energy properties, derived properties, work function, Gibbs free energy, Relationships among thermodynamic properties: Maxwell’s relations, Clapeyron equation, Entropy-heat capacity relationships, effect of temperature, pressure and volume on internal energy, enthalpy and entropy. Joule-Thomson coefficient, Gibbs-Helmholtz equation, method of Jacobians, Fugacity, Activity, Departure functions and generalized charts, Thermodynamic diagrams.


Module – II

Phase equilibria - criterion of phase equilibria - criterion of stability - phase equilibrium in single - component systems - phase equilibria in multicomponent systems - phase rule for non-reacting systems - Duhem’s theorem - vapour-liquid equilibrium - phase diagram for binary solutions - VLE in ideal solutions - non-ideal solutions - positive and negative deviation - azeotropes - VLE at low pressures - Wohl’s equation - van Laar equation – Wilson equation - application of activity coefficient equations in equilibrium calculations - basic idea on NRTL, UNIQUAC and UNIFAC methods - calculation of activity coefficients using Gibbs -
Duhem equations - consistency tests for equilibrium data - Redlich-Kister method - coexistence equation.

**Module – III**


**Module – IV**


**References:**

5. Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities Press.

**Internal Continuous Assessment (Maximum Marks-50)**

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class
University Examination Pattern:

Examination duration: 3 hours          Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be three questions each from Module I and Module II, and two questions each from Module III and Module IV.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Note: Part B questions should have at least 50 % numerical problems. There could be numerical problems in part A also.

Course Outcome:

On successful completion of the course the students shall have the capacity to synthesis, analyse thermodynamic data relevant to chemical engineering problems that appear in chemical processing operations. They will be made to relate the information acquired to the real world of engineering design and operations. The students develop a quantitative knowledge of thermodynamic properties from a macroscopic to a molecular level.
13.506.1 BIOCHEMICAL ENGINEERING (H)

Teaching Scheme: 2(L) - 1(T) - 0(P)  
Credits: 3

Course Objective:

To impart basic knowledge in biochemical reactions and process involving biochemical reactions. Students will be introduced to methods of determining kinetics of biochemical reactions, enzyme immobilization and isolation, biochemical reactors, sterilization, fermentation and biomass production.

Module – I

**Micro Biology:** Cell theory, Structure of cells: – Procaryotic and Eucaryotic cells, cell fractionation, classification of microbes, protist kingdom. Important cell types (animal and plant cell) and their distinguishing characteristics. *Chemicals of life:* Cell polymeric chemicals repetitive and non repetitive bio polymers - lipids, sugars and polysaccharides, nucleotides - RNA and DNA, amino acids and proteins. Protein structure, hybrid biochemicals, hierarchy of cellular organization.

Module – II


Module – III

Immobilized enzyme technology: enzyme immobilization - industrial process using immobilized enzymes - medical and analytical applications of immobilized enzymes. Applications of hydrolytic enzymes: esterases, carbohydrases, proteolytic enzymes, enzyme mixtures, pectic enzymes and additional applications. Medical application of enzymes, non hydrolytic enzymes in current and developing industrial technology. Metabolic pathways and energetics of the cell: Metabolic reaction coupling : ATP, ADP and NAD. Oxidation and reduction- Coupling via NAD. Embden-Meyerhof pathway (EMP), Pentose phosphate cycle - Entner Doudorff (ED) pathway, Respiration - TCA cycle, Kerb cycle, Photo Synthesis. Transport across cell membranes - passive transport, active transport and facilitated diffusion.
Module – IV

Kinetics of substrate utilization - product formation and biomass production, measuring and monitoring of growth process (Hemacytometer, colony count and turbidity methods). Batch cultivation - growth cycle (lag, exponential, stationary and death phase). Fermentation schemes - Gaden's classification (type I, II and type III) and Deindoerfer classification. Transport phenomena in Bio process system - Gas-liquid mass transfer in cellular system - basic mass transfer and concepts - rates of metabolic oxygen utilisation – determination of oxygen transfer rates-mass transfer across free falling or raising bubble and free surface with or without agitation in heat transfer. Microbial heat generation and correlation, biochemical reactors, types of reactors for sterilization, fermentation and Bimass production.

References:-


Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

On doing this course, students will be able to study, analyze and design biochemical engineering systems.
13.506.2 FERTILIZER TECHNOLOGY (H)

Teaching Scheme: 2(L) - 1(T) - 0(P)  
Credits: 3

Course Objective:

The students will be introduced to basics of soil-plant relationships and fertilizer usage. In particular the will be introduced to the manufacture and handling technology of Nitrogenous fertilizers, phosphatic fertilizers, potassium fertilizers, biofertilizers and compound and complex fertilizers.

Module – I


Module – II

Nitrogenous fertilizers. Manufacture of urea by once through process and total recycle process, ammonium sulphate manufacture from coke-oven gas and by direct neutralisation. Manufacture of ammonium chloride, ammonium sulphate, ammonium nitrate, ammonium phosphate, calcium ammonium nitrate, barium nitrate, nitro chalk and urea.  
Phosphatic fertilizers - phosphate ore beneficiation, phosphoric acid manufacture by wet process and electric furnace process. super phosphates - single and triple super- phosphate.  
Potassium fertilizers - basic slag, potassium chloride, potassium sulphate.

Module – III

Biofertilizers: rhizobium blue green algae, azospirillum, azolla, acetobactor and phosphate solubilizing bacteria. Organic farming Vs chemical farming.

Module – IV

Sampling and analysis of fertilizer, grading, regulations, consumption pattern, optimum dosage/fertilizer management system, storage and handling pricing and their manufacturing industries in India. Safety, health and environment – Corrosion in fertilizers industries, greenhouse emission, effluent treatment and disposal.
References:-

1. Ferman E Bear., "Chemistry of soil".
5. Chemtech Vol. II
6. Govt. of Kerala proceedings of the national workshop on fertility evaluation for soil health enhancement.

Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

On doing this course, students will be able to involve in the design, manufacture and management of commonly used types of fertilizers.
**13.506.3 MATHEMATICAL METHODS IN CHEMICAL ENGINEERING (H)**

**Teaching Scheme:** 2(L) - 1(T) - 0(P)  
**Credits:** 3

**Course Objective:**

To impart basic knowledge in mathematics needed for modelling chemical engineering systems. In particular linear algebra, system of differential equations, Fourier series, Fourier transforms, Laplace Transforms, Greens function, linear and nonlinear dynamical systems, bifurcation theory and chaos.

---

**Module – I**


---

**Module – II**


---

**Module – III**


---

**Module – IV**


**References:**


**Internal Continuous Assessment (Maximum Marks-50)**

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

**University Examination Pattern:**

*Examination duration: 3 hours  Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

**Part A (20 marks)** - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

**Part B (80 Marks)** - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

**Course Outcome:**

*On doing this course, the students will be able to apply basic mathematical modelling concepts for modelling and simulation of process engineering systems.*
13.506.4 PROCESS OPTIMIZATION (H)

Teaching Scheme: 2(L) - 1(T) - 0(P)  
Credits: 3

Course Objective:

To impart basic knowledge in optimization techniques generally used in process industries practice. Students will be introduced to the concepts of modelling for the purpose of optimization. They will trained to formulate optimization problems in the required proper forms and solve them.

Module – I


Formulation of objective functions, Investment costs and operating costs. Time value of money. Measures of profitability, Optimizing profitability, Financial evaluation of projects.

Cost Estimation. Basic concepts of optimization: Continuity of functions, unimodality and multimodality, convex and concave functions, convex region, necessary and sufficient condition for extremum of an unconstrained function.

Module – II


Module – III


Module – IV

Linear Programming and its Applications: Basic Concepts of Linear Programming, Degenerate LPs, Graphical Solution, Natural Occurrence of linear Constraints, Simplex

Introduction to dynamic programming: Advantages and Disadvantages of dynamic programming, applications of dynamic programming, examples. Integer programming and mixed integer programming.

References:

Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

On doing this course, the students will be able formulate any optimization problem, pose the problem in the proper form and solve them.
13.506.5 ENTREPRENEURSHIP AND MANAGEMENT OF PROCESS INDUSTRIES (H)

Teaching Scheme: 2(L) - 1(T) - 0(P)  
Credits: 3

Course Objective:

To impart basic knowledge required for preparing a project report for starting a new venture and finding possible financial resources. Students will be introduced to the industrial policy of the government, International opportunities, methods of managing growth.

Module – I

Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of entrepreneur, Intrapreneur – an emerging class, Concept of Entrepreneurship-Evolution of Entrepreneurship; Development of Entrepreneurship; The entrepreneurial Culture; Stages in entrepreneurial process. Concepts of Entrepreneur, Manager, Intrapreneur/Corporate. Entrepreneur–comparative study-Roles, Responsibilities, Career opportunities. Entrepreneurship as a career, Entrepreneurship as a style of management.


Module – II


Module – III

Institutions supporting entrepreneurs Small industry Financing in developing countries, A brief overview of financial institutions in India, Central level and state level institutions, SIDBI, NABARD, IDBI, SIDO, Indian Institute of Entrepreneurship, DIC, Single window, Latest Industrial policy of Government of India

Module – IV

International Entrepreneurship Opportunities: The nature of international entrepreneurship, Importance of International business to the firm, International versus domestic entrepreneurship, Stages of economic development, Entrepreneurship entry into international business, exporting, Direct foreign investment, barriers to international trade.

Informal risk capital and venture capital: Informal risk capital market, venture capital, nature and overview, venture capital process, locating venture capitalists, approaching venture capitalists.

Managing growth: Using external parties to help grow a business, franchising, advantages and limitations, investing in a franchise, joint ventures- types, Acquisitions and mergers.

References:-


Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

24
University Examination Pattern:

Examination duration: 3 hours  Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

On doing this course, students will be able to apply the knowledge acquired to start a new venture and after starting the venture they will be able to manage the growth of the enterprise.
13.506.6 CORROSION ENGINEERING (H)

Teaching Scheme: 2(L) - 1(T) - 0(P)  
Credits: 3

Course Objective:

To impart basic knowledge in corrosion engineering. In particular the course aims at introducing the students to causes and science of corrosion, quantitative and qualitative assessment of corrosion and methods of prevention and control of corrosion.

Module – I

Basic concepts: Definition and importance; Electrochemical nature and forms of corrosion; Corrosion rate and its determination. Electrochemical thermodynamics and kinetics: Electrode potentials; Potential-pH (Pourbix) diagrams; Reference electrodes and experimental measurements; Faraday’s laws; Electrochemical polarization; Mixed potential theory; Experimental polarization curves; Instrumentation and experimental procedure. Galvanic and concentration cell corrosion: Basic concepts.

Module – II

Experimental measurements, and determination of rates of galvanic corrosion; Concentration cells. Corrosion measurement through polarization techniques: Tafel extrapolation plots; Polarization resistance method; Instrumental methods and Errors in measurement of polarization resistance; Commercial corrosion probes; Other methods of determining polarization curves. Passivity: Basic concepts of passivity; Properties of passive films; Experimental measurement.

Module – III

Applications of Potentiostatic Anodic Polarization; Anodic protection. Pitting and crevice corrosion: Basic concepts; Mechanisms of pitting and crevice corrosion; Secondary forms of crevice corrosion; Localized pitting. Metallurgical features and corrosion: Inter-granular corrosion; Weldment corrosion; De-alloying and dezincification. Environmental induced cracking: Stress corrosion cracking; Corrosion fatigue cracking; Hydrogen induced cracking; Some case studies; Methods of prevention and testing; Erosion, fretting and Wear. Environmental factors and corrosion.

Module – IV

Corrosion in water and Aqueous Solutions; Corrosion in sulphur bearing solutions; Microbiologically induced corrosion; Corrosion in soil; Corrosion of concrete; Corrosion in acidic and alkaline process streams. Atmospheric and elevated temperature corrosion: Atmospheric corrosion and its prevention; Oxidation at elevated temperatures; Alloying;
Oxidising environments. Prevention and control of corrosion: Prevention techniques, modification of the material, alloying, appropriate surface or core treatment, chemical and mechanical methods of surface treatment. Coatings, metallic, non-metallic linings, cathodic protection, anodic protection and passivity. Material selection and design.

References:


Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

On doing this course, students will be able to study and analyse the basic cause of the corrosion, determine the extent of corrosion under the given service conditions and suggest methods for prevention and control.
13.506.7 NUCLEAR ENGINEERING (H)

Teaching Scheme: 2(L) - 1(T) - 0(P)  
Credits: 3

Course Objective:

- To impart knowledge in nuclear engineering and design. In particular concepts of fission, fusion, radioactivity, and neutron physics are introduced.
- Expose students to current uses, issues and events of nuclear fields.
- Give students practice at solving typical basic radiation and nuclear reactor calculations.

Module – I

Introduction: World Energy Sources, Indian Power Scenario, Nuclear Power Scenario in the World, Nuclear Power Scenario in India. Introduction to nuclear engineering, Elements of nuclear power reactor system.


Module – II


Module – III

Applications, Reflector Savings, classification, constituent parts, Heterogeneous Reactors, swimming pool reactor, breeder reactor, heavy water cooled and moderated type reactor, Gas cooled reactor.

Module – IV

Nuclear wastes, types of wastes and its disposal. Radiation hazards and their prevention.

Weapons proliferation.

References:


Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

On doing this course, students will be able to demonstrate ability to solve typical radiation and nuclear reactor calculations. Demonstrate an understanding of the fundamental concepts and principles of nuclear engineering. Realize the impact of nuclear engineering on the society and the need for nuclear education, regardless of career field.


13.506.8 TECHNICAL ENGLISH AND COMMUNICATION SKILLS (H)

Teaching Scheme: 2(L) - 1(T) - 0(P)  
Credits: 3

Course Objective:

To improve the vocabulary power, listening, speaking and reading ability, written communication skill, technical communications skills of the students. To Impart knowledge about business letters, resume, official letters, reports, proposals, technical papers, projects, dissertation/thesis, presentation.

Module – I

Vocabulary and Functional English: This area attempts at making learners withstand the competition at the transnational technical environment so as to enable them to undertake various professional operations such as

1) Vocabulary – a basic word list of one thousand words.
2) Functional grammar, with special focus on Common Errors in English.
3) Idioms and Phrasal verbs.

(Only a brief review of the above topic is required).

Module – II

Listening, Speaking and Reading: This area exposes the learners to the standard expressions including stress, rhythm and various aspects of isolated elements and connected speech. The use of diphthongs, elements of spoken expression, Varieties of English, accent neutralization

Listening Skills: Listening for general content, Intensive listening, listening for specific information. Sounds, stress, intonation, question tag, listening to lectures, audio/video Cassettes, asking and answering questions, note-taking, dialogue-writing.

Speaking Skills: Oral practice: Describing objects/situations/people-Role play-(Individual and group activities) Just A Minute (JAM)/Group Discussion.

Reading Comprehension: This area exposes the learners to the techniques deciphering and analyzing longer texts pertaining to various disciplines of study. Types of Reading, Sub skills of Reading, Eye span – fixation, Reading Aloud and Silent Reading, Vertical and Horizontal Reading, Vocalization and sub-vocalization.

Reading Skills: Skimming the text- exposure to a variety of technical articles, essays, graphic representation, and journalistic articles.
Module – III

Written Communication Skill: This area exposes the learners to the basic tenets of writing; the style and format of different tools of written communication Description (through Paragraph Writing), Reflection (through Essay Writing), Persuasion (through indented Letter Writing), Skills to express ideas in sentences, use of appropriate vocabulary -sentence construction-paragraphs development-note making, informal letters, essentials of telephonic conversation, invitations, minutes of a meeting, editing a passage and essay writing.

Technical communication skills: Technical Report Writing (Informational, Analytical and Special reports), Technical Vocabulary, Technical communication- features, distinction between general and technical communication, language as a tool of communication: levels of communication, interpersonal, organizational, mass communication, the flow of communication: upward, downward and lateral, importance of technical communication, barriers to communication.


Module – IV

A non-detailed study of the autobiography: “Wings of Fire-An Autobiography by APJ Abdul Kalam”. Students should read the book on their own and selected topics may be discussed in the class.

References:-

1. Andrea J Rutherford, Basic Communication Skills for Technology, Pearson Education.
8. Thomson A.J and Martinet A.V, Oxford Practical English Grammar 3rd Edn,

**Internal Continuous Assessment** (*Maximum Marks-50*)

- 50% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
- 20% - Regularity in the class

**University Examination Pattern:**

- Examination duration: 3 hours
- Maximum Total Marks: 100

*The question paper shall consist of 2 parts.*

**Part A (20 marks)** - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

**Part B (80 Marks)** - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

**Course Outcome:**

*On doing this course, the students will be able to improve their vocabulary, listening ability, and speaking ability. They will be good at writing technical reports, business letters, technical papers, dissertation etc.*
13.507 PARTICLE TECHNOLOGY AND MINERAL PROCESSING LAB (H)

Teaching Scheme: 0(L) - 0(T) - 3(P)  
Credits: 3

Course Objective:

To give the students hands on practice for the following.

1. to experimentally determine energy requirement for size reduction of solids, size distribution particulates,
2. Validation of theoretical knowledge of mechanical separation equipments.
3. To experimentally collect data required for designing a few industrial separation equipments and use it to design.

List of Experiments:

1. Particle size analysis: Sieving, hydrometer analysis, pipette method, decantation and elutriation.
4. Size reduction: Determination of Rittinger number using drop weight crusher, verification of laws of crushing - study of industrial equipment - ball mill - jaw crusher - hammer mill
5. Sedimentation: Batch sedimentation test, design of continuous thickeners from batch sedimentation test data.
6. Study of industrial equipments for classification, centrifugal filtration, centrifuging and solids transportation
7. Filtration: Determination of rate of filtration curve for constant pressure filtration and determination of specific cake resistance. Experiments using Rotary Drum Filters and Plate and Frame Filters
9. Cyclone separator: Determination of efficiency of separation
10. Flotation: Determination of efficiency of separation and optimum concentration of additives.

Internal Continuous Assessment (Maximum Marks-50)

40% - Test
40% - Class work and Record
20% - Regularity in the class
University Examination Pattern:

Examination duration: 3 hours  Maximum Total Marks: 100

University question paper consists of 2 experiments based on the list of experiments prescribed. Marks should be awarded as per the following guidelines.

20% - Principle and procedure (During the first 20 minutes of the examination duration, the candidates shall write submit a brief procedure of the experiment he/she is going to perform and show how they will arrive at the desired results)

25% - Conducting experiment

25% - Calculation, Results and Accuracy

30% - Viva voce (based on knowledge related to various experiments listed in syllabus)

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

- On doing this course, the students will be able to experimentally generate data required to characterise particulates, data required to design solids handling and separating equipments and use the data to design such equipments.
**13.508 FLUID MECHANICS LAB (H)**

**Teaching Scheme:** 0(L) - 0(T) - 3(P)  
**Credits:** 3

**Course Objective:**
- Familiarising plumbing tools, pipes, pipe fittings
- Measurement of fluid flow using commonly used instruments.
- Calibration of flow measuring instruments
- Experimental validation of theoretical results for fluid moving machineries.

**List of Experiments:**
1. Study of Plumbing tools, pipe fittings, valves, gauges and meters
2. Measurement of flow using notch and weirs
3. Measurement of flow using orifices and mouth pieces under constant and varying heads
4. Calibration of flow meters
5. Reynold’s experiment
6. Determination Losses in pipes and fittings
7. Determination of Darcy’s coefficient
8. Determination of equivalent length
9. Determination of velocity profile using pitot tube
10. Study and experiments on reciprocating pumps and

**Internal Continuous Assessment (Maximum Marks-50)**
- 40% - Test
- 40% - Class work and Record
- 20% - Regularity in the class

**University Examination Pattern:**
- Examination duration: 3 hours  
- Maximum Total Marks: 100

University question paper consists of 2 experiments based on the list of experiments prescribed. Marks should be awarded as per the following guidelines.
- 20% - Principle and procedure(During the first 20 minutes of the examination duration, the candidates shall write submit a brief procedure of the experiment he/she is going to perform and show how they will arrive at the desired results)
- 25% - Conducting experiment
25% - Calculation, Results and Accuracy
30% - Viva voce (based on knowledge related to various experiments listed in syllabus)
Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

On completing this course, students will be able to fix the power rating for standard fluid moving machineries for a specific pumping task, calibrate and use various commonly used flow measuring instruments.