UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

V SEMESTER

CHEMICAL ENGINEERING

SCHEME -2013

V SEMESTER
CHEMICAL ENGINEERING (H)

Course No	Name of subject	Credits	Weekly load, hours			C A Marks	Exam Duration Hrs	U E Max Marks	Total Marks
			L	T	D/ P				
13.501	Engineering Mathematics IV (BCHMPSU)	4	3	1	-	50	3	100	150
13.502	Heat Transfer Operations I (H)	4	3	1	-	50	3	100	150
13.503	Particle Technology (H)	4	3	1	-	50	3	100	150
13.504	Chemical Reaction Engineering I (H)	4	3	1	-	50	3	100	150
13.505	Chemical Engineering Thermodynamics (H)	4	2	2	-	50	3	100	150
13.506	Elective I	3	2	1		50	3	100	150
13.507	Particle Technology and Mineral Processing Lab (H)	3	-	-	3	50	3	100	150
13.508	Fluid Mechanics Lab (H)	3	-	-	3	50	3	100	150
	Total	**29**	**16**	**7**	**6**	**400**		**800**	**1200**

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)

13.501 ENGINEERING MATHEMATICS - IV (BCHMPSU)

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

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

Linear programming - Formation of LPP - General linear programming problem - Slack and surplus variables - Standard form - Solution of LPP - Basic solution - Basic feasible solution - Degenerate and non-degenerate solutions - Optimal solution - Solution by simplex method - Artificial variables - Big-M method.

Module – IV

Duality in LPP - Properties of primal and dual optimal solutions - solution using duality-Transportation problem and Assignment problem.

References:

1. Veerarajan, T., *Probability, Statistics and Random Processes,* 3/e, Tata McGraw Hill, 2002.

2. Papoulis A. and S. U. Pillai, *Probability, Random Variables and Stochastic Processes*, 3/e, Tata McGraw Hill, 2002.
3. Koneru S. R., *Engineering Mathematics*, 2/e, Universities Press (India) Pvt. Ltd., 2012.
4. Bali N. P. and M. Goyal, *Engineering Mathematics*, 7/e, Laxmi Publications, India, 2012.
5. Kreyszig E., *Advanced Engineering Mathematics*, 9/e, Wiley India, 2013.
6. Swarup, K., P. K. Gupta and Manmohan, *Operations Research*, 6/e, Sulthan Chand and Sons, 1978.
7. Sharma S. D. and H. Sharma, *Operations Research: Theory, Methods and Applications*, 13/e, Kedar Nath and Ram Nath, 1972.

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.

13.502 HEAT TRANSFER OPERATIONS - I (H)

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

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.

Heat Conduction in systems with variable thermal conductivity (without generation of heat**):** Steady state one dimensional heat conduction in plane walls, cylindrical and spherical hollow surfaces without generation of heat- expressions for heat flux and temperature distribution. Numerical problems of practical interest 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.

Heisler Charts for transient one-dimensional Heat Flow in solids:- Features of Heisler charts. Use of Heisler charts for determination of temperature distribution and energy transfer for one dimensional transient heat conduction in plane wall, cylinder and sphere for boundary conditions of practical importance. Numerical Problems.

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 cylinder, spheres and tube banks. Heat transfer in liquid metals- empirical correlations. Numerical problems of practical interest.

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- Emmision, 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 gray 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:

1. Ramesh K. Shah and Dušan P. Sekulic, *Fundamentals of Heat Exchanger Design,* John Wiley & Sons, Inc. 2003
2. M.Necati. Ozizik, *Heat transfer - A basic Approach,* McGraw-Hill College (1985)
3. Binay K. Dutta, *Heat Transfer- Principles and Applications*, Prentice Hall of India.
4. Geankopolis C J, *Transport Processes and Separation Process Principles*, Prentice Hall of India, 4th Edition, Eastern Economy Edition (2004)
5. Holman J P, *Heat Transfer*, McGraw Hill Book Co. (1992).
6. Incropera F P and DeWitt D P, *Introduction to Heat Transfer,* 2nd Ed John Wiley New York (1996).
7. Kern D Q, *Process Heat Transfer*, McGraw Hill Book Co. (1997).
8. Coulson J M and Richardson J F, *Chemical Engineering* Volume 1, Pergamon Press (1999).

9. Holman, J.P., *Heat Tansfer*, 9th edn. The McGraw-Hill Companies, 2008.

10. Kothandaraman C.P, *Heat and Mass Transfer Data Book*, New Age International, India.

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

Particle size analysis - mean diameter, shape factors, derived diameter. Sieving - cumulative and differential method of size analyses. Subseive size analysis - microscopic counting, pipette analysis, hydrometer analysis, photo sedimentation - sedimentation balance, sedimentation and decantation, ICI sedimentation, elutriation, Laser beam Particle size analysis, Online particle analysis. Size reduction - equipments used for primary and secondary stage size reductions - Jaw crusher - Gyratory crusher - Roll crusher – Hammnding and er mill - Ball mill - Rod mill - Disk attrition mills - cutters - Fluid energy mills. Cascade mills. Laws of size reduction, Selection of equipments. Closed circuit grinding and open circuit grinding. Wet grinding and dry grinding.

Module – II

Screening - Industrial screens - Capacity of screens, effectiveness of screens - type of screening mechanisms- differential and cumulative analysis. Classification - Principles of free and hindered settling - Sizing and sorting. Classifiers - Hydraulic classifiers - Rake classifier-Spiral Classifier - Bowl classifier - Pneumatic classifier - Hydroclones. Principles of Sedimentation, coagulation and flocculation-Thickeners - Kynch theory - interpretation of batch sedimentation test. Design of continuous thickeners.

Module – III

Filtration - constant rate and constant pressure filtration - batch and continuous filtration – filtration equipments- sand filter - chamber press - plate and frame filter press - leaf filter - rotary drum filter - Theory of filtration - incompressible cake - cake porosity - filter aids - methods of application - Cake washing- Optimum time cycles. Centrifugal methods of separation - centrifugal filtration - batch, semi and continuous types of centrifuges - centrifuges for liquid-liquid and liquid-solid separation - critical speed.

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:

1. McCabe and Smith, *Unit Operations in Chemical Engineering*, 5th Edn. McGraw Hill.
2. Badger and Banchero, *Introduction to Chemical Engineering*, McGraw Hill.
3. Brown T. G et al., *Unit Operations*, Asia publishing House.
4. Wills B.A., *Mineral Processing Technology*, 4th Ed., Pergamon Press.
5. Allen T, *Particle Size Measurement*, Chapman and Hall, London, 1977.
6. Foust, *Principles of Unit Operations*, McGraw Hill.
7. Gaudin A. M. *Principles Mineral Dressing*, McGraw Hill.
8. Coulson and Richardson, *Chemical Engineering*, Vol 2, Pergamon Press.
9. Perry and Chilton, Eds*, Chemical Engineer's Hand Book*, McGraw Hill.

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. The 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.

13. 504 CHEMICAL REACTION ENGINEERING - I (H)

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

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

Analysis of rate equations –Interpretation of batch reactor data: integral and differential method of rate analysis. Integral method; irreversible first order ,second order and third order type reactions, zero order reactions, reversible first and second order reactions, autocatalytic reactions. Variable volume batch reactor. Differential method of rate analysis, method of half lives, method of initial rates, least square analysis, linearisation of rate laws. Evaluation of laboratory reactors, Integral (fixed bed) reactor, stirred batch reactor, stirred contained solid reactor (SCSR), Differential reactors: Continuous stirred tank reactor (CSTR), Laminar flow reactor, stirred through transport reactor, recirculating transport reactor.

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

Design for multiple reactions: Reactions in parallel, contacting patterns for reactions in parallel, quantitative treatment of product distribution and reactor size for reactions in parallel and series, kinetics of series parallel reaction. Pressure drop in reactors, accounting the pressure drop in the rate law, flow through a packed bed, pressure drop in pipes, simultaneous reactions and separations, Reactive distillation, membrane reactors, inert membrane reactor. Enzymatic reaction fundamentals, Michaelis - Menten kinetics, batch reactor calculations for enzymatic reactions. Bioreactors-cell growth kinetics- Monod equation- batch and chemostat models.

References:

1. Levenspiel Octave , "Chemical Reaction Engineering", John Wiley & Son's.
2. H, Scott Fogler, "Elements of Chemical Reaction Engineering", Prentice Hall of India.
3. Smith J.M, "Chemical Engineering Kinetics," Mc Graw Hill

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.

13.505 CHEMICAL ENGINEERING THERMODYNAMICS (H)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits:** 4

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

Review of laws of thermodynamics and their applications; Brief introduction of first and second laws of thermodynamics. limitations of first law - general statements of second law - concept of entropy - calculation of entropy changes - Carnot's principle - absolute scale of temperature - Clausius inequality - entropy and irreversibility – statistical explanation of entropy - Third law of thermodynamics.

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.

Properties of solutions: Partial molar properties, definition - physical significance - determination - tangent-intercept method - chemical potential - definition - effect of temperature and pressure - fugacity in solution - ideal solution - Lewis-Randall rule -Raoult's law - Henry's law - activity and activity coefficients in solutions - effect of temperature and pressure on activity coefficients - Gibbs-Duhem equations - applications - property changes on mixing - heat effects of mixing processes - enthalpy composition diagrams - excess properties - relation between excess Gibbs free energy and activity coefficient.

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

Applied phase equilibrium - vapour-liquid equilibrium at high pressures – vaporisation equilibrium constants - bubble point, dew point and flash calculations in multi component systems - computer programs for these calculations - vapour-liquid equilibrium in partially miscible and immiscible systems - phase diagrams - principles of steam distillation – phase equilibrium considerations in steam distillation - liquid-liquid equilibrium - binary and ternary equilibrium diagrams - use of triangular diagrams for ternary equilibrium – Different types of ternary systems and their representation on triangular coordinates. Thermodynamic analysis of processes - rate of entropy generation in steady flow processes - calculation of ideal work and lost work - thermodynamic analysis of steady state flow processes.

Module – IV

Chemical reaction equilibria - reaction stoichiometry - criteria of chemical equilibrium - equilibrium constant - standard free energy change - standard state - feasibility of reaction - effect of temperature on equilibrium constant - presentation of free energy data – evaluation of K - equilibrium conversion in gas-phase reactions - effect of pressure and other parameters on conversion - liquid-phase and heterogeneous reaction - reactions in solutions - pressures of decomposition in gas-solid reaction - simultaneous reactions - phase-rule for reacting systems.

References:

1. Smith J. M. & Van Ness H.V., Introduction to Chemical Engineering Thermodynamics, McGraw Hill.
2. Narayanan K. V., A Textbook of Chemical Engineering Thermodynamics, Prentice-Hall of India.
3. Hougen A., Watson K.M. & Ragatz R.A., Chemical Process Principles Vol.2, Asia Pub.
4. Kyle B.G., Chemical and Process Thermodynamics, Prentice-Hall of India.
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 bio-chemicals, hierarchy of cellular organization.

Module – II

Kinetics of Enzyme catalyzed reactions: simple enzyme kinetics with one or two substrates, Michaelis - Menten Kinetics, Evaluation of parameters in Michaelis – Menten equation, kinetics of two substrate reactions. Substrate concentration dependence of enzyme catalysed reactions: substrate activation and inhibition, multiple substrates reacting on a single enzyme. Modulation and regulation of enzyme activity - competitive and uncompetitive inhibition, other influences on enzyme activity. Enzyme specificity and enzyme specificity hypotheses. Applied enzyme catalysis: enzymes of industrial importance. Isolation of crude enzyme - Koji technique - Enzyme purification.

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 classifiation (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, bio-chemical reactors, types of reactors for sterilization, fermentation and Bimass production.

References:-

1. James E. Baileay and David F. Ollis., “Bio-chemical Engineering Fundamentals”. McGraw Hill International Editions.
2. D G Rao., “Introduction to Biochemical Engineering”, Tata Mc Graw Hill.
3. Michael L Shuler and Frikret Khargi., “Bioprocess Engineering Basic Concepts” PHI Publications.
4. Rajiv Dutta., “Fundamentals of Biochemical Engineering”. Anu books.

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

Introduction, history and development, classification - chemical, organic, inorganic and biofertilizers. Solid and liquid fertilizers. Fundamentals of nutrient management, primary, secondary and micronutrients, economics of plant nutrient use. Basic soil plant relationships, nutrient availability in soil, fertilizer usage, fertility evaluation of soil. Manufacture of fertilizers and their intermediates: Ammonia manufacture.

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

Compound and complex fertilizers- MAP and DAP, urea ammonium phosphate, ammonium phosphate sulphate, nitro phosphates, NPK fertilizers. Other fertilizers: Mixtures and granulated products, granulation techniques. Fluid/liquid fertilizers - Urea Ammonium Nitrate, Superphosphoric Acid, Ammonium Polyphosphate, controlled release fertilizers.
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, green house emission, effluent treatment and disposal.

References:-

1. Ferman E Bear., "Chemistry of soil".
2. John L Havlin, James D Beaton, Samuel L Tisadale, Wernor L Nelson., "Soil fertility and fertilizers". PHI
3. Nyle C Brady., "Nature and properties of soil", Eureshia publication
4. Austin G.T. "Shrieves Chemical Process Industries" 3rd Edn.
5. Chemtech Vol. II
6. Govt. of Kerala proceedings of the national workshop on fertility evaluation for soil health enhancement.
7. Fertilizer Manual., United Nations Industrial Development Organization (UNIDO) & International Fertilizer.Development Center (IFDC)., Kluwer Academic Publishers.
8. Pitam singh & U.S. Aw Asthi "Fertilizer Industry in India", Karishma publishers.
9. Bench mark, "Soils of Kerala", Soil survey organization, Agriculture unit.

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

Models in Chemical Engineering: Modeling and simulation. Linear equations. Nonlinear equations. vectors, vector spaces, Metrics, Norms, Inner products, Linear dependence and dimension. Gram- Schmidt Orthonormalisation. Matrices, Eigen values, Eigen vectors, Fredholm alternative. Applications to Chemical Engineering: Linear algebraic equations.

Module – II

Systems of first order homogeneous Ordinary Differential Equations (ODE) (IVP). First order non homogeneous ODE (IVP). Geometric basis of the method. Implications in process control. Partial differential Equations: Classification of Second order partial differential equations. Linearity and superposition. Sturm- Louiville Theory: Infinite dimensional spaces, Eigen value problems, Classical Eigen value problems, Fourier Series, Rayleigh's Quotient. Separation of variables and Fourier Transforms: Rectangular Cartesian Coordinates. Cylindrical coordinates, Spherical coordinates, Fourier series and finite Fourier Transforms.

Module – III

Laplace Transform. Green's Function: Ordinary Differential Equations. Green's function for partial differential equations. Unbounded domains. Uniqueness conditions for Linear and Nonlinear Systems. Maximum principle, Energy methods, Fredholm alternative, Monotone iteration method.

Module – IV

Steady State Characteristics of Nonlinear Dynamical Systems: Dynamic systems, Steady state, Continuation methods. Linear Stability and Limit Cycles: Linear Stability of Dynamical Systems. Bifurcation Theory, Maps. Secondary bifurcation and chaos.

References:-

1. S. Pushpavanam, "Mathematical Methods in Chemical Engineering", Prentice Hall of India Pvt. Ltd. 1998.

2. T. K. V. Iyengar, B. Krishna Gandhi et al. "Mathematical Methods", S. Chand and Company.
3. Gilbert Strang, "Linear Algebra and Applications", Holden Day Publishers.
4. Irvin Kreyszig, "Advanced Engineering Mathematics"**,** New Age International (Pvt) Ltd., New Delhi.

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

Scope of optimization in chemical process industries. Examples of application of optimization. General procedure for solving optimization problems. Simple problems of optimization. Classification of models for the purpose of optimization. Fitting models to empirical data. Factorial experimental designs, method of least squares. Fitting models to data subject to constraints.

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

Optimization of unconstrained functions: Numerical methods for optimizing functions of one variable: Scanning and bracketing, Newton's method, quasi-Newton's method, and secant method. Region elimination methods, two –point equal interval search, dichotomous search, golden section method, Fibonacci search, polynomial approximation methods, quadratic and Cubic interpolation, Application of line search to multidimensional problems.

Module – III

Unconstrained multivariable optimization: Direct methods- Random Search, Grid Search, univariate Search, Nelder Mead Simplex method, method of Conjugate Directions, Powells Method, Indirect Methods: Gradient Method, Steepest Descent and Steepest Ascent, Method of Fletcher and Reeves, Indirect Second order method, Newton's method, method of forcing the Hessian to be Positive definite, Marquardt's method, Movements in search directions. Line search, Trust regions, Termination Secant method, BFGS Method.

Module – IV

Linear Programming and its Applications: Basic Concepts of Linear Programming, Degenerate LPs, Graphical Solution, Natural Occurrence of linear Constraints, Simplex method, Standard LP form. Dual Simplex method, Big- M method, Revised Simplex Method, Sensitivity Analysis, Duality in LP, Karmarker Algorithm, LP applications.

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

References:

1. F. Edgar and D. M. Himmelblau, "Optimization of Chemical Processes", McGraw Hill, Singapore, 1989.
2. A. Ravindran, K. M. Ragsdell and G. V. Reklaitis, "Engineering Optimization: Methods and Applications", Wiley India Pvt Ltd. New Delhi, 2006.

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.

The changing role of the entrepreneur: mid career dilemmas–Closing the window: Creativity and Innovation: Creativity, Exercises on Creativity, Source of New Idea, Ideas into Opportunities. Creative problem solving: Heuristics, Brainstorming, Synectics, Value Analysis Innovation and Entrepreneurship: Profits and Innovation, Globalization.

Module – II

Modules of Innovation, Sources and Transfer of Innovation, Why Innovate, What Innovation, How to Innovate, Who Innovates. Business Planning Process: Meaning of business plan, Business plan process, Advantages of business planning, Marketing plan, Production/operations plan, Organizational plan, financial plan, Final project report with Feasibility study, preparing a model project report for starting a new venture.

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

Family Business: Importance of family business, Types, History, Responsibilities and rights of shareholders of a family business, Succession in family business, Pitfalls of the family business, strategies for improving the capability of family business, Improving family business performance.

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:-

1. David H. Holt, *Entrepreneurship-new venture creation,* Prentice Hall of India
2. Poornima Charantimath, *Entrepreneurship Development-Small Business Enterprise*, Pearson Education, 2007.
3. Robert D Hisrich, Michael P Peters, Dean A Shepherd, *Entrepreneurship,* 6th Edition, McGraw Hill Companies, 2007.
4. Mathew J. Manimala, *Entrepreneurship theory at crossroads,* Biztantra, 2007.
5. Vasant Desai, *Entrepreneurial Development and Management*, Himalaya Publishing House, 2007.
6. Madhurima Lall, Shikha Sahai, *Entrepreneurship*, Excel Books, 2006.
7. Kurakto, *Entrepreneurship-Principles and practices*, 7th Edition, 2007, Thomson publication.
8. Satish Taneja and S.L.Gupta, *Entrepreneurship Development New Venture Creation.*
9. Marc J. Dollinger , *Entrepreneurship: Strategies and Resources.*
10. Brigitte Berger , *The Culture of Entrepreneurship*.
11. Peter F. Drucker, *Innovation and Entrepreneurship.*
12. Dale Meyer G., Kurt A. Heppard , *Entrepreneurship As Strategy.*
13. Sahay A. and.Chhikara M.S, *New Vistas of Entrepreneurship: Challenges & Opportunities*

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 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 (Pourbiax) 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 Aaqueous 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:-

1. Fontana, M.G., "Corrosion Engineering", McGraw-Hill.
2. Jones, D.A., "Principal and Protection of Corrosion", Prentice-Hall.
3. S.N.Banerjee, "An Introduction to Corrosion Science and Corrosion Inhibition", Oxonian Press P.Ltd.,New Delhi, 1985.
4. Zaki Ahmad, "Principles of Corrosion Engineering & Corrosion Control", Butterworth Heinemann, 2006.
5. L. L. Shrier "Corrosion", Butterworth Heinemann, Vol. I & II, 1994.
6. H.H.Uhlig and R.W.Revie, "Corrosion and Corrosion Control", A Wiley – Inter Science. Publication JohnWiley & Sons, New York, 3rd Edition, 1985.
7. C.G. Munger, Vincent, L.D, "Corrosion prevention by protective coatings," NACE Press, Texas, Houston, USA, 2nd Edition 2002.

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.

A short review of nuclear physics: Atomic Structure, Atomic Weight, Mass & Energy, Relativity, Wavelengths, Excited States, Nuclear Decay, Radioactivity Calculations, Nuclear Reactions, Mass Defect, Binding Energy, Properties of Matter, Cross Sections, Reaction Rates, Photon Interactions with Matter, Charged Particle Interactions, Neutron Attenuation.

Module – II

Neutron Reactions, Compound Nucleus, Neutron Scattering, Energy Loss, Nuclear Fission, energy available from fission, liquid drop model, Nuclear chain reaction, Fission Products, Fission Neutrons (Prompt vs. Delayed). Nuclear reactor theory, Fuel Enrichment Process, Neutron Flux, Fick's Law, Equation of Continuity, Diffusion Equation, Infinite Planar Source, Point Source, Bare Slab, Diffusion Groups, Diffusion Length, Thermal Diffusion, Multiple Group Neutron Moderation, One Group Reactor Equation, Slab Reactor, Buckling, Other Reactor Shapes, One Group Critical Equation, Four Factor Formula, Criticality Calculations.

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 reactor dynamics and control, Nuclear reactor thermal-hydraulics, Nuclear instrumentation, Health physics, Radiation shielding, Poisoning, Reactor Accidents - A review of nuclear disasters, Nuclear reactor safety and licensing. Principles of costing.

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

References:-

1. Thomas J.Cannoly, " Fundamentals of Nuclear Engineering ", John Wiley (1978).
2. Collier J.G., and G.F.Hewitt, " Introduction to Nuclear Power ", (1987), Hemisphere Publishing, New York.
3. Lamarsh U.R. " Introduction to Nuclear Engineering Second Edition ", (1983), Addison Wesley M.A.
4. Lipschutz R.D. " Radioactive Waste Politics, Technology and Risk ", (1980), Ballingor, Cambridge. M.A.
5. Irving Kaplan, "Nuclear Physics", Narosa Book Distributors, 2002.
6. R.D. Evans, *"The atomc Nucleus", McGraw-Hill,1955.*
7. D.C.Tayal, Nuclear Physics, Himalayan Publication house, Bombay ,1980.
8. J.H.Horlock ,"Combined Power Plants" ,Pergamon Press, 1992.

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.

Technical English for specific purposes (ESP): Business letters-sales and credit letters, letter of enquiry, letter of quotation, placing order. Job application and resume. Official letters, government letters, letter to authorities. Reports-types, significance, structure and style, writing reports, condensing .Technical proposals-writing a proposal –the steps involved. Technical papers- projects- dissertation- thesis writing. Preparing audio-visual aids.

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.
2. Mohan K and Sharma R C, *Business Correspondence and Report Writing*, Tata McGraw Hill.
3. Barun K Mitra, *Effective Technical Communication,* Oxford University Press, New Delhi.
4. Robert J Dixson, *Everyday Dialogues in English*, Prentice Hall of India.
5. Lakshmi Narayanan K.R, *English for Technical Communication,* Vol. I and II, Sci Tech Publications.
6. Abdul Kalam A.P.J, *Wings of Fire-an autobiography, Universities* Press, 2004.
7. Randolph Quirk, *Use of English Ist Edn,* Pearson, 1962.
8. Thomson A.J and Martinet A.V, *Oxford Practical English Grammar 3rd Edn,*

9. Thomas Eliot Berry, *Most Common Mistakes in English Usage*, McGraw Hill.
10. Sarma B.S, *Structural Patterns and Usage in English*, Poosha Series.
11. John Langan, College Writing Skills, Tata McGraw Hill, 2001.
12. Louis Trimble, *Technical Communication Skills in English,* Cambridge University Press.
13. John Gartside, *Business Communication,* ELBS, 1991.
14. Sethi J and Dhamija P.V, *A Course in phonetics and spoken English*, Prentice Hall, 2004.

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.
2. Screening: Study of industrial screening equipments, determination of effectiveness of screens.
3. Mineral Beneficiation: Study of equipments - mineral jig - Wilfley table
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
8. Free settling: verification of Stoke's law.
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.