SHIVAJI UNIVERSITY, KOLHAPUR

SYLLABUS

Third Year (B. Tech.) CBCS

In

CHEMICAL ENGINEERING

(To be implemented From JUNE 2020)

Shivaji University, Kolhapur

T.Y.B.Tech (Chemical Engineering) – CBCS PATTERN

SEMESTER – V

Sr. No	Course (Subject Title)	TEACHING SCHEME									EXAMINATION SCHEME										
		THEORY			TUTORIAL			PRACTICAL			THEORY					PRACTICAL			TERM WORK		
		Credits	No. of Lecture	Hours	Credits	No. of Lecture	Hours	Credits	No. of Lecture	Hours	Hours	Mode	Marks	Total Marks	Min	Hours	Max	Min	Hours	Max	Min
1	PCC-CH-501	3	3	3	-	-	-	1	2	2		CIE ESE	30 70	100	40	As per BOS Guidelines	25	10	2	25	10
2	PCC-CH-502	4	4	4	1	1	1	1	2	2		CIE ESE	30 70	100	40		25	10	2	25	10
3	PCC-CH-503	3	3	3	1	1	1	-	-	-		CIE ESE	30 70	100	40		-	-	2	25	10
4	PCC-CH-504	4	4	4	-	-	-	1	2	2		CIE ESE	30 70	100	40		50	20	2	50	20
5	OEC-CH-505	4	4	4	-	-	-	-	-	-		CIE ESE	30 70	100	40		-	-	-	-	-
6	MP-CH-506	1	1	1	-	-	-	1	2	2		-	-	-	-		-	-	2	75	30
	TOTAL	**19**	**19**	**19**	**2**	**2**	**2**	**4**	**8**	**8**				**500**			**100**			**200**	

SEMESTER –VI

1	PCC-CH-601	3	3	3	-	-	-	-	-	-		CIE ESE	30 70	100	40	As per BOS Guidelines	-	-	2	25	10
2	PCC-CH-602	3	3	3	1	1	1	1	2	2		CIE ESE	30 70	100	40		25	10	2	25	10
3	PCC-CH-603	4	4	4	-	-	-	1	2	2		CIE ESE	30 70	100	40		25	10	2	25	10
4	PCC-CH-604	3	3	3	1	1	1	1	2	2		CIE ESE	30 70	100	40		25	10	2	25	10
5	OEC-CH-605	3	3	3	-	-	-	-	-	-		CIE ESE	30 70	100	40		-	-	-	-	-
6	PCC-CH-606	1	1	1	-	-	-	1	2	2		-	-	-	-		-	-	2	50	20
7	PCC-CH-607	1	1	1	-	-	-	1	2	2		-	-	-	-		-	-	2	75	30
	TOTAL	**18**	**18**	**18**	**2**	**2**	**2**	**5**	**10**	**10**				**500**			**75**			**225**	
	TOTAL	**37**	**37**	**37**	**4**	**4**	**4**	**9**	**18**	**18**				**1000**			**175**			**425**	

CIE- Continuous Internal Evaluation: Three tests of 30 marks duration 1 hour are to be conducted in a semester

ESE – End Semester Examination: Theory paper of 70 marks duration 2 and 1/2 hrs by University.

• Candidate contact hours per week : 30 Hours (Minimum)	• Total Marks for T.E. Sem V & VI : **1600**
• Theory and Practical Lectures : 60 Minutes Each	• Total Credits for T.E. Sem V & VI : **50**
• In theory examination there will be a passing based on separate head of passing for examination of CIE(min. 12 marks) and ESE (min. 28 marks).	
• There shall be separate passing for theory and practical (term work) courses.	
• **Sem V: SSC**: Constitution of India and Local Self Government (2 Credits) (Self Study)	
• **Sem VI: SSC:** Any one from following (vi) to (x) (2 Credits) (Self Study) vi) Interview & Personal Presentation Skill, vii) Entrepreneurship Development Skill, viii) Travel & Tourism, ix) E-Banking & financial services, x) RTI & Human Right Education, IPR & Patents	

Note :

1. **PCC-CH :** Professional Core course –Chemical Engineering are compulsory
2. **OEC-CH :** Open Elective Course – Chemical Engineering
3. **MP-CH :** Mini Project- Chemical Engineering

Shivaji University, Kolhapur

T.Y. B. Tech. (Chemical Engineering) Syllabus

w.e.f. June 2020

Semester V

Sr. No	Course Code No.	Name of course	Credits
1.	PCC-CH-501	Process Instrumentation and Instrumental Methods of Analysis	4
2.	PCC –CH-502	Mass Transfer-I	6
3.	PCC-CH-503	Chemical Engineering Thermodynamics-II	4
4.	PCC-CH-504	Chemical Equipment Design	5
5.	OEC-CH-505	**Open Electives -I	4
6.	MP-CH-506	Mini Project Work	2
		Total=	25

Semester VI

Sr. No	Code No.	Subject	Credits
1.	PCC –CH-601	Plant Utility and Process Safety	3
2.	PCC –CH-602	Mass Transfer-II	5
3.	PCC-CH-603	Process Dynamics and Control	5
4.	PCC-CH-604	Chemical Reaction Engineering-I	5
5.	OEC-CH-605	**Open Electives -II	3
6.	PCC-CH-606	Process Simulation Laboratory	2
7.	PCC-CH-607	Industrial Practices and case studies	2
		Total=	25

**** Indicates List of open electives included in the syllabus**

T.Y.B. Tech. (CHEMICAL ENGINEERING)

Semester-V

1. PCC-CH-501 PROCESS INSTRUMENTATION AND INSTRUMENTAL METHODS OF ANALYSIS

Lectures: 3 Hrs Per Week	Evaluation Scheme : CIE -30 Marks
Practical's: 2 Hrs Per Week	ESE: 70 Marks
Credits: 04	Term work: 25 Marks
	Practical : 25 Marks

OBJECTIVES:

1) To understand classification, parts and characteristics of instruments.
2) To understand basic principle behind measurements and their applicability in chemical processes.
3) To understand differences between various analytical methods.
4) To understand correct analytical method for sample analysis.
5) To understand modern analytical technique like chromatography, its types like gas chromatography, HPLC and its applications.

COURSE OUTCOMES:

On completion of the modules students should be able to

1. To impart ability to classify and identify parts of instruments with its charactertics. Also impart ability to measure pressure by using various instruments.
2. Select appropriate instruments for a given chemical parameter. Also impart ability to calibrate instruments.
3. To impart ability to measure Temperature, Flow, Pressure & level by using various instruments and realize importance of data analysis.
4. Use various analytical methods for analysis of various industrial samples.
5. To analyze the chemical industrial samples by using modern techniques like flame photometry, chromatography, gas chromatography, HPLC, FTIR, Mass spectroscopy

SECTION – I

PROCESS INSTRUMENTATION

Unit I

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

Pressure Measurement: Introduction, methods of pressure measurement by manometers, elastic pressure transducer, force balance pressure gauges, electrical pressure transducers and vacuum measurement. Pressure switches,

Unit II

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

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

Unit III

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

P & I Diagram- Introduction to P & I Diagram

SECTION – II:

INSTRUMENTAL METHODS OF ANALYSIS

Unit IV

Introduction to instrumental methods of analysis: General Introduction, classification of instrumental methods, spectroscopy, properties of electromagnetic radiation, electromagnetic spectrum.

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

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

Unit V

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

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

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

Unit VI

Chromatography: Introduction, types, theoretical principles, theories of chromatography, development of chromatography.

Gas Chromatography: Introduction, principles of gas chromatography, gas liquid chromatography, instrumentation.

High Performance (Pressure) Liquid Chromatography: Introduction, principles, instrumentation, apparatus & materials, applications.

Introduction to Advanced analytical methods: Introduction to Mass Spectrometry, Nuclear Magnetic Resonance, FTIR.

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.

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

6. Galen W. Ewing, "Instrumental Methods of Chemical Analysis", 5th Edition, McGraw Hill Book Company, Singapore, 1990
7. D. A. Skoog, "Principal of Instrumental Analysis", Southern Collage Publication, Japan 1984

8. G. R. Chatwal, S.K. Anand, "Instrumental method of chemical analysis", 5th Edition, Himalaya Publishing House, Mumbai 2002.

TERM WORK: Any 10 Experiments are to be conducted from the following

1. Calibration of pressure gauge.
2. Thermocouple calibration.
3. Liquid level measurement.
4. Flow measurement.
5. Acid–base titration with help of conductometer.
6. Experiment based on Nephelo and turbidity meter.
7. Study of spectrophotometer.
8. Study of flame photometer.
9. Demonstration of GLC.
10. Demonstration of HPLC.
11. Measurements of RI of different liquid samples with Refractometer.
12. Determination of percentage composition with help of RI measurement.
13. Estimation Of total solids, volatile solids, suspended solids and dissolved solids.
14. Industrial waste water analysis.

2. PCC-CH-502. MASS TRANSFER –I

Lectures: 4 hrs per week
Tutorials- 1 hr per week
Practicals: 2 hrs per week
Credits ; 6

Evaluation Scheme: CIE – 30 Marks
ESE : 70 marks
Term Work ; 25 Marks
Practical ; 25 Marks

OBJECTIVES:

The student completing this course are excepted to understand mass transfer operation with the concept of molecular diffusion, flux rate, theories of mass transfer, mass transfer coefficient, designed for equipment in which two phases are contacted. Application of Navier-Stoke equation in unsteady state convective mass transfer and mass transfer analogy.

It gives details about method of conducting mass transfer operation, concepts of driving force, operating line, designing

of stages for operations like adsorption, absorption, distillation, extraction, leaching, drying. Also it helps in process design and study of equipment for above mentioned operations. They will understand implication through laboratory experiments performed.

OUTCOME:

- To able to design equipment for mass transfer operations, the rate equations are important which can

be utilized for optimization concept.

. Concept of steady state & unsteady state diffusional operations studied for controlling parameters in

actual industrial process.

. Student can able and to understand the trouble shooting problem in actual operation

. To implement the knowledge of various unit operations in the real plants.

SECTION –I

Unit I

Introduction to mass transfer operations, Classification & Applications, 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. Experimental diffusivity measurement equipments – Arnold cell, Twin bulb,Stefan tube,Diaphragm cell.

Diffusion In Solids: Steady State Diffusion, Unsteady State Diffusion, Diffusion in Polymers & Crystals.

Unit II

Mass transfer coefficients: Determination Of mass transfer coefficient through contacting equipment. Eddy diffusion, film theory, penetration theory, surface renewal theory, analogy of mass transfer, heat Transfer and its significance, mass transfer coefficient in laminar flow and turbulent flow, Simultaneous mass & heat transfer.

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 force line. Cascades – cross current, Counter Current stages. Solved examples on stages and driving force lines with interfacial compositions.

Unit III

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.

b) Liquid dispersed:

Ventury Scrubber, Wetted wall tower, Spray tower, Spray chamber, Packed tower, Mass Transfer coefficients for packed tower, Random & Stacked packing, 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.

SECTION –II

Unit IV

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

Unit V

Adsorption: adsorption isotherm, Types of adsorbents, Adsorption equipment, Adsorption hysteresis, Heat of adsorption, break through curves, Single and multistage adsorption operation calculations, Principle of Ion Exchange, Principles & Techniques of Ion Exchange.

Unit VI

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”, 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 McGrawHill, 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. C. J Geankolis, Transport Processes and unit operations, 3rd Edition, Prentice hall, India, 1993.
7. B.K Datta, Principles of mass transfer & separation process.

TERM WORK: Any 08 Experiments are to be conducted from the following

1. Diffusivity 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. Binodle Curve.
10. Cooling Tower.

3. PCC-CH-503. CHEMICAL ENGINEERING THERMODYNAMICS- II

Teaching Scheme	Evaluation Scheme
Lectures: 3 hours per week	CIE- 30 Marks
Tutorial : 1 hour per week	ESE- 70 marks
Credits:- 4	Termwork: 25 Marks

Course Objectives:

1) Students should be able to describe the terminologies associated with engineering thermodynamics.
2) Students should be able to calculate properties of ideal & real mixtures based on thermodynamics principles.
3) Students should be able to explain underlying principles of phase equilibrium in bi-component & multicomponent systems.
4) Students should be able to communicate effectively, both orally & in writing, regarding scientific & engineering principles and thermodynamics aspects of engineering design.
5) Students should be able to apply knowledge of problem solving to thermodynamics.
6) Students should be should be able to recognize the need for life-long learning in order to remain effective as scientist or an engineer.

Outcomes:

The learning outcomes are assessed through graded homework exercises, Assignments, mid semesters and a final exam. Science the course is a prerequisite for other course in the curriculum, there are additional opportunities to evaluate the extent to which course objective are achieved from the feed backs of the faculty teaching professional course such as process design and equipment design that have increased emphasis on application of basic principles, including control mass and volume

The acquired knowledge of vapour liquid equilibrium can be applied to various unit operation such as distillation, absorption etc. with the thorough knowledge of thermodynamics purity of products and feasibility can be analyzed.

SECTION – I

UNIT 1 - VAPOR / LIQUID EQUILIBRIUM:

The nature of equilibrium, The phase rule &Duhem's Therom, VLE: Qualitative Behavior, Azeotropes, 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.

UNIT 2 - SOLUTION THERMODYAMICS: THEORY I

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.

UNIT 3 - SOLUTION THERMODYAMICS: THEORY II

Fugacity & Fugacity Coefficient, pure Species & Species in Solution, the Fundamental Residual Property relation , the ideal Solution, The Lewis Randall Rule, Excess properties, The excess Gibbs Energy and the Activity Coefficient

SECTION –II

UNIT 4 - SOLUTION THERMODYNAMICS: APPLICATIONS

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

UNIT 5 - 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, Phase Rule & Duhem'sTherom For Reacting Systems.

UNIT 6 - THE PHASE EQUILIBRIA & THERMODYNAMIC ANALYSIS

Criteria of Phase equilibrium, Criterion of Stability .Phase Equilibrium in Single Component

System, Non ideal Solutions. Liquid – Liquid Equilibrium (LLE), Solid – Liquid Equilibrium (SLE), Solid – Vapor Equilibrium (SVE), Work and free energy.

Text Books:

1. J.M.Smith, H.C.Vanness," Introduction to Chemical Engineering Thermodynamics" 8th 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.
5. S. I. Sandler "Chemical Engineering Thermodynamics" – Wiley - @nd Edition.
6. Koretsky M.D. "Engineering& Chemical Thermodynamics" – John Wiley & Sons – 2004.

4. PCC-CH-504. CHEMICAL EQUIPMENT DESIGN

Teaching Scheme: L : 04 hrs/week
T : NA
P : 02 hrs/week
Credits : 05

Examination Scheme: CIE : 30 Marks
ESE : 70 Marks
Term Work : 50 marks
Practical : 50 marks

Objectives:
To introduce the students the Basic concept in design, different types of stresses involved, various types of joints, Design of various types of equipments like pressure vessel, storage vessel, vessel supports, heat exchangers, evaporators, agitator and reaction vessels.

Outcomes:
On completion of the module students should be able to design individual pieces of equipment.

SECTION –I

Unit 1.
Design preliminaries
Design codes, Maximum working pressure, Design pressure, Design temperature, Design stress & factor of safety, Weld joint efficiency factor, Corrosion allowance, Design wall thickness, minimum actual wall thickness, Design loadings, Moment of inertia, Radius of gyration, Section modulus

Unit 2.
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)
Storage vessels
Storage of fluids, Different types of storage vessels, Design of cylindrical storage vessels with roof.

Unit 3.
Design of tall vessels
Determination of longitudinal stresses, Period of vibration, Determination of resultant longitudinal stress.
Design of Support for process vessels
Design of Bracket Support, Lug Support, Skirt Support & Saddle support.

SECTION –II

Unit 4.

Mechanical design of heat exchanger

Types of heat exchangers, Special type of heat exchangers, Design of Shell & Tube Heat Exchanger. (Use IS 4503 for above design procedure)

Mechanical design of evaporator

Types of evaporators, Entrainment Separators, Design of Standard Short Tube Vertical Evaporator.

Unit 5.

Mechanical design of Reaction vessel

Classification of reaction vessel, Heating systems, Design consideration

Mechanical design of Agitator

Types of agitators, Baffling, Power requirements for agitation, Design of agitation system components

Unit 6.

Equipment testing methods

Hydrostatic Pressure test, Pneumatic pressure test, Dye penetrant test, Magnetic test, Ultrasonic test, Freon test, Radiography test.

Process Hazards & Safety

Hazards in Process Industry, Analysis of Hazards, Safety Measures in pressure vessels, Safety measures in Equipment Design, Pressure Relief Devices

Text Books:

1. B. C. Bhattacharya, "Introduction to chemical equipment design" (Mechanical accepts) 1985.
2. 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.
3. Dr. S.D. Dawande, "Process Design of Equipment", Central Techno Publication, 1st Edition 1999.

References:

1. L. E. Brownel and E. H. Young "Process equipment design", Wiley Eastern Ltd.1977.

TERM WORK: Design and drawing of any 8 from the following

1. Design of pressure vessels with heads, flanges and gaskets.
2. Design of atmospheric storage vessels.
3. Design of head and closures
4. Design of tall vertical vessels
5. Design of supports.
6. Design of heat exchangers.
7. Design of reaction vessel.
8. Design of evaporator.
9. Design of agitation system
10. Design of Safety Devices

Note:

- Preparation of 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 4 should be drawn with the help of software AutoCAD.
- **Evaluation Guidelines**
  a. Out of 50 marks of **Term Work** , 25 marks are allotted for model making
  b. Out of 50 marks **Practical** , 25 marks are allotted for model making

5. OEC-CH-505.

1. COMPUTATIONAL TECHNIQUES IN CHEMICAL ENGINEERING

Teaching Scheme
Lectures: 4 hours per week

Evaluation Scheme
CIE- 30 Marks

ESE- 70 marks

Credits:- 4

OBJECTIVE:

1. Student will able to Understand, motivation for Computational Technique and do error analysis.

2. Student will able to Understand and solve linear and algebraic system of equations.

3. Student will able to analyze and solve differential equations by different numerical methods.

4. Student will able to Understand C++ Programming basics and analyze Control Structures.

5. Student will able to apply Arrays

6. Student will able to construct function

Course outcomes

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

1.Ability to Understand, motivation for Computational Technique and do error analysis.

2.Ability to Understand and solve linear and algebraic system of equations.

3.Ability to analyze and solve differential equations by different numerical methods.

4.Ability to Understand C++ Programming basics and analyze Control Structures.

5.Ability to apply Arrays.

6. Ability to construct the function.

SECTION -I

Unit 1 Introduction of Numerical methods and error

Introduction, Motivation and applications. Computation and Error Analysis- Introduction, Accuracy of Number. Error, Accuracy and precision; Truncation and round-off errors; Binary Number System; Error propagation.

Unit 2 Linear Systems and Equations and **Algebraic Equations**

Matrix representation; Cramer's rule; Gauss Elimination; Matrix Inversion; LU Decomposition; Iterative Methods; Relaxation Methods; Power Method, Hosuseholder's methods.

Algebraic Equations: Bracketing methods: Bisection, Reguli-Falsi; Open methods: Secant, Newton Raphson

Unit 3 Differential Equations

ODEs: Initial Value Problems: Euler's methods; Modified Euler's method; Runge-Kutta methods; Predictor-corrector methods;

ODEs: Boundary Value Problems shooting method

PDEs Introduction to Partial Differential Equations.

SECTION -II

UNIT 4: C++ Programming basics:

Introduction to C++, Operators in C ++ and types, Input Output Statements, Manipulator Functions and Programs. Introduction to Control Structures, Conditional Statements, Loop Statements, Break Statements and Programs.

UNIT 5: Arrays

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

UNIT 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.

Note: The student has to submit the assignment assigned by the subject in-charge, that should contains the programs and the output generated from the computer prints based on the topics. Minimum any 10 programs are to be assigned.

Text Books:

1. Gupta S.K. (1995) Numerical Methods for Engineers, New Age International.
2.Robert Lafore, "Object Oriented Programming in Turbo C++", Galgotia Publication Pvt Ltd.1994

References:

1. Chapra S.C. and Canale R.P. (2006) Numerical Methods for Engineers, 5th Ed; McGraw Hill.

2. B. S. Grewal (2002) Khanna Publishers.
3. Davis. M.E., “Numerical Methods and Modeling for Chemical Engineers”, Wiley 1984.
4. Alan. L,.Myers and Warren. D Seider., “Introduction to Chemical Engineering and Computer Calculations”, Prentice Hall, Engle Wood Cliffs (N.J), 1976.
5. Jaan Kiusalaas “Numerical Methods in Engineering with MATLAB”,Cambridge University Press, 2005
6. R.J.Micheli, “C++ Object Oriented Programming”, McMillan London 1993
7. E.Balguruswamy, “Object Oriented Programming in C++”, Tata McGraw Hill Publishing Company Ltd. New Delhi 1995.
8. H.M Deitel and P.J.Deitel, “C++ how to program” .2nd Edition, Prentice hall, New Jersey, 1998.

5. OEC-CH-505.

2. Applications of MATLAB in CHEMICAL ENGINEERING

Teaching Scheme
Lectures: 4 hours per week

Evaluation Scheme
CIE- 30 Marks

ESE- 70 marks

Credits:- 4

Objectives

1 To familiarize the student in introducing and exploring MATLAB software.
2 To enable the student on how to approach for solving Engineering problems using simulation tools.
3 To prepare the students to use MATLAB in their project works.
4 To provide a foundation in use of this software for real time applications.

Outcomes

1 Able to express programming & simulation for engineering problems.
2 Able to find importance of this software for Lab Experimentation.
3 Able to write basic Chemical Engineering problems in Matlab & to use in research by simulation work.
4 Able to connect programming files with GUI Simulink.

SECTION -I

Unit 1

Introduction MATLAB:

Introduction MATLAB, MATLAB window, Command window , workshop window, workspace, basic command assigning variables, operations with variables, data files and data types, characters and string.

Unit 2

Control loops:

Control statement programming, conditional statement programming, loop and conditional statements, if, else, switch, for, while, continue, break, programming with control statements.

Unit 3

Functions:

Function definition, User defined function, Built in function, Function calling, Return value, Type of functions, Global Variables

SECTION -II

Unit 4

Array and Linear equations:

Array definition, Types of Array, Matrix Arithmetic operations, Array Arithmetic operations, operators and special characters, Relational ,mathematical and logical operators, matrix operations, transpose determinant and inverse and matrix function.

Unit 5

MATLAB operations and plot:

Arithmetic operations, operators and special characters, solving arithmetic equations, matrix operations,. Trigonometric functions, complex numbers, fractions real numbers, M file, plots 2D, 3D, GUI design

Unit 6

Debugging M files:

Debugging process, preparation for debugging, setting break points, running with break points, correcting and ending debugging, correcting M file

Note: The student has to submit the assignment assigned by the subject in-charge, that should contains the programs and the output generated from the computer prints based on the topics. Minimum any 10 programs are to be assigned.

Reference Books:

1 .Dr. Rudra Pratap,"Getting started with MATLAB" , Oxford University Press.

2.David Houcqe, "Introduction to MATLAB for Engineering students", Northwestern University (ver 1.2Aug 2005)

3. Dr. Partha , S. Mallick, "MATLAB & Simulink" ,Scitech publications pvt ltd.

4. Dr. Shailendra Jain & Dr. Sanjeevan Kapshe, "Modeling and simulation using MATLAB

Simulink", Wiley.

5. S. J. Chapman, "Essential of MATLAB programming".

6. D. J. Higham and N. J. Higham. "MATLAB Guide". Siam, second edition edition, 2005.

7. Gilat.,"MATLAB: An introduction with Applications", John Wiley and Sons, 2004.

8. D. Houcque, "Applications of MATLAB: Ordinary Differential Equations". Internal communication, Northwestern University.

9. William J. Palm, "Introduction to MATLAB for Engineers".

6 MP-CH-506 . MINI PROJECT WORK

Lectures: 1 hrs per week

Practical: 2 hrs per week

Credits: 2

Examination:

Theory: NIL-

Term work: 75 marks

Objectives:

- Development of ability to define and design the problem and lead to its accomplishment with proper
- Planning Learn the behavioral science by working in a group
- To develop student's abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project.
- To understand the importance of document design by compiling Technical Report on the Mini Project work carried out

Outcomes:

After successfully completing this course, the student shall be able to:

- Understand, plan and execute a Mini Project with team.
- Implement basic engineering knowledge.
- Prepare a technical report based on the Mini project.
- Deliver technical seminar based on the Mini Project work carried out.

The project can be taken by group of 4 students and mini project can be carried out in the dept. under a guide or outside the department/institute/ company under a guide from the dept. and co guide from the outside department/institute/ company.

Evaluation procedure:

1	Report	Abstract, Introduction, Literature survey, And parameters planned to study
2	PPT Presentation	Evaluation by the committee

T.Y.B. Tech. (CHEMICAL ENGINEERING)

Semester-VI

1. PCC-CH-601. PLANT UTILITY AND PROCESS SAFETY

Teaching Scheme: L : 03 hrs/week

Examination Scheme: CIE : 30 Marks
ESE : 70 Marks
Term Work : 25 marks

Credits : 03

Course Outcomes: Students will be able to

1. Understand the principles of plant utilities, pollution control and Process safety in industry & modern society.
2. develops an understanding of air, water, steam as utilities and water, air pollution control technologies, as well as better product or process design to mitigate the problems of utilities and pollution both in the chemical industry and other process industries.
3. Tackle the problems of water, air and hazardous waste minimization, generation, treatment and disposal.
4. Analyze the utilities and waste characterization, generation and composition analysis, development of optimum collection routing networks, transfer stations, design, process safety and related social and environmental issues.
5. Interpret & formulate the Boiler classification and thermal efficiency calculation as design aspects in industries.
6. Apply the principles of utilities and waste minimization, source reduction, material use, process safety and recovery in the design for the environment/industrial safety & economical way.

SECTION-I

Unit 1

Steam Generation and Utilization Steam generation and its application in chemical process plants, distribution and utilization; Types of boilers and their operation; steam economy, Steam condensers and condensate utilization, Steam generation by utilizing process waste heat using thermic fluids, Selection and sizing of boilers; waste heat boilers.

Unit 2

Air pollution control:

Sources and effects .air pollution monitoring system, theory, thermal combustion techniques, control of air pollution in industry viz. paper and pulp industries, cement industries and Petrochemical Industry.

Unit 3

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

SECTION-II

Unit 4

Process Hazards and Safety Basics

Introduction :Process Safety – What is it ?, Risk Based Process Safety, Process Safety Culture,Process Safety Competency, Hazard Identification. The Need for Process Safety. Hazards**:** Classifications and assessment of various types of hazards, , hazard and operability studies (HAZOP), Hazard operability (HAZOP) hazard analysis (HAZAN), Risk assessment methods, General principles of industrial safety, toxicity and radiations, Industrial hygiene, Introduction to industrial safety regulations.

Unit 5

The Need for Process safety and Engineering disciplines

Process Safety Culture – Methyl Isocyanate Release , Bhopal , India , 1984:Summary, Detailed Description, Key Lessons. Process Safety for Engineering Disciplines: Introduction, Process Knowledge Management,Compliance with Standards.

Unit 6

Process safety in Design and Process Hazards

Process Safety in Design: General Unit Operations and Their Failure Modes, Heat Exchange Equipment, Mass Transfer, Distillation, Leaching and Extraction, Absorption, Reactors and Reactive Hazards, Storage. Process Hazards**:** Chemical Reactivity Hazards, Fires and Explosions

Text Books:

1. Ashutosh Pande, Plant Utilities, Vipul Prakashan, Mumbai.
2. C. S. Rao “Environmental pollution control engineering” Wiley Eastern, Ltd 1994.
3. Dan Crowl et.al. “Introduction to Process safety for Undergraduates and engineers”CCPS, Wiley.

References:

1. S. P. Mahajan, "Pollution Control in Process Industries", Tata McGraw hill, 1985.
2. Matcalf and Eddy, "Waste Water Engineering Treatment", Tata
3. WarenViessman and Mark J. Hammer, "Water supply and pollution control", Harper & Row, New York, 1985.
4. M.V. Rao and A. K. Datta : "Waste Water Treatment".
5. H. C. Perkins, "Air Pollution", McGraw Hill 1974.
6. M. J. Hammer, "Water & waste water Technology", Wiley, 1975.
7. Artur L. Kohi and Fred C. Reisenfled, "Gas Purification", Gulf Publishing Co.1979.
8. G.D.Ulrich,"A Guide to Chemical Engineering Process Design and Economics",John Wiley and Sons 1934.
9. Banerjee, S., Industrial Hazards and Plant Safety, Taylor & Francis 2003).
10. Sanders, R. E. Chemical Process Safety-Learning from Case Histories, Oxford (2005)
11. Daniel A. Crowl, Joseph F. Louvar, "Chemical Process Safety Fundamentals with Applications", Prentice Hall, Third Edition, 2011
12. Trevor A. Kletz, "Hazop & Hazan: Identifying and Assessing Process Industry Hazards", Fouth Edition, CRC Press, 1999.

Evaluation Guidelines for Term Work: Student has to submit minimum four assignment with their case studies and evaluation is to be carried based on the assignments.

2. PCC-CH-602. MASS TRANSFER – II

Lectures: 3 hrs per week
Tutorials- 1 hr per week
Practicals: 2 hrs per week
Credits ; 5

Evaluation Scheme: CIE – 30 Marks
ESE : 70 marks
Term Work ; 25 Marks
Practical ; 25 Marks

OBJECTIVES:

The student completing this course are excepted to understand mass transfer operation with the concept of molecular diffusion, flux rate, theories of mass transfer, mass transfer coefficient, designed for equipment in which two phases are contacted. Application of Navier-Stoke equation in unsteady state convective mass transfer and mass transfer analogy. It gives details about method of conducting mass transfer operation,concepts of driving force, operating line, designing of stages for operations like adsorption, absorption,distillation, extraction, leaching, drying. Also it helps in process design and study of equipment for above mentioned operations. They will understand implication through laboratory experiments performed.

OUTCOME:

To able to design equipment for mass transfer operations, the rate equations are important which can be utilized for optimization concept.

. Concept of steady state & unsteady state diffusional operations studied for controlling parameters in actual industrial process.

. Student can able and to understand the trouble shooting problem in actual operation

. To implement the knowledge of various unit operations in the real plants.

SECTION –I

Unit I

Distillation: Vapor Liquid Equilibrium, Ideal Solutions, Relative volatility, Azeotropic mixtures, Methods Of distillation: Flash, Differential, Steam, Vacuum, molecular, 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.

Unit II

Liquid–Liquid Extraction: Liquid Equilibrium, coordinate systems, cross and counter current operation and its calculation, selection of extractors, Extraction Equipment.

Unit III

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

SECTION –II

Unit IV

Humidification:

Application of Humidification, Study of Adiabatic Saturation Curve, Humidifier height calculations, definition of wet bulb ,dry bulb and equation for wet bulb depression, Percentage saturation , Percentage Humidity, Water cooling towers, Spray chamber, Evaporative Cooler.

Unit V

Drying: Theory and Mechanism of Drying, Steady and Unsteady Drying, Definition of moisture content, total time of drying, length of continuous dryer, Material and Enthalpy balance in dryer, Classification and selection of Industrial dryers.

Unit VI

Crystallization: Nucleation, Crystal Growth, Methods of super saturation, 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. Robert E. Treybal, "Mass Transfer Operations", Third Edition, McGraw Hill, 1980.
2 Richardson & Coulson, "Chemical Engineering", Vol. 2, Pergamon Press, 1970.
3 McCabe and Smith, "Unit Operation of Chemical Engineering", 5th Edition McGrawHill, Kogakusha Ltd.,1998.
4. Foust et.al, "Principles of Unit Operations", 2nd Edition, John Wiley and Sons, 1979.
5. G. Astalita Elsevier, "Mass Transfer with Chemical Reaction", Publication.
6. C. J Geankolis, Transport Processes and unit operations, 3rd Edition, Prentice hall, India, 1993.
7. B.K Datta, Principles of mass transfer & separation process.
8. K. D Patil, Mass Transfer Operation Vol. I & II.

TERM WORK (Any 10) Any 10 Experiments are to be conducted from the following

1. Simple Distillation.
2. Packed column distillation
3. Steam distillation.
4. Tray dryer
5. Rotary dryer.
6. Cross current leaching.
7. Counter current leaching.
8. Single stage and multistage extraction.
9. Packed column extraction.
10. Batch crystallization.
11 Spray Chamber
12 Humidification & Dehumidification
13 Spray Dryer

3. PCC-CH-603. PROCESS DYNAMICS & CONTROL

Teaching Scheme	Evaluation Scheme
Lectures: 4 hours per week	CIE- 30 Marks
Practical's: 2 hrs per week	ESE- 70 marks
Credits:- 5	Termwork: 25 Marks
	Practical: 25 Marks

OBJECTIVES

The students completing this course are expected to understand the basic principles and problems involved in process control. They are expected to understand dynamic behavior of different order systems with examples and response to various forcing functions. They are able to understand design aspects of process control system, block diagram preparation, various types of controllers and there selection for particular application. To evaluate and analyze the transfer functions for various elements of the various control systems and processes. The students are expected to quantify and acquire knowledge of different stability methods such as standard algebraic method, Root locus method, frequency response. Application of control system to unit operations such as heat exchangers, Absorption column, jacketed kettle, Distillation tower. The students have to perform experiments based on theory to acquire practical knowledge. So that they can understand how the chemical engineering parameters are controlled

OUTCOMES:

1) Students should remember Laplace transform and understand basic principles and objectives of process control
2) To understand basic fundamentals of first and second order process dynamics and its behaviour.
3) Able to know about applying fundamental knowledge to design controllers and the control system
4) To evaluate different parameters affecting on the overall transfer function and response of process control system.
5) To understand stability characteristics for design of process control systems & analyse the frequency response of the control system
6) To develop the practical skill, team work and ethical thinking to choose right career in allied industries or higher studies.

SECTION-I

Unit 1- Review of Laplace Transform & Basic Principles & problems involved in process control:

Definition of transform, properties of Laplace transform, initial & final value theorem, examples, Need of process control, Principals involved in process control, agitated heating tank control system, steady state and transient design, step input, P control, PI control, Block diagram.

Unit 2 - Dynamic behavior of First order & Higher order: Second order System

First order system, Mercury in glass thermometer, Transfer Function, Time constant, Transient response of First order system, Single liquid level system, Mixing process, heating process, Linearization of non linear system, Response of first order system in series, Non interacting system, Interacting system, examples, second order systems, U tube manometer, Damped vibrator, step response for second order systems, terms used to describe second order under damped system, Transportation lag, examples

Unit 3 - Control System

Introduction, control system for CSTR, Block diagram, Development of block diagram, negative versus positive feedback control system, servo & regulator problem, Introduction to feedback control, concept, Types of Feedback Controllers like P,PI,PD,PID with transfer function and application, motivation for addition of integral and derivative modes of control, final control element, control valves with transfer function, block diagram for chemical reactor control system, Process & Instrumentation Diagram of Distillation column, Heat Exchanger, Reactor, Pressure vessel, etc. Introduction to MATLAB software, examples

SECTION-II

Unit 4 - Overall transfer function & Transient response of simple control system

Overall transfer function single loop system, Overall transfer function for change in set point & load, Overall transfer function multiple loop system, offset, P controller for change in set point & load point, PI controller for change in set point & load point, examples.

Unit 5 - Stability Analysis of Feedback Systems

Concept of Stability, definition, Stability criterion, The Characteristic Equation, Routh-Hurwitz Criterion for Stability with theorems and limitations, examples, Root-Locus Analysis, concept, plotting root locus diagram, rules for negative feedback system, examples.

Unit 6 - Frequency Response Analysis of Linear Processes

Substitution rule, The Response of a First-Order System to a. Sinusoidal input, Bode diagrams, Rules, Bode plot for a) first order system ,b) second order system, c) Transportation lag, d) Bode plot for P,.PI,.PD controller, Bode stability criterion, gain & phase margin, Introduction to DCS, PLC systems

Text Books:

1. Le Blanc & Coughanowr, "Process system analysis and C-ontrol", McGraw Hill, Third edition

2. Coughanowr Koppel, "Process System Analysis and Control", McGraw Hill, New York.

3. Donald K. Coughanowr, "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: Any 10 Experiments are to be conducted from the following

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.

4 PCC-CH-604. CHEMICAL REACTION ENGINEERING –I

Teaching Scheme	Evaluation Scheme
Lectures: 3 hours per week	**CIE**- 30 Marks
Tutorial: 1 hour per week	**ESE-** 70 marks
Practical's: 2 hrs per week	**Term Work:** 25 marks
Credits:- 5	**Practical's**: 25 marks

Objectives:

1. Write a rate law and define reaction order and activation energy
2. Demonstrate the ability to quantitatively predict the performance of common chemical reactors using simplified engineering models
3. Demonstrate the ability to regress the experimental data from which they determine the kinetic model of a multi-reaction system and use this information to design a commercial reactor.

Outcomes:

1. Ability to size batch reactors, semi batch reactors, CSTRs, PFRs, for isothermal operation given the rate law and feed conditions.
2. Ability to define and develop rate equations for homogeneous reactions
3. Ability to derive design equations for different types of reactors based on mole and energy balance.
4. Ability to relate rate of reaction with design equation for reactor sizing.

SECTION –I

Unit 1.

Introduction with Kinetics of homogeneous reactions :

Chemical kinetics and thermodynamics of reaction; Classification of reactions – Homogeneous and Heterogeneous reactions. Rate of reaction- broad definition for homogeneous and heterogeneous 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, Introduction to reaction mechanism .

Unit 2.

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.

Unit 3.

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

Unit 4.

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.

Unit 5.

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.

Unit 6.

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.H. Fogler," Elements of Chemical Reaction Engineering", PHI, 4 th Edition.
3. S. M. Walas, "Reaction Kinetics for Chemical Engineers" McGraw Hill, New York.
4. J. M. Smith, "Chemical Engineering Kinetics", McGraw Hill, New York.
5. J. Rajaram and J. C. Kuriacose, "Kinetics and Mechanics of Chemical Transformation", McMillan India Ltd., 1993.

TERM WORK: Any 10 Experiments are to be conducted from the following

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.

Note: Experimental calculations & graphs by using software's like Polymath, Excel etc.

5. OEC-CH-605.

1. INDUSTRIAL ECONOMICS, MANAGEMENT AND ENTREPRENEURSHIP

Teaching Scheme: L : 03 hrs/week **Examination Scheme:** CIE : 30 Marks
ESE : 70 Marks

Credits : 03

OBJECTIVES:

1) To understand economical aspects in chemical industry.
2) To understand and introduce general common terms related to economics, management and entrepreneurship.
3) To make students to develop skills required for entrepreneurship development and leadership.

OUTCOMES:

1) Upon completion of the course students should:1) Understand basic models of the behavior of firms and industrial organization and how they can be applied to policy issues.
2) Be able to manipulate these models and be able to solve analytically problems relating to industrial economics.
3) Be able to apply the models to important policy areas while being aware of the limitations of the theory.

SECTION – I

Unit 1

Economic problem:

Introduction of Macroeconomics, 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 and break-even point.

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

Unit 2

Inflation/Deflation:

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

Industrialization:

Need, capital requirement, rising of finance, cottage and small-scale industries, role in the Indian economy, problems of small scale industries, remedies, RBI.

Unit 3

Entrepreneurship:

Need of entrepreneurship, Various Assistance Programmer for Small Scale and large Scale Industries through agencies, like IDBI, IFC, NSIC SFC, SIDCO and DIC.

SECTION – II

Unit 4

Principles of management:

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

a) **Planning:** nature, importance, types of plans, planning process, decision making.

b) **Organizing:** Principles of organization, process of organising, organizational structure.

c) **Directing:** Theories of motivation, communication, process and barriers, leadership styles

d) **Controlling:** Control techniques.

Unit 5

Production management:

Selection of site, plant layout, its type, functions of P.P.C. Materials management: purchase, inventory control, production and quality control.

Finance management:

Scope and importance, capital structure planning,, working capital management, sources of funds, financial institutions of India, Indian economics and its challenges.

Unit 6

Marketing management :

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

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.

5. OEC-CH-605.

2. PROJECT MANAGEMENT AND SMART TECHNOLOGY

Teaching Scheme: L : 03 hrs/week **Examination Scheme:** CIE : 30 Marks
ESE : 70 Marks

Credits : 03

Objectives:

1. To understand basic concepts project management and application of PM to process industries
2. To understand project feasibility reports and learn about various clearances required to start an industry
3. To learn various project organizations and basics of contracting
4. To learn various tools and techniques used in PM.

Outcomes:

Students will be able to use

1. concepts and knowledge of project management to manage projects in process industries
2. Students should be able to prepare feasibility reports.
3. Students should be able to understand various clearances required to start industry
4. Students should be able to prepare project organization charts and contracts
5. Students should be able to prepare contracts
6. Students should be able to use tools of PM to solve problems.

Unit I : Concepts of project management:

Definition of project, project management, project types, project life cycle: purpose, inputs, project manager's role and outputs, Tools and techniques in project management, major knowledge areas of project management , Difference between project management and formal management, Role-responsibilities and skills of project manager, project overruns
Project management in process industries: project strategy, project specification, project engineering, detailed design, procurement, construction, commissioning and closure

Unit II : Project :

Conception to commissioning , mile stones, project executions conglomeration of technical and non technical activities,

Contract: meaning , contents, types of contracts , lumpsum turnkey (LSTK), Engineering

procurement and construction(EPC) , Engineering procurement and construction management(EPCM), Mergers and acquisitions,

Legislation: Intellectual Property Rights (IPR), Patents, trade marks , copy rights

Features of factories act 1948 with amendment (only salient points)

Features of payment of wages act 1936 (only salient points)

Unit III :

Feasibility report, licensing and clearances

Feasibility reports: Raw material survey, Market survey and demand study, technical study, location survey, financial survey and types of cost estimates, Estimation of project profitability Industrial license and LOI, Various laws & regulations governing industries, need for clearances and influences on project, List of various clearances.

Unit IV : Project organization and contracting

Project scope, project priorities, development of WBS, Development of process breakdown structure, Development of responsibility matrix, development of project communication plan. The traditional management structure, Project management organizational structure: pure project, matrix, task force, Project team, responsibilities of various members. Contracts types, selection criteria,3R of contracting, types of reimbursements and tendering procedure

Unit V : Tools and techniques in project Management :

Health-safety and environmental guidelines for chemical plants Quality assurance, Hazard analysis, Riskanalysis and management, Change Management. Cost benefit analysis, Project execution plan (PEP), Bar charts/GANTT charts, LOB, Networking techniques (PERT/CPM), Productivity budgeting techniques, Value engineering (VE) , ABC and VED Analysis , Economic Order Quantity (EOQ), CAT vs RAT, Time and cost control tools and techniques. Use of Microsoft projects: start your plan, adding resources to the model, resources management and crashing, resources rates and using calendars, handling multiple projects, uncertain activity times , tracking, base line and reports

Unit VI : Smart Technology:

Concept of IoT, how IoT works

Components of IoT , Characteristics of IoT , Categories of IoT

Applications of IoT-smart education, smart project , smart industry , smart energy management ,smart cities , smart transportation, smart homes, smart health care , smart agriculture.

References

1. Project Management, Choudhary, S., Tata McGraw Hill(module 1 to 4)
2. Total Project Management, Joy, P. K.,(module 1 and 2)
3. Project Management for process Industries, Gillian Lawson, I chem. E

(Module 1 and 4)
4. Project Management Case Studies, Harold Kerzner, Second edition, John Wiley and Sons (for case studies)
5. Project Management Methodology Guidelines, City of Chandler (Module 1)
6. Project Management-The Managerial Process, Clifford Gray, 6th edition, McGraw Hill (module 1, 2, 3)
7. Plant Design and Economics for Chemical Engineers, Klaus D Timmerhaus, 5th edition, McGraw Hill (Module 2 and 4)
8. Chemical Process Economics, Mahajani V.V.& Mokashi .M.
9. Process Plant and Equipment Cost estimation by Kharbanda O.P.
10. Project Management by K. Nagrajan, New Age International 2004
11. Internet of Things by Jeeva Jose, Khanna Publications ,New Delhi
12. https://www.fundable.com/learn/resorces/guides/startup

6 . PCC-CH-606. PROCESS SIMULATION LABORATORY

Teaching Scheme	Evaluation Scheme
Lectures: 1 hours per week	**CIE**- NIL
	ESE- NIL
Practical's: 2 hrs per week	**Term Work:** 50 marks

Credits:- 2

Objectives:

1) To introduce basic concepts of computer applications to solve chemical engineering problems.
2) To make use of computer oriented methods for solving problems.
3) To develop computer programming skills for solving problems related to fluid mechanics, heat transfer, mass transfer and reaction engineering.

OUTCOMES:

After successfully completing this course, the student shall be able to:

1) Understand, plan and execute a chemical Processes
2) Implement basic engineering knowledge.
3) Prepare a computer based technical report.

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 evaporators.

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.

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. Bansal A.K. ,Goel .M.K. ,Sharma ,"MATLAB and its application in engineering ",Person education ,2012.

TERM -WORK :

Note -Practical's are to be performed using Scilab/Matlab OR Perform the experiments on Open source software.

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

7. PCC-CH-607. INDUSTRIAL PRACTICES & CASE STUDIES

Teaching Scheme: L : 01 hr/week
P : 02 hrs/week
Credits : 02

Examination Scheme: CIE : Nil
ESE : Nil
Term Work : 75 marks

Course Outcomes: Students will be able to

1. understand the gap between lecture room explanations and real life experiences.
2. describe various organizations in the chemical industry chain from production, research, to processing and consumption.
3. opportunities for self-employment in the chemical sector after graduation.
4. acquire basic information of sources of raw materials for chemical industries as well as their products and by- products of such activities and what uses they could be put to.
5. understand how industrial establishments are administered.

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 5 local industries & 5 large scale Chemical Process Industries (Mandatory) and submit brief reports.
The term work marks shall be given on,

1. Number of industrial visits
2. Industrial visits reports
3. Orals and /or Written examination.

Report shall consist of:

1. History of Industry
2. Raw materials.
3. Process flow chart.
4. Equipment details.
5. Production process details.
6. Cost of Production and profits.
7. Quality control aspects.
8. Pollution control aspects.
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.

Evaluation Guidelines:

Out of 75 marks of Term work, 50 marks are allotted to visit of large scale Chemical Process Industries (Mandatory)

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

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