UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

VII SEMESTER

CHEMICAL ENGINEERING

SCHEME -2013

VII 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				
13.701	Chemical Engineering Design I (H)	4	2	2	-	50	3	100	150
13.702	Mass Transfer Operations II (H)	4	3	1	-	50	3	100	150
13.703	Petroleum Refinery Engineering (H)	3	2	1	-	50	3	100	150
13.704	Economics and management of Process Industries (H)	3	2	1	-	50	3	100	150
13.705	Elective III	3	2	1	-	50	3	100	150
13.706	Mass Transfer Operations Lab (H)	3	-	-	3	50	3	100	150
13.707	Process Control Lab (H)	3	-	-	3	50	3	100	150
13.708	Mini Project (H)	3	-	-	3	50	-	100	150
13.709	Seminar, Industrial Visits (H)	3	-	-	3	100	-	-	100
	Total	**29**	**11**	**6**	**12**	**500**		**800**	**1300**

13.705 Elective III

13.705.1	Environmental Biotechnology (H)
13.705.2	Fuel Cell Technology (H)
13.705.3	Nanotechnology (H)
13.705.4	Process Modeling and Simulation (H)
13.705.5	Total Quality Management (H)
13.705.6	Catalysts and Catalysis (H)

13.701 CHEMICAL ENGINEERING DESIGN I (H)

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

Course Objective:

The course offers the fundamental mechanical design of different industrial units like storage tanks, flanges, pressure vessels, supports and pipes. It also introduces the concept of different stress components in the design of such units.

Module – I

General design considerations; Design codes; Design pressure; Design temperature; Design stress; materials; welded joint efficiencies; corrosion allowances; Design loads, liquid storage tank codes, classification, Storage tanks for liquefied gases, Horizontal, cylindrical storage tanks with flat head, design of shell, bottom plates, self supported, and column supported roofs, wind girder, nozzles and other accessories.

Bolted Flanges: Types of Flanges, and selection, Gaskets-Design and selection of gasket, gasket seating , bolt diameter. Design of non-standard flanges.

Module – II

Unfired pressure vessel: Pressure vessel codes, classification of pressure vessels, Design of cylindrical and spherical shell under internal and external pressures; Selection and design of flat plate, torisperical, ellipsoidal, and conical closures, compensations of openings. Tall vertical & horizontal vessels: Pressure dead weight, wind, earthquake and eccentric loads and induced stresses; combined stresses, Shell design of skirt supported vessels. Vessel supports;

Design of skirt, lug, and saddle supports.

Design of Pipes: Pipe thickness, pipe diameter for condensate piping, pipe diameter for steam, pipe supports. Design of pipe lines for natural gas, transportation of crude oil. Pipeline design on fluid dynamics parameters.

References:

1. Bhattacharya B. C., *Introduction to Chemical Engineering Design – Mechanical Aspect*, Chemical Engineering Education Development Centre, IIT, Madras.
2. Joshi M. V., Process Equipment Design, McMillan India.
3. Brownell and Young, Process Equipment Design, John Wiley.
4. Perry, Robert H. and W. Green Don, *Perry's Chemical Engineering Handbook*, 8/e, McGraw Hill New Delhi.

5. Ludwig E.E., *Applied Process Design in Chemical Petrochemical Plants*, Vol. 2, Gulf Publishing Co. 1964.
6. Coulson J. M. and J. F. Richardson, *Chemical Engineering*, 6/e, Pergamon Press.
7. Standards : IS 403 (1967), 803 (1963) & 2825 & TEMA

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2)
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 (50 marks) - Two questions of 50 marks each from module I. Candidates have to answer one full question out of the two.

Part B (50 Marks) - Two questions of 50 marks each from module II. Candidates have to answer one full question out of the two.

Note: *IS Codes mentioned in the reference (item no. 7) are permitted for the examination*

Course Outcome:

Upon successful completion of this course, the students become familiar with the concepts of different stress factors and its importance in the design units like storage tank, pressure vessels, flange, supports and pipes.

13.702 MASS TRANSFER OPERATIONS II (H)

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

Course Objectives:

In this course, the students will be introduced to the different types of unit operations like distillation, extraction, leaching and adsorption operations. Further they will be introduced to analyze simultaneous material and energy transfer operations and develop mathematical models of different mass transfer operations.

Module – I

Basic concepts of Distillation: Vapour - Liquid equilibrium pressure - temperature - concentration - phase diagram - isothermal and isobaric equilibrium - Relative Volatility - Raoult's law - ideal solutions deviations from ideality - Minimum and maximum boiling azeotropes - Partially miscible liquids distillation - Insoluble liquids(Steam distillation) - Enthalpy - concentration diagrams - Treatment ofmulticomponent systems-Different distillation Methods : Flash Vapourisation of binary mixture - Simple distillation of binary mixtures -Vacuum distillation - Continuous rectification methods - brief discussion on general characteristics of tray and packed tower - Azeotropic and extractive distillation, low pressure distillation and molecular distillation. Multistage Tray tower Design: Material and enthalpy balance of a fractionator - Ponchon and Savarit and McCabe - Thiele Method – Enriching section with total condenser and reflux below the bubble point - partial condenser - Stripping section. Complete fractionation- Feed below bubble point - Feed tray location - Effects of reflux ratio - total reflux - minimum reflux - Optimum reflux. Reboiler arrangements - use of open steam - Use of multiple feeds - effect of heat loss - Introduction of feed and its influence on operating lines - q-lines and location of tray - Fractionation of azeotropic and partially miscible binary mixtures - Tray efficiencies. Continuous Contact Equipment: Concepts of transfer units - HTU and NTU - and height of the enriching section and stripping section - Graphical methods.

Module – II

Description of liquid extraction - terminologies - application of ternary liquid equilibrium - representation in equilateral triangular co-ordinate of different type systems - Effect of temperature - Representation of ternary equilibrium data in rectangular co-ordinates on total and solvent free bases, equilibria of multicomponent systems - Criteria for selection of solvent. Design of stage wise extractors: Mixers -settlers - Sieve tray tower single - stage extraction - graphical method of determining composition, flow rates. Multistage cross current extraction with practically miscible and immiscible solvents, graphical method of determining number of stages. Continuous counter current multistage extraction - graphical method of determining number of stages - composition and minimum solvent on total and solvent free basis - Counter current extraction with insoluble solvents - continuous counter current extraction with reflux - Graphical solution in total and solvent free basis - total reflux minimum reflux ratio. Constructional & hydrodynamic aspects of stage wise extractors - Design of differential continuous contact extractors. Common characteristics of differential extractors. Types of extractors and their brief description - Design of differential contact tower extractors - Two resistance theory - Overall transfer Coefficient and corresponding HTU and NTU for insoluble liquids and dilute solutions - Hydro dynamics of differential contact extractors selection of extractors.

Module – III

Solid Liquid Extraction: Description of leaching operations and technologies - Applications of leaching - Preparation of solid - Methods of Operation and classification of equipment - Solid - Liquid Equilibrium in leaching - methods of representation on total and inert free basis - Counter current leaching - material balance and graphical solution. Ion Exchange: Principles of ion exchange techniques and application - Ion exchange Equilibira - Rate of ion exchange. Modern separation Techniques - Membrane separation process - solid and liquid membrane separation process solid and liquid membranes - concept dialysis and electro dialysis - Continuous dialyser - concept of diffusion and permeation - Concept of osmosis and reverse osmosis - Industrial application and design aspects.

Module – IV

Description of adsorption processes and their application - Types of adsorption - nature of adsorbents - adsorption equilibria - adsorption hysteresis - Isotherms for adsorption of single components and mixtures - Effect of temperature and pressure - Freundlich equation. Stage wise adsorption : Contact filtration of liquids - single and multistage crosscurrent adsorption - Multistage Counter current adsorption - Agitated vessels for solid- liquid adsorption - Multi stage fluidised bed adsorber for recovery of Vapour - Continuous Contact Adsorption : Steady state moving bed adsorber – Counter current adsorption of one component - Adsorption of two components - Unsteady state fixed bed adsorber - adsorption wave - break through curves and rates of adsorption.

References:

1. Treybal R.E, *Mass Transfer Operations*, McGraw Hill.
2. Coulson J.M. and Richardson, F.F. *Chemical Engineering, Vol.I Fluid, Heat Transfer and Mass Transfer*. 3/e, Pergamon Press.
3. Coulson J.M. and J. F. Richardson, *Chemical Engineering*, *Unit Operations (Vol.2)*, 3/e, Pergamon Press, 1978.
4. Mc Cabe W. L. and J. C. Smith, *Unit Operations of Chemical Engineering* McGraw Hill.
5. Sherwood, T.K.P., R. L. Pigford and C.R. Wilke, *Mass Transfer*, McGraw Hill.

6. King C. J., *Separation Processes*, McGraw Hill.
7. Marcel Mulder, *Basic Principles of Membrane Technology*, ISBN 978 - 81- 8128-683.

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.

Course Outcome:

On successful completion of this course, the students should have the basic concept of different types of unit operations like distillation, extraction, leaching and adsorption operations. The student will be able to analyze simultaneous material and energy transfer operations and develop mathematical models of different mass transfer operations.

13.703 PETROLEUM REFINERY ENGINEERING (H)

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

Course Objectives:

- *Gain knowledge of origin occurrence and exploration of crude oil.*
- *Understand composition and Characterisation for various types of crude oil.*
- *Demonstrate knowledge of petroleum products and quality control.*
- *Understand processing of crude oil into finished fuels and other products including lube oil, bitumen and asphalt.*

Module – I

History and development of refining - Origin, formation, nature, composition and classification of petroleum. Exploration, Drilling and Secondary recovery methods of crude. Storage and transportation of crude oil and products. Petroleum industry in India. Nature of crude from India and Middle East Countries. Evaluation of oil stock - Important properties and test methods. ASTM, TBP and Equilibrium flash vaporisation. Properties, test methods and uses of refinery products such as LPG, Motor spirit, aviation gasoline, kerosene, aviation turbine fuel, white spirit and solvents, diesel fuel, gas oil, fuel oil, petroleum coke, petroleum waxes, lubricating oil and bitumen.

Module – II

Petroleum processing: Dehydration and desalting of crude, heating of crude, Distillation of crude - Arrangement of tower, Atmospheric and Vacuum distillation unit. Treatment processes - Sweetening, hydrogen treatment, hydrodesulfurification process, solvent extraction of kerosene. Stabilization of gasoline - Treatment technique. Production and treatment of L.P.G. Lube oil manufacture – solvent dewaxing, solvent extraction, propane deasphalting and treatment, clay treatment, hydro finishing, hydrotreatment. Lube oil additives. Asphalt blowing.

Module – III

Thermal Conversion process: Thermal cracking-Mechanism of cracking-Visbreaking and Coking. Catalytic conversion process: fluid bed Catalytic cracking, Types of Catalyst, Types of reaction, Mechanism of Catalytic cracking. Hydrocracking: mechanism, type of catalyst, process description and application of Hydrocracking. Reforming: Chemical reforming and Catalytic reforming, reforming reactions, type of catalyst and process description. Polymerization, Alkylation and Isomerisation.

Module – IV

Production of Acetylene, Ethylene and Propylene by steam cracking of Naphtha. Production of butadiene and isoprene. Aromatics in Refinery: Manufacture of Caprolactum from

Benzene, Production of Phenol, Acetone, Cumene and Styrene. Manufacture of Poly ethylene, P.V.C, Poly propylene, Poly styrene, Mono ethylene glycol, Methanol, Formaldehyde, ethanol amine and phthalic anhydride.

References:

1. Bhaskara Rao B.K., *Modern Petroleum Refining Process*, Oxford IBH Publishing Company, New Delhi.
2. Venkateswarlu (Ed), *CHEMTECH IV -, CEED*, Department of Chemical Engg. IIT Madras.
3. Nelson W.L., *Petroleum Refinery Engineering*, McGraw Hill.
4. Meyer R. A., *Hand Book of Petroleum Refining Process*, 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:

Upon completion of the Course the student will able to:

- *Comprehend an overview of the modern, integrated petroleum refinery, its feed stocks, products and the processes employed to convert crude oil and intermediate streams into finished products.*
- *Demonstrate knowledge of each refining process covering operating description and conditions, feedstock and catalyst selection, product yields, and the relationship between different process parameters.*
- *Gain a comprehensive knowledge of different petroleum based products and their uses.*
- *Differentiate between petroleum and petrochemical products and get familiarized with various petrochemical products, their manufacture and uses.*

13.704 ECONOMICS AND MANAGEMENT FOR PROCESS INDUSTRIES (H)

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

Course Objective:

This course aims at introducing the students the basic concepts of economic calculations, different types of depreciation, cost estimation techniques, financial statements and different types of profitability analysis with particular reference to process industries.

Module – I

Introduction to Engineering economy, Engineering Decision - makers, Problem solving Decision making. Interest and Interest Factors - Interest rate, simple interest & Compound interest factors. Equivalence and cost comparisons: Time value of money and equivalence, Equations that are used in economic analysis. Compound interest as an operator, Unacost, Hoskolds formula, Cost comparisons, Present Worth Comparison, Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future worth comparison, Unacost and Capitalized cost. Depreciations and taxes: Purpose of Depreciation as cost, Nature of depreciations - Methods for determining depreciation - Straight line method - sinking fund method - Declining balance method - Double declining balance method - Sum of digits methods - Units of production method. Taxes and depreciation method - Comparison of depreciation methods - Cost comparison after taxes, Present worth after taxes.

Module – II

Continuous interest and discounting, Logic for continuous interest, Continuous interest as an operator, Uniform flow, Flow changing at an exponential rate, flow declining in a straight line to Zero - Discounting with improving performance, Unaflow - Capital recovery factor, Capitalised cost-taxes. Technical advancement and inflation : Displacement Vs replacement, One year more of existence, More than one year of existence, Uniform gradient series delay value of an existent. Inflation, Cost comparison under inflation, una-burden, high inflation rates, Inflation and technological advancements.

Module – III

Capital requirements and cost of production for process plants - Equipment for process plants, cost index, Nelson refinery construction index - Material cost indices - Process equipment cost index - Material cost indices - Process equipment cost index - Labor cost index - equipment costs - Williams six-tenths factor. Cost Estimation: Capital investments, Factors affecting investment & production costs, Fixed capital investment and working capital, Estimation of capital investment, direct cost and indirect costs, Types of capital cost estimates, Order of magnitude estimates, study estimates, preliminary estimate definitive estimate and detailed estimate, Cost factors in capital investment, Cost and installation of purchased equipment, Estimating equipment costs by scaling 6/10 Factor Rule,. insulation costs, Instrumentation and controls, Piping, Electric installation, Building, Yard improvements, Service facilities, Land design engineering and supervision, construction expenses contractors fee, Contingencies, Start up expenses, Methods for estimating capital investment. Estimation of total product cost, Different costs involved in the total product for a typical Chemical Process plant. Estimation of total product cost, Manufacturing costs, general expenses- Direct production costs, Fixed costs, plant over head cost, administration expenses - Distribution and marketing expenses.

Module – IV

Financial statements: Balance sheet and profit and loss accounts - Ratios used for comparing the balance sheet and profit and loss account. Break even and minimum cost analysis, Types of costs, Cost analysis, Economic production charts, Differential analysis of economic production charts, criteria in the use of break-even and minimum cost analysis. Profitability: Investment evaluation, Profitability standards, mathematical methods for profitability evaluation: pay out time, pay out time with interest, rate of return on original investment, return on average investment, discounted cash flow, Net Present worth, Venture worth.

References:

1. Peters and Timmerhaus, *Plant Design and Economics for Chemical Engineers,* McGraw Hill , New York , 4thEdition, 2003.
2. Davies G.S., *Process Engineering Economics*, CEED IIT Madras.
3. Kenneth King Humphrey, *Jelen's Cost and Optimization Engineering*, 3/e, McGraw Hill, 1991.
4. Robert S. Aries and Robert D. Newton, *Chemical Engineering Cost Estimation,* Chemonomics, New York, 1951.
5. John Happel and Donald G. Jordan, *Chemical Process Economics*, Marcel Decker, 1975.
6. Vibrandt, F. C., *Chemical Engineering Plant Design*, McGraw Hill
7. Holand E. A., Watson, F.A. and J. K. Wilkinson, *Introduction to Process Economics*, John Wiley & Sons.
8. Paneerselvam R*., Engineering Economics*, PHI, Eastern Economy Edition
9. Tuesen G., *Engineering Economy*, PHI, 2002
10. Ulrich G. D., *A Guide to Chemical Engineering Process Design and Economics*, John Wiley (1984)
11. Guthrie K. M., *Process Plant Estimation, Evaluation and Control,* Craftsman Solano Beach, California (1974)
12. Douglas, *Conceptual Design of Chemical Processes*, McGraw Hill,1998.

13. Valle Riestra , *Project Evaluation in Chemical Process Industries*, McGraw Hill
14. Schweyer, *Process Engineering Economics*, McGraw Hill, 1955

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 understand the concept of depreciation, different types of depreciation and cost estimation techniques .Further the students will be able to create financial statements and to do different types of profitability analysis.

13.705.1 ENVIRONMENTAL BIOTECHNOLOGY (H) (ELECTIVE III)

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

Course Objectives:

The course is designed to teach students the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments and to generate valuable resources for the human society. The course will look into the biotechnological applications in waste treatment and biodegradation of various xenobiotic compounds using microorganisms.

Module – I

Fundamental Aspects of Environmental Microbiology: -Structure and Functions of Procaryotic Cells -Structure and Functions of Eucaryotic Cells -Taxonomy of Microorganisms: Bacteria, Algae, Fungi and Protozoa - Environmental Significance of Bacteria, Fungi, and Algae

Microbial Metabolism, Growth and Biokinetics: Microbial Nutrition and Metabolism - Microbial Growth and Energy -Enzymes and Their structures -Effect of Environment on Enzyme activity-Microbial Growth and Substrate Utilization Kinetics -Biokinetic Models - Batch and Continuous Chemostat Studies -Determination of Biokinetic Parameters.

Module – II

Microbiology Reactions: Suspended Growth Reactors-Biofilm Reactors -Batch Reactors - Completely Stirred Tank Reactors -Plug Flow Reactors -Reactors in Series

Bioflim Processes: Trickling Filters and Biological Towers -Rotating Biological Contactors - Granular Media Filters -Fluidized-bed Reactors -Hybrid Biofilm Processes.

Module – III

Bioremediation for Soil Environment-Environment of Soil Microorganisms -Soil Organic Matter and Characteristics -Soil Microorganisms Association with Plants -Pesticides and Microorganisms -Petroleum Hydrocarbons and Microorganisms -Industrial solvents and Microorganisms -Biotechnologies for Ex-Situ Remediation of Soil-Biotechnologies for in-Situ Remediation of Soil -Phytoremediation Technology for Soil Decontamination

Bioremediation for Air Environment-Atmospheric Environment for Microorganisms - Microbial Degradation of Contaminants in Gas Phase-Biological Filtration Processes for Decontamination of Air Stream -Biofiltration -Biotrickling Filtration -Bioscrubbers

Bioremediation for Water Environment-Biochemical, Molecular, and Ecological Foundations of Bioremediation -Contaminants in Groundwater -Ex-situ Decontamination of Groundwater -Selecting the Bioremediation Option - -In-situ Bioremediation of Groundwater -Factors Affecting Bio-augmentation-Delivery Systems for Oxygen, Nutrients, and Innoculation-Landfill Leachate Biotreatment Technologies -Industrial Wastewater Biotreatment Technologies-Biotreatment of Surface Waters.

Module – IV

Biotreatment of Metals-Microbial Transformation of Metals -Biological Treatment Technologies for Metals Remediation -Bioleaching and Biobenificiation -Bioaccumulation -Oxidation/Reduction Processes -Biological Methylation

Biodegradation of lignocelluloses, PAH, agricultural chemicals, oil pollution; biosurfactants; microbial leaching

Advances in Environmental Biotechnology: Phytoremediation -Sequestering Carbon Dioxide-Biomonitoring -Application of Microbial Enzymes -Biomembrane Reactors.

References:

1. Rittmann, B. E. and P. L. McCarty, *Environmental Biotechnology: Principles and Applications*, McGraw Hill, 2001.
2. Prescott, L. M., P. Harley, and D. A. Klein, *Microbiology,* Second Edition, Wm. C. Brown Publishers, Dubuque, Iowa, 1993.
3. Hurst C. J., R. L. Crawford, G. R. Knudsen, M. J. MacInerney and L .D. Stetzenbach, *Manual of Environmental Microbiology*, ASM press, Washington, DC, Second edition. 2002.
4. Metcalf and Eddy, Wastewater Engineering- Treatment, Disposal and Reuse, 3rd Edition, Tata McGraw-Hill, New Delhi. 1995.
5. Pickup R. W. and J. R. Saunders, *Molecular Approaches to Environmental Microbiology*, Ellis Horwood Limited, First Edition, UK. 1996.
6. Scragg A*., Environmental Biotechnology*, First Edition, Pearson Education, UK. 1999.
7. Evans G. M. and J. C. Furlong, *Environmental Biotechnology- Theory and Application*, John Wiley & Sons, USA.

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.

Course Outcome:

Upon successful completion of this course, the students shall become familiar with the fundamental principles and applications of biotechnology in waste treatment. The student shall be able to describe the principles and techniques underpinning the application of biosciences to the environment as well as discuss the existing and emerging technologies that are important in the area of environmental biotechnology.

13.705.2 FUEL CELL TECHNOLOGY (H) (ELECTIVE III)

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

Course Objective:

To expose the students to the fundamental knowledge required in the development of fuel cell technology.

Module – I

Introduction: Fuel Cell, Brief History of fuel cells, Types of Fuel Cells, Working of a PEM fuel Cell, Fuel Cell and conventional processes – comparison, Energy & power relations, units, Application scenarios, Advantages and disadvantages.

General Thermodynamics: Enthalpy-Heat potential of fuel, Gibb's free energy-Work potential of fuel, Reversible voltage - NERNST Equation, Voltage and P, T and concentration dependence – examples, Faraday's Laws, Efficiency: thermodynamic, voltage and fuel.

Module – II

Reaction Kinetics: Electrochemical reaction fundamentals, electrode kinetics, Charge transfer and activations energy, Exchange current density - slow and fast reactions, Potential and equilibrium - galvanic potential, Reaction rate and potential - Butler Volmer equation & Tafel equation, Electrocatalysts and reaction kinetics – typical exchange current densities, Electrode design basics

Charge and Mass Transport: Charge transport resistances, voltage losses, Ionic and electronic conductivities, Ionic conduction in different FC electrolytes: Aqueous, polymeric and ceramic, Diffusive transport & voltage loss: Limiting current density, Nerstian and kenetic effect, Convective transport: flow channels, gas diffusion / porous layer, gas velocity, pressure, Flow channel configurations.

Module – III

Overview of Fuel Cell Types: PAFC, PEMFC, AFC, MCFC, SOFC. Major Cell Components, Material Properties, Processes and Operating Conditions of PEMFC.

Stack Design: Sizing of a Fuel Cell Stack, Stack Configuration, Uniform distribution of Reactants, Heat removal, Stack Clamping.

Module – IV

Fuel Cell System Design: Hydrogen-Oxygen Systems, Hydrogen-Air Systems, Fuel Cell Systems with Fuel Processor, System Efficiency

Fuel Cells and Hydrogen Economy: Hydrogen Energy Systems, Hydrogen Energy Technologies, Transition to Hydrogen Economy.

References:-

1. Vielstich W., H. A. Gasteiger and A. Lamm (Eds), *Handbook of Fuel Cells-Fundamentals, Technology and Applications*; Vols1-4, John Wiely & Sons Ltd: NY, 2003.
2. Larminie, J. Dicks, A. *Fuel Cell Systems Explained.* John Wiely & Sons Ltd: Chichester, 1999.
3. Ryan P. O'Hayre, Suk-Won Cha, Whitney Colella & Fritz B. Printz, *Fuel Cell Fundamentals*, John Wiley & Sons, Inc., New Jersey, 2006.
4. Fuel Cell Handbook, 7/e, EG & G Technical Services, Nov 2004.
5. Frano Barbir. *PEM Fuel Cells: Theory and Practice*. Elsevier, 2005.
6. Kordesch, K.; Simader, G. *Fuel Cells and Their Applications.* VCH: 1996.
7. Hordeski, M. F. *Alternative Fuels: The Future of Hydrogen*, Fairmont Press: Lilburn, GA, 2007.
8. Costamagna P. and S. Srinivasan, *J Power Sources* 2001, *102*, 242-252.
9. Costamagna P. and S. Srinivasan, *J. Power Sources* 2001, *102*, 253-269.
10. Andreas Zuttel, Andreas Borgschulte and Louis Schdaptach, *Hydrogen as a Future Energy Carrier*, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2008.

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:

Upon completion of the Course the student will able to:

- *Recall the fundamentals of electrochemistry, thermodynamics, fluid mechanics, and heat and mass transfer, as appropriate, to design or review the design of components of fuel cells and fuel cell systems.*

- *Summarize the fundamentals of electrochemistry and electrochemical potentials.*
- *Analyze the fuel cell technology and compare different types of fuel cell systems.*
- *Calculate the various losses in fuel cells.*
- *Analyze the fuel cell power plant subsystems.*
- *Defend the significance of fuel cell technology in the new global energy scenario.*
- *Distinguish the expectances of hydrogen as a fuel and energy vector in the context of renewable energy.*

13.705.3 NANOTECHNOLOGY (H) (ELECTIVE III)

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

Course Objective:

The course introduces the fundamental principles of nanotechnology and nanomaterials. The course further offers an outline of the various methods of characterization and synthesis of nanomaterials. Adequate emphasis has been given to the applications of nanotechnology and nanomaterials.

Module – I

Introduction to Nanotechnology, its emergence and challenges. Classification of nano-materials: Zero, one, two and three dimensional nano-structured materials

Supramolecular Chemistry:Definition and examples of the main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supramolecular structures. Types of Nanomachines and nanotechnology- Atomic structure of molecules and phase Energy-Molecular and Atomic size-surfaces and dimensional space-Top down and bottom up. Electrical, magnetic, optical, thermal and mechanical properties of nano-structured materials.

Module – II

Instrumentation for nanoscale characterization: Basic characterization techniques; Electron microscopy; Atomic force microscopy; Photon correlation spectroscopy

The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nanometer range.

Methods of Synthesis of Nanomaterials: Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches.

Special nano-materials: carbon, carbon fullerenes and carbon, nano-tubes, nano and microporous materials, core shell structure and nano-composites.

Module – III

Biologically-Inspired Nanotechnology: basic biological concepts and principles that may lead to the development of technologies for nano engineering systems.

Molecular nanoscale engineered devices. Synthesis of nano-particles through homogenous and heterogeneous nucleation. Kinetically confined synthesis of nano-particles: Synthesis of nano-wire, rod, tubes and thin films.

Manufacturing of nanoscale materials: Chemical vapor deposition of carbon nano tubes, Plasma deposition of ultra-thin functional films on nano materials.

Module – IV

Structural nano composites, carbon nano fiber and carbon nano tube/polymer composite fibers and films. Nano scale intelligent materials.

Applications: Solar energy conversion and catalysis, Molecular electronics and printed electronics, Nanoelectronics,

Polymers with a special architecture, Liquid crystalline systems, Linear and nonlinear optical and electro-optical properties, Applications in displays and other devices,

Advanced organic materials for data storage, Photonics, Plasmonics, Chemical and biosensors, Nanomedicine and Nanobiotechnology.

References:-

1. Jean-Marie Lehn, *Supramolecular Chemistry,* Wiley VCH, 1995
2. Jonathan Steed & Jerry Atwood, Supramolecular Chemistry, John Wiley & Sons, 2004
3. Jacob Israelachvil, *Intermolecular and Surface Forces*, Academic Press, London, 1992.
4. Hari Singh Nalwa, "*Nanostructured Materials and Nanotechnology*", Academic Press, 2002
5. Rao C.N.R., Muller A., Chutham A.K, *The Chemistry of Nanoparticles Synthesis, Properties and Applications, Vol 1 and Vol 2,* WILEY-VCH
6. Challa Kumar, *Tissue, Cell And Organ Engineering*, Vol 9, WILEY-VCH, 2006.
7. Challa Kumar, *Nanomaterials for Medical Diagnosis and Therapy,* Vol 10, WILEY VCH.
8. William A. Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J. Iafrate, *Handbook of Nanoscience, Engineering, and Technology,* CRC Press Taylor and Francis Group, 2007.
9. Bhushan*, Handbook of Nanotechnology,* Springer–Springer, 2007.
10. Challa Kumar, *Nanomaterials for Cancer Diagnosis and Therapy, Vol 6 and 7*, WILEYVCH, 2007
11. Challa Kumar, *Nanodevices for Life Sciences, Vol 4*,WILEY-VCH, 2006.
12. Gero Decher and Joseph B. Schlenoff, *Multilayer Thin Films*, Wiley-VCH Verlag GmbH and Co. KGaA, 2003
13. David S. Goodsell, *Bionanotechnolog, Lessons from Nature*, Wiley-Liss, 2004.
14. Kenneth J. Klabunde, *Nanoscale Materials in Chemistry*, John Wiley & Sons, Inc., 2001.
15. Christof M. Niemeyer and Chad A. Mirkin, *Nanobiotechnology: Concepts, Applications and Perspectives* by Wiley-VCH; 1 edition, 2004

16. Guozhong A.O, *Nano structure and nano-materials,* Imperial College Press, London.
17. Poole P, Jr and Frauk J. Owens, *Introduction to Nano technology*, Charles P, Wiley Interscience, New Jersey, 2003.
18. Carl C. Koch. Noyes, *Nano-structured materials: Processing, properties and Potential Applications*, William Andrew Publishing New York.
19. David S. Goodsell, *Bionanotechnology: Lessons from Nature,* Wiley
20. Pradeep.T, *Nano: The Essentials,* Tata McGraw-Hill Publishing Company Ltd, 2007.
21. Nicholas A.Kotov , *Nanoparticles Assemblies and Superstructures,* 2006, CRC.
22. Ralph et al, (Eds), *Nanoscale Technology in Biological Systems,* 2005, CRC.
23. Fujita H, *Micromachines as Tools for Nanotechnology*, Springer Verlag, 2003
24. Niemeyer C.M and Mirkin C.A, *Nanobiotechnology Concepts, Applications and Perspectives* 2004, Wiley VCH Verlag GMBH and Co.
25. Mark J. Schulz, Mannur J. Sundaresan, Ajit D. Kelkar, *Nanoengineering of Structural, Functional and Smart Materials,* CRC 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 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:

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

- *Identify different instruments for Nano scale characterization.*
- *Explain various methods of synthesis of Nano materials*
- *Summarize various applications of nanomaterials.*
- *List the important properties of nanostructured materials.*
- *Outline various manufacturing techniques of Nano scale materials.*

13.705.4 PROCESS MODELING AND SIMULATION (H) (ELECTIVE III)

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

Course Objective:

- *To get an overview of various methods of process modeling and different computational techniques for simulation.*
- *To develop process models based on conservation principles and process data.*

Module – I

Introduction to modeling. Principles of system modeling, System modeling applied to process engineering systems. Systematic approach to model building, Classification of models, Conservation principles, thermodynamic principles and reaction kinetics principles of process systems. Development of steady state lumped parameter models. Dynamic lumped parameter models based on first principles.

Module – II

Mathematical models for chemical engineering systems - continuous flow tanks - enclosed vessel - mixing vessel - mixing with reaction - reversible reaction - steam jacketed vessel - boiling of single component liquid - open and closed vessel - continuous boiling - multicomponent boiling system - batch distillation.

Module – III

Gas flow system - hydraulic transients between two reservoirs - reaction kinetics - general modelling scheme - liquid phase CSTR - batch reactor - ideal binary distillation column - distributed systems - jacketed tubular reactor - laminar flow in a pipe - counter current heat exchanger.

Module – IV

Digital simulation - numerical integration - Euler and fourth order Runge-Kutta methods - simulation of gravity flow tank - CSTR in series- non isothermal CSTR - binary distillation column - batch reactor.

References:-

1. Luyben W.L., Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill
2. Franks R.G.E., Mathematical Modeling in Chemical Engineering, John Wiley
3. John Ingham et.al., Chemical Engineering Dynamics- Modeling with PC Simulation, VCH Publishers

4. Biquette W.B., Process Dynamics - Modeling Analysis and Simulation, Prentice Hall

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:

Upon completion of the Course the student will able to:

- *Identify the important physical phenomena from problem statements.*
- *Summarize the various models in chemical process systems.*
- *Detect and implement suitable simulation techniques and tools.*
- *Design the appropriate method to verify and validate models and simulations.*

Combine the results to reach an appropriate conclusion.

13.705.5 TOTAL QUALITY MANAGEMENT (H) (ELECTIVE III)

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

Course Objective:

To impart basic knowledge in Total Quality Management.

Module – I

INTRODUCTION: Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

TQM PRINCIPLES: Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen

Module – II

Supplier Partnership –Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

STATISTICAL PROCESS CONTROL: The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

Module – III

TQM TOOLS: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

QUALITY SYSTEMS: Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

Module – IV

Total Quality Environment Management and EMS 14000: Municipal pollution prevention Programmes – Environment Management System-14000- Systematic, Structured and

Documented Response to Environmental Issues - Auditable and Time Targeted Environmental Improvement Programs.

Hierarchy of Environment Management Practices**:** Waste-specific pollution prevention: Waste pre-generation focus on minimization / recycling, Waste-specific pollution control treatment: pre - generation focus on disposal/ recycling- Waste-specific Post-release-to environment focus: recycling/ remediation.

References:-

1. Dale H. Besterfiled, *et al.*, *Total Quality Management*, Pearson Education Asia, 1999. (Indian reprint 2002).
2. James R.Evans & William M.Lidsay, *The Management and Control of Quality*, 5/e, South- Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
3. Feigenbaum.A. V., *Total Quality Management,* McGraw-Hill, 1991.
4. Oakland.J. S., *Total Quality Management*, Butterworth Heinemann Ltd., Oxford. 1989.
5. Narayana V. and N. S. Sreenivasan, *Quality Management – Concepts and Tasks*, New Age International 1996.
6. Zeiri, *Total Quality Management for Engineers* Wood Head Publishers, 1991.
7. Bishop P, *Pollution Prevention: Fundamentals and Practice, McGraw-Hill,* Singapore, 2000.
8. Roy K, *(Editor), Chemical Technology for better Environment,* Allied publishers Ltd, Chennai, 1998
9. El Halwagy M. M, *Pollution Prevention through Process Integration: Systematic Design Tools,* Academic Press, N.Y., 1997.
10. Anastas P.T. and Warner J.C., *Green Chemistry: Theory and Practice,* Oxford University Press. N.Y., 1998.

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 understand the various aspects of TQM

13.705.6 CATALYSTS AND CATALYSIS (H) (ELECTIVE III)

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

Course Objective:

- *To impart the basic concepts of catalysis, preparatory methods, characterization and the industrial applications of catalyst.*
- *To expose the students to recent trends in catalysis such as polymer supported, nano and bio catalysis.*

Module – I

Catalysis. General characteristics of catalysis. Classification of Catalyst, Thermodynamics of adsorption, Physical adsorption and chemisorptions. Adsorption isotherms. Catalyst selectivity.

Catalyst preparative methods – Precipitation and co precipitation, Sol gel process, Flame hydrolysis, Supported catalyst from CVD and related techniques, preparation and structure of supports, Synthesis of aluminosilicate zeolites.

Module – II

Catalyst Characterisation- surface area measurements, BET theory, Pore size distribution, Porosimetry, Chemisorption techniques, Static and dynamic methods, Crystallography and surface analysis techniques – XRD, NMR.

Module – III

Industrial catalysis – Homogeneous, Heterogeneous, Biocatalysts, Transition metal catalyst, Organo metallic catalyst, Dual function catalyst, Zeolite, Powder and pellet catalyst and their typical industrial applications.

Modern trends in catalysis – Phase transfer catalysis, electrocatalysis, Nano catalysis, Polymer supported catalysis, Biocatalysis, Photocatalysis (Types, uses and indusrial application).

Module – IV

Deactivation of catalyst – classification of catalyst deactivation processes, poisoning of catalysts, poisoning of metallic catalysts, poisoning of non-metallic catalysts, poisoning of bifunctional catalysts, coke formation on catalysts, metal deposition on catalysts ,sintering of catalysts. Regeneration of deactivated catalyst.

References:-

1. Smith J. M., *Chemical Engineering Kinetics*, McGraw Hill

2. Emmett, P.H *, Catalysis* Vol I and II, Reinhold Corp, New York, 1954
3. Thomas and Thomas , *Introduction to Heterogeneous Catalysis*, Academic Press, London, 1967
4. Fogler H.S., *Elements of Chemical Reaction Engineering*, Prentice Hall of India
5. Levenspiel O*., Chemical Reaction Engineering*, John Wiley
6. Hill C.G., *An Introduction to Chemical Engineering Kinetics & Reactor Design*, John Wiley
7. Viswanathan B., S. Sivasanker, A. V. Ramaswamy, *Catalysis: Principles and Applications.*
8. R. A. Van Santen, Piet W. N. M. Van Leeuwen, Jacob A. Moulijn, Bruce A. Averill, *Catalysis: An Integrated Approach* , Elsevier.
9. Diazo Kunii, and Octave Levenspiel, *Fluidization Engineering,* Butterworth-Heinemann.

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:

At the end of the course, the student will be able to

- *explain the basic concepts of catalysis*
- *describe the different techniques used for catalyst characterization*
- *summarize the catalytic process used in industries*
- *outline the modern trends in catalysis.*

13.706 MASS TRANSFER OPERATIONS LABORATORY (H)

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

Course Objective :

This course aims at giving practical knowledge in the basics of mass transfer operations.

Experiments

1. Diffusion coefficient measurement
2. Wetted wall column, measurement of mass transfer coefficient.
3. Distillation: Determination of VLE, steam requirement and vaporization efficiency, efficiency in steam distillation, verification of Rayleigh's equation for simple distillation, Distillation in packed columns, HETP.
4. Absorption: Verification of design equation for height of packing in packed tower absorption of ethanol in water, absorption of carbon dioxide in sodium carbonate solution.
5. Surface evaporation - Free convection mass transfer.
6. Liquid extraction: Determination of ternery liquid - liquid equilibria.
7. Leaching: simple leaching; cross current leaching and counter current leaching.
8. Adsorption: Determination of adsorption isotherm.
9. Drying: Determination of drying rate curve and mass transfer coefficient for atmospheric batch drying.
10. Fluidisation: Determine experimentally the pressure drop versus superficial velocity plot and find minimum and settling velocity.

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 will be 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 successful completion of this course, students will be able to

- *Analyse material balance and estimate vapour -liquid equilibrium for binary systems.*
- *Determine the overall stage efficiencies for leaching operations and compare with theoretical values.*
- *Design adsorption and drying equipment based on number of transfer units (NTU) approach.*
- *Judge various model equations for adsorption systems.*
- *Estimate binary diffusivity Estimate binodal solubility curve and apply to liquid –liquid extractions.*

13.707 PROCESS CONTROL LAB (H)

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

Course Objective :

*This course aims at giving practical knowledge in the basics of control engineering***.**

List of experiments

1. Dynamics of first order system- Thermometer
2. Dynamics of first order system- Thermometer with thermo well
3. Dynamic response of U-tube manometer
4. Pressure control trainer
5. Flow control trainer
6. Temperature control trainer
7. Level control trainer
8. Liquid level dynamics- Single tank system
9. Liquid level dynamics- Two tank in series non-interacting system
10. Liquid level dynamics- Two tank in series interacting system.

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 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 successful completion of this course, students will be able to

- *Determine the dynamic response of first order and second order type systems to different forcing functions.*
- *Determine and compare the response of different types of controllers.*
- *Generate hands-on experience to tune different types of controllers for a stable response.*

13.708 MINI PROJECT (H)

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

Course Objective :

The mini-project is to be considered as a prequel to the main project work, the students shall have during the higher semester. All necessary background information required to pursue an effective final project should be collated at this level itself. An acceptable minimum level of practical work should be compulsorily done and the feasibility of the proposed work should be proven with supporting theoretical and practical evidence at the end of the mini project.

Every student will be required to submit a project report in a typed form. The topic is to be selected by the student, but specifically approved by the faculty member who guides the student. The mini project work on the topic will consist of either some investigational work on an experimental set up or prototype equipment of some development work, computer simulation or design problem. On completion of the work, every student will be orally examined in the topic selected by the student.

The student will be required to submit three copies of his/her project report to the department office for record before the last working day of the semester (One copy each for the department library, participating faculty and students own copy). The work on the mini project shall be started by the starting date of the semester.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Assessment by Guide (20% weightage for Report)
40% - Assessment by Evaluation Committee (three member committee out of which one member is the guide)
20% - Regularity in the class

University Examination Pattern:

Maximum Total Marks: 100

80% - Based on quality of work, report and presentation of the mini project
20% - Viva voce

Candidate shall submit the certified report for endorsement by the external examiner.

Course Outcome:

At the end of this course, the students should have selected the appropriate area on which they shall pursue their project work during the higher semester. They should have collected relevant background information and should have produced convincing and conclusive evidence (both theoretical and practical) in support of the feasibility of their proposed project.

13.709 SEMINAR, INDUSTRIAL VISITS (H)

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

Course Objective :

- *To do a detailed study of a selected topic based on current journals or published papers and present a seminar based on the study done.*
- *To get exposed to real life industrial situations and gain practical experience in a relevant domain in computer science engineering, and to instill a motivation for pursuing a covetable job as an engineer in future.*
- *To identify a problem for the final-year project, outline a solution, and prepare a preliminary design for the solution.*
- *To improve the ability to perform as an individual as well as a team member in completing a project work.*

SEMINAR

Each student has to present a seminar for the duration specified by the department before the audience consisting of students and members of the faculty of the department on a topic which is selected by the student in consultation with the internal project guide. The student will be required to submit three copies of his/her seminar report to the department office for record (One copy each for the department library, participating faculty and students own copy).

INDUSTRIAL VISITS

Each student has to undergo a minimum of 4 industrial visits during the course in any reputed process industry and submit a report of the same to the department in the format prescribed by the department. The student shall be permitted to take up the training only in process industries or well established and reputed centres only after completing the first year but before the expiry of the seventh semester. The evaluation of the industrial visits undergone by the student needs to be done only at the end of the seventh semester.

MARKS DISTRUBUTION

Marks: Total Marks for Seminar /Industrial Training: 100 (Internal Evaluation).

The following guidelines may be used for distribution of marks.

Total Marks for Industrial visits: 40

An evaluation committee constituted from among the faculty of the department has to evaluate the student orally based on the industrial visits undergone by the student. This may be done along with the internal evaluation of the mini project and marks may be awarded based on a maximum of 40 marks exclusively for the industrial visits.

Total marks for seminar: 60.

The guide has to award a maximum of 30 marks based on the sincerity, dedication and performance of the student during the course of literature survey and material preparation associated with the seminar. An evaluation committee constituted from among the faculty of the department has to award the remaining 30 marks based on the overall performance of the student in the seminar. The student's presentation skills, way of answering queries, time management, delivery of lecture may be used as parameters for evaluation.

Course Outcome:

At the end of the course, the students would have acquired the basic skills to for performing literature survey and paper presentation. This course shall provide students better communication skills, exposure to working of industries and improve their leadership quality as well as the ability to work in groups, and thus aid them in building a successful career as an engineer