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Enclosure to Item No. 4.15
27.5.2009

UNIVERSITY OF MUMBAI

Revised Syllabus for the

Third Year Chemical Engineering

(Semester V & VI)

(With effect from the academic year 2009-2010)

(1)

SCHEME OF INSTRUCTIONS AND EXAMINATIONS
UNIVERSITY OF MUMBAI

COURSE: BE (CHEMICAL ENGINEERING)
YEAR: TE **SEMESTER: V**

Sr. No.	Subject	Scheme of Instructions 1 Hr Periods			Duration of Papers Hrs	Scheme of Examination				
		Lecture	Practical	Tutorial		Theory Paper	Term Work/ Assignment/Test	Practical (with Oral)	Oral	Total
5.1	Heat Transfer Operations	4	2	-	3	100	25	25	-	150
5.2	Chemical Engineering Thermodynamics-I	4	-	1	3	100	25	-	-	125
5.3	Process Equipment Design & Drawing-I	4	3	-	4	100	25	-	-	125
5.4	Solid Fluid Mechanical Operations	4	2	-	3	100	25	25	-	150
5.5	Mass Transfer Operations-I	4	2	-	3	100	25	25	-	150
5.6	Chemical Engineering Economics	4	-	-	3	100	-	-	-	100
	TOTAL	**24**	**09**	**01**	-	**600**	**125**	**75**	-	**800**

COURSE: BE (CHEMICAL ENGINEERING)
YEAR: TE **SEMESTER:VI**

Sr. No.	Subject	Scheme of Instructions 1 Hr Periods			Duration of Papers Hrs	Scheme of Examination				
		Lecture	Practical	Tutorial		Theory Paper	Term Work/ Assignment/Test	Practical (with Oral)	Oral	Total
6.1	Chemical Process-I	4	-	1	3	100	25	-	-	125
6.2	Chemical Engineering Thermodynamics-II	4	-	1	3	100	25	-	-	125
6.3	Mass Transfer Operations-II	4	2	-	3	100	25	25		150
6.4	Process Equipment Design & Drawing-II	4	3	-	4	100	25	-	25	150
6.5	Transport Phenomenon	4	-	1	3	100	25	-	-	125
6.6	Elective-I	4	-	1	3	100	25	-	-	125
	TOTAL	**24**	**05**	**04**	-	**600**	**150**	**25**	**25**	**800**

Elective-I: 1. Piping Engineering
2. Numerical Methods in Chemical Engineering
3. Optimization & Operation Research
4. Computer Aided Design

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T.E. CHEMICAL ENGINEERING (SEM-VI)

Class: T.E. Chemical Engineering		Semester: VI	
Subject: **Chemical Processes-I**			
Periods Per Week (60 Min)	Lectures	04	
	Practical's	----	
	Tutorials	01	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical with oral Examination	-----	-----
	Term Work	----	25
	Total	---	**125**

Detailed Syllabus

6.1.1	Module 1	
	6.1.1.1 Introduction Historical Development Of Chemical Industry In India 6.1.1.2 Material Resources And Shortcomings Challenges Faced By Chemical Industry In India Future Trends 6.1.1.3 Unit Operations And Processes concepts Used In Chemical Industries. 6.1.1.4 General principles applied in studying an industry.	06
6.1.2	Module 2	
	6.1.2.1 Nitrogen Industries : Manufacture Of Ammonia , Ammonium Sulphate, Urea And Nitric Acid.	06
	6.1.2.2 Chlor-Alkali Industries: Manufacture Of Caustic Soda , Chlorine, Hydrochloric Acid And Hydrogen, Manufacture Of Soda Ash (Solvay And Dual Process).	06
6.1.3	Module 03	
	6.1.3.1 Manufacture Of Sulphur By Frasch Process, By Iron Pyrites Burning, Manufacture Of Sulphuric Acid By Dcda Process (Different Configurations Of Catalyst And Absorber Units)	07
6.1.4	Module 04	
	6.1.4.1 Phosphorous Industries Including The Manufacture Of Phosphorous (Electric Furnace Method), Phosphoric Acid (	07

	Wet And Electrolytic) And Manufacture Of Single And Triple Super Phosphates.	
6.1.5	Module 05	
	6.1.4.1 Electrolytic Industries: Manufacture Of Aluminium, Manufacture Of Sodium Metal, Manufacture Of Sodium Chlorate	05
6.1.6	Module 06	
	6.1.6.1 Industrial Gases Air Liquefaction And Fractionation To Manufacture Oxygen , Nitrogen. 6.1.6.2 Manufacture Of Acetylene 6.1.6.3 Manufacture Of Synthesis Gases, Carbon Dioxide, Hydrogen, Carbon Monoxide By Steam Reforming, By Partial Combustion Of Hydrocarbons.	08

Important note regarding content of instructions:

While discussing the manufacturing process , the following areas should be highlighted so that the relevance and application of the various subjects covered in the B.E. course can be underscored. Chemistry , stoichiometry and alternate routes / raw materials involved Byproducts and purification / separation techniques
Thermodynamics , kinetics and catalyst considerations for the process conditions Adopted
Energy considerations and conservation measures adopted
Flow diagram and its concordance with the chemical and purification steps / Chemical engg. Principals
Chemical and Engineering aspects of the process design / key equipment design And material of construction
Safety and Environmental engineering aspects of the process of manufacture Recent trends in the design of processes which are more eco-friendly and Inherently safer.
Major Engineering problems

Theory Examination:

1. Question paper will comprise of 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question 1 will be compulsory and it will be based on entire syllabus.
4. Remaining questions will be mixed in nature. (for example if Q2 has part (a) from module 3 then part (b) will be from any module other than module 3.)
5. In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

TERM WORK :

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1. A minimum of 08 assignments should be given at regular intervals.
2. The performance of the students should be evaluated based on each assignment giving suitable weight age to punctuality & contents.
3. Point nos. 1 & 2 above should account for 15 marks (out of 25 marks) for term work .
4. Average of a minimum of two test should account for 10 marks (out of 25 marks) for term work
5. A minimum of two mandatory visits to chemical process industry. The faculty members are expected to accompany the students
6. Each student must prepare a four page report on the visit stressing on the process , environmental , safety measures , major equipments , process control equipments (if any) etc. while highlighting the information obtained.
7. The performance of the students during the visit and evaluation of the report together should contribute towards 10 out of 25 marks for term work.

Text Books :

1. Austin , G. T. , " Shreve's Chemical Process Industries " . 5 th Ed. , McGraw Hill International Edition
2. Pandey , G. N. " A text book of Chemical Technology " Vol. I and II . Vikas Publications , 1984
3. Rao , G. N. and Sitting , M. " Dryden's Outlines of Chemical Technology for 21st Century " , East West Press , 3rd edition

Referance Books

1. Heaton , C. A. " An introduction to industrial chemistry " , Leonard Hill , 1984
2. Ibid , " The chemical industry " , ibid , 1986
3. Thomson , R. , " Morden inorganic chemicals industries" , Royal Society of chemistry , 2nd ed. , 1994
4. Kirk-Othmer 's " Encyclopaedia of chemical technology " , John Wiley and sons Inc., 4th ed. 1990
5. Ullmann's " Encyclopaeia of Industrial Chemistry" , VCH, 1985
6. McKetta's " Encyclopaedia of chemical processing and design ", Marcel Dekker, 1999
7. Pletcher , D. and Walsh , F. C. , " Industrial Electrochemistry" , Chapman & Hall, 1990

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Class: T.E. Chemical Engineering		Semester: VI	
Subject: **Chemical Engineering Thermodynamics-II**			
Periods Per Week (60 Min)	Lectures	04	
	Practical's	----	
	Tutorials	01	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical with oral Examination	-----	-----
	Term Work	----	25
	Total	---	**125**

Detailed Syllabus

6.2.1	Module 1 1.1 Fundamental property relation for open and closed systems. 1.2 Criteria of equilibrium in terms of intensive and extensive properties. 1.3 Chemical potential as criteria for phase equilibria.	06
6.2.2	Module 2 2.1 Properties of ideal mixtures and solutions. 2.2 Review of Raoult's law, Henry's law, non-idealities of solutions and mixtures. 2.3 Electrolytes and non-electrolytes. 2.4 molar and partial molar properties. 2.5 Gibbs- Duhem equation.	07
6.2.3	Module 3 3.1 Fugacity and fugacity coefficients. 3.2 Estimation and determination of activity coefficients for prediction of thermodynamic equilibria. 3.3 empirical and semi-empirical methods. 3.4 Group contribution methods.	07
6.2.4	Module 4 4.1 Phase equilibria at low and moderate pressures. 4.2 High pressure gas liquid and vapour liquid equilibria. 4.3 Liquid- liquid and solid-liquid equilibria. 4.4 Application of these methods to simple cases. 4.5 Computer methods of prediction of equilibria.	09

6.5.5	Module 5 5.1 Homogenous and heterogenous reaction systems. 5.2 Equilibrium constant and compositions in simple reactions. 5.3 Multiphase and multireactions equilibria.	09
6.6.6	Module 6 6.1 Refrigeration cycles (P-V, T-S, H-S, H-X diagrams) for vapour compression And Absortion refrigeration systems. 6.2 Evaluation of COP, duty and load of such cycles.	07

Theory Examination:

1. Question paper will comprise of 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question 1 will be compulsory and it will be based on entire syllabus.
4. Remaining questions will be mixed in nature. (for example if Q2 has part (a) from module 3 then part (b) will be from any module other than module 3.)
5. In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

TERM WORK

Term work consists of minimum of eight assignments and written test. There should be at least one assignment covering each of the modules mentioned above.
The distribution of the term work will be as follows:

Assignments- 10 marks
Test-10 marks
Ateendance-5 marks

TEXT BOOKS

7 Smith J.M and Van Ness H.C ; 'Introduction to Chemical Engineering Thermodynamics' 4/e , McGraw Hill, 1994.
8 Rao Y.V.C; 'Chemical Engineering Thermodynamics' ,University Press, 1997.

REFERENCE BOOKS

4 Sandler S.L; 'Chemical Engineering Thermodynamics', 2/e, John Wiley, 1989.
5 Daubert T.E ; 'Chemical Engineering Thermodynamics', McGraw Hill, International edition , 1994.
6 Glasstone; 'Thermodynamics for Chemists', Van Nostrand East-West Press,1964.
7 Walas J W; 'Phase Equilibria', Prentice Hall N J.

T.E. CHEMICAL (SEM-VI)

Class: TE. Chemical Engineering		Semester: VI	
6.3 Mass Transfer Operations-II			
Periods Per Week (60 Min)	Lectures	04	
	Practical's	02	
	Tutorials	--	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical with Oral Examination	-----	25
	Term Work	----	25
	Total	---	**150**

Sr. No.	Detailed Syllabus	Hours
6.3.1	Module 1	
	Review of Mass Transfer Operations – I: Mass Transfer coefficients, equilibrium stage operations etc. Distillation: • Vapor-liquid equillibria, ideal and non-ideal solutions, effect of temperature/pressure on P-x,y / T-x,y plots, Azeotropes, immiscible liquids etc. • Flash distillation, binary and multi-component, Numerical examples. • Differential distillation, Rayleigh equation, Numerical examples. • Multistage distillation-Concept of stage by stage calculations for multicomponent systems.(quantitative procedure only) • Multistage distillation-Binary distillation, Ponchon-Savarit method, Numerical examples, McCabe-Thiele Method, Numerical Examples. • Packed bed distillation – Concepts of NTU, HTU, and HETP. • Distillation with immiscible liquids – Steam distillation, Numerical examples. • Concepts of Azeotropic, Extractive, Reactive distillation and Molecular distillation.	08
6.3.2	Module 2	
	Liquid-Liquid Extraction • Definition and comparison with other separation operations. • Mutual solubilities of liquids, liquid-liquid equillibria, Effect of temperature and pressure on equillibria. Other	05

	forms of representation of liquid-liquid equillibria. Other forms of representation of liquid-liquid equillibria (solvent free coordinates) • Choice of solvent. • Similarities between extraction and distillation operations. Single stage operations. Numerical examples using various types of coordinates. • Multistage extraction - co-current, cross current and counter current(with and without reflux).Numerical examples using all types of coordinates. • Extraction in packed columns. • Multistage extraction with reflux. Method of calculations. • Extraction equipment – description, design principles. Numerical examples.	
6.3 3	Module 03	
	Solid-liquid extraction (Leaching) • Representation of equillibria. Construction of simple equilibrium curves. Numerical examples. • Similarities in calculations for liquid-liquid and solid-liquid extractions. Numerical examples for single stage, multistage-co-current, cross current and counter current operations. Equpments for leaching-description.	08
6.3 4	Module 04	
	Adsorption and ion exchange • Types of adsorption, adsorption equillibria, Isotherms-Friendlich and Langmuir. Effect of temperature and pressure etc. • Stage wise (single/multi) cross current and counter current adsorption operations – graphical procedures. Application of Friendlich isotherm. Numerical examples. • Fixed bed adsorber design. Numerical examples using breakthrough curve data. • Pressure swing and Temperature swing adsorption operations. • Adsorption equipment – description and operation. • Ion-exchange-equillibria, equipments and calculations. • Application to chromatography, molecular sieves.	05
6.3 5	Module 05	
	Crystallization • Solubility curves, Theories of crystallization, Progress of crystallization • ΔL Law of crystal growth.	10

	• MSMPR model of crystallization, Population balance method. • Material and energy balances for crystallizers, Numerical examples. • Melt crystallizers • Crystaflization equipment-description.	
6.3 6	Module 06	
	Membrane Separation Operations • Types of membranes-supported and unsupported. Modules for supported membranes. Transport through membranes-fluxes and polarization. • Types of operations. Ultrafiltration, Reverse Osmosis, Electrodialysis, Pervaporation, Liquid membranes elc. • Flux calculations and design operations for supported membranes, Numerical examples. • Equipment and operations Introduction to combination separation processes. • Comparison between all separation processes covered in MTO-I and MTO-II. • Principles of selection of separation processes.	12

Theory Examination:

1. Question paper will comprise of 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question 1 will be compulsory and it will be based on entire syliabus.
4. Remaining questions will be mixed in nature. (for example if Q2 has part (a) from module 3 then part (b) will be from any module other than module 3.)
5. In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

TERM WORK

1. A minimum of four assignments should be given at regular intervals.
2. The following parameters should be considered for laboratory performance evaluation.
   a. Punctuality b. diligence c. contents of journal (originality of discussions)
3. Points 1 and 2 above should account for 15 marks (out of 25 marks) for term work.
4. Average of a minimum of two tests should account for 10 marks (out of 25 marks) for term work.
5. Each and every experiment should conclusively demonstrate/verify the theory. Experimental results should correlate with theoretical/estimated/reported values. The students should explain variations between observed and expected results based on technical grounds and systematic error evaluations. Each experimental report should contain a discussion of the results obtained.

6. A minimum of ten experiments should be performed. A suggested list is given below.
    1) Vapor-liquid equilibrium measurements.
    2) Batch distillation
    3) Steam distillation
    4) Packed bed distillation
    5) Flash distillation
    6) Liquid-liquid extraction equillibria measurements
    7) Packed bed liquid-liquid counter current/co-current extraction.
    8) Multistage liquid-liquid extraction(batch).
    9) Leaching(cross current/counter current).
    10) Hydrodynamics of counter current liquid-liquid contacting in packed bed .
    11) Crystallization(with and without nucleation).
    12) Break-through curve for a fixed bed adsorber.

Text Books:

1. Treybal.R.E, 'Mass Transfer Operations', 3rd edition, McGraw Hill Newyork, 1980.
2. McCabe, W.L and Smith,J.C, 'Unit Operations in Chemical Engineering' 5th edition,McGraw Hill,New York,1993.
3. Geankoplis, C.J,'Transort Processes and Unit Operations', Prentice Hall, New Delhi,1997.
4. Coulson,J.M., Richardson, J.F.,Backhurst, J.R and Harker, J.H Coulson & Richardsons Chemical Engineering, vol I,Butterworth Heinman, New Delhi,2000.
5. Coulson,J.M., Richardson, J.F.,Backhurst, J.R and Harker, J.H Coulson & Richardsons Chemical Engineering, vol II,Asian Books Private Ltd.,NewDelhi,1998
6. R.K Sinnot,(Ed) Coulson & Richardsons Chemical Engineering, vol 6,Butterworth Heinman, New Delhi,2000.

Reference Books:

1. Perry J.H and Chilton, Perry's Chemical Engineering Handbook, 6th Edition, McGraw Hill,1984(or a later edition when available).
2. Sherwood T.K, Pigford R.I. and Wilke.C.R 'Mass Transfer' McGraw Hill,1975.
3. Walas,S.M'Phase Equillibria in Chemical Engineering, Butterworth, Boston 1985
4. Hoffman, E.J 'Azeotropic and Extractive distillation' Interscience Publishers Inc, New York,1964.
5. Holland, C.D, 'Fundamentals of multicomponent distillation, McGraw Hill,New York,1981.
6. Schweitzer, P.A, (Ed), Handbook of seperation techniques for Chemical Engineers, McGraw Hill, New York, 1988.
7. Walas, S.M., 'Chemical Process Equipment Selection and Design, Butterworth, London, 1989.

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T.E. CHEMICAL (SEM-VI)

Class: TE. Chemical Engineering		Semester: VI	
6.4 **Process Equipment Design & Drawing-II**			
Periods Per Week (60 Min)	Lectures	04	
	Practical's	03	
	Tutorials	---	
		Hours	Marks
Evaluation System	Theory Examination	04	100
	Practical Examination	-----	-----
	Oral Examination	-----	25
	Term Work	----	25
	Total	---	**150**

Sr. No.	Detailed Syllabus	Hours
6.4.1	Module 1	
	HEAT EXCHANDERS Introduction. Types of Heat Exchangers. Codes and Standards for Heat Exchangers Material of construction. Baffles and tie rods. Tube joining methods. Design of shell and tube heat exchanger (U-tube and fixed tube) as per IS: 4503 & TEMA standards i.e. shell, tube, tube sheets, channel and channel cover, flanged joints Complete fabrication drawing for designed Heat Exchanger to a recommended scale.	04
6.4.2	Module 2:	
	EVAPORATORS AND CRYSTALLIZERS Introduction. Types of Evaporators. Material of construction. Entrainment separators and vapor release chambers. Complete design of Evaporators with design of calendria and tube, flange, evaporator drum & heads Types and design considerations for Crystallizers(No numerical problems on crystallizers). Complete fabrication drawing for designed Evaporators to a recommended scale.	10
6.4.3	Module 03	
	DISTILLATION AND ABSORPTION COLUMNS Basic features of columns. Stresses in column shell. Shell thickness determination at various heights. Elastic stability under compression stresses. Allowable deflection. Column internals. Design of supports for trays. Complete fabrication drawing for designed column to a recommended scale.	08

	HIGH PRESSURE VESSELS. Materials of construction. Review of design of thick cylinder. Prestressing. Design of high pressure vessels-Monoblock and Compound (Multi-layered) Design of shell and head along with stress distribution. Complete fabrication drawing for designed high-pressure vessels to a recommended scale.	
6.4.4	Module 04	
	HIGH PRESSURE VESSELS. Materials of construction. Review of design of thick cylinder. Prestressing. Design of high pressure vessels-Monoblock and Compound (Multi-layered) Design of shell and head along with stress distribution. Complete fabrication drawing for designed high-pressure vessels to a recommended scale. **FILTERS** 1.Study of various types of filters such as a. Vacuum filters. b. Pressure filters. c. Centrifuges. d. Rotary drum filters. 2.Design of rotary drum filters which includes design of drum, shaft, bearing and drive system. 3 Complete fabrication drawing for designed rotary drum filter to a recommended scale. AUXILLARY PROCESS VESSELS Study of various auxiliary process vessels such as a. Reflux drum. b. Compressor knock out drum. c. Liquid-liquid & gas-liquid separators. d. Entrainment separators.	06
6.4.5	Module 05	
	PROCESS FLOW DIAGRAMS AND SYMBOLS 1 Symbols of process equipments and their concept. 2 Engineering line diagram (Flow diagram). 3 Utility block diagram. 4 Process flow diagram. 5 P and ID preparations relevant to chemical engineering processes.	06

(20)

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6.4.6	Module 06	
	PIPING DESIGN AND LAYOUT 1. Pipe sizing for gases and liquids. 2 Piping for high temperature. 3 Piping layout and its factors under consideration. 4 Design of buried and overhead pipeline. ***DESIGN OFFICE MANAGEMENT*** 1 Generation of equipment data sheet/Specification sheet. 2 Evolution of drawings. 3 Importance of conclusion of projects. " As built drawings"	08

Theory Examination:

1. Question paper will comprise of 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question 1 will be compulsory and it will be based on entire syllabus.
4. Remaining questions will be mixed in nature. (for example if Q2 has part (a) from module 3 then part (b) will be from any module other than module 3.)
5. In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Oral Examination:

Oral Examination will be based on PEDD-I and PEDD-II and of 25 marks

TERM WORK:

1. Total term work should include minimum Seven drawing sheets. At least one design and drawing should be based on each topic from chapter no. 2 to chapter no.6 & chapter no. 8 (6 sheets). At least one of these six drawings should be printed by using any Computer Aided Design Software. At least one assignment based on chapter no 7 & chapter no 9 and filling up of three Equipment Data sheets (5 assignments) should be given at regular intervals during the semester.]
2. Points No 1 and 2 should account for 15 marks (out of 25 marks) for term work.
3. Average of the minimum of two tests should account for 10 marks (out of 25 marks) for term work.

TEXT BOOKS/ REFERENCE BOOKS

1. Process Equipment Design- Vessel Design by E. Brownell and Edwin, H. Young, John Wiley, New York 1963.
2. Chemical Engineering Vol 6-Design by J.M. Coulson, J.F.Richardson and P.K Sinnot, Pregamon press, International edition 1989.
3. Introduction to Chemical Equipment Design- Mechanical Aspects by B.C Bhattacharya, CBS Publications.
4. Process Equipment Design by M.V. Joshi, Macmillan India.
5. Pressure Vessel Hand Book by Eugene F., Megyesy Pressure Vessel Company USA.
6. Design of Machine Elements by V.B. Bhandari, McGraw Hill.
7. Appropriate ISI Specifications and codes for unfired pressure vessels, viz. IS:4503, IS:5403, IS:4049, IS:4864, IS:4870, IS:3138, IS:1239, IS:6392, IS:6418, IS:2062, IS:1730.
8. ASME Codes Division VIII, Section 1 & 2.
9. Equipment Design Handbook for refineries and chemical plant Vol 1 & 2 by Evans F.L Gulf Publishing 1980.
10. Structurai Analysis and Design of Equipment by Jawad M.H, Fav., J.R, John Wiley 1984.

T.E. CHEMICAL (SEM-VI)

Class: TE. Chemical Engineering		Semester: VI	
6.5 **Transport Phenomena**			
Periods Per Week (60 Min)	Lectures	04	
	Practical's	----	
	Tutorials	01	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical Examination	-----	-----
	Oral Examination	-----	-----
	Term Work	----	25
	Total	---	**125**

Sr. No.	Detailed Syllabus	Hours
~~7.6.1~~	Module 1	
6.5.1	Viscosity and mechanism of Momentum Transport, Thermal Conductivity and mechanism of energy transport, diffusivity and mechanism of mass transport.	06
~~7.6.2~~	Module 2:	
6.5.2	Shell Balance: Velocity distribution in laminar flow, temperature distribution in solids and laminar flow, concentration distributions in solids and in laminar flow (restricted to rectangular and cylindrical coordinates only)	06
~~7.6.3~~	Module 03	
6.5.3	Equations of Change: Isothermal systems, non-isothermal system, multi-component systems (restricted to rectangular coordinate system).	08
~~7.6.4~~	Module 04	
6.5.4	More than one independent variable systems: velocity distribution, temperature distribution concentration distribution (restricted to rectangular and cylindrical coordinates only).	08
~~7.6.5~~	Module 05	
6.5.5	Turbulent Flow: Velocity distribution, temperature distribution, concentration distribution.	06
~~7.6.6~~	Module 06	
6.5.6	Interphase Transport: Isothermal systems, non-isothermal system, multi-component systems.	08

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Theory Examination:

1. Question paper will comprise of 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question 1 will be compulsory and it will be based on entire syllabus.
4. Remaining questions will be mixed in nature. (for example if Q2 has part (a) from module 3 then part (b) will be from any module other than module 3.)
5. In question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

TERM WORK:

1. A minimum of 10 assignments involving a report based on literature survey and an oral presentation to the class on one of the assignments during tutorial sessions are envisaged. In addition numerical problems on various topics as included above.
2. The performance of the students should be evaluated based on report and presentations.
3. Point nos. 1 and 2 above along with an average of a minimum of two tests should account for term work.

Text Books/ Reference Books:

1. Transport Phenomena by Dr. G.D. Nageshwar
2. R.B. Bird, W.E. Stewart, E.N. Lightfoot, Transport Phenomenon, Edition-I, John Wiley, 1960
3. C.O. Bannet and J.E. Myers, Momentum, Heat and Mass Transfer, 3rd Edition, McGraw Hill, 1982.
4. S. Foust, L.A. Wenzel, C.W.Clums, L.Maus and L.A. Anderson, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.

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T.E. CHEMICAL (SEM-VI)

Class: TE. Chemical Engineering		Semester: VI	
6.6 ELECTIVE (i) Piping Engineering			
Periods Per Week (60 Min)	Lectures	04	
	Practical's	----	
	Tutorials	01	
		Hours	Marks
Evaluation System	Theory Examination	03	100
	Practical Examination	-----	-----
	Oral Examination	-----	-----
	Term Work	----	25
	Total	---	**125**

Sr. No.	Detailed Syllabus	Hours
6.6.1	Module 1	
	1) INTRODUCTION Role of piping, Scope of piping engineering, Responsibilities of piping engineer, Inputs received by piping engineers and output given by them, Interactions of piping engineers with other disciplines such as process engineering, instrumentation engineering etc., Introduction to engineering line diagram, Process flow diagram and piping and instrumentation diagram for process plant utilities including various symbols. 2 MATERIAL OF CONSTRUCION AND FABRICATION Selection of various piping materials such as Ferrous, non-ferrous and non-metallic, Piping fabrication, Precautions, Preparations of pipe edges. Designation of coated electrodes, Requirements of weld tests, Hot bending and cold bending operations, Fabrication specifications.	06
6.6.2	Module 2:	
	CODES/STANDARDS/STATUTARY REGULATIONS Statuary rules and regulations such as C.O.E, S.M.P.V rules, Petroleum rules, Gas cylinder rules, Factories act, I.B.R and N.F.P.A rules, Codes and standards such as A.N.S.I codes for pressure piping 31.1 and 31.3 standards, D.I.N and A.P.I	03
6.6.3	Module 03	
	PIPE AND PIPE FITTINGS Introduction to various standard pipe fittings, pipe flanges and gaskets and their selection and specification, Design calculations for 1 Schedule number and pipe thickness. 2 I.D. sizing for liquids and gases	07

	3 Branch pipe and its drawing details. 4 Meter band and its drawing details for single curt and multiple cuts . 5 Stress intensification factor and flexibility factor for various bends Specialty piping system such as traced piping, jackets, piping, Hoses and flexible metallic piping etc	
6.6.4	Module 04	
	VALVES AND OTHER PIPING COMPONENTS Functions of valves and their selection, valve materials and, material of construction for the following type: Gate, globe, Needle, piston, Butterflies, plug. Diaphragm, pinch, foot and float valves, Application of various valves and their operational characteristics relevant to piping engineering. Special piping components: Construction working and selection of various components such as steam traps, strainers, sight glass, level gage, expansion bellows, flame arresters, inline mixers and static mixtures	07
6.6.5	Module 05	
	PIPING SYSTEM DESIGN Mechanical end thermal stress analysis in piping, Loop calculations, types and design of pipe supports and their selection and design of pipe racks, protection of pipe system such as cathodic protection, painting and insulation etc.	07
6.6.6	Module 06	
	1) PIPING LAYOUTS AND DRAWING Factors considered in piping layout, recommended pratices/statutary requirements in equipment spacing and piping layout in process utility and offside area, Various drawings and their preparations e.g. general arrangements, Mater plot plan, unit plot plan, piping plan and piping isometrica, drawings for approval, fabrications and records, specification sheet, bill of material and line designation lists 2) COMPUTER AIDED PIPING DESIGN, DRAFTING AND DOUCUMENT **3) APPLICATION OF PIPING ENGINEERING.** Piping arrangements and factors considered in Tank farm piping Heat exchanger piping Reactor piping Furnace piping Process and storage vessel piping Piping compressor and pumps Reboiler piping Utility piping	10