Proposed Syllabus

(With effect from 2014-15)

T.E. Chemical Engineering

Third Year Chemical Engineering

Faculty of Engineering and Technology

North Maharashtra University, Jalgaon

T.E. Chemical Engineering

Semester-V

Third Year Chemical Engineering

Faculty of Engineering and Technology

North Maharashtra University, Jalgaon

Course Outline

Process Equipment Design- I	**PED-I**	**CHL 501**
Course Title	Short Title	Course Code

Course Description:

This course describes to use appropriate terminology of process equipment preliminaries and design. It illustrates basic functions of process equipment; and relates scientific principles associated with process equipment design.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(S): Chemical Engineering Materials, Fluid Flow Operation, Applied Inorganic Chemistry, Process Calculations, Mechanical Operation, Applied Physical chemistry.

General Objectives:

1. To study the design preliminaries.
2. To study the corrosion and its prevention.
3. To study the mechanical design of heads.
4. To study the mechanical design of keys.
5. To study the process equipment design of circular flange pipe joints.
6. To study the process equipment design of storage vessel.
7. To study the process equipment design of cylindrical vessel using external pressure.
8. To study the process equipment design of packed absorption tower.
9. To study the safety measures in equipment design.
10. To study the pressure relief devices.

Learning Outcomes:

At the end of course students exhibit how to use basic standard equipment symbols in chemical process industry and in a competitive manner how to design Heads, Keys, and cylindrical vessels under external pressure, circular flange pipe joints and packed absorption tower with safety requirements of equipments. Students demonstrate the ability to perform the task by identifying, formulating, designing and providing the solution to various chemical engineering problems, understanding of professional and ethical responsibilities formally and informally show the capacity of designing the product to meet economical and societal requirements and understanding about the environmental issues and will provide solutions for green and clean technologies.

TE Chemical Engineering Semester – V

Process Equipment Design-I
(Course Content)

Teaching Scheme		Examination Scheme	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
		Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Design Considerations: Design codes, Maximum working pressure, Design pressure, Design Temperature, Design stress, Factor of safety, Selection of factor of safety, Design wall thickness, Corrosion ratio, Poisson ratio, Criteria of failure, Elastic stability.
Corrosion: Types of Corrosion, Corrosion prevention, Protective coating, Choice of materials

UNIT-II **No. of Lect. – 08, Marks: 16**

Keys: Introduction, Types of keys, Strength of sunk key, Effect of key ways, Design of keys
Design of Heads: Introduction, Analysis and design of conical head, Flat cover head, Standard dished heads.

UNIT-III **No. of Lect. – 08, Marks: 16**

Pipe joints: Standard pipe flanges for steam, Hydraulic pipe joints for high pressure, Design of circular flange pipe joints.
Storage vessels: Introduction, Design of fixed conical roof cylindrical tank, Storage of gases in Spherical vessels.
Supports for vessels: Introduction of Bracket or Lug supports and Leg supports.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Design of Cylindrical Vessels under internal Pressure: Introduction, Thin wall vessels, Design Equations.
Design of process vessels and pipes under external pressure: Introduction, Determination of safe pressure against elastic failure, Determination safe external pressure against plastic deformation, circumferential stiffness, Pipes and tubes under external pressure.

UNIT-V **No. of Lect. – 08, Marks: 16**

Process Hazards and Safety Measures in Equipment Design: Introduction, Hazards in Process Industries, Hazards Analysis, Safety Measures, Safety Measures in Equipment Design, Pressure relief Devices.
Design of packed absorption tower: Introduction, Design of height & diameter of Packed Absorption Tower.

Textbooks:

1 B.C. Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects), CBS Publisher and Distributors, New Delhi.
2 Coulson & Richardson Chemical Engineering (Vol. VI), Butterworth-Heinmann (Elsevier) (Sixth Edition).
3 M.V.Joshi, V.V. Mahajani Process Equipment Design, Macmillan Publishers India Ltd. (Fourth Edition).
4 R. S. Khurmi, J.M. Gupta, A Text Book of Machine Design, S. Chand & Company Ltd, New Delhi.

References:

1 S.D. Dawande, Process Equipment Design (Vol. I),Denett & Co., Nagpur.

Course Outline

Process Heat Transfer	**PHT**	**CHL 502**
Course Title	Short Title	Course Code

Course Description:

This course aims to introduce students the heat transfer mechanisms in solids and fluids and their chemical process applications. The purpose of the course is to make student capable to model steady and unsteady heat transfer in simple systems, and design heat exchangers and simple heat exchanger networks.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(S): Fluid Flow Operation, Applied Inorganic Chemistry, Process Calculations, Mechanical Operation, Applied Physical chemistry.

General Objectives:

1. To introduce the heat transfer principles.
2. To study various modes of heat transfer.
3. To study the heat exchanger for conversion of hot and cold fluid.
4. To study the design techniques involving heat transfer in chemical process.
5. To study dimensional analysis in heat transfer.
6. To study the natural and forced convection.
7. To study the equation of one dimensional and three dimensional conduction.
8. To study the lumped heat capacity method of unsteady state conduction.
9. To study the heat exchange equipment, counter current and parallel flows.
10. To study the individual & overall heat transfer coefficient and its significance.

Learning Outcomes:

After successful completion of this course the student will be able to understand conduction, convection and radiation modes applicable to design heat exchanging equipments widely used in chemical process and allied industry. The students will also apply the knowledge of individual and overall heat transfer coefficient for designing steady state and unsteady state heat transfer processes and will provide suitable designing of heat exchanger network.

TE Chemical Engineering **Semester – V**

Process Heat Transfer
(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
Practical	: 2 hours week	Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks
		Internal Continuous Assessment (ICA)	: 25 Marks
		End Semester Examination (ESE) (OR)	: 25 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Heat transfer by conduction in solids: Fourier's law of heat conduction, steady state heat conduction through walls (single and multilayer), heat flow through cylinder, unsteady state heat conduction. Derivation of Fourier's heat conduction equation in three dimensions, equation for one dimensional conduction. Thermal insulation- insulating material, design factor and properties, economics of thickness, critical thickness

UNIT-II **No. of Lect. – 08, Marks: 16**

Heat transfer through extended surface of uniform cross section: Fin efficiency and its conditions, fin efficiency and effectiveness, counter current and parallel flows, energy balances, overall heat transfer coefficient , log mean temperature difference, individual heat transfer coefficient, calculation of overall heat transfer coefficient from individual coefficients , transfer units in heat exchangers.

UNIT-III **No. of Lect. – 08, Marks: 16**

Convection without phase change: Types of convection, empirical equations for forced convection, heat transfer in laminar and turbulent flow through tubes over a flat plate and submerged plate, dimensional analysis method, Dropwise and film type condensation, coefficient for film type condensation, practical use of Nusselt's equations, and application in petroleum industry.

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UNIT-IV **No. of Lect. – 08, Marks: 16**

Heat transfer of boiling liquids: Boiling of saturated liquids, maximum flux and critical temperature drop, maximum Flux and film boiling.
Radiation heat transfer: Fundamental of radiation, black body radiation, laws of radiation, radiant heat exchange between non black surfaces. Greenhouse effect and radiation shape factor.

UNIT-V **No. of Lect. – 08, Marks: 16**

Heat exchange equipments:
Heat exchanger single pass 1-1 exchanger, 1-2 shell and tube heat exchanger, correction for LMTD for cross flow, design calculation (Kern Method) in heat exchanger.

Evaporation:
Liquid characteristics and types of evaporator, single effect evaporator calculation, pattern of liquid flow in multiple effect evaporators.

Textbooks:

1 Coulson & Richardson Chemical Engineering (Vol. I), Butterworth-Heinmann (Elsevier) (Sixth Edition).
2 Donald Q. Kern. Process Heat Transfer, Tata McGraw Publishing Company Limited, New Delhi (Tenth Edition).
3 S.S.Barkade and Mrs. P.L.V.N. Saichandra, Heat Transfer, Denett & Co., Nagpur.

References:

1 D.S.Kumar, Process Heat Transfer, S.K.Kataria and Sons Publisher, New Delhi
2 W.L.McCabe and J.C.Smith, Unit Operations of Chemical Engineering, McGraw Hill/ International Edition (Seventh Edition).

Course Outline

Instrumentation & Instrumental Analysis IIA **CHL 503**
Course Title Short Title Course Code

Course Description:

This course describes basic principles of instrumentation and instrumental analysis. The rationale of the course is to apply the principles learned in science and to provide characterization of solids and fluids for understanding the changes occurring in the chemical processes. This course aims to examine the variables and measure them to get exact product specifications.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(S): Applied Inorganic Chemistry, Applied Physical chemistry.

General Objectives:

1. To study the meaning of measurement.
2. To study elements of instruments.
3. To study static and dynamic characteristics of instruments.
4. To study the principle of different instruments and their characteristics.
5. To understand how to calibrate the instruments.
6. To understand differences between various analytical methods.
7. To study the analytical chemistry and spectroscopic analysis.
8. To study the concepts, terminology, conventions and calculations important in analytical chemistry and instrumental analysis.
9. To understand basic principle behind measurements and their applicability in chemical processes.
10. To study characterization of materials using modern instrumentation and techniques.

Learning Outcomes:

After completion of the course the students will learn basics of instrumentation, dynamic and static characteristics of an instrument and importance of measuring and thereby controlling the quantities which are frequently involved in chemical process industries. After finishing the course the learners will also identify the instrument needed for measuring the quantity in different working atmospheres.

TE Chemical Engineering Semester – V

Instrumentation & Instrumental Analysis

(Course Content)

Teaching Scheme		Examination Scheme	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
Practical	: 2 hours/ week	Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks
		Internal Continuous Assessment (ICA)	: 25 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Qualities of Measurement: The meaning of measurement, elements of instruments, Static Characteristics, Dynamic characteristic.
Expansion Thermometers: Introduction, Temperature scales, Constant volume gas Thermometer, Bimetallic Thermometer, Industrial pressure spring Thermometer, Response of Thermometer.

UNIT-II **No. of Lect. – 08, Marks: 16**

Thermoelectric Temperature Measurement: Introduction, Simple thermocouple circuit, Industrial thermocouples, Thermocouple lead wires, thermal wells, response of thermocouples.
Resistance Thermometer: Introduction, Industrial resistance-thermometer bulbs, Resistance thermometer element, Resistance thermometer circuit, RTD.

UNIT-III **No. of Lect. – 08, Marks: 16**

Radiation Temperature Measurement: Introduction, Black body conditions, Black body devices, Radiation receiving elements, Thermopile, Vacuum thermocouples, Radiation pyrometers , Lens type thermal radiation receiver , Photoelectric pyrometers, Photoelectric radiation receiver, Optical pyrometer.
Pressure and Vacuum Measurement: Introduction, Indicating pressure gage, Bellows pressure element, Useful ranges of absolute pressure measuring gages, McLeod vacuum gage.
Measurement of Pressure in Corrosion Fluids: The steam gage siphon, Diaphragm seal in Pressure measurement, Liquid seal in pressure measurement, Response of mechanical pressure gages.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Measurement of Level: Float and tape liquid level gage, Float & shaft liquid level unit, Level measurement in pressure vessels, Gamma ray method, Ultrasonic method & resistive method.
Introduction, Theory, Instrumentation, advantages, and Application of: pH measurement, Refractrometry, Potentiometry, colourometry, Flame photometry, and Conductometric titrations.

UNIT-V **No. of Lect. – 08, Marks: 16**

Introduction, Theory, Instrumentation, Advantages and Application of: Gas chromatography, Thin layer chromatography, Paper chromatography, HPLC.
Introduction, Theory, Instrumentation, Advantages and Application of: Infrared spectroscopy, Ultraviolet spectroscopy, Mass spectroscopy, NMR spectroscopy.

Textbooks:

1. D.P.Eckman, Industrial Instrumentation, Willey Eastern Ltd., New Delhi.
2. Dr.B.K.Sharma, Instrumentation methods of chemical analysis, Goel Publishing House, Meerut, U.P.
3. Gurdeep Chatwal and Sham Anand, Instrumental methods of Chemical analysis, Himalaya Publication House, Mumbai.

References:

1 Nakra B.C. and K.K. Chaudhary, Instrumentation Measurement & Analysis, Tata – McGraw Hill, New Delhi.
2 Patranabis D. Industrial Instrumentation, Tata – McGraw Hill Publications, New Delhi.
3 V.P. Kudesia and S.S. Sawhaney, Instrumental methods of chemical analysis Pragati Prakashan, Meerut,U.P.

Course Outline

Mass Transfer- I	**MT-I**	**CHL 504**
Course Title	Short Title	Course Code

Course Description:

This course describes fundamental aspects of Mass Transfer operations, Mass Transfer theories and Mass transfer with phase change. The objective of the course is to apply the principles learned in science and engineering courses to the design of equipment for physical transformations, to design new processes and optimize existing processes.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(S): Fluid Flow Operation, Applied Inorganic Chemistry, Process Calculations, Mechanical Operation, Applied Physical chemistry.

General Objectives:

1. To introduce the mass transfer principles.
2. To study various modes of mass transfer.
3. To study steady state and unsteady state diffusion.
4. To estimate diffusion coefficients.
5. To study concept of convective mass transfer coefficient.
6. To study gas liquid equilibrium and various gas liquid contactors.
7. To study design of cooling towers.
8. To study and design various gas absorption systems.
9. To study crystallization operation.
10. Analyze and design drying systems.

Learning Outcomes:

At the end of the course the students will learn about the basics of the mass transfer process, diffusion phenomenon in solids and fluids. They will be capable to demonstrate knowledge of mathematics, science and engineering principles. Students also will be capable of providing a sound process design of various equipments used in humidification, gas absorption/stripping, crystallization and drying operation.

TE Chemical Engineering Semester – V

Mass Transfer-I
(Course Content)

Teaching Scheme

Theory : 3 hours/ week
Practical : 4 hour/ week

Examination Scheme

End Semester Examination (ESE)	: 80 Marks
Paper Duration (ESE)	: 03 Hours
Internal Sessional Examination (ISE)	: 20 Marks
Internal Continuous Assessment (ICA)	: 50 Marks
End Semester Examination (ESE) (PR)	: 50 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Introduction to mass transfer operations, classification of mass transfer operations, diffusivity, Fick's law of diffusion.
Steady state molecular diffusion in fluid at rest, molecular diffusion in gases and liquids, multicomponent mixture diffusion, Maxwell's law of diffusion, diffusion in solids, unsteady state mass transfer.

UNIT-II **No. of Lect. – 08, Marks: 16**

Eddy (turbulent) diffusion, relation between mass transfer coefficients. Mass transfer coefficient in laminar and turbulent flow, theories of mass transfer, Equilibrium for mass transfer process: Local two phase mass transfer, Local overall mass transfer coefficient, Use of local overall coefficient.

UNIT-III **No. of Lect. – 08, Marks: 16**

Equipments for gas liquid operation.
Material balances for steady state co current, countercurrent, cross flow cascade, counter flow cascade.
Introduction to humidification: vapor liquid equilibrium, humidification terms, Determination of humidity, humidification and dehumidification, cooling towers.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Introduction to gas absorption operation, equilibrium solubility of gases in liquids.
Material balance for one component transferred in countercurrent flow and co current flow, countercurrent multistage operation, one component transferred .Absorption with chemical reaction
Different absorption operation equipments (plate tower, packed tower, venturiscrubber)

UNIT-V **No. of Lect. – 08, Marks: 16**

Introduction to crystallization, Growth and properties of crystals, Effect of impurities in crystallization, Effect of temperature on solubility, Fractional crystallization, Caking & yield of crystals, Different type of crystallizers.

Introduction to drying operation, rate of drying, mechanism of moisture movement during drying, drying equipments, different methods of drying.

Textbooks:

1 Coulson & Richardson Chemical Engineering (Vol. I), Butterworth-Heinmann (Elsevier) (Sixth Edition).
2 Coulson & Richardson Chemical Engineering (Vol. II), Butterworth-Heinmann (Elsevier) (Fifth Edition).
3 R.E.Treybal , Mass transfer operation ,McGraw Hill Book Company, (Third Edition).

References:

1 Christie J.Geankoplis, Transport Processes & Unit Operations, Prentice Hall Inc.
2 Coulson & Richardson Chemical Engineering (Vol.IV), Butterworth-Heinmann (Elsevier).
3 Coulson & Richardson Chemical Engineering (Vol.V), Butterworth-Heinmann (Elsevier).

Course Outline

Industrial Economics & Management	**IEM**	**CHL 505**
Course Title	Short Title	Course Code

Course Description:

This course provides basic understanding about importance of economics and economic system and its contribution in the technological development. The course intents to develop managerial skill and enhance decision making power for providing economically viable products.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(s): -- Soft Skills – I, Soft Skills - II

General Objective:

1. To understand nature & scope of economics, and to Study different economic systems.
2. To understand demand & supply schedule, markets & market forms.
3. To understand concept, factors & measurement of national income:
4. To study various types of banks & their role in economic development.
5. To study principles & functional areas of management.
6. To study concepts of marketing, and sales management.
7. To study concepts of personnel management.
8. To study concepts of purchasing and materials management.
9. To understand importance of leadership qualities in an organization.
10. To understand importance of motivation and communication.

Learning Outcomes:

The students will be able to understand and apply the principle of economics along with science, engineering and technology, and will contribute to the profitable growth of industry. The study of various economic systems will help the students to share responsibilities and will make them able to work effectively in diverse, multicultural environments. The students will demonstrate ability to work in multidisciplinary team and will display communication skills. The students will display ability to design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and energy and will provide engineering solutions in a global, economic, environmental, and societal context.

TE Chemical Engineering **Semester – V**

Industrial Economics & Managment
(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
		Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Economics, Nature & Scope of economics, Usefulness of Economics to engineering organizations, Economy: Types, Problems and Functioning, Basic Terms & Concepts used in Economics. Principal Economic system: Socialism, Capitalism, Mixed Economy.
Utility analysis of Demand, Demand & Law of Demand, Elasticity of Demand.

UNIT-II

No. of Lect. – 08, Marks: 16

Factor of Production, Land, Labor, Capital & Organization, Forms of Business Organizations, Laws of returns. Market & Market Forms, Price determinations: Perfect & Imperfect Competitions
National Income: Concept, Factors & Measurement, Keynesian Model.

UNIT-III **No. of Lect. – 08, Marks: 16**

Types of Banks & Role of Banks in economic development, Theories of Money. Sources of Finance: Shares & Debentures & other Sources of Finance.
Management Concept: Difference & Relationship between Management, Administration.
Principles, Process, Functions, Levels & Types of Management. Management by Objectives.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Marketing Research and Techniques, Sales Management, Function of sales Manager, Salesman's quota. Marketing Management, Duties of Marketing Manager.
Personnel Management: Manpower Planning, Recruitment, selection & Training, Job Evaluation Methods, Merit Rating, Industrial Safety.

UNIT-V **No. of Lect. – 08, Marks: 16**

Purchasing Techniques and Purchasing Cycle, Materials Management its Functions, Importance of Materials Management,
Leadership in Business and Qualities, Motivation, Industrial Relations, Industrial Disputes. Communication: Principles, Types, Characteristics and Role of Communication in Management.

Textbooks:

1 Dewett & Varma, Elementary Economic Theory, S. Chand & Company Ltd New Delhi
2 O.P.Khanna, Industrial Engineering & Management, Dhanpat Rai Publications (P) Ltd New Delhi

References:

1 Banga & Sharma, Industrial Engineering Science & Management, Khanna Publishers New Delhi.
2 C.R.Basu, Business Organisation and Management, Tata McGraw Hill Publishing Company Ltd. New Delhi.

Course Outline

Lab Process Heat Transfer	**Lab PHT**	**CHP 506**
Course Title	Short Title	Course Code

Course Description:

This course illustrates practical aspect of heat transfer and its application to chemical engineering. It describes various modes of heat transfer and mechanism responsible for heat transmission. It helps the students to understand various equipments used in industries.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Engineering Physics I&II, Engineering Chemistry I&II, Fluid Flow Operation.

General Objectives:

1. To develop the students' skills in applying differential equations for describing steady and transient heat transfer problems.
2. To develop students' skills in applying mechanical design approaches for thermal engineering components and heat transfer systems.
3. To provide the students with fundamental theoretical concepts and practical analysis skills associated with convective heat transfer including external and internal heat transfer configurations.
4. To provide the students with fundamental theoretical concepts and practical analysis skills associated with radiation heat transfer.

Learning Outcomes:

Students will demonstrate an ability to mathematically describe different practical heat transfer problems including governing equations together with boundary and initial conditions. Students will demonstrate an ability to solve the heat transfer problems for a range of practically important simplified configurations and symmetries, including one dimensional problem in cylindrical and spherical coordinates. Students will learn using generic data processing software to solve heat transfer problems.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1. Determination of thermal conductivity of metals rod.
2. To determine heat flux through composite walls.
3. Determination of heat transfer coefficient in natural/ forced convection.
4. Determination of temperature distribution, fin efficiency in natural and forced convection.
5. Determination of emissivity of a test surface.
6. Determination of Stefan Boltzmann constant..
7. Determinations of log mean temperature difference and over all heat transfer coefficient of Parallel and counter flow heat exchanger.
8. Heat transfer through lagged pipe.
9. Study of heat transfer in evaporator.
10. Study and calculate the efficiency of a fin in natural convection.
11. To find out overall heat transfer coefficient by drop wise and film wise condensation.

References for Practicals:

Prof.Addul Matheen, Heat Transfer laboratory Manual (Second Edition), University Science Press.

Course Outline

Lab Instrumentation & Instrumental Analysis	**Lab IIA**	**CHP 508**
Course Title	Short Title	Course Code

Course Description:

This course describes the importance of instrumentation in the field of chemical engineering. By instrumental analysis, different materials and their properties can be studied and measured which provides characterization of raw materials and finished products from the industry.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Lab Applied Inorganic Chemistry.

General Objectives:

1. To expertise the students in handling laboratory instruments with due care & precautions.
2. To train the students in calibration of instruments.
3. To develop analytical skills in students through instrumental techniques.

Learning Outcomes:

Students completing this laboratory course will learn due care and precautions in handling measuring instruments. Students will also have proficiency in measuring different properties of samples and their concentration with the aid of instruments. They will also expertise in chromatographic techniques for analyzing the samples.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1 To study the response of bimetallic thermometer.
2 To study the response of thermocouple.
3 To measure the pH of given solution.
4 To measure the conductance of given solution.
5 To investigate the conductometric titration of strong acid and strong base.
6 To determine concentration of given solution by colorimeter.
7 To study separation of components present in given mixture by thin layer chromatography.
8 To study separation of components present in given sample by paper chromatography.
9 To determine refractive index of liquids by Abbey's refractometer.
10 To identify the given sample by FTIR.

References for Practicals:

Designed Standard College Laboratory Manual and Instruction Manuals of the Laboratory Equipment Suppliers.

Course Outline

Lab Mass Transfer-I	**Lab MT-I**	**CHP 508**
Course Title	Short Title	Course Code

Course Description:

This course describes how practically Mass Transfer takes place within and during inter-phase transfers. It aims to understand, operate various equipments and gain practical knowledge of diffusion phenomenon through experimentation.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**04**	**15**	**32**	**02**

Prerequisite Course(S): Lab Applied Inorganic Chemistry, Lab Applied Physical Chemistry.

General Objectives:

1. To reinforce concepts of Mass Transfer operation through experimentation.
2. To analyze & interpret data obtained during performance of the experiment for understanding the Mass Transfer lecture course.
3. To improve technical skills & ability by formulating a solution through experimentation.

Learning Outcomes:

Students will understand types of diffusion and the mechanism of diffusion. Students will demonstrate an ability to solve the mass transfer problems by calculating the Mass Transfer Coefficient and will use practical considerations for designing and operation of mass transfer operations/equipments.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1. Diffusion in Still Air: To estimate mass transfer coefficient for given system at room temperature.
2. Liquid – Liquid Diffusion: To determine diffusion coefficient for given system as function of concentration.
3. Solid – Liquid Diffusion: To determine mass transfer coefficient for dissolution of given system without chemical reaction.
4. Solid in Air Diffusion: To calculate mass transfer coefficient for vaporization of given solid in air using packed bed.
5. Wetted Wall Column: To determine mass transfer coefficient for air – water system.
6. Cooling Tower: To determine volumetric mass transfer coefficient for air – water system.
7. Absorption in Packed Column: To find mass transfer coefficient of given system.
8. Crystallization: To determine percentage yield of crystallization without and with seeding.
9. Natural Drying: To obtain drying curve for batch drying operation.
10. Fluidized Bed Dryer: To determine the rate of drying and to obtain mass transfer coefficient for the given material.

References for Practicals:

Designed Standard College Laboratory Manual and Instruction Manuals of the Laboratory Equipment Suppliers.

Course Outline

Lab Data Analysis & Interpretation	**Lab DAI**	**CHP 509**
Course Title	Short Title	Course Code

Course Description: The laboratory course intended to develop ability amongst the student to understand qualitative and quantitative techniques and to evaluate and analyze the data obtained by these techniques. This course will be a thorough and reasonably comprehensive introduction to understanding, critically evaluating, conducting, and writing about analyses for most studies.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**01**	**15**	**10**	**01**
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Engineering Mathematics I, II and III, Soft Skills- I, II and III, LAB Computer Applications.

General Objectives:

1. To learn and use the qualitative and quantitative techniques in engineering profession.
2. To prepare and present various reports using standard procedure adopted.
3. To demonstrate the designing, computational abilities required to prepare a technical report.

Learning Outcomes:

The students after completing the course will be able to coordinate, analyze and interpret data, and work in groups. It will develop an ability to apply classroom concepts in report writing along with importance of concepts of accuracy and precision. The students will develop an ability to communicate specialized results into a standard formats. The students will demonstrate interpersonal skills required to lead and will recognize the importance of life-long learning.

TE Chemical Engineering **Semester – V**

Lab Data Analysis & Interpretation
(Course Content)

Teaching Scheme
Theory : 1 hours/ week
Practical : 2 hours/ week

Examination Scheme
Internal Continuous Assessment (ICA): 50 Marks

Theory:

Qualitative Data: Collection of data, Open-ended questions and written comments on questionnaires, Testimonials, Interviews, Focus groups, Logs, Journals, Diaries ,Observations, Documents, Reports, News Articles, Stories, Case studies.
Quantitative Data: Tabulation of data, Count (frequencies), Percentage, Mean, Mode, Median, Range, Standard deviation, Variance, Ranking, Cross tabulation.

Lab Work: (Any Eight from the following)

1. To design questionnaire.
2. To write Analysis Report for the questionnaire.
3. To prepare and write sample Industrial Reports/Seminar Reports/Case Studies.
4. To write Literature review using Websites, Magazines, Books, Reports, Surveys, Journals, Research Papers, Research work on PhD .etc.
5. To prepare and write sample Project Reports with references in standard format.
6. To Prepare Excel Chart for Count (frequencies).
7. To Prepare Excel Chart for Percentage.
8. To Prepare Excel Chart showing Mean, Mode, and Median.
9. To Prepare Excel Chart for Range, Standard deviation.
10. To Prepare Excel Chart showing Variance, Ranking.

Reference Books:

1. C.R. Kothari (2008), Research Methodology- Methods and Techniques, New Age International Publishers, New Delhi (2nd Revised edition).
2. S.C.Gupta (2007), Fundamentals of statistics, Himalaya Publishing House (6^{th} Revised & Enlarged edition)

Course Outline

Industrial Training/EDP/Special Study	**IT/EDP/SS**	**CHP 510**
Course Title	Short Title	Course Code

Course Description:

The course aims to understand industrial applications of chemical engineering and management principles. It attempts to investigate current status and trends adopted in actual practice. The reason to undergo this course is to make aware the students about real life working environment and practice.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	--	--	--	**2**

Prerequisite Course(S): F.E. Chemical Engineering & S.E. Chemical Engineering

General Objectives:

1. To develop technical and managerial skills.
2. To understand various problems of industry and society.
3. To develop competent, patriotic engineers for societal development.

Learning Outcomes:

At the end of this course, students will be able to understand real life working environment and practice the right work attitude to solve industrial problems and can suggest possible solutions. The students will be able to gain new knowledge, skills and aware of current technologies. The students will be able to communicate both orally & in writing on their work experience and will be able to know safety measures to be taken to avoid industrial hazards.

Course Content:

Industrial Training:

Every student has to undergo industrial/practical training for a minimum period of two weeks during summer vacation between fourth semester and fifth semester.

• The industry in which practical training is taken should be a medium or large scale industry.

• The paper bound report on training must be submitted by every student, along with a certificate from the company where the student has undergone industrial training.

• The report on industrial training should be detailed one.

• Maximum number of students allowed to take training in a company should be five. Every student should write the report separately.

In case if a student is not able to undergo industrial training, then such student should prepare any one of the following report

A. EDP (Engineering Development Program)

A detailed study of problem faced by any chemical or allied engineering industry based on recent topic from reported literature.

- The paper bound report must be submitted by every student, along with a certificate from the company where the student approached for study.
- The report should be detailed one.
- Maximum number of students allowed to take training in a company should be three. Every student should write the report separately.

B. Special Study

A case study defining problem related to society and perspective chemical engineering based solution based on study material available through various resources.

- The paper bound report must be submitted by every student, along with a certificate from the company/authority where the student approached for study.
- The report should be detailed one.
- Maximum number of students allowed to take training in a company should be three. Every student should write the report separately.

Every student shall be required to present a seminar in presence of Panel of teachers constituted by the Head of Department in consultation with the Principal. The evaluation shall be based on:

(a) Report: 10 marks

(b) Seminar Presentation: 10 marks

(c) Viva-Voce at the time of Seminar: 05 marks

Total 25 marks

T.E. Chemical Engineering

Semester-VI

Third Year Chemical Engineering

Faculty of Engineering and Technology

North Maharashtra University, Jalgaon

Course Outline

Process Equipment Design-II	**PED-II**	**CHL 601**
Course Title	Short Title	Course Code

Course Description:

This course describes how to use appropriate terminology of process equipment design. It illustrates the application of scientific principles associated with process equipment design.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(s): Process Equipment Design-I, Process Heat Transfer, Mass Transfer-I

General Objective:

1. To study the process design of shell and tube heat exchanger.
2. To study the process design of calendria type evaporator.
3. To study the process design of crystallizers.
4. To study the process design of reaction vessel.
5. To study the process design of rotary dryer.
6. To study the process design of vertical tall vessel.
7. To study the process design of sieve tray column.
8. To study the process design of thick wall high pressure vessel.
9. To study the process design of bubble cap tray distillation column.
10. To study the mechanical design of turbine agitator.

Learning Outcomes:

At the end of course students exhibit how to use basic standard equipment symbols in chemical process industry and in a competitive manner how to design shell and tube heat exchanger, calendria type evaporator, crystallizers, reaction vessel, rotary dryer, vertical tall vessel, sieve tray column, thick wall high pressure vessel, bubble cap tray distillation column and turbine agitator with safety requirements of equipments. Students demonstrate the ability to perform the task by identifying, formulating, designing and providing the solution to various chemical engineering problems, understanding of professional and ethical responsibilities formally and informally, show the capacity of designing the product to meet economical and societal requirements and understanding about the environmental issues and will provide solutions for green and clean technologies.

TE Chemical Engineering Semester – VI

Process Equipment Design-II (Course Content)

Teaching Scheme		Examination Scheme	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
		Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Process Design of Heat Exchanger: Introduction, Types of Heat Exchanger, Process Design of Shell and Tube Heat Exchanger.
Process Design of Evaporator: Introduction, Types of Evaporator, Methods of Feeding of Evaporator, Design of Calendria type Evaporator.

UNIT-II

No. of Lect. – 08, Marks: 16

Process Design of Reaction Vessels: Introduction, Materials of Construction, Agitation, Classification of Reaction Vessels, Heating Systems, Design of Reaction Vessel.
Crystallizer Design: Introduction, Types of Crystallizers, Design of crystallizers.

UNIT-III **No. of Lect. – 08, Marks: 16**

Process Design of Rotary Dryer: Introduction, Types of Dryer, Design of Rotary Dryer.
Design of Tall Vessels: Introduction, The Axial Stresses Due To Dead Loads, The Axial Stresses Due To Pressure, Longitudinal Bending Stresses due to Dynamic Loads, Design of Distillation (Tall) Column (Tower).

UNIT-IV **No. of Lect. – 08, Marks: 16**

Design of Sieve Tray for Distillation Column.
Design of Thick Walled High Pressure Vessel.

UNIT-V **No. of Lect. – 08, Marks: 16**

Design of Bubble Cap Tray for Distillation Operation.
Agitators: Introduction, Types of Agitators, Baffling, Power Requirements, Design of Turbine Agitator.

Textbooks:

1 B.C. Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects), CBS Publisher and Distributors, New Delhi.
2 M.V.Joshi and V.V. Mahajani Process Equipment Design, Macmillan Publishers India Ltd. (Fourth Edition).
3 Coulson & Richardson Chemical Engineering (Vol. VI), Butterworth-Heinmann (Elsevier) (Sixth Edition).

4 R.E.Treybal, Mass Transfer Operations, McGraw Hill, New Delhi
5 G.K.Roy, Solved Problems In Chemical Engg., Khanna Publications, NewDelhi.

References:

1 S.D. Dawande, Process Equipment Design (Vol. I & II), Denett & Co., Nagpur.
2 J.H.Perry, Chemical Engineer's Hand Book, McGrawhill, New Delhi.
3 Lloyed E.Brownell, Edwin H.Young, Process Equipment Design, John Wiley & Sons

Course Outline

Chemical Reaction Engineering-I	**CRE-I**	**CHL 602**
Course Title	Short Title	Course Code

Course Description:

This course applies the concepts of reaction rate, stoichiometry and equilibrium to the analysis of chemical reacting systems. It derives rate expressions from reaction mechanisms and equilibrium or steady state assumptions, design of chemical reactors via synthesis of chemical kinetics, mass and energy balances.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(s): Chemical Engineering Materials, Fluid Flow Operation, Applied Organic Chemistry, Applied Physical Chemistry, Process Calculations, Process Heat Transfer, Mass Transfer-I.

General Objective:

1. To study the chemical reaction, rate of reaction, order and molecularity of reaction, rate constant.
2. To study the activation energy and temperature dependency of rate equation.
3. To study the constant volume batch reactor and variable volume batch reactor.
4. To study the integral and differential method of analysis of data.
5. To study the ideal batch reactor, mixed flow reactor and plug flow reactor.
6. To study the space time and space velocity, holding time and space time for batch, mixed and plug flow reactors.
7. To study the reaction in parallel, series, Series parallel reaction.
8. To study the Optimum temperature progression for single reaction, Isothermal, adiabatic, non adiabatic operation.
9. To study the residence time distribution of fluid in vessel.
10. To study the Concept of micro and macro mixing.

Learning Outcomes:

Students will be able to understand the basic concepts of chemical reaction engineering. Students will be able to understand the concept of micro and macro mixing & residence time distribution of fluid in vessel. Students will be capable of identifying the calculation and solutions to chemical reaction engineering problems.

TE Chemical Engineering Semester – VI

Chemical Reaction Engineering-I
(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
Practical	: 2 hours week	Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks
		Internal Continuous Assessment (ICA)	: 25 Marks
		End Semester Examination (ESE) (OR)	: 25 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Introduction to chemical reaction engineering: Review of chemical reaction equilibrium, Classification of chemical reaction, rate of reaction, order and molecularity of reaction, rate constant, Temperature dependent term of rate equation, comparison of theories, Activation energy and temperature dependency, rate of reaction predicted by theories, Reaction mechanism.

UNIT-II

No. of Lect. – 08, Marks: 16

Collection & interpretation of kinetic data, Constant volume batch reactor, integral and differential method of analysis of data, Variable volume batch reactor , integral and differential method of analysis of data, The search for rate equation.

UNIT-III **No. of Lect. – 08, Marks: 16**

Ideal batch reactor ,mixed flow reactor ,plug flow reactor, space time and space velocity, holding time and space time for batch , mixed and plug flow reactors, comparison in mixed and plug flow reactors, Combined flow system, Recycle reactor, Autocatalytic reaction.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Introduction to multiple reactions: Reaction in parallel, Reaction in series, Series parallel reaction. Optimum temperature progression for single reaction, Isothermal, adiabatic, non adiabatic operation. Product distribution and temperature for multiple reactions.

UNIT-V **No. of Lect. – 08, Marks: 16**

Residence time distribution of fluid in vessel, Conversion directly from tracer information, Models for non-ideal flow, Dispersion models, Tank in series model, Concept of micro and macro mixing.

Textbooks:

1. Octave Levenspiel, Chemical Reaction Engineering, John Wiley and Sons.
2. J.M. Smith, Chemical Engineering Kinetics, McGraw Hill
3. H.Scott Fogler, Elements of Chemical Reaction Engineering, Prentice Hall New Jersey.

References:

1. Coulson & Richardson Chemical Engineering (Vol. III), Butterworth-Heinmann (Elsevier) (Sixth Edition).
2. Coulson & Richardson Chemical Engineering (Vol. V), Butterworth-Heinmann (Elsevier) (Sixth Edition).
3. S.D. Dawande, Principles of Reaction Engineering, Denett & Co., Nagpur.
4. Lanny D. Schimdt , Chemical Reaction Engineering, Oxford University Press.

Course Outline

Chemical Engineering Thermodynamics	**CET**	**CHL 603**
Course Title	Short Title	Course Code

Course Description:

The purpose of this course is to introduce chemical engineering thermodynamics and its importance to study the phase behavior and properties of pure fluids with applications. The course covers the application of the first and second law of thermodynamics to non-flow and steady-flow processes.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(s): Process Calculations, Applied Physical Chemistry, Process Heat Transfer.

General Objective:

1. To study the laws of thermodynamics.
2. To study equations of state.
3. To study concept of entropy.
4. To study Vapour-Liquid Equilibria (VLE) and test of VLE data.
5. To study phase equilibria for single component system.
6. To study the determination of partial molar quantities, fugacity and fugacity coefficient.
7. To study properties of solutions.
8. To study phase equilibrium.
9. To study chemical reaction equilibria.
10. To study and construct pressure-composition & boiling point diagrams.

Learning Outcomes:

Students will execute knowledge of basic science and engineering after study of the laws of thermodynamics and state functions. Students will be capable of identifying, formulating, designing and providing the solution to chemical engineering problems by study of calculations of entropy changes, Vant' Hoff equation. Students will display the research ability by designing, conducting, interpreting and analyzing to experimental data for preparing reports by study of the thermodynamic consistency test of VLE data.

TE Chemical Engineering Semester – VI

Chemical Engineering Thermodynamics (Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
		Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Introduction to the subject, The laws of Thermodynamics, Cyclic rule, Coefficient of Thermal Expansion, Compressibility Coefficient ,First Law of Thermodynamics : Basic Laws, Law of corresponding state, Heat Capacities, Enthalpy as a function of Temperature & Pressure, Joule-Thomson Coefficient , Relation between C_p and C_v, Thermodynamic relations, Generalized Equation of State, Redlich-kwong equation of state, Soave-Redlich-Kwong equation of state.

UNIT-II

No. of Lect. – 08, Marks: 16

The Second Law of Thermodynamics, Mathematical Treatment of Entropy Concept, Combined form of First and Second Law of Thermodynamics, Thermodynamic Relations based on Second Law of Thermodynamics, Calculations of Entropy Changes, Third Law of Thermodynamics.

UNIT-III **No. of Lect. – 08, Marks: 16**

Partial Molar Quantities: General Aspects, Determination of Partial Molar Volume and Enthalpy, Fugacity and Fugacity Coefficient, Fugacity coefficient through equation of state, Fugacity coefficient through virial coefficient correlation.
Ideal solution: General Aspects, Phase equilibrium: General Aspects, Gibbs-Duhem Equation, Gibbs-Duhem-Margules Equation, Application of Gibbs-Duhem Equation.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Vapour-Liquid Equilibria (VLE): Basic equations for VLE, Reduction of VLE data, Excess Gibbs free energy Model, Margules Equation & Van Laar Equation, Thermodynamic consistency test of VLE data
Phase Equilibria for Single Component System: Gibbs-Helmholtz Equation, The Clapeyron Equation, Clausious-Clapeyron Equation, Application of Clapeyron Equation.

UNIT-V **No. of Lect. – 08, Marks: 16**

Chemical Reaction Equilibria: The criteria for chemical equilibrium, Equilibrium constant, Law of chemical equilibrium, Relations between equilibrium constant, Homogeneous gaseous equilibria, Temperature dependence of the equilibrium constant (The Van't Hoff Equation), Integrated form of the Van't Hoff equation, Pressure dependence of the equilibrium constant.
Applications of Phase Equilibrium in Ideal Solutions: To construct pressure-composition and boiling point diagrams.

Textbooks:

1. K.V. Narayanan, A Text book of Chemical Engineering Thermodynamic, Prentice Hall India Pvt. Ltd., New Delhi.
2. R.R.Rastogi and R.R.Mishra, An Introduction to Chemical Thermodynamics, Vikas Publishing House Pvt.Ltd, New Delhi.

References:

1. B.G.Kyle, Chemical and Process Thermodynamics, Prentice Hall India Pvt. Ltd., New Delhi.
2. G.N. Pandey and J.C.Chaudhari, Chemical Engineering Thermodynamics, Khanna Publishers, Delhi.
3. J.M.Smith, H.C.Vanness, M.M.Abbott Introduction to Chemical Engineering Thermodynamics, 5^{th} edition, McGraw Hill International Edition.
4. Y.V.C. Rao, Chemical Engineering Thermodynamics, University Press (INDIA) Ltd., Orient Longman Ltd., Hyderabad.

Course Outline

Mass Transfer-II	**MT-II**	**CHL 604**
Course Title	Short Title	Course Code

Course Description:

The purpose of this course is to introduce the fundamental concepts, principles to various separation processes such as distillation, liquid- liquid extraction, solid liquid extraction, adsorption and ion exchange. The course illustrates new techniques of separation such as membrane separations and their possible areas of industrial application.

	Hours per Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(s): Fluid Flow operation, Process Calculations, Mass Transfer-I, Process Heat Transfer

General Objective:

1. To study the vapor liquid equilibrium and importance of relative volatility in distillation.
2. To study different methods of distillation.
3. To design various distillation equipments.
4. To study liquid-liquid extraction process, with material balances.
5. To study and design stage contact and continuous contact type extractors.
6. To study adsorption operation and various adsorption isotherms.
7. To study ion exchange operation and its application in industry.
8. To study mass transfer in leaching operation.
9. To study and design leaching operation.
10. To study different membrane separation processes.

Learning Outcomes:

The students will develop ability to apply mass transfer principles to various phase equilibrium based separation processes viz. perform graphical calculations for binary distillation. The students will understand and apply process design principles for large scale industrial separators – process design of liquid-liquid; solid liquid extraction, columns and thus will be capable of identifying, formulating, designing and providing the solution to chemical engineering problems. The students will develop understanding of implications of factors affecting column operation, and design, effect of reflux ratio, feed conditions, and flow regimes and thus will demonstrate the caliber of product design according to the standards. The students will understand the concept of membrane separation and thus will have an understanding about the environmental issues and will provide solutions for green and clean technologies.

TE Chemical Engineering **Semester – VI**

Mass Transfer-II
(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
Practical	: 4 hour/ week	Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks
		Internal Continuous Assessment (ICA)	: 50 Marks
		End Semester Examination (ESE) (PR)	: 50 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Introduction to distillation process, Vapor liquid equilibrium, The methods of distillation (Binary mixture), - differential , flash, azeotropic, extractive, low pressure, steam distillation, batch rectification. Condition for varying overflow in non- ideal system (Binary), Multi component mixture.
The fractionating column, Continuous rectification for binary system. Equipments for Distillation.

UNIT-II

No. of Lect. – 08, Marks: 16

Multistage (Tray) towers: Bubble cap trays, Sieve trays, Valve trays. Tray efficiencies, concept of reflux, minimum reflux ratio, optimum reflux, total reflux. Lewis Sorrel, McCabe Thiele, and Ponchon Savarit methods for multistage operations.
Packed towers for distillation, Types of Packing's, NTU, HTU, HETP concept and calculations.

UNIT-III **No. of Lect. – 08, Marks: 16**

Introduction to extraction process, Liquid equilibria, Material balances for stage wise contact methods, Extraction with reflux, Fractional extraction, Stage contact and continuous contact type extractors.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Introduction to adsorption operation, Type of adsorption operation, Nature of adsorbents, Adsorption equilibria, Adsorption of vapor, gas mixture and liquids, Material balances for stage wise operation, Continues contact process for adsorption, Unsteady state fixed bed adsorption, Principle of ion exchange operation, Equilibria for ion exchange operation, Rate of ion exchange operation, Application of ion exchange operation.

UNIT-V **No. of Lect. – 08, Marks: 16**

Introduction to leaching operation, Mass Transfer in leaching operation, Calculation of stages for different processes, Graphical method for calculation of number of stages counter current washing process, Equipments for leaching operation.

Introduction to membrane separation process, Different Types of membrane separation process, (Ultrafiltration, Reverse Osmosis, Dialysis, Electro Dialysis, Pervaporation), General membrane equation, Liquid membrane.

Textbooks:

1 Coulson & Richardson Chemical Engineering (Vol. II), Butterworth-Heinmann (Elsevier) (Fifth Edition).
2 R.E.Treybal , Mass transfer operation ,McGraw Hill Book Company, (Third Edition).

References:

1 Christie J.Geankoplis, Transport Processes & Unit Operations, Prentice Hall Inc.
2 Coulson & Richardson Chemical Engineering (Vol.V), Butterworth-Heinmann (Elsevier).

Course Outline

Process Engineering Economics & Costing	**PEEC**	**CHL 605**
Course Title	Short Title	Course Code

Course Description:

The purpose of this course is to understand important principles and present economic principles and their applications in the field of Chemical Engineering. It is a collective effort of Economics and Management along with Chemical Engineering field, to present optimum engineering solutions by developing cost effective products and processes.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Lecture	**03**	**15**	**40**	**03**

Prerequisite Course(s): IEM

General Objective:

1. To introduce concepts of process economics and importance in engineering decisions.
2. To study scales of production, selection of plant capacity, plant location.
3. To study present economic scenario and status of chemical industries.
4. To study factors affecting investment and production cost.
5. To study methods of estimating capital investment.
6. To study various interests.
7. To study various types of taxes and tax returns and types of insurances and legal responsibility.
8. To estimate depreciation and study replacement analysis.
9. To study methods of profitability analysis.
10. To study break even analysis.

Learning Outcomes:

At the end of the course students will be capable of understanding various factors responsible for establishing a chemical process industry. The students will be capable of applying their process engineering knowledge by allocating resources to obtain maximum profitability. The students will be capable of applying management techniques by a systematic study of economic system of the country to engineering problems. The students will exhibit their ability to identify, formulate, and solve engineering problems with the economic consideration.

TE Chemical Engineering **Semester – VI**

Process Engineering Economics & Costing
(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hours/ week	End Semester Examination (ESE)	: 80 Marks
		Paper Duration (ESE)	: 03 Hours
		Internal Sessional Examination (ISE)	: 20 Marks

UNIT-I **No. of Lect. – 08, Marks: 16**

Indian Chemical Industry, Current Status, Trends and Challenges ahead.
Scale of Production, Selection of Plant Capacity, Plant Location : Factors involved, Selection of Plant Site. Energy Gestation Period. Expansion, Diversification and Obsolescence. Scope for Standardization in Design and Production. Economics of Research and Development.

UNIT-II

No. of Lect. – 08, Marks: 16

Cost: Prime Cost, Overhead Cost, Total Cost, Standard Cost & Variances.
Cost Estimation: Factors Affecting Investment and Production Cost. Capital Investment, Fixed Investment and Working Capital .Estimating Equipment Cost By 6 /10 Factor Rule. Method of Estimating Capital Investment. Different Costs Involved in Total Product Cost. Computer Automization in Costing.

UNIT-III **No. of Lect. – 08, Marks: 16**

Interest and Investment Cost, Simple and Compound Interest, Nominal and Effective Rates of Interest, Continuous Interest, Present Worth, Ordinary Annuity, Perpetuities and Capital Costs.
Taxes and Insurances: Types of Taxes and Tax Returns. Types of Insurance and Legal Responsibility.

UNIT-IV **No. of Lect. – 08, Marks: 16**

Depreciation: Types of Depreciation, Service Life, Salvage Value, Present Value. Methods of Determining Depreciation, Single Unit and Group Depreciation. Causes of Obsolescence and Inadequacy.

UNIT-V **No. of Lect. – 08, Marks: 16**

Profitability: Mathematical Methods of Profitability Evaluation, Cash Flow Diagram, Alternative Investment, Replacement: Types and Factors.
Break Even Analyses, Balance Sheet, Pricing Issue Method and Income Statement.

Textbooks:

1. Max S. Peters, Klaus D. Timmerhaus, Ronald E. West, Plant Design and Economics for Chemical Engineers, McGraw Hill (Fifth Edition).
2. T.R. Banga and S.C.Sharma, Industrial Organization & Engineering Economics, Khanna Publishers, New Delhi (Twenty Fourth Edition).
3. O.P.Khanna, Industrial Engineering & Management, Dhanpat Rai Publications (P) Ltd. New Delhi (Revised Enlarged Edition).

References:

1. Dewett & Varma, Elementary Economic Theory: S. Chand & Company Ltd New Delhi.
2. James Riley Couper, (2003), Process Engineering Economics, CRC Press (Taylor & Francis Group).

Course Outline

Lab Chemical Reaction Engineering-I	**Lab CRE-I**	**CHP 606**
Course Title	Short Title	Course Code

Course Description:

The intent of this course is to help to understand concepts in chemical reaction engineering. This course describes experimental techniques for determining rate laws for chemical reactions, the mechanisms and theories of chemical reactions.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Lab Applied Physical Chemistry.

General Objectives:

1. To introduce and study the multiple reactions and concept of residence time distribution.
2. To study various Models for non-ideal flow, concept of micro and macro mixing.
3. To study ideal batch reactor, mixed flow reactor, plug flow reactor.

Learning Outcomes:

Students will demonstrate the concepts of chemical reaction engineering using knowledge of basic Sciences and Mathematics. The students will be able to design various reactors such as Continuous Stirred Tank Reactor, Plug Flow Reactor, and Packed Bed Reactor by obtaining experimental data.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1 To determine the reaction rate constant {k} for given reaction.(CSTR / BATCH / SEMIBATCH / PFR)
2 To determine the effect of temperature on reaction rate constant. .(CSTR / BATCH / SEMIBATCH / PFR)
3 To determine the activation energy {E} for the given reaction. .(CSTR / BATCH / SEMIBATCH / PFR)
4 To draw C [t], E [t] & F [t] curve and to calculate the mean residence time {tm} variance { σ^2 } and skew ness { S^3 } for plug flow reactor.
5 To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance { σ^2 } and skew ness { S^3 } for packed Bed reactor.
6 To study the cascaded CSTR
7 To draw C [t], E [t] and F [t] curve and to calculate the mean residence time {tm} variance { σ^2 } and skew ness {S^3 } for Annular reactor.
8 To study the kinetic in tubular flow reactor [coiled tube] for the given reaction.

References for Practicals:

Designed Standard College Laboratory Manual and Instruction Manuals of the Laboratory Equipment Suppliers.

Course Outline

Lab Mass Transfer-II	**Lab MT-II**	**CHP 607**
Course Title	Short Title	Course Code

Course Description:

This course aims to apply principle and theory of diffusion to various Mass Transfer operations. It helps to understand, operate various equipments and gain practical knowledge of Mass Transfer phenomenon through experimentation.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**04**	**15**	**32**	**02**

Prerequisite Course(S): Lab Applied Inorganic Chemistry, Mass Transfer-I, Lab Mass Transfer-I

General Objectives:

1. To impart design skills, both in analysis and synthesis.
2. To define driving potential for mass transfer as concentration gradient, and verify for various mass transfer operations.
3. To understand and develop process replica of experiments performed.

Learning Outcomes:

Students are able to understand the theoretical principles and practical considerations for design and operation of mass transfer operations, processes, and the engineering approaches to deriving the design equations for complex mass transfer operations. The students are able to design and predict the major process parameters in separation processes. The students can use and analyze experimental data to derive the kinetic and process parameters with simple computing techniques.

Course Content:

(Any eight experiments from the following)

List of Experiments:

1. Simple Distillation: To verify Rayleigh's equation for simple distillation.
2. To plot the vapor liquid equilibrium curve for a binary mixture.
3. Determination of HTU, HETP and NTU.
4. Ternary Diagram: To construct ternary diagram for given system.
5. Tie Lines.
6. Liquid – Liquid Extraction: To study and determine the efficiency of cross current liquid-liquid extraction.
7. Spray Column.
8. Leaching: To calculate efficiency of cross current leaching operation.
9. Adsorption: To study adsorption of acetic acid on activated charcoal
10. Ion Exchange.

References for Practicals:

Designed Standard College Laboratory Manual and Instruction Manuals of the Laboratory Equipment Suppliers.

Course Outline

Lab Entrepreneurship	**Lab ENTR**	**CHP 608**
Course Title	Short Title	Course Code

Course Description:

The purpose of this course is to prepare the students as successful Entrepreneurs and choose Entrepreneurship as career option. It is an effort to build the necessary competencies and motivation for a career in Entrepreneurship. This course provides practical insights to launch successfully and subsequently manage their enterprises.

	Hours per Week	No. of Weeks	Total Hours	Semester Credits
Laboratory	**02**	**15**	**16**	**01**

Prerequisite Course(S): Industrial Economics and Management, LAB Data Analysis & Interpretation, Industrial Training/EDP/Special Study.

General Objectives:

1. To develop basic skills in operations, finance, marketing and human resource management.
2. To plan and design a business according to current status, trends.
3. To encourage and develop young entrepreneurs to meet global challenges.

Learning Outcomes:

Students completing this course will be able to develop core skills and competencies required to start an enterprise. The students will be able to initiate, organize, control the business and will be able to undertake the risk. The students introduce innovations along with technical skills, and will learn the characteristics of an effective team through projects. Students will learn the characteristics of leadership and management styles, using effective communication and feedback techniques by developing their approach to case studies and real-world examples and will help in overall socio-economic development of the nation.

TE Chemical Engineering **Semester – VI**

Lab Entrepreneurship

Teaching Scheme
Practical : 2 hours/ week

Examination Scheme
Internal Continuous Assessment (ICA): 25 Marks

Course Content:

(Any eight assignments from the following)

List of Assignments:

1. To identify and define various elements essential for developing and leading a successful enterprise.
2. Enlist the qualities entrepreneur posses to be successful businessman.
3. How to select and what procedure is to be adopted for setting up an enterprise.
4. With the help of schedule/questionnaire how to prepare a market survey report.
5. What are the possible financial resources available for setting up an enterprise?
6. Preparation of feasibility report to set up a small scale enterprise.
7. A report on various industry promotion schemes facilitated by State and Central government.
8. A visit report to various State and Central Agencies involved in setting up an enterprise such as industrial development corporation, pollution control board etc.
9. A visit report by group of students to any enterprise of their interest.
10. A case study defining what great managers do to sustain in ever changing world.

References for Practicals:

1. Amar Bhide, (2000), The Origin and Evolution of New Business, Oxford University Press, New York.
2. C.R. Kothari (2008), Research Methodology- Methods and Techniques, New Age International Publishers, New Delhi (2nd revised edition).
3. Dr.Vasant Desai (2013), Entrepreneurial Development, Himalaya Publishing House, Mumbai.
4. O.P.Khanna, Industrial Engineering & Management, Dhanpat Rai Publications (P) Ltd.

Course Outline

Minor Project	**MNRP**	**CHP 609**
Course Title	Short Title	Course Code

Course Description:

This course intends to induce amongst students the skills required to undertake research activities and enhance competency in preparing products, based on chemical engineering principles in the laboratory/industry.

	Hours per Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Laboratory	**02**	**15**	**16**	**02**

Prerequisite Course(S): LAB Chemical Process, LAB Data Analysis & Interpretation, Industrial Training/EDP/Special Study

General Objectives:

1. To induce the habit of self study, enhance analytical ability.
2. To promote research oriented activity
3. To develop ability of extracting the material from the different sources and writing comprehensively and exhaustive report on an allotted topic.

Learning Outcomes:

Students finishing this course will develop ability to explore and present a topic in systematic manner. It will enhance the technical and analytical ability required to write a project report amongst the upcoming engineering talents. The students will build up confidence for writing review papers, articles, and technical papers. The students will be capable of providing solutions to various engineering, social problems by investigation based on research activity.

TE Chemical Engineering **Semester – VI**

Minor Project
(Course Content)

Teaching Scheme
Practical : 2 hours/ week

Examination Scheme
Internal Continuous Assessment (ICA): 50 Marks

Course Content:

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A mini project related to the Chemical Engineering and Allied disciplines. A mini project may be based upon following

- Preparation of Chemical Compound and study of its properties.
- Kinetics of different types of reactions.
- Analysis of Natural Products, Chemical Products etc.

Project report should contain

1. Problem defining
2. Objectives of the project
3. Benefits & highlights
4. Relevant literature
5. Chemicals and glassware and any other requirement
6. Methodology
7. Solution
8. Books and Journals referred

Course Outline

Seminar-I	**SMNR-I**	**CHP 610**
Course Title	Short Title	Course Code

Course Description:

The purpose of the course is to introduce students to several major themes of chemical engineering. It also aims to boost the communication ability of an individual and to improve technical knowledge through study of specific topic.

	Hours per Week	**No. of Weeks**	**Total Hours**	**Semester Credits**
Laboratory	**02**	**15**	**16**	**02**

Prerequisite Course(S): Industrial Economics and Management, LAB Data Analysis & Interpretation, Industrial Training/EDP/Special Study.

General Objectives:

1. To develop communication skills.
2. To inculcate presentation skills and enhance confidence level of individual.
3. To improve overall technical knowledge.

Learning Outcomes:

Students completing this course will be able to present the concepts in chemical engineering and allied engineering disciplines by extensive literature review. It will induce a clear understanding ability, ability to listen, proper language, oral presentation skill amongst students. The students will be able to communicate effectively by answering questions and giving explanations and/or instructions. The students will demonstrate ability to transfer of information orally, in writing and electronically and will be able to work in multidisciplinary teams.

TE Chemical Engineering **Semester – VI**

Seminar-I
(Course Content)

Teaching Scheme
Practical : 2 hours/ week

Examination Scheme
Internal Continuous Assessment (ICA): 25 Marks

Course Content:

- **Every student has to present a seminar based on Minor Project carried out during Semester- VI**

The student shall be required to present a seminar in presence of Panel of teachers constituted by the Head of Department in consultation with the Principal. The evaluation shall be based on:
(a) Report: 10 marks
(b) Seminar Presentation: 10 marks
(c) Viva-Voce at the time of Seminar: 05 marks

Total 25 marks