SHIVAJI UNIVERSITY, KOLHAPUR
SYLLIBUS/ STRUCTURE (REVISED from June- 2009)
T.E. Chemical (Sem. – V)

Sr. No.	Name of the Subject	Teaching Scheme(Hrs)				Examination Scheme (Marks)			
		L	**T**	**P**	**Total**	**Theory**	**TW**	**Pract./ Oral**	**Total**
1	**P.I &I.M.A.**	4	--	2	6	100	25	25	150
2	**Computer Techniques in Chemical Engg.**	3	--	2	5	100	50	-	150
3	**Mass Transfer-I**	3	1	2	6	100	25	25	150
4	**Chemical Engg. Thermodynamics-II**	4	--	--	4	100	25	--	125
5	**Chemical Equipment Design-I**	4	--	2	6	100	50	25	175
6	**Soft Skills – I**	2	--	2	4	--	50	--	50
	Total	**20**	**01**	**10**	**31**	**500**	**225**	**75**	**800**

SEMESTER – VI

Sr. No.	Name of the Subject	Teaching Scheme(Hrs)				Examination Scheme (Marks)			
		L	T	P	Total	Theory	TW	Pract./ Oral	Total
1	**IEM &E**	3	--	--	3	100	25	--	125
2	**Plant Utility and Pollution Control**	4	--	2	6	100	25	--	125
3	**Mass Transfer-II**	3	1	2	6	100	25	25	150
4	**Process Dynamics & Control**	4	--	2	6	100	25	25	150
5	**Chemical Reaction Engg.-I**	4	--	2	6	100	25	25	150
6	**Computer Applications**	1	--	2	3	--	25	25	50
7.	**I.P.& Case Studies**	1	--	2	3	--	50	--	50
	Total	**20**	**01**	**12**	**33**	**500**	**200**	**100**	**800**

THIRD YEAR CHEMICAL ENGINEERING SEM.-V

1. PROCESS INSTRUMENTATION AND INSTRUMENTAL METHODS OF ANALYSIS

Lectures: 4 hrs per week
Practical: 2 hrs per week

Examination:
Theory:100marks
Practical:
Internal: 25 marks
External: 25 marks

SECTION – I:

PROCESS INSTRUMENTATION

1. **Introduction**: Basic Concepts and characteristics of measurement system, various elements of instrument, performance characteristics.

2. **Pressure Measurement**: Introduction, methods of pressure measurement by manometers, elastic pressure transducer, force balance pressure gauges, electrical pressure transducers and vacuum measurement. Pressure switches, calibration. Repairs and maintenance of pressure measuring instruments, trouble shooting.

3. **Temperature measurement**: Introduction, methods of temperature measurement by expansion thermometers, filled system thermometers, electrical temperature instruments, pyrometers. Calibration of Thermometers

4. **Flow measurements**: Introduction, methods of flow measurements by inertial flowmeters, quantity flow meters, and mass flow meters.

5. **Liquid level measurement**: Introduction, Methods of liquid level measurements by direct methods, indirect methods, electrical methods. Servicing of liquid level measuring instruments.

6. **Digital Transducers**: Introduction, digital encoders, linear displacement transducers, digital tachometer, frequency output type transducers, signals and conversions, instrument system.

Text Books:

1. S.K.Singh, “Industrial Instrumentation & Control”, Tata McGraw Hill publishing company ltd, New Delhi, 2000

2. D. Pastranabis, “Principals of industrial instrumentation”, 2nd edition, Tata McGraw

Hill publishing company ltd, New Delhi, 2003

Reference Books:

1.Eckman D.P. "Industrial Instrumentation", Willey Eastern Ltd, New Delhi, 1984.

2. A.C. Shrivastav "Techniques in Instrumentation", New Delhi, 1984.

3. W.Boltan, "Instrumentation and Process Measurement", Orient Longman Ltd, Hyderabad, 1st Edition, 1993.

4. Ray Choudhuri and Ray Choudhuri "Process Instrumentation, Dynamics and control for Engineers", 1st Edition, Asian Books Pvt Ltd, New Delhi, 2003.

SECTION – II:
INSTRUMENTAL METHODS OF ANALYSIS

1. **Introduction to instrumental methods of analysis**: General Introduction , classification of instrumental methods, spectroscopy, properties of electromagnetic radiation, electromagnetic spectrum, different types of molecular energies, interaction of electromagnetic radiations with matter , origin of spectrum, examples.

2. **Visible Spectrophotometry & Colorimetry**: Deviation from Beer's law, instrumentation applications. Molar compositions of complexes, examples.

3. **Conductometry**: Introduction, laws, conductance, measurements, types of conductometric titrations, applications, advantages and disadvantages.

4. **Nephelometry and Turbidimetry**: Introduction, theory, comparison with spectrophotometry, instrumentation, applications.

5. **Refractometry:** Introduction, Abbe refractometer, instrumentation, applications, optical exaltation, numericals.

6. **Flame Photometry**: Introduction, principles of flame photometry, instrumentation, interferences in flame photometry, limitations, and applications.

7. **Chromatography**: Introduction, types, theoretical principles, theories of chromatography, development of chromatography, qualitative and quantitative analysis, applications and numerical.

8. **Gas Chromatography**: Introduction, principles of gas chromatography, gas liquid chromatography, instrumentation, evaluation, retention volume, resolution. Branches of gas chromatography, applications and numericals.

9. **High Performance (Pressure) Liquid Chromatography**: Introduction, principles,

instrumentation, apparatus & materials, column efficiency and selectivity, applications.

Reference Books:

1. Willard H.H, "Instrumental methods of analysis", 6th Edition, CBS Publication New Delhi 1986

2. Galen W. Ewing, "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw Hill Book Company, Singapore, 1990
3. D. A. Skoog, "Principal of Instrumental Analysis", Southern Collage Publication, Japan 1984
4. G. R. Chatwal, S.K. Anand, "Instrumental method of chemical analysis", 5th Edition, Himalaya Publishing House, Mumbai 2002.

TERM WORK A: (P.I.)

1. Calibration of pressure gauge.
2. Thermocouple calibration.
3. Liquid level measurement.
4. Flow measurement.
5. Study of I to P converter.
6. Study of level, flow, pressure and temperature transmitters.
7. Study of instrumentation circuit diagrams of selected measuring elements.

TERM WORK B: (I.M.A.)

1. Acid–base titration with help of conductometer.
2. Experiment based on Nephelo turbidity meter.
3. Study of spectrophotometer.
4. Study of flame photometer.
5. Demonstration of GLC.
6. Demonstration of HPLC.
7. Measurements of RI of different liquid samples with Refractometer.
8. Determination of percentage composition with help of RI measurement.

THIRD YEAR CHEMICAL ENGINEERING SEM.-V
2.COMPUTER TECHNIQUES IN CHEMICAL ENGINEERING

Lectures: 3 hrs per week

Practicals : 2 hrs per week

Examination

Theory: 100 marks

Practical/ Oral

Internal: 50 marks.

External: ------

SECTION – I

1. **Introduction to C++.**

Development of Computer Languages, Translators ,Types of Programs, History of C++, Programming Paradigm.

2 **Fundamentals of C++.**

C++ Character set, Identifiers & keywords, Data types in C++, Constants, Variables, Statements, Operators in C++ and Types, Programs.

3. **C++ Programming basics:**

Input Output Statements, Single Character Input and Output functions, Gets and Puts, Manipulator Functions and Programs.

4. **Control Structures:**

Introduction to Control Structures, Conditional Statements, Loop Statements, Break Statements and Programs.

SECTION –II:

5. **Arrays**

Array declarations, passing array to functions, sorting array, Multidimensional arrays and Programs.

6.**Functions:**

Introduction , Function definition, Types of Functions, Function Prototypes, Header File ,Storage Classes ,Scope rules. Recursive Functions, Unary Scope resolution Operator, Preprocessor and Programs.

7.**Structure:**

Introduction, Structure declaration, Initialization of Structure, Nested Structures, Introduction of Unions and Programs.

8.**Object Oriented Programming**:

Introduction to OOP, OOP Characteristics of C++, Classes and Objects, Class definition and Programs.

9. **Introduction to Graphics in C++.**

Text Books:

1. Robert Lafore, “Object Oriented Programming in Turbo C++”, Galgotia Publication Pvt Ltd .1994

References:

1. R.J.Micheli, “C++ Object Oriented Programming”, McMillan London 1993

2. E.Balguruswamy, “Object Oriented Programming in C++”, Tata McGraw Hill Publishing Company Ltd. New Delhi 1995.

3. H.M Deitel and P.J.Deitel, “C++ how to program” .2nd Edition, Prentice hall, New Jersey, 1998.

TERM WORK:

1. Programs based on Fundamentals Of C++.
2. Programs based on C++ Programming basic.
3. Programs based on Different Control Statements [Any Four]
4. Programs based on Arrays [Any Two]
5. Programs based on Functions [Any Three]
6. Programs based on Structures [Any Two
7. Programs based on Class and Objects.[Any Two]

THIRD YEAR CHEMICAL ENGINEERING SEM.-V
3. MASS TRANSFER -I

Lectures: 3 hrs per week

Tutorials- 1 hr

Practicals: 2 hrs per week

Examination:

Theory : 100 marks

Practical /Oral:

Internal : 25 marks

External : 25 marks

SECTION -I

1. **Introduction to mass transfer operations**.

2. **Molecular diffusion in fluids :**
Concept of diffusivity ,Flux transfer equations for gas and liquid phase based on steady and unsteady state equation ,empirical equations used to determine diffusivity through gas and liquid phase, equation of continuity and its application in the form of Navier - Stoke equation.

3. **Mass transfer coefficients**
Determination Of mass transfer coefficient through contacting equipment. Eddy diffusion ,film theory ,penetration theory, surface renewal theory, Dimensionless group of mass transfer and its applications, mass transfer coefficient in laminar flow and turbulent flow, Simultaneous mass & heat transfer.

4. **Diffusion In Solids :**
Steady State Diffusion , Unsteady State Diffusion ,P:roblems involved in above situations.

5. Interphase mass transfer:

Equilibrium , Study Of Raults law, Daltons law, henrys law,

Two Film Theory - Concept Of individual and overall mass transfer coefficient, operating line, driving foprce line.

Cascades –cross current , Counter Current stages.

Solved examples on stages and driving force lines with interfacial compositions.

6.Equipment for gas –liquid operations:

a) Gas dispersed :Multistage absorption tray towers ,Type Of trays, flow arrangements

on tray, Tray efficiency, Sparged vessels . Gas hold up – concept of sleep velocity.

SECTION -II

b) Liquid dispersed:

Ventury Scrubber, Wetted wall tower, Spray tower, Spray chamber, Packed tower, Mass Transfer coefficients for packed tower, Types of packings , End effects and axial mixing, Tray tower Verses packed tower .Liquid hold up – determination of interfacial area based on hold up and Mass Transfer Coefficients.

7.Gas absorption: Choice of solvent, Material balance on cross current and counter current absorption or stripping ,Absorption factor and stripping factor, Tray efficiency , design equation for packed tower ,HETP,NTU,HTU calculation for packed tower.

8. **Adsorption :** adsorption isotherm, Types of adsorbents ,Adsorption equipment , Adsorption hysteresis, Heat of adsorption, break through curves , Single and multistage adsorption operation, study of ion exchange.

9.Mass transfer with chemical reactions : Theory of simultaneous mass transfer and chemical reaction, Theory of simultaneous mass transfer with reaction ,Mass transfer reaction operations considering heterogeneous and homogeneous slow reaction ,fast reaction.

Text Book:

1. Robert E. Treybal, “Mass Transfer Operations”l, Third Edition, McGraw Hill, 1980.

References:

1. Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke, “Mass transfer” International Student Edition, McGraw Hill, Kogakusha Ltd., 1975.
2. McCabe and Smith, “Unit Operation of Chemical Engineering”, 5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3. Foust etal, “Principles of Unit Operations”,2nd Edition, John Wiley and Sons, 1979.
4. Richardson & Coulson, “Chemical Engineering”, Vol. 2 , Pergamon Press, 1970.
5. G. Astalita Elsevier, “Mass Transfer with Chemical Reaction”, Publication.

TERM WORK

1. Difusivity of acetone in air.
2. Mass transfer through packed bed
3. Wetted wall tower.
4. Liquid –liquid diffusion.
5. Vapour – liquid equilibrium.
6. Surface evaporation.
7. Liquid hold up in packed column.
8. Batch adsorption .
9. Humidification & dehumidification.
10. Cooling Tower.

THIRD YEAR CHEMICAL ENGINEERING SEM.-V

4 .CHEMICAL ENGINEERING THERMODYNAMICS -II

Lectures: 4 hrs per week

Examination

Theory: 100 marks

Practical/ Oral -----

Internal: 25 marks.

SECTION –I

1. VAPOR / LIQUID EQUILIBRIUM:
The nature of equilibrium, The phase rule & Duhem's Therom,

VLE: Qualitative Behavior, Simple models for Vapor / Liquid Equilibrium Raoults law, Dew point and bubble point calculations with Raoults law, Henry's law, VLE by modified Raoults law, VLE from k- value correlations, problems.

2. SOLUTION THERMODYAMICS :THEORY;
Fundamental Property Relation ,Chemical Potential & Phase Equilibria , Partial Properties, Equations relating molar & partial molar Properties ,Partial Properties in Binary Solutions, Relations among partial Properties, Problems ,Ideal Gas Mixtures. Fugacity & Fugacity Coefficient, pure Species & Species in Solution, The Fundamental Residual Property relation, Fugacity Coefficient from the viral equation of state, The ideal Solution, The Lewis Randall Rule, Excess properties .The excess Gibbs Energy and the Activity Coefficient. The nature of excess properties.

SECTION –II

3. SOLUTION THERMODYNAMICS: APPLICATIONS

Liquid Phase Properties from VLE Data, fugacity ,Activity Coefficient, Excess Gibbs Energy ,Data Reduction ,Thermodynamic consistency, Models For Excess Gibbs Energy Local Compositions Models, Property Changes Of Mixing.

4. CHEMICAL REACTION EQUILIBRIA:
The Reaction Coordinate, Application of Equilibrium Criteria to Chemical reactions, The Standard Gibbs Energy change & the Equilibrium Constant, Effect of Temperature On the equilibrium Constant, Evaluation of Equilibrium Constants. Relation Of Equilibrium

Constants to Compositions .Equilibrium Conversions For Single Reactions .Reactions in Heterogeneous System, Phase Rule & Duhem's Therom For Reacting Systems.

5. THE PHASE EQUILIBRIA:

Criteria Of Phase equilibrium, Criterion Of Stability .Phase Equilibrium in Single Component System , Phase Equilibrium in Multicomponent System ,Non ideal Solutions. Azeotropes, Liquid-Liquid Equilibrium (LLE), Vapor/liquid/liquid equilibrium (VLLE), Solid /Liquid Equilibrium (SLE), Solid /Vapor Equilibrium (SVE).

Text Books:

1. J.M.Smith, H.C.Vanness," Introduction to Chemical Engineering Thermodynamics" 6 th Edition, Tata McGraw Hill Publishing Co.
2. Thomas E Daubert, "Chemical Engineering Thermodynamics "McGraw Hill International Edition.

References:

1. K.V. Narayanan "Chemical Engineering Thermodynamics" ,Prentice Hall ,India
2. B.F.Dodge "Chemical Engineering Thermodynamics, International Student Edition, McGraw Hill Publication.
3. O.A.Hougen, K.M.Watson & R.A. Rogatz "Chemical Process Principles", Vol –II, Asia Publishing House.
4. Kenneth Denbigh, the Principles Of Chemical Equilibrium", Cambridge University Press.

THIRD YEAR CHEMICAL ENGINEERING SEM.-V

5. CHEMICAL EQUIPMENT DESIGN - I

Lectures: 4hrs per week

Practical: 2 hrs per week

Examination:

Theory: 100 marks

Practical /Oral:

Internal: 50 marks

External: 25 marks

SECTION –I

1. **Introduction.**

2. **Equipment fabrication methods and testing**.

3. **Design preliminaries**.

4. **Pressure vessels**:

Classification of pressure vessels, Codes and Standards for pressure vessels. Design of pressure vessels under internal and external pressures .Design of thick walled high pressure vessels, Design of Gasket, Flanges, Nozzle, Design of spherical vessels.

(Use ASME Sec A Div I and IS 2825 for above design procedure)

5. **Storage vessels:**

Storage of fluids, Different types and safe of storage vessels, Design of cylindrical storage vessels with roof.

6. **Design of tall vessels**.

SECTION –II

7. **Design of Support for process vessels**.

8. **Mechanical design of piping system:**

Codes and standards, Wall thickness, Pipe supports, Pipe fittings, Pipe stressing, Pipe size selection, Economic pipe diameter..

11. **Mechanical design of heat exchanger**.

12. **Mechanical design of heat evaporator.**

13. **Mechanical design of Reaction vessel.**

14. **Mechanical design of Agitator.**

Text Books:

B. C. Bhattacharya, “Introduction to chemical equipment design” (Mechanical accepts) 1985.

M. V. Joshi, “Process equipment design” McMillan India Ltd. 1981.

Coulson J. M. and Richardson J. F., “Chemical Engg.” Vol. 2 & 6, Pergaman Press, 1970.

Dr. S.D. Dawande, “Process Design of Equipment”, Central Techno Publication, 1st Edition 1999.

References:

L. E. Brownel and E. H. Young “Process equipment design”, Wiley Eastern Ltd. 1977.

TERM WORK

1 Design of pressure vessels with heads ,flanges and gaskets.

2 Design of atmospheric storage vessels .

1. Design of head and closures
2. Design of tall vertical vessels
3. Design of supports.
4. Design of heat exchangers.
5. Design of reaction vessel.
6. Design of evaporator.
7. Design of agitation system
8. Due prototype model containing all parts should be submitted by a group of 4-6 students. Minimum 8 sheets needed to be drawn .out of which 3 should be drawn with the help of software AutoCAD.
9. Demonstrated models of all components of vessels.

THIRD YEAR CHEMICAL ENGINEERING SEM.-V
6. SOFT SKILL

Lecture: 2 hour/week:

Practical: 2 hour/week: **Term work**: 50 marks

Communication skills-

Importance, types of communication, effective presentation skill

Soft skills

Definition of skill, significance and need of soft skill, types of soft skill.

Personal Qualities

Introduction, components of personality, multitask handling, different types of personal qualities, introduction to personal evaluation and appraisal

Leadership skills

Definition, types of leaderships, leadership styles difference between manager and leader.

Business etiquettes

Introduction, importance, different types of etiquettes, manners, protocols, corporate culture

Interpersonal skills-

Definition, significance, different types of interpersonal skills

Problem-solving skills –

Introduction, types of conflicts, Different steps in problem solving, barriers in problem solving, negotiation, Decision making,

Work ethic -

Definition of work ethic, Importance of values, types of management's ethics, work attitude

TERM WORK MARKS SHALL BE BASED ON-

IQ and EQ tests,

Leadership essays

Time schedules of different organizations

Brainstorming

Technical Presentation

Team work- case study

Corporate meeting

Case study of corporate problem

Self evaluation

Reference Books:

Robert M. Sherfield ; Rhonda J. Montgomery ; Pamcia g. Moody “Developing Soft Skills” , 4th Ed.

Organizational Behavior by Don Hellriegel, Jhon W. Slocum,Richard W. Woodman.

Emotional intelligence, Danial Golman

Human behavior at Work by Keith Davis, Tata Magraw Hill Publication.

Managemwnt of Organizational Behavior ,Hersey P H I

Leadership in organization, by Gary A Yakl, Prentice – hall Igc. , Englewood Cliffs, 1991

THIRD YEAR CHEMICAL ENGINEERING SEM.-VI

1. INDUSTRIAL ECONOMICS , MANAGEMENT AND ENTREPRENERSHIP

Lectures: 3hrs per week

Examination:

Theory : 100 marks

Practical /Oral:

Internal : 25 marks

Section – I

1. Economic problem :

Law of Demand, Equilibrium between demand and supply, concepts of costs, cost curves and revenue curves of a firm, equilibrium of a firm under perfect competition, break-even analysis, break-even point.

2. National income: Concept of national income, estimation of national income, difficulties in measurement of national income, uses of national income figures.

3. Inflation:

Meaning, types of inflation, causes, effects, control of inflation, value of money, index numbers, construction, utility, limitations, business cycles, phases of business cycles.

4.**Industrialisation:**

Need, capital requirement, block and working raising, finanace, cottege and small scale industries, role in the Indian economy, problems of small scale industries, remedies.

Section – II

5. Principles of management :

Definition ,nature ,levels of management ,functions of management .

a) **Planning** : nature ,importance ,types of plans ,planning process ,decision making.
b) **Organising** : Principles of organization ,process of organising ,organizational structure.
c) **Directing** : Theories of motivation ,communication ,process and barriers , leadership styles
d) **Controlling** : Control techniques .

6.Production management :

Selection of site , plant layout ,its type ,function of P.P.C.

Materials management : purchase ,inventory control ,production and quality control.

7.Finanace management :

Scope and importance , caital structure planning ,working capital management , sources of funds ,financial institutions of India.

8.Marketing management :

Marketing concepts ,physical distribution ,advertising and sales promotion , marketing research ,sales management.

9.Entrepreneurship :

Function – why men become economic innovators – Various Assistance Programmes for Small Scale and large Scale Industries through agencies ,like IDBI,IFC,NSIC SFC,SIDCO and DIC.

References :

1. Stonier , A.W. and Hague ,D.C. A Text Book of Economic Theory ,Longman.
2. Bach ,George Lealand , " Economics Analysis ,Decision Making and policy",Prentice Hall Inc .Engiewood Cliffs N.J.
3. Benham ,F. " Economics " ,Sir Issac Pitman and sons Ltd ., London.
4. Jhingan,M.L."Advanced Economics Theory" ,Vikas publishing House Pvt .Ltd ,New Delhi .
5. Seth , M.L . " Principles of Economics ,Lakshmi Narain Agarwal,Agra.
6. Agarwal , A.N. " Indian Economy" ,Vikas Publishing House Pvt .Ltd ,New Delhi .
7. Datta R and Sundharam , K.P.M " Indian Economy" S.Chand & Co.Ltd ,New Delhi .
8. Peter F .Drucker " The Practice of Management" ,Allied publishers pvt. Ltd ,Bombay.

THIRD YEAR CHEMICAL ENGINEERING SEM.-VI
2. PLANT UTILITIES AND POLLUTION CONTROL

Lectures: 4 hrs per week

Practical: 2 hrs per week

Examination:

Theory: 100 marks

Practical:

Internal: 25 marks

SECTION-I

1. Purification of Water : Methods of Purification of Water, Treatment of Boiler Feed Water,Color Codes of water ,Air and Process Streams etc.

2. Steam : Steam generators ,Classification ,Indian act of Boiler ,Mountings and accessories ,Types Of Steam ,Types of Steam, Superheaters ,Injectors ,Condencers ,Performance of Boilers & Boiler Calculations .[More Weight age should be given to Boiler Calculations.

3. Air Fluids: Introduction, Compressed Air ,Blower Air ,fan air ,Types Of Compressor ,Instrumental Air .

4. Refrigeration:

Evaporative Refrigeration , refrigerants ,Cooling Towers and Performance of cooling Towers.

5.Insulation : Introduction ,Insulating factors , Properties of insulating materials ,Classification ,Cold insulation .

Section – II

6. Air pollution control:

Sources and effects .air pollution monitoring system, theory ,design and operating principles of the air pollution control equipments, dry collectors ,wet collectors ,electrostatic precipitators ,thermal combustion techniques ,control of air pollution in industry viz. Iron and Steel industries ,paper and pulp industries ,cement industries. Thermal power plants.

7. **Stream and river pollutions**:

Causes and parameters to be measured ,pollution control legislation measure, Maharashtra pollution control board norms(MPCB norms), Iso norms for Environmental quality assessment.

8.Primary and Secondary waste water treatment :

Theories and practices of equalization, neutralization , screens ,grit removal, floatation, settling & Coagulation.

Trickling filters , activated sludge process and its modification and anaerobic sludge treatment, low cost waste treatment methods such as stabilization ponds ,Oxidation & aerate lagoons, roots zone technologies etc.

9.Solid Waste Disposal:

Sources and effects ,Characterisation, resources consumption and recovery, treatment and disposal method ,Sludge handling and disposal.

10.**Advanced Oxidation processes**:

Photo catalytic treatment.

Treatment with H_2O_2 and ozone.

Wet Oxidation Process.

Supercritical Oxidation.

11.Removal of oxides of nitrogen :

Introduction , Analysis Of Nox ,Control Measures .

12.Pollution Control aspects of fertilizer industries:

Introduction, ammonia plant effluents, ammonia sulfate plant, Phosphoric acid plant, complex fertilizer plant.

TERM- WORK:

1.Estimation Of total solids ,volatile solids , suspended solids and dissolved solids.

2.Determination of BOD of industrial waste.

3.Determination of COD of industrial waste.

4.Determination of total / Kjeldhal nitrogen.

5. Determination of phosphate .

6. Determination of potassium.

7. Determination of chlorine content of bleaching powder.

8. Determination of sulfate.

9. Determination of moisture content.

10 .Characterization Of Waste Water from Following Industries

Sugar

Pulp & Paper

Distillery

Dairy

11.Performance Study Of :a) Cooling Tower

b) Chilled Water System .

c)Humidification & Dehumidification System .

12.Heat Balance In Boiler /Thermic Fluid System

13.Study Of Following :

a) Steam Trap .

b) Compressors .

c) Vacuum System.

d) Emergency Vents & Safty Valves.

e) Utility Line Diagram

Text Books:

,D.B.Dhone , “ Plant Utilities “, Nirali Prakashan ,Pune.

B.I.Bhatt ,S.M. Vora, “Stoichiometry”,Tata McGraw Hill Publisning Company Ltd.

S. P. Mahajan, “Pollution Control in Process Industries”, Tata McGraw hill, 1985.

Matcalf and Eddy, “Waste Water Engineering Treatment”, Tata

C. S. Rao “Environmental pollution control engineering” Wiley Eastern, Ltd 1994.

References:

1. Waren Viessman and Mark J. Hammer, “Water supply and pollution control”, Harper & Row, New York, 1985.

2. M.V. Rao and A. K. Datta : “Waste Water Treatment”.

3. U. N. Mahida, “Water Pollution and disposal of Waste Water on land”.

4. Soli Arceivala, “Waste Water Treatment for Pollution Control”.

5. “Chem. Tech. I”. Chemical Engg. Edu. Development Centre, I. I. T., Madras, 1975.

Lund H. F,”Industrial Pollution Control”, Hand Book , McGraw Hill, 1971.

H. C. Perkins, “Air Pollution”, McGraw Hill 1974.

D. J. Hagerty et. al. “Solid Waste Management”, Van Nostrand Reinhold 1973.

L. D. Benffield and C. W. Randall, “Biological Process Design for Waste Water treatment”, Prentice Hall, 1980.

C. P. Gaady Jr. and H. C. Lim “Bio-logical Waste Water Treatment”, 1980.

Degrenont, “Water Treatment” Hand Book Wiley, 1979.

M. J. Hammer, “Water & waste water Technology”, Wiley, 1975.

Artur L. Kohi and Fred C. Reisenfled, “Gas Purification”, Gulf Publishing Co.1979.

Arcadio P. Sincero, Gregoria A. Sincero, “Environmental engineering” (Design approach), Prentice Hall of India Pvt. Ltd, New Delhi, 1999.

G.D.Ulrich,”A Guide to Chemical Engineering Process Design and Economics”,John Wiley and Sons 1934.

THIRD YEAR CHEMICAL ENGINEERING SEM.-VI
3. MASS TRANSFER - II

Lectures: 3 hrs. per week

Tutorial : 1 hr.

Practicals: 2 hrs. per week

Examination:

Theory :100 marks

Practical /Oral:

Internal : 25 marks

External:25 marks

SECTION –I

1. **Distillation:**
   Vapor- Liquid Equilibrium, Ideal Solutions, Relative volatility, Azeotropic mixtures,

   Methods Of distillation: Flash, Differential, Steam, Vacuum, Continuous,Multicomponent system, batch rectification, Introduction to reactive distillation. Analysis and determination of stages: Material balance, Analysis of Fractionating column by McCabe Thiele method, Ponchon Savarit method, Lewis – Sorrel method, Lewis Matheson, Transfer unit Concept in Packed Column Design.

2. **Liquid –liquid extraction :**
   Liquid Equilibrium, coordinate systems, cross and counter current operation and its calculation, selection of contractors, Extraction Equipment.

SECTION –II

3. **Leaching:**
   Leaching Principles, Various Types of Leaching Operations with application, Method of Calculations, Leaching equipment.

4. **Humidification :**
   Application of Humidification, Study of Adiabatic Saturation Curve, Humidifier height calculations, definition of wet bulb ,dry bulb and equation for wet bulb depression ,water cooling tower ,Spray chamber ,Evaporative Cooler.

5. **Drying :**
   Theory and Mechanism of Drying ,Steady and Unsteady Drying , Definition of moisture content, total time of drying, length of continuous dryer ,Characteristics, Classification

and selection of Industrial dryers.

6. **Crystallization :**
   Nucleation, Crystal Growth, Overall and Individual Growth coefficient, material and enthalpy balance of crystallizer, The Law of Crystal Growth Crystallization Equipment.

Text Book:

1.Robert E. Treybal, “Mass Transfer Operations”, Third Edition, McGraw Hill, 1980.

References:

1. Thomas-K-Sherwood, Robert L. Pigford, Chorles R. Wilke, “Mass transfer” International Student Edition, McGraw Hill, Kogakusha Ltd., 1975.
2. McCabe and Smith, “Unit Operation of Chemical Engineering”, 5th Edition McGraw Hill, Kogakusha Ltd., 1998.
3. Foust et.al, “Principles of Unit Operations”, 2nd Edition, John Wiley and Sons, 1979.
4. Richardson & Coulson, “Chemical Engineering”, Vol. 2, Pergamon Press, 1970.
5. G. Astalita Elsevier, “Mass Transfer with Chemical Reaction”, Publication.

TERM WORK

1. Simple Distillation.
2. Packed column distillation
3. Steam distillation.
4. Tray dryer
5. Vacuum dryer
6. Rotary dryer.
7. Cross current leaching.
8. Counter current leaching.
9. Binodal curve.
10. Single stage and multistage extraction.
11. Packed column extraction.
12. Batch crystallization.
13. Demonstration of batch rectification column.

THIRD YEAR CHEMICAL ENGINEERING SEM.-VI
4. PROCESS DYNAMICS AND CONTROL

Lectures: 4 hrs per week

Practical: 2 hrs per week

Examination:

Theory : 100 marks

Practical /Oral:

Internal : 25 marks

External : 25 marks

SECTION -I

1. Review of Laplace transform.

2. Basic principles & Problem involved in process control and design aspects of process control systems, Needs of Control, Objectives of Control, classification of control system. Steady state design and transient design. Feed back control, block diagram for analysis.

3. Response of first order systems.

4. Physical examples of First order systems.

5. Response of first order system in series.

6. Higher order systems: Second Order and transportation lag.

7. The control system: Block Diagram, Development of Block diagram. Mechanism of Control Valve, Ideal Transfer functions of control valve and controllers, comparison of response of various modes of control, block diagram for a Chemical Reactor Control System.

8. Controller and final control element .comparison of response of various modes of control.

SECTION -II

9. Block Diagram for chemical reactor control system**.**

10. Closed loop transfer functions, overall transfer function for single and multiloop systems.

11. Transient response of simple control systems.

Proportional and proportional –integral control for load and set point changes

12. Stability: Concept of Stability, Stability criterion. Routh test for stability.

13. Root locus method: Concept of Root Locus, Plotting root Locus diagram.

14. Introduction to frequency response: Substitution Rule, Bode diagrams for (a) First Order System, (b) First Order System series, (c) Second Order System, (d) Transportation Lag (e) Proportional Controller (f) P- I Controller, (g) P-D Controller. The bode stability Criterion. Gain and Phase margins, Ziegler Nichols Controller Settings.

15. Control of Distillation Column, jacketed–kettle & Heat Exchanger, Introduction to Distributed Control System & Scada Software.

Text Books:

1. Coughanour Koppel, "Process System Analysis and Control", McGraw Hill, New York.
2. Donald K. Coughanour, "Process system analysis and control", McGraw Hill, Second edition, New York, 1991.

References:

1. Peter Harriott, "Process Control", Tata McGraw Hill, New Delhi, 1977.
2. Coulson and Richardson, "Chemical Engineering" Volume – III, Second Edition, Pergmon Press, (UK), 1985.
3. Stephanopoulos G ,"Chemical Process Control and introduction to theory and practice"

TERM - WORK:

1. Time Constant of Thermometer.
2. Time Constant of Manometer.
3. Liquid Level Control System.
4. Two Tank Interacting System.
5. Two Tank non-interacting System.
6. Study of Control Valve Characteristics.
7. Control of Flow System.
8. Control of level System.
9. Control of Pressure System.
10. Control of temp control System.
11. PID control of Shell and tube heat exchanger.
12. Transient Response of U Tube Manometer.
13. Study of Pneumatic Servo System.
14. Study of microprocessor based PID control system.
15. Study of Design of Control loops using any basic computer language and /or application of MATLAB in such a system.

THIRD YEAR CHEMICAL ENGINEERING SEM.-VI
5. CHEMICAL REACTION ENGINEERING -I

Lectures: 4 hrs. per week

Practical: 2 hrs. per week

Examination:

Theory: 100 marks

Practical /Oral:

Internal: 25 marks

External: 25 marks

SECTION –I

1. **Introduction :**
   Chemical kinetics and thermodynamics of reaction; Classification of reactions – Homogeneous and Heterogeneous reactions. Rate of reaction- broad definition for homogeneous and heterogeneous reactions.

2. **Kinetics of homogeneous reactions** :
   Irreversible and reversible reactions ,Equilibrium ,Order and molecularity of reaction .Elementary and non elementary reactions , Stoichiometry ,Fractional conversion .Rate of reaction based on all components of the reaction and their inter relation .Law of mass action ,Rate Constant Based on thermodynamic activity, partial pressure, mole fraction and concentration of the reaction components and their interrelation Temperature dependency of rate Constant , Arrhenius law ,Transition state theory and collision theory.

3. **Interpretation of batch reactor data:**
   Batch reactor concept, Constant volume batch reactor system; Design equation for zero ,first ,Second and third order irreversible and reversible reactions ,graphical interpretation of these equations and their limitations ,Variable volume Batch reactors .Design equation for zero , first and second order irreversible and reversible reactions ,graphical interpretation of their limitations, Introduction to catalytic and auto catalytic reactions ,Rate equation concept for these reactions .Multiple reactions-stoichiometry and Rate equations for series and parallel reactions; Non elementary single reactions Development of rate expression; chain reactions development of rate expressions.

4. **Ideal flow reactors:**
   Concept of ideality. Types of flow reactors and their differences, Space-time and space velocity. Design equation for plug flow reactor and CSTR; Design equations for first and second order reversible and irreversible constant volume and variable volume reactor.

Graphical interpretation of these equations; mean holding time; Development of rate expression for mean holding time for a plug flow reactor.

SECTION –II

5. **Single and multiple reactor system :**
   Size comparison of single reactors ;Optimum size determination ;Staging of reactors , Reactors in series and parallel; Performance of infinite number of back mix reactors in series ,Back mix and plug flow reactors of different sizes in series and their optimum way of staging ; Recycle reactors ,Optimum recycle ratio for auto –catalytic (recycle)reactors.

6. **Design for multiple reactions :**
   Yield and selectivity, Parallel reactions Requirements for high yield. Best operating condition for mixed & plug flow reactors, Series reactions Maximization of desired product rate in a plug flow reactor and back mixed reactor.

7. **Temperature effects in homogeneous reactions:** Equilibrium Conversion, Optimum temperature progression, Adiabatic and non adiabatic operations, Rate, Temperature and conversion profiles for exothermic and endothermic reactions, Stable operating condition in reactors.

References:

1. Octave Levenspeil, “Chemical Reaction Engineering”, 2nd Edition, John Wiley, London.
2. S. M. Walas, “Reaction Kinetics for Chemical Engineers” McGraw Hill, New York.
3. J. M. Smith, “Chemical Engineering Kinetics”, McGraw Hill, New York.
4. J. Rajaram and J. C. Kuriacose, “Kinetics and Mechanics of Chemical Transformation”, McMillan India Ltd., 1993.

TERM WORK :

1. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in batch reactor-I (where M=1)

2. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in batch reactor-II (where M=2)

3. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in straight tube reactor.

4. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in bend tube reactor.

5. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in helical coil reactor.

6. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in spiral coil reactor.

7. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in packed bed reactor.

8. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in mixed flow reactor.

9. To calculate value of rate constant “K” for the saponification of ethyl acetate with NaOH in mixed flow reactors in series.

10. Verification of Arrhenius law.

11. To calculate rate of reaction of auto catalytic reaction in recycle reactor.

THIRD YEAR CHEMICAL ENGINEERING SEM.-VI
6. COMPUTER APPLICATIONS

Lectures: 1 hrs. per week

Practical: 2 hrs. per week

Examination:

Theory : nil

Practical /Oral:

Internal : 25 marks

External : 25 marks

THEORY:

1. **Material balances for mixing of Multiple streams:** Recycling of a multi component Stream without chemical reactions; Curve fitting examples; Specific heats, Vapor pressure, PVT Equations.

2. **Estimation of Pipe diameter by Trial and Error:** Optimum Pipe Diameter, Determination of flow rates in branched Sections, Determination of Average velocity from velocity profiles.

3. **Optimum Insulation thickness:** Optimum outlet temperature for Heat exchangers, Optimum diameter of Heat exchanger tubes, design of multiple effect evaporator.

4. **Determination of Optimum Reflux:** Product compositions / Temperatures / Flow Rates / Pressures in Multi component flash Distillation, Number of Theoretical stages by McCabe Thiele and other methods.

5. **Calculation of Volume from P-V-T relations,** Equilibrium compositions for simultaneous chemical reactions, Reflux concentrations as a function of time in a continues stirred tank with accumulation.

6. **Solution of Diffusion Equations,** Solutions of steady state continuously contacting equipment Models.

References:

1. Robert E. Treybal, “Mass Transfer Operations”, Third Edition, McGraw Hill, 1980.
2. Octave Levenspeil, “Chemical Reaction Engineering”, 2nd Edition, John Wiley, London.
3. S. M. Walas, “Reaction Kinetics for Chemical Engineers” McGraw Hill, New York.
4. Peter Harriott, “Process Control”, Tata McGraw Hill, New Delhi, 1977.
5. B. C. Bhattacharya, “Introduction to chemical equipment design” 1985.
6. Robert Lafore, “Object Oriented Programming in Turbo C++”, Galgotia Publication Pvt Ltd 1994.
7 R.J.Micheli, “C++ Object Oriented Programming”, McMillan London 1993
8 H.M Deitel and P.J.Deitel, “C++ how to program” .2nd Edition, Prentice hall, New Jersey, 1998.
9. B.I.Bhatt ,S.M. Vora, “Stoichiometry”,Tata McGraw Hill Publisning Company Ltd.

TERM -WORK :

1. Write and execute computer program to find specific heat and vapor pressure.

2. Write and execute computer program to find optimum diameter of pipe.

3. Write and execute computer program to determine flow rates and average velocity.

4. Write and execute computer program to find optimum insulation and optimum temperature for heat exchanger.

5. Write and execute computer program to design a heat exchanger.

6. Write and execute computer program to design multi effect evaporator.

7. Write and execute computer program to find optimum reflux, product composition in distillation.

8. Write and execute computer program to find number of theoretical stages by any method.

9. Write and execute computer program to find mass balance in continuous stirred tank reactor.

10. Write and execute computer program to find the length of a packed bed heat exchanger.

THIRD YEAR CHEMICAL ENGINEERING SEM.-VI

7. INDUSTRIAL PRACTICES AND CASE STUDIES

Lectures: 1hrs per week

Practicals: 2 hrs per week

Examination:

Theory : NIL

Practical /Oral:

Internal : 50 marks

The Concerned staff member should take the students of a batch consisting of 15 – 20 once a week to an industry , Before taking them to an industry ,the staff member has to give complete details of the particular industry in the theory class .In a semester ,they have to visit a minimum of 5 industries and submit brief reports. The term work mark shall be given on (1) No Of industrial visits (2)Reports (3)Orals and /or (4) written examination.

Report shall consist of :

(1)History.

(2) Raw materials.

(3)Process flow chart .

(4) Equipment details.

(5)pollution control aspects.

(6) Production process details.

(7) Quality control aspects.

(8)Cost of Production and profits.

(9) Suggestions for improvement.

(10)Safety aspects.

(11)Process hazards and safety measures in chemical process industries : Safety in industries ,chemical process industries , Potential Hazards,Physical job safety analysis. High Pressure High temp operation ,Dangerous and toxic chemicals, Highly explosive and inflammable chemicals ,Highly radioactive materials ,Safe handling & operation of materials .Planning & layout,industrial accidents and remedial measures ,effective steps to implement safety procedures, periodic inspection, study of plant layout and constant maintenance, Periodic advice and checking to follow safety procedures ,Proper selection and replacement of handling equipment, Personal protective equipment.

12) P & I Diagram at least for any one plant which they have visited should be drawn.

13) Final Year Project Topics & Guide should be finalized & minimum five page literature survey should be submitted in the term work.

Reference:

1) Hand Book of Cane Sugar Engineering by Hugot E - Elsevier Applied Science Publication
2) Hand Book of Cane Sugar by Cane.J.C.P.- John Wiley & Sons.
3) Milk & Milk Products by Eckles.C.H. - Tata McGraw hill Publication
4) Dairy of an Frank by Nigudkar M - Mehta Publication
5) Principles of Distillation by Pandharipande.S. - Central Techno Publication
6) Distillation Engineering by Billet.R. - Chemical Publishing
7) Pulp & Paper by Casely.J.P. - John Wiley & Sons
8) Shreves Chemical Process Industries by Austin.G.T. – McGraw hill Book Co.
9) Handbook of Analysis & Quality for fruit & Vegetable products by Ranganna.S. - Tata McGraw hill Publication
10) Petrochemicals by Wiseman.P. - John Wiley & Sons.
11) Applied Process Design for Chemical & Petrochemical Plants by Ludwig.E.E. - Gulf Publication
12) Journal of Chemical Engineering World
13) Chemical Industry Digest
14) Indian Journal of Chemical Technology

SHIVAJI UNIVERSITY, KOLHAPUR

Equivalences of T.E. Chemical for repeater students

T.E.CHEMICAL SEM.-V

Sr.No.	Pre-Revised	Revised	Remarks
1	P.I.& I.M.A	P.I.& I.M.A	--
2	NMCP	CTCE	--
3	Mass Transfer-I	Mass Transfer-I	--
4	Chemical Engg. Thermodynamics-II	Chemical Engg. Thermodynamics-II	--
5	Chemical Equipment Design-I	Chemical Equipment Design-I	--
6	I.P.& Case Studies	I.P.& Case Studies T. E. Part- II	Shifted to T. E. Part- II

T.E.CHEMICAL SEM.-VI

Sr.No.	Pre-Revised	Revised	Remarks
1	IEM &E	IEM &E	
2	Industrial Pollution Control	Plant Utilities & Pollution Control	
3	Mass Transfer-II	Mass Transfer-II	
4	Process Dynamics & Control	Process Dynamics & Control	
5	Chemical Reaction Engg.-I	Chemical Reaction Engg.-I	
6	Computer Applications	Computer Applications	
7	I.P.& Case Studies	----	Shifted from T. E. Part- I