Syllabus

(With effect from 2015-16)

B.E. Chemical Engineering

Semester-VII

Final Year Chemical Engineering

CGPA Pattern

Faculty of Engineering and Technology

North Maharashtra University, Jalgaon

NORTH MAHARASHTRA UNIVERSITY, JALGAON
STRUCTURE OF TEACHING & EVALUATION
B.E. (CHEMICAL ENGINEERING) W.E.F.2015-2016

SEMESTER VII

COURSE CODE	NAME OF THE COURSE	GROUP	TEACHING SCHEME				EVALUATION SCHEME					CREDITS
							THEORY		PRACTICAL		TOTAL	
			THEORY HRS/week	TUTORIAL HRS/week	PRACTICAL HRS/week	TOTAL	ISE	ESE	ICA	ESE		
CHL 701	Process Dynamics & Control	D	3	--	--	3	20	80	--	--	100	3
CHL 702	Chemical Reaction Engineering-II	D	3	--	--	3	20	80	--	--	100	3
Interdisciplinary Elective (Any One From CHL 703 & CHL 704)												
CHL 703	Energy Engineering	E	3	--	--	3	20	80	--	--	100	3
CHL 704	Industrial Hazards & Safety	E	3	--	--	3	20	80	--	--	100	3
Elective-I (Any One From CHL 705-CHL 708)												
CHL 705	Biochemical Engineering	E	3	--	--	3	20	80	--	--	100	3
CHL 706	Petrochemical Technology	E	3	--	--	3	20	80	--	--	100	3
CHL 707	Computational Fluid Dynamics	E	3	--	--	3	20	80	--	--	100	3
CHL 708	Piping Design	E	3	--	--	3	20	80	--	--	100	3
CHL 709	Transport Phenomenon	D	3	--	--	3	20	80	--	--	100	3
CHP 710	LAB Process Dynamics & Control	D	--	--	2	2	--	--	25	25(OR)	50	1
CHP 711	LAB Chemical Reaction Engineering-II	D	--	--	2	2	--	--	25	25(OR)	50	1
Lab Elective-I												
CHP 712	LAB Biochemical Engineering	E	--	--	2	2	--	--	25	25(OR)	50	1
CHP 713	LAB Petrochemical Technology	E	--	--	2	2	--	--	25	25(OR)	50	1
CHP 714	LAB Computational Fluid Dynamics	E	--	--	2	2	--	--	25	25(OR)	50	1
CHP 715	LAB Piping Design	E	--	--	2	2	--	--	25	25(OR)	50	1
CHP 716	Project-I	D	--	--	2	2	--	--	25	25(OR)	50	2
CHP 717	Seminar-II	D	--	--	2	2	--	--	25	--	25	2
CHP 718	Industrial Visit	D	--	--	--	--	--	--	25	--	25	1
	TOTAL		**15**	**--**	**10**	**25**	**100**	**400**	**150**	**100**	**750**	**23**

NORTH MAHARASHTRA UNIVERSITY, JALGAON
STRUCTURE OF TEACHING & EVALUATION
B.E. (CHEMICAL ENGINEERING) W.E.F.2015-2016

SEMESTER VIII

COURSE CODE	NAME OF THE COURSE	GROUP	TEACHING SCHEME				EVALUATION SCHEME					CREDITS
							THEORY		PRACTICAL		TOTAL	
			THEORY HRS/week	TUTORIAL HRS/week	PRACTICAL HRS/week	TOTAL	ISE	ESE	ICA	ESE		
CHL 801	Computer Aided Process Equipment Design Modeling & Simulation	D	3	--	--	3	20	80	--	--	100	3
CHL 802	Chemical Plant Design &Project Engineering	D	3	--	--	3	20	80	--	--	100	3
Elective-II (Any One From CHL 803 - CHL 806)												
CHL 803	Industrial Pollution Control	E	3	--	--	3	20	80	--	--	100	3
CHL 804	Advance Separation Techniques	E	3	--	--	3	20	80	--	--	100	3
CHL 805	Polymer Technology	E	3	--	--	3	20	80	--	--	100	3
CHL 806	Oil Technology	E	3	--	--	3	20	80	--	--	100	3
Elective-III (Any One From CHL 807-CHL 810)												
CHL 807	Mathematical Methods in Chemical Engineering	E	3	--	--	3	20	80	--	--	100	3
CHL 808	Advance Catalysis	E	3	--	--	3	20	80	--	--	100	3
CHL 809	Plant Utility	E	3	--	--	3	20	80	--	--	100	3
CHL 810	Intellectual Property Rights	E	3	--	--	3	20	80	--	--	100	3
CHP 811	LAB Computer Aided Process Equipment Design Modeling & Simulation	D	--	--	2	2	--	--	25	25	50	1
CHP 812	LAB Chemical Plant Design &Project Engineering	D	--	--	2	2	--	--	25	25(OR)	50	1
Lab Elective-II												
CHP 813	LAB Industrial Pollution Control	E	--	--	2	2	--	--	25	25(OR)	50	1
CHP 814	LAB Advance Separation Techniques	E	--	--	2	2	--	--	25	25(OR)	50	1
CHP 815	LAB Polymer Technology	E	--	--	2	2	--	--	25	25(OR)	50	1
CHP 816	LAB Oil Technology	E	--	--	2	2	--	--	25	25(OR)	50	1
CHP 817	Industrial Lecture*	C	--	--	1*	1	--	--	50	--	50	2
CHP 818	Project-II	D	--	--	4	4	--	--	75	75	150	6
	TOTAL		**12**	**--**	**11**	**23**	**80**	**320**	**200**	**150**	**750**	**23**

NOTE: * Minimum 06 lectures to be delivered by experts of the industry in alternative weeks. Next week group discussion on the lecture delivered.

Course Outline

Process Dynamics & Control	**PDC**	**CHL 701**
Course Title	Short Title	Course Code

Course Description:

This course describes fundamental aspects of dynamic processes and the engineering tasks of process operations and control. The objective of the course is to apply the principles of science and chemical engineering to design static and dynamic model of processes, design of feedback and other control structures; and advanced control strategies.

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

Prerequisite Course (s): Fluid Flow Operation, Process Calculations, Process Heat Transfer, Mass Transfer I & II, Instrumentation & Instrumental Analysis, Chemical Engineering Thermodynamics, Chemical Reaction Engineering-I.

General Objectives:

1. To understand the importance of process control and role of process control engineers.
2. To develop input-output model of various processes by mathematical models.
3. To study the concept of linearization.
4. To develop transfer functions and study the dynamic behavior of various systems.
5. To design a control system to meet desired needs of chemical engineering process.
6. To design and analyze block diagrams from process information.
7. To study, design and tune different controllers.
8. To study dynamic behavior of feedback control processes.
9. To understand stability analysis using frequency response techniques.
10. To study advanced control strategies by various control mechanisms.

Learning Outcomes:

By the end of this course the students will be able to understand process dynamics and various forms of mathematical models required to express them, including differential equations, transfer functions, and frequency response plots. The students will understand the main ideas behind advanced multivariable control and also will be capable to analyze, design and tune various control systems. As the subject requires understanding of basic sciences and engineering, the students will be able to function along with multidisciplinary teams and will be capable of setting and complete team projects.

BE Chemical Engineering **Semester – VII**

Process Dynamics & Control

(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**

Characteristics of Chemical Process Control, Mathematical Modeling of Chemical Processes, State Variables and State Equation for Chemical Processes. Input –Output Model, Linearization of non linear systems. First order system and their transfer functions.

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

Dynamic behavior of first order system, Pure capacity process, First order system with variable Time constant and gain, Response of first order system in series: Interacting and Non-interacting. Second order system and their transfer function.

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

Dynamic behavior of second order system: under damped and over damped and critically damped systems. Transportation lag. Higher order systems. Introduction to feedback control systems, Controllers and final control element. Block diagram of chemical reactant control systems.

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

Dynamic behavior of feedback control processes: P, PD, PI, and PID. Design of feedback controller: Performance criteria, selection of type of controller, Tuning of feedback controller. Stability analysis by Routh criteria, Root Locus Diagram.

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

Frequency response analysis of linear processes: Bode's diagram, Nyquist plots. Design of feedback control system using frequency response technique: Bode's stability criteria, gain and phase margin. Ziegler – Nichols tuning technique. Control Systems with Multiple Loops: Feed forward, Cascade, Ratio, selective, split range, Adaptive and Inferential control. Multi Variable Control.

Textbooks:

1. George Stephanpolous, Chemical Process Control, Prentice Hall of India.
2. D.R. Coughnour, Process System Analysis and Control, McGraw-Hill.
3. R.P. Vyas, Process Control & Instrumentation (2^{nd} edition). Central Techno publication, Nagpur.

References:

1. K. Krishnaswamy, Process Control, New age International.

Course Outline

Chemical Reaction Engineering-II	CRE-II	CHL 702
Course Title	Short Title	Course Code

Course Description:

This course describes to use appropriate terminology of chemical reaction engineering of heterogeneous nature and design. It illustrates basic scientific principles associated with the reactor design.

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

Prerequisite Course (s): Applied Physical chemistry, Chemical Reaction Engineering – I, Mass Transfer I & II, Process Equipment Design I & II.

General Objectives:

1. To study the fluid particle reaction non-catalytic reactions.
2. To study the determination of rate controlling step.
3. To study the fluid-fluid system (without catalyst).
4. To study the reactors for gas-liquid reactions.
5. To study the preparation and deactivation of catalyst.
6. To study the determination of surface area and Pore volume of catalyst.
7. To study the solid catalyzed reactor.
8. To study the diffusion and reaction in spherical catalyst pellets.
9. To study the design of Moving Bed Reactor, Fluidized Bed Reactor and Slurry Bed Reactor.
10. To study the design of Trickle bed reactors, Isothermal and Adiabatic fixed bed reactor.

Learning Outcomes:

At the end of the course students are able to apply basic kinetics and mass transfer principles for development of heterogeneous system rate expressions for fluid particle and fluid -fluid non catalytic reaction. The students demonstrate their ability how to prepare and use the catalyst for enhancements of reaction rate and understand its deactivation and generation. The students will become competitive to undertake the designing of solid catalyzed reaction, Fluidized bed Reactors, Slurry bed reactors, Trickle bed reactors, Isothermal and Adiabatic fixed bed reactor.

BE Chemical Engineering **Semester – VII**

<u>Chemical Reaction Engineering-II</u>

(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 fluid particle reaction non-catalytic reactions, unreacted core model for Spherical particle of unchanging size, Rate of reaction for shrinking spherical particles, Determination of rate controlling step , Various contacting patterns in fluid solid reactors for fluid particle non-catalytic reactions.

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

Introduction to fluid-fluid system (without catalyst), Rate equation for Instantaneous, Fast, Intermediate and slow reaction, Slurry Reaction kinetics, Rate equation for infinitely slow reaction, Film conversion parameter , Reactors for gas-liquid reactions and their comparative evaluations on the basis of holdups. Aerobic fermentation, Tower for fast and slow reaction, Mixer settler and semi-batch contacting pattern. Reactive distillation and extractive reaction.

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

Introduction, Classification, Characteristics, Preparation and Deactivation of catalyst, promoters and inhibitors, Determination of surface area and Pore volume of catalyst, Adsorption process and its classification, Types of adsorption isotherm.

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

Introduction to solid catalyzed reactor , Rate equation for adsorption , desorption and surface reaction, Diffusion and reaction in spherical catalyst pellets , Internal effectiveness factor, Overall effectiveness factor, Estimation of diffusion and reaction limited regimes, Mass transfer and reaction in a packed bed, The determination of limiting situation from reaction data, chemical vapor deposition reactors.

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

Introduction to heterogeneous catalytic reactors.

Design, Mechanical construction and applications of: Moving bed reactors, Fluidized bed Reactors, Slurry bed reactors, Trickle bed reactors, Isothermal and Adiabatic fixed bed reactor.

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.
4. Coulson & Richardson Chemical Engineering (Vol. III), Butterworth-Heinmann (Elsevier) (Sixth Edition).
5. Coulson & Richardson Chemical Engineering (Vol. V), Butterworth-Heinmann (Elsevier) (Sixth Edition).
6. S.D. Dawande, Principles of Reaction Engineering, Denett & Co., Nagpur.

References:

1. Lanny D. Schimdt , Chemical Reaction Engineering, Oxford University Press.
2. Froment and Bischoff, Chemical Reactor Analysis and Design, Wiley Publication, New York.
3. Hiroo Tominaga and Masakazu Tamaki, Chemical Reactions and Reactor Design, Wiley and Maruzene Publications.

Course Outline

Interdisciplinary Elective

Energy Engineering	**EE**	**CHL 703**
Course Title	Short Title	Course Code

Course Description:

Energy engineering aims to give students real-world technical expertise in strategic renewable energy disciplines, as well as an in depth understanding of the issues associated with renewable energies and their development, including the short and medium-term technical, technological, geopolitical and environmental challenges.

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

Prerequisite Course (s): Engineering Chemistry I & II, Engineering physics I and II, Mathematics I and II, Soft Skill I and II, Elements of Electrical & Electronics Engineering, Elements of Civil Engineering & Engineering Mechanics, Elements of Civil Engineering & Engineering Mechanics, Elements of Electrical & Electronics Engineering.

General Objectives:

1. To impart introduction to energy engineering. Energy resources and forms of energy.
2. To study about Conventional Energy Sources like Coal and types of coal and byproduct, Petroleum, Natural gas and Refinery Products
3. To study about solar energy, wind energy, geothermal, tidal energy, Bio energy.
4. To impart the knowledge of Chemical Energy Sources- Fuel cell, Hydrogen, Methanol, Nuclear energy.
5. To give the knowledge of Energy conversion processes and devices, Power plants with conventional energy sources.
6. To study national energy strategies and national energy plans.

7. To study energy power management, energy planning in India.
8. To study energy audit of a company.

Learning Outcomes:

Students shall have ability to apply knowledge of mathematics, science, and engineering to various processes, as well as to analyze and interpret the data. They will be able to understand the conventional and nonconventional source of energy, National energy strategy and energy plans, energy power management, energy audit, various energy conversion processes, devices and about the power plants.

Final Year **Semester – VII**

(Interdisciplinary subject(s) offered

by Chemical Engineering Department)

Energy Engineering

(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**

Energy engineering and energy technology: Law of conservation of Energy, Generalized equation of Energy conservation, Energy resources and forms of energy, Energy demand, Changing energy consumption trends, National energy strategies of India, Crucial Issue in India's energy planning. Energy power management and Energy planning in India. Energy Audit- Types of Energy Audits Conservation and recycling.

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

Conventional Energy Sources

Coal : Type of coal, classification of Indian coal. Important Properties of coal. Exploration, Coal Preparation, Removal of sulphur, Storage and Transportation of coal. Coal gasification, coal liquefaction.

Petroleum, Natural gas and Refinery Products: Introduction to Petroleum and Natural gas and Naphtha. Exploration of petroleum. Production of crude oil and Natural gas. Transportation of crude oil and Natural gas. Refining of crude oil and Natural gas Refinery. Liquefaction of Natural gas

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

Chemical Energy Sources:

Fuel cells: Introduction, Design and operation of a Fuel cell. Classification of fuel cells: Types of fuel cells, Advantages and disadvantages of fuel cells, Applications of fuel cells. Hydrogen: Introduction, Applications of Hydrogen, Production of Hydrogen, Storage and transportation safety and management, Hydrogen technology development in India.

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

Nuclear Energy: Nuclear energy and application compared with coal, Fuels for Nuclear Fission Reactor. Storage and Transportation. Energy from Nuclear fission reactor. Fast breeder Reactor. Boiling water reactor. Pressurized heavy and Light Water reactor. Uranium Enrichment Process. Nuclear Waste Management.

Solar Energy: Terms and definition ,units. Application of solar heater solar energy storage, Thermal storage, battery storage. Applications of Solar energy. Wind energy: Basic Principles of wind energy conversion. Site Selection Considerations. Classification of wind energy conversion system, Wind power density, Power in wind stream, Forces on the blades of a propeller, Energy pattern factor, Definition of wind speed for Turbines.

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

Bio energy: Biomass energy resources, Biomass conversion processes, direct combustion of biomass, Thermo chemical conversion of biomass, Biochemical conversion, Ethanol from biomass, Applications, Biodiesel.

Energy conversion technologies and Electrical power plants: Power plants with conventional energy sources, Coal fired steam thermal power plants, Combined cycle power plants, Integrated coal gasification combined cycle power plants, Plant factors and reserves.

Textbooks:

1 S. Rao and Dr. B.B. Parulekar, “Energy Technology” Non Conventional, Renewable and Conventional, Khanna Publishers, New Delhi.
2 G.D. Rai “Non conventional Energy Sources”, Khanna Publishers,New Delhi

References:

1 S.B. Pandya, "Conventional Energy Technology" Fuels and Chemical Energy Tata McGraw-Hill Publishing Company Ltd, New Delhi

2 S.P. Sukhatme, "Solar Energy", Principals of thermal collection and Storage. Tata McGraw-Hill Publishing Company Ltd, New Delhi

3 Thipse, S. S. " Alternative fuels" Jaico Publishing House; First edition , 2010

Course Outline

Interdisciplinary Elective

Industrial Hazards & Safety	**IHS**	**CHL 704**
Course Title	Short Title	Course Code

Course Description:

This course describes identification of components needed to provide a safe environment, analyze resulting safety and health issues.

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

Prerequisite Course (s): Chemical Plant Design and Project Engineering, Process Heat Transfer, Project Engineering Economics & Costing.

General Objectives:

1. To identify the components needed to provide a safe and healthful work environment through case studies and review of injury statistics provided in the course.
2. To analyze safety and health issues resulting from worker complaints or OSHA violations and suggest potential remedies.
3. To identify potential workplace safety and health hazards and determine how to mitigate the hazards through engineering controls, administrative controls and personal protective equipment.
4. To demonstrate research skills necessary for mastery of the topic, which will entail a presentation on a specific industry. Worker compensation claims in the industry selected by the student will be evaluated and injury prevention methods reviewed in the report.
5. To conduct basic safety inspections using strategies that they have developed though hazard identification and job hazard analysis.

6. To review the principles for developing and implementing a successful occupational health and safety program and evaluation of a work site.
7. To compare past and contemporary philosophies of safety and accident prevention as well as be able to compare injury data from previous decades.
8. To identify the moral and economic consequences associated with the major classifications and causes of accidents and the cost of workers' compensation based on the risk classes of industries.
9. To explain the causal relationship between accidents and liability including the no fault workers compensation system and the third party liability type lawsuit.
10. To identify basic fire prevention and protection programs in the workplace.
11. To identify essential elements of an occupational safety and health program and the components of international standard organizations in safety and health..
12. To describe basic components of an effective company safety and health program including management commitment, employee involvement, hazard recognition and control and training.

Learning Outcomes:

At the end of this course, the student will have ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. They shall understand the function of hydrogen and its safety during working and energy from various power plants. Students shall understand the impact of engineering solutions in a global, economic, environmental, and societal problem during study. Students will have an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Final Year **Semester – VII**

(Interdisciplinary subject(s) offered
by Chemical Engineering Department)

Industrial Hazards & Safety

(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 Industrial Safety:

History and development of safety movement, Need for safety, Safety legislation: Acts and rules, Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels. Accident sequence theory, Causes of accidents, Accident prevention and control techniques, Plant safety inspections, Job safety Analysis and investigation of accidents, First aid.

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

Industrial Safety Management

Management**:** Concept, definition, nature and importance, Role and functions of a manager, Elements and functions of Management.

Management Principles**:** Authority, responsibility & power of Management, Span of Control.

Delegation and decentralization of authority. General principles of Management.

Industrial Safety**:** History of Safety Movement in India and abroad. The Accident Problem, Nature & size need for safety, legal, humanitarian, economic and social considerations.

Safety Management**:** Role of management in Industrial Safety. Safety Management Principles & Practices.

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

Safety Awareness & Training:

Training for Safety: Assessment of needs. Design & development of training programmes. Training methods and strategies. Training of manager, supervisors & workers. evaluation of training programmes.

Training Programme: In-Plant training programmes. Out-of-plant training programmes. Seminars, Conferences & Workshop, Programmes for new workers. Job instructions Vs Safety instructions.

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

Safety Promotion & Publicity:

Safety suggestion schemes. Safety competitions, Safety incentive Schemes. Audio Visual Publicity, other promotional methods.

Human behavior and safety: Human factors contributing to accidents. Individual differences. Behaviour as function of self and situation. Perception of danger and acceptance of risks. Knowledge and responsibility vis-a-vis safety performance. Role of management, Supervisors and safety department in motivation.

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

Control of Physical and Chemical Hazards:

Purpose of lighting. Advantages of good illumination. Lighting and safety. Lighting and the work. Sources and types of artificial lighting. Principles of good illumination. Recommended minimum standards of illumination. Design of lighting installation, Lighting and colour, Purpose of ventilation. Engineering Control of noise, Vibration damping, Noise isolation.

Hazardous properties of chemicals and appreciation of information provided in Material safety data sheets. Classification of dangerous materials. Safety in transportation of dangerous materials by road, rail, ships and pipelines. Safety in bulk storage of hazardous substances. Safety in handling of chemicals in the plant by pipelines.

Textbooks:

1. R.S. Gupta, Handbook of Fire Technology, National Safety Council of India.
2. Major hazard control, A Practical Manual, Inter National Labour Office, 3rd impression (1 Nov. 1988), www.amazon.in
3. Encyclopedia of occupational health and safety, Inter National Labor Office, 4th revise edition, 1 March 1990. www.amazon .in
4. R.K. Jain and Sunil S. Rao, Industrial Safety, Health and Environment Management Systems, Khanna Publishers, New Delhi (2006)Slote.L. Handbook of Occupational Safety and Health, John Willey and Sons, NewYork
5. Frank P. Lees, Loss of Prevention in Process Industries, Vol. 1 and 2, Butterwort
6. Heinemann Ltd., London (1991).

References:

1. Industrial Safety -National Safety Council of India.
2. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai Grimaldi and Simonds, Safety Management, AITBS Publishers, New Delhi (2001).
3. Industrial Safety and Pollution Control Handbook: National Safety Council and Associate Publishers Pvt. Ltd, Hyderabad (1993).
4. Risk Assessment and Environmental Management: D. Kofi Asvite- Dualy, John Willey & Sons, West Sussex, England (1998).
5. Gilbert M. M., Pearson, "Introduction to Environmental Engineering & Science": Education, Singapore (2004).
6. R.S. Gupta," Fire Technology", National Safety Council of India.
7. Major hazard control, Inter National Labor Office.
8. Encyclopedia of occupational health and safety, Inter National Labor Office.
9. Safety, health and working condition in the transfer of technology, Inter National Office.

Elective - I

Course Outline

Biochemical Engineering	**BCE**	**CHL 705**
Course Title	Short Title	Course Code

Course Description:

The course consists of study of Biological Material & Energy Balances for bioprocesses & unit operations used in the bioprocesses. It also includes Enzyme Engineering. Immobilization of enzymes and kinetic study of the enzyme catalyzed reactions. Study of microbial kinetics, various models, different types of Bioreactors with material balances are the integral part of this course. Sterilization reactors, air sterilization, O_2 transport in bioprocesses, recovery of the fermentation products followed by instrumentation and control are also included in the course.

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

Prerequisite Course (s): Process Calculation, Mass Transfer – I & II, Instrumentation and Instrumental Analysis, Chemical Reaction Engineering – I.

General Objectives:

1. To study the biological materials to obtain various chemicals from them and Energy and Material balances for the bioprocesses and Unit operations involved in these processes.
2. To study Enzyme Engineering.
3. To study kinetics of microbial growth, various models and different reactor configurations for the growth of microorganisms.
4. To study sterilization of liquids and air, O_2 transport through cell and determination of oxygen transfer coefficients.
5. To study the unit operations for the recovery of fermentation products.
6. To study the application of controls and instrumentations in bioprocesses.

Learning outcomes:

The students after completing the course will be able to apply a knowledge and understanding of various biochemical processes for the recovery of many important chemicals and biochemical's. The students will utilize the principles of hygiene, will demonstrate the understanding of basic science and engineering and will use the knowledge of chemical engineering to design efficient product bioprocesses by designing bioreactors and effective downstream processing mechanism.

. **BE Chemical Engineering** **Semester – VII**

Biochemical Engineering

(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hour/ week	End Semester Examination (ESE)	: 80 Marks
Practical	: 2 hour/ 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**

Characteristics of Biological material. Types of microorganisms; general physical properties of cells and chemical composition of cells; requirement for growth of cells and formulation of media; reproduction cycles in microorganisms; changes in composition of cells with age and with growth rate; effect of substrate limiting growth on the composition of cells; strain breeding; Maintenance of pure cultures.

Material Balances in bioprocesses, Application of material balances to bioprocesses.

Energy balances in bioprocesses, Heat of reaction for processes with biomass production. Unsteady state energy and material balances in bioprocesses.

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

Enzymes. History. Enzyme nomenclature and classification. Applications of enzymes. Enzyme substrate complex and enzyme action. Effect of Temperature and pH on enzyme activity. Kinetics of enzyme catalyzed reaction; simple enzyme kinetics with one and two substrates; Michaelis Menten kinetics. Evaluation of parameters of Michaelis Menten equation. Kinetics of reversible enzyme catalyzed reaction. Enzyme inhibition. Types of enzyme inhibition. Kinetics of competitive, uncompetitive and noncompetitive enzyme inhibition. Substrate activation and inhibition. Immobilization of enzymes and their applications.

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

Microbial Kinetics: Monod's growth kinetics. Environmental effects on growth kinetics. Balanced growth kinetics, Transient growth kinetics, Unstructured batch growth model, Growth of filamentous organisms, Product formation kinetics. Unstructured model.

Reactor Configurations: Batch growth of microorganisms, Stirred tank reactor with recycle of biomass, Continuous stirred tank fermenters in series, plug flow fermenter, fed batch fermenter, Numericals on these, multiphase reactors such as packed bed reactors, bubble column reactors, fluidized bed reactors and trickle bed reactors.

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

Sterilization: Importance of Sterilization. Batch Sterilization of liquids, continuous sterilization of liquids, sterilization of air.

Aeration and Agitation: Mass transfer and Microbial respiration, bubble aeration and mechanical agitation, correlation between oxygen transfer coefficient and operating variables, effect of temperature, organic substances, surface active agents, mycelium and types of sparger on oxygen transfer coefficient. Measurement of oxygen transfer coefficient, Scale up.

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

Recovery of fermentation products, Disruption of cells, mechanical methods, ultrasonic vibrations, grinding and mechanical shear, shearing by pressure, induction by lysis.

Reverse Osmosis: Ultra filtration, Instrumentation and Control: Introduction, methods of measuring process variables; temperature measurement and control, pressure measurement and control, foam sensing and control, weight of fermenter and estimation of microbial biomass, dissolved oxygen measurement and control, inlet and exit gas analysis, pH measurement and control, bioprocess economics.

Textbooks:

1. James E. Bailey & David F. Ollis, Biochemical Engineering. Fundamentals; McGraw Hill Publication.
2. P.F.Stanbury, A. Whitaker & S,J.Hall, Principles of Fermentation Technology; Aditya Books Ltd; New Delhi.
3. Doran Pauline M. Bioprocess Engineering Principles, Academic Press. An Imprint of Elsevier.4. Shular Michael L. and Kargi Fikret. Bioprocess Engineering Basic Concepts, Prentice Hall of India.
4. Shular Michael and Kargi Fikret, Bioprocess Engineering Basic Concepts, Prentice Hall of India
5. Editors: J.F. Richardson, D.G. Peacock, Coulson's & Richardson's Chemical Engineering, (Vol-III) Asian Books Pvt. Ltd. New Delhi
6. J.H. Backhurst & J.H.Harker, Coulson's & Richardson's Chemical Engineering (Vol-V) Asian Books Pvt. Lt

References:

1. Shuichi Aiba, Arthur E.H. & Nancy F.M., Biochemical Engineering; University of Tokyo Press.

Elective - I

Course Outline

Petrochemical Technology	**PCT**	**CHL 706**
Course Title	Short Title	Course Code

Course Description: This course describes the various unit operations and unit processes involved in the manufacturing various petrochemicals.

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

Prerequisite Course (s): Chemical Engineering Processes-I & II.

General Objectives:

1. To introduce with the petroleum refinery worldwide
2. To develop knowledge of different refining processes
3. To develop knowledge of safety and pollution control in the refining industries
4. To study production of Methane and its derivatives
5. To study general characteristics, production of ethane- ethylene-Acetylene and their derivatives
6. To study Dehydrogenation of Butane
7. To study Synthesis gas and synthetic chemicals and their applications.
8. To study Petroleum Aromatics.
9. To study derivatives of benzene.
10. To study chemicals from xylene.

Learning Outcomes:

Studying this subject the students will learn about petrochemicals as well as different refining processes. This subject will guide the students about the development of petrochemical industries. This subject furnishes the conversion of petroleum feedstock to chemicals and intermediates. As the subject requires understanding of basic knowledge of petrochemicals and basic sciences the students will be able to work along with multidisciplinary teams and will be capable of handling consultancy projects related to petrochemical technology.

BE Chemical Engineering **Semester – VII**

Petrochemical Technology

(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hour/ week	End Semester Examination (ESE)	: 80 Marks
Practical	: 2 hour/ 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**

Petrochemical Industry in India. Feed stocks for petrochemicals, separation of aromatics.

Chemicals from methane: Manufacture of methanol, formaldehyde, acetic acid, ethylene glycol, CS_2, liquid fuels from methanol, manufacture of ethanol.

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

Chemicals from ethane- ethylene-Acetylene.

Ethane: Occurrence, halides of ethane, Nitroethane and oxidation of ethane. Ethylene production, production of ethylene derivatives like vinyl acetate monomer, ethylene oxide, ethylene diamine, ethanol and acetaldehyde.

Chemicals from acetylene: acrylic acid, vinyl chloride, vinyl acetate and Acetonitrile.

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

Chemicals from C3, C4 and higher carbon atoms:

Products from propane. Dehydrogenation of propane and higher paraffin's.

Chemicals from propylene: Isopropyl alcohol, acetone, propylene glycol, acrylic acid and ester, Phenol.

Dehydrogenation of butanes. Production of Iso and n- butanol. Production of methyl –tert-butyl ether [MTBE], Adipic acid. Derivatives from hydrocarbons higher than butane.

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

Synthesis gas and chemicals:

Synthesis gas. Steam reforming of hydrocarbons. Production of synthesis gas. Chemicals from synthesis gas. Oxo synthesis, vinyl acetate, acetic acid.

Fischor- Tropsch synthesis: catalysts and the products.

LPG: sources, properties grades of LPG. Supply of LPG to consumers, the storage and use of LPG.

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

Petroleum aromatics: Production of BTX. Benzene derivatives like Aniline, phenol, alkylation of benzene.

Products from toluene: Chlorotoluenes, O- Cresols, Dinitrotoluenes, Benzaldehyde, caprolactum, Terephthalic acid.

Textbooks:

1. Bhaskararao B.K. “A Text on Petrochemicals”, Khanna Publishers, New Delhi
2. Sarkar G.N. “Advanced Petrochemicals” Khanna Publishers, New Delhi

References:

1. Maiti Sukumar [editor],”Introduction to Petrochemicals”, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi

Course Outline

Elective-I

Computational Fluid Dynamics	**CFD**	**CHL707**
Course Title	Short Title	Course Code

Course Description:

The incorporation of CFD (Computational Fluid Dynamics) as a possible solution to modern day fluid mechanic problems has become part of the daily lives of many engineers along with the companies they work for. Usually, the main objective is to quantitatively estimate forces produced by flows around a specific structural component or to optimize the design of an individual part responding to forces originating from fluid dynamics.

These skills imply a high degree of multidisciplinary competence in order to accurately define and resolve specific problems. A profound knowledge is needed in different key areas such as CAD to properly discretize the problem, fluid mechanics to properly understand the governing phenomena behind the problem, numerical methods to understand how these fluid dynamic problems are numerically solved and finally, experimental techniques in fluid mechanics to understand the underlying errors in reference values used for validation.

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

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

General Objectives:

1. To understand the philosophy of computational fluid dynamics and conservation principles.
2. To understand classification of flows & characteristics of simple turbulent flows, free turbulent flows.

3. To study different models such as turbulence models, mixing length model, the k-e model and their algebraic stress equations.
4. To study Grid Generation.
5. To understand discretization of ordinary and partial differential equations.
6. To study approximation of first, second and mixed derivatives & its implementation on boundary conditions.
7. To study applications of discretisation in solving engineering problems.
8. To understand heat transfer in a complex tubes and channels.
9. To study type of flow processes.

Learning Outcomes:

On completion of this course the student is expected to apply the differential equations governing fluid flow, heat transfer and mass transport to formulate strategies for the solution of engineering problems, to use basic methods for solving these equations numerically using a computer.

BE Chemical Engineering **Semester – VII**

Computational Fluid Dynamics

(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hour/ week	End Semester Examination (ESE)	: 80 Marks
Practical	: 2 hour/ 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**

Philosophy of computational fluid dynamics, conservation principles of mass, energy, and momentum, simplified flow models such as incompressible, potential and creeping flows, classification of flows. Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows.

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

Turbulence models, Mixing length model, The k-e model, Algebraic stress equation models. Grid Generation: Structured and unstructured grids, choice of grid, general transformation of equations, some modern developments in grid generation in solving the engineering problems. Finite Difference Method.

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

Discretization of ordinary and partial differential equations, approximation of first, second and mixed derivatives, implementation of boundary conditions, discretization errors, applications to the engineering problems.

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

Discretisation methods, approximations of surface integrals and volume integrals, interpolation and differentiation practices, implementation of boundary conditions, applications to the engineering problems. One-dimensional unsteady heat conduction.

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

Flow in a sudden pipe contraction / expansion, flow and heat transfer in a complex tubes and channels, reactive flow, multiphase flow, and turbulent flow processes.

Textbook :

1. Anderson Jr J. D., "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill. 1995.
2. Muralidhar K. and Sundararajan T. "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, 2003.
3. H. K. Versteeg and W. Malalasekera, "An introduction to computational fluid dynamics: the finite volume method", Longman scientific & technical publishers, 2007.
4. Ranade V. V, "Computation Flow Modeling for Chemical Reactor Engineering", Academic Press. 2002.

References:

1. Ferziger J. H. and Peric M., "Computational Methods for Fluid Dynamics", 3ed. Springer, 2002.

Elective - I

Course Outline

Piping Design	**PDSN**	**CHL 708**
Course Title	Short Title	Course Code

Course Description:

Piping design course is structured to raise the level of expertise in piping engineering and to improve the competitiveness in the present scenario of industries. This course provides various know how of piping system designs, development skills and knowledge of current trends of plant layout.

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

Prerequisite Course (s): Chemical Engineering Materials, Fluid Flow Operation, Process Calculations, Mechanical Operation, Process Heat Transfer, Mass Transfer I & II, Process Equipment Design I & II.

General Objectives:

1. To study the role of piping engineer.
2. To study the scope of piping engineering.
3. To study the criteria for selection of pipe joints.
4. To study the frictional losses and Pressure drops calculation for Newtonian & Non-Newtonian fluids.
5. To study the types of valves.
6. To study the constructional features.
7. To study the pipe rack spacing and drawing.
8. To study the piping systems for plant utilities.
9. To study the how to use various symbols like piping, line, valve and equipment in piping drawing.

10. To study the PFD, P&ID and utility flow diagram.

Learning Outcomes:

The students after completing the course will be able to apply a knowledge and understanding of the role of chemical engineer as piping engineer, the scope, selection of the various pipe joint, calculations involved like frictional losses and pressure drops, various valves to be used and their construction features, piping supports for utilities pipeline. Students are able to draw drawings like PFD, P&ID and Utility flow diagram.

BE Chemical Engineering **Semester – VII**

Piping Design

(Course Content)

Teaching Scheme		**Examination Scheme**	
Theory	: 3 hour/ week	End Semester Examination (ESE)	: 80 Marks
Practical	: 2 hour/ 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**

Role of piping engineer, Scope of piping engineering, Responsibilities of piping engineer, Inputs received by piping engineers and output given by them, Interactions of piping engineers with other disciplines such as process engineering, instrumentation engineering etc.

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

Pipes and pipe fittings – standards and specification, steel pipes, steel pipe fittings, cast iron pipes, cast iron fittings, joining of cast iron pipes, tubes of other materials, design of flanges and flange joints.

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

Types of Valves, Control Valves, Safety Valves, Constructional features, Criteria for selection, Piping components, Safety valves and other pressure relieving devices, Constructional features, Selection criteria.

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

Pipe Rack Spacing, Drawing pipe in the rack, Pipe insulation shoes, Pipe guides, Pipe Flexibility, Pipe Supports, Field supports, Dummy supports, Hanger rods, Spring hangers, Pick-up pipe supports, Plant utilities, Control valve manifolds, Utility stations, Sewer and underground piping system**.**

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

Introduction to PFD, P&ID, Utility flow diagrams, Piping symbols, Line symbols, Valve symbols, Equipment Symbols, Plant layout.

Textbooks:

1. Design of Piping system, M.W. Kellogg Co. 1976 (2ndEdition).
2. G. K. Sahu, Handbook of Piping Design.
3. Sam Kannapan, P.E. Pipe Stress Analysis , Willey-Interscience Publications.
4. Roy A. Parisher, Robert A. Rhea ,Pipe Drafting and Design, Gulf Professional Publishing,3rd Edition.
5. Thakore,Bhatt,Introduction to Process Engineering and Design,Tata McGraw-Hill Education, 2007
6. D. J. Deutsch, Process piping systems, Chemical Engineering Magazine. McGraw Hill.

References Books:

1. M. L. Nayyar, P.E , Piping Handbook, 6 th edition, McGraw-Hill, Inc
2. Johan J McKetta,Piping Design Handbook , CRC Press, 1992.

Course Outline

Transport Phenomenon	**TP**	**CHL 709**
Course Title	Short Title	Course Code

Course Description:

The main aim is to give a balanced overview of the field of transport phenomena, discussing the fundamental theories of the subject, and illustrating how to use them to solve transport problems and elaborate conceptual and mathematical models, from conservation principles.

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

Prerequisite Course (s):--Fluid Flow Operation, Mass Transfer –I, Process Heat Transfer, Mass Transfer-II

General Objective:

1. To develop an ability to apply knowledge of mathematics, interdisciplinary science, and engineering in the field of transport processes.
2. To study equilibrium and non equilibrium processes.
3. To study role of intermolecular forces.
4. To study fundamental laws of conservation and apply to understand behavior of transport processes.
5. To study Newtonian and Non Newtonian behavior of fluids.
6. To formulate momentum, energy and mass balances in chemical processes.
7. To determine momentum, heat, mass flux distribution in rectangular, cylindrical and spherical co-ordinates.
8. To develop equation of motion using equation of continuity.
9. To develop equation of energy.
10. To study simultaneous momentum, heat and mass transport.

Learning Outcomes:

Students will be able to apply engineering principles and analyze problems dealing with transport phenomena. Students will be able to apply mathematics, science, and engineering principles to analyze transport phenomena problems. This course provides a fundamental basis for applying and physically interpreting the transport mechanism. The student will be capable of understanding various transport operations and collective effect of momentum, heat and mass transfer.

BE Chemical Engineering **Semester – VII**

Transport Phenomenon

(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. Transport phenomenon and Unit Operation. Equilibrium and Rate Processes. Fundamental variables. The role of Intermolecular forces. Simple Balance: Material and Energy.

Molecular transport Mechanism:

The Analogy. The Case of Heat Transfer. The Case of Mass Transfer. The Case of Momentum Transfer. The Analogues forms. Heat, Mass, Momentum Diffusivities. Thermal Conductivity. Diffusion Coefficient. Viscosity.

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

Viscosity and Mechanism of Momentum Transport. Velocity Distribution in Laminar Flow.

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

Thermal Conductivity and The Mechanism of Energy Transport. Temperature Distribution in Solids and in laminar Flow.

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

Diffusivity and Mechanism of mass Transport. Concentration Distribution in Solids and in Laminar Flow.

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

The Equation of Change for Isothermal System. The Equation of Change for Non-Isothermal System.

Textbooks:

1. R.B. Bird; W.E. Stewart; E.N. Lightfoot, Transport Phenomenon, John Wiley & Sons1994;Singapore
2. R.S. Brodsky & H.C. Hershey, Transport Phenomenon ,McGraw-Hill{International edition}

References:

1. C.O. Bennett & J.E. Myers; Momentum, Heat & Mass Transfer; McGraw-Hill, 1982.
2. James R. Welly, Charles E. Wicks & Robert E. Wilson; Fundamentals of Momentum, Heat& Mass Transfer {3rd edition}. John Wiley & Sons; Singapore.

Course Outline

Lab Process Dynamics & Control	**Lab PDC**	**CHP 710**
Course Title	Short Title	Course Code

Course Description:

This course illustrates practical aspect of process control and its application to chemical engineering. It describes various systems used in process control.

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

Prerequisite Course (s): Fluid Flow Operation, Process Calculations, Process Heat Transfer, Mass Transfer I & II, Instrumentation & Instrumental Analysis, Chemical Engineering Thermodynamics, Chemical Reaction Engineering-I .

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 completing this laboratory course are able to apply the knowledge of control theory for understanding the various processes, carried out in the Chemical Engineering Industry. The students demonstrate their ability of understanding the process control and its application by virtue of experimentation.

Course Content:

(Any eight experiments/assignments from the following)

List of Experiments/Assignments:

1. Dynamic behavior of Mercury Thermometer.
2. Dynamic behavior of Single Tank system.
3. Dynamic behavior of C.S.T.R.
4. Dynamic behavior of two tank non-interacting system.
5. Dynamic behavior of two tank interacting system.
6. Dynamic behavior of Mercury Manometer Second order system.
7. Dynamic behavior of Final Control Element.
8. Study of Controllers.
9. Study of closed loop control system.
10. Study of flow, temperature and pressure control systems.

References for Practicals:

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

Course Outline

Lab Chemical Reaction Engineering-II	**Lab CRE-II**	**CHP 711**
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 for heterogeneous chemical reactions, the mechanisms and theories of heterogeneous chemical reactions.

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

Prerequisite Course (s): Lab Applied Physical Chemistry, Lab. Mass Transfer I and II.

General Objectives:

1. To introduce and enhance the rate of non catalytic heterogeneous chemical reactions.
2. To study improvement in purity of ethanol using various reactive and extractive distillation.
3. To study absorption and adsorption processes for heterogeneous systems.

Learning Outcomes:

At the end of course students will able to understand how to enhance rate of non catalytic chemical reactions and how to use reactive and extractive distillation for improvement of purity of ethanol. The students learn how to use absorption and adsorption processes for heterogeneous systems.

Course Content:

(Any eight experiments/assignments from the following)

List of Experiments/Assignments:

1. To study the reaction of solid liquid system for an instantaneous reaction for benzoic acid NaOH and calculate the enhancement factor.
2. To study the isothermal decomposition of ethyl alcohol in tubular reactor packed with activated alumina catalyst.
3. To improve the % purity of commercially used ethanol using reactive distillation.
4. To improve the % purity of commercially used ethanol using extractive distillation.
5. To carry out the catalytic reaction to convert the nitrobenzene to aniline in presence of iron filling / HCl catalyst in the reactor.
6. To study the reaction of liquid-liquid system for butyl acetate - NaOH and to calculate the enhancement factor.
7. Absorption – to study the reaction of liquid gas system for NaOH – CO2 to determine rate of absorption.
8. Adsorption – to study the adsorption of Acetic Acid on charcoal.
9. Preparation of Butyl Acetate by Reactive Esterification.

References for Practicals:

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

Elective - I

Course Outline

Lab Biochemical Engineering	**Lab BCE**	**CHP 712**
Course Title	Short Title	Course Code

Course Description:

The course develops ability among the students to apply the principles of Chemical Engineering to Bioprocesses. They will learn to apply principles of process calculation, mechanical operations, mass transfer and Chemical reaction engineering to biochemical process and shall develop an ability to design bioreactors.

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

Prerequisite Course (s): Process calculation, Mechanical operations, Mass Transfer-I & II and Chemical Reaction Engineering –I.

General Objectives:

1. To apply material balances & energy balances to bioprocesses/unit operations involved in bioprocesses.
2. To study & calculate the rate of reactions, size of reactors, selection of reactors etc.
3. To determine the oxygen transfer coefficient.
4. To study instrumentation & process controls for bioprocesses.

Learning Outcomes:

1. Students will be able to apply material and energy balances to biochemical processes.
2. They will be able to select the proper bioreactor and calculate size of reactor.
3. They will be able to apply various instrumentation and control.
4. They will get acquainted with sterilization processes for liquids and air.

Course Content:

(Continuous Assessment will be based on the following assignment)

List of Assignments:

1. Material balances in Bioprocesses.
2. Energy balances in Bioprocesses.
3. Unsteady state Energy and Material Balances.
4. Bioreactors and numericals based on them.
5. Bioreactors in series and Bioreactors with recycle.
6. O_2 transfer coefficient and determination of K_La.
7. Sterilization of liquids and air.
8. Instrumentation and control in Bioprocesses.

References for Practicals:

1. Doran Pauline M. "Bioprocess Engineering Principles", Academic Press, an Imprint of Elsevier.
2. Editors: J. F. Richardson, D. G. Peacock, "Coulson's & Richardson's Chemical Engineering, Vol-III", Asian Books Pvt. Ltd. New Delhi
3. J.H. Backhurst&J.H.Harker, "Coulson's & Richardson's Chemical Engineering, Vol-V Asian Books Pvt. Ltd.
4. P.F.Stanbury, A.Whitaker&S,J.Hall, "Principles of Fermentation Technology", Aditya Book Ltd., New Delhi.

Elective - I

Course Outline

Lab Petrochemical Technology	**Lab PCT**	**CHP 713**
Course Title	Short Title	Course Code

Course Description:

This course describes how to determine the various physical and chemical properties of various petrochemicals.

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

Prerequisite Course (s): Applied organic chemistry, Applied physical chemistry, Mass transfer-I Mass transfer-II, Chemical Engineering processes-I, Chemical Engineering processes-II.

General Objectives:

1. To study various physical/chemical properties of petrochemicals
2. To study & analyze petrochemicals.
3. Application of physical & chemical data in various processes.

Learning Outcomes:

The students after completing the course will be able to determine the various physical and chemical properties of petrochemicals. The students will be able to design various unit operations for petrochemicals during experimental data.

Course Content:

(Any eight experiments/assignments from the following)

List of Experiments/Assignments:

1. Determination of Sulphur content of oil
2. Determination of Aromatic content of petrochemical
3. Determination of Refractive index of petrochemicals
4. Determination of Moisture content of petrochemical
5. Determination of Carbon residue of petrochemical
6. Determination of Cloud and pour point of petrol/diesel
7. Determination of Smoke point of fuel
8. Determination of Sediment content of crude oil / fuel oils
9. To study the water separability of petroleum products:
10. To study the Oxidation stability of gasoline /ATF

References for Practicals:

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

Elective - I

Course Outline

Lab Computational Fluid Dynamics	**Lab CFD**	**CHP 714**
Course Title	Short Title	Course Code

Course Description:

The incorporation of CFD (Computational Fluid Dynamics) as a possible solution to modern day fluid mechanics problems has become part of the daily life of many engineers along with the companies they work for. Major automobile manufacturers have incorporated CFD's in their design cycles. Usually, the main objective is to quantitatively estimate forces produced by flows around a specific structural component or to optimize the design of an individual part responding to forces originating from fluid dynamics.

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

Prerequisite Course (s): Fluid Flow Operation, Process Calculations, Mechanical Operation, Mass Transfer-I, Mass Transfer-II, Process Heat Transfer.

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 of flow processes, mass transfer and heat transfer and also the engineering approaches to deriving the design equations for complex transfer operations. The students are able to design and predict the major process parameters in flow processes. The students can use and analyze experimental data to derive the kinetic and process parameters with simple computing techniques. The students are able to develop an understanding for the major theories, approaches and methodologies used in CFD; The students will be able to build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modeling etc.) in using commercial CFD codes. The students will gain experience in the application of CFD analysis to real engineering designs.

<u>Course Content:</u>

(Any eight Experiments /assignments from the following)

List of Experiments/assignments:

1. Problems on Gauss-Siedel/Jacobi/TDMA.
2. Numerical simulation of quasi one dimentional nozzle flow.
3. Analysis of boundary layer over a flat plate. (Blasius equation)
4. Transient Conduction equation in 2 dimensions.
5. Convection-Diffusion Equation in 2 dimensions.
6. Analysis of internal flow.
7. Analysis of external flow: Aerofoil or similar shape.
8. Validation of natural convection in a square cavity.
9. CFD analysis of heat transfer in pin fin.
10. Study of different mesh generation schemes.

References for Practicals :

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

Elective - I

Course Outline

Lab Piping Design	**Lab PDSN**	**CHP 715**
Course Title	Short Title	Course Code

Course Description:

The laboratory course intended to develop ability amongst the student to understand need and importance of piping design and to evaluate actual piping system required for the process industries. The ability of students to translate piping design into the drawing of process flow diagrams, piping and instrumentation diagrams and utility flow diagrams using various drawing of pipe fittings, pipe joints, piping symbols, line symbols, valve symbols, equipment symbols and pressure relieving devices. It helps to understanding, critically evaluating, interpreting, and drawings the piping system based on economically feasible.

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

Prerequisite Course (s): Chemical Engineering Materials, Fluid Flow Operation, Process Calculations, Mechanical Operation, Process Heat Transfer, Mass Transfer I & II, Process Equipment Design I & II.

General Objectives:

1. To study how to draw and use pipe fittings.
2. To study how to draw and use pipe joints.
3. To study how to draw and use piping symbols.
4. To study how to draw and use line symbols.
5. To study how to draw and used valve symbols.
6. To study how to draw and use equipment symbols.
7. To study how to draw and use pressure relieving devices.

8. To study how to use given information to draw the Process flow diagram, Piping and instrumentation diagram and Utility flow diagram.

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 how to draw the piping system drawings along with importance of concepts of accuracy and precision. The students will develop an ability to communicate through the drawing transparently into a standard formats like process flow diagrams, piping and instrumentation diagrams and utility flow diagrams.The students will demonstrate interpersonal skills required to lead and will recognize the importance of life-long learning.

<u>Course Content:</u>

(Any five drawing sheets of half imperial size based on the following)

List of Drawings:

1. Pipe Fittings
2. Pipe Joints
3. Piping Symbols
4. Line Symbols
5. Valve Symbols
6. Equipment Symbols
7. Pressure Relieving Devices
8. Process Flow Diagram
9. Piping and Instrumentation Diagram
10. Utility Flow Diagrams

References for Practicals:

Textbooks:

1. M.W. Kellogg Co. Design of Piping system 1976
2. G. K. Sahu, Handbook of Piping Design
3. Sam Kannapan, P.E. Pipe Stress Analysis, Willey-Inter science Publications.
4. Roy A. Parisher, Robert A. Rhea, Pipe Drafting and Design, Gulf Professional Publishing,3rd Edition
5. Thakore/Bhatt, Introduction to Process Engineering and Design ,Tata McGraw-Hill Education, 2007
6. D. J. Deutsch, Process piping systems, , Chemical Engineering Magazine, McGraw Hill.

References Books:

1. M.L. Nayyar, P.E., Piping Handbook, 6th edition, McGraw-Hill, Inc
2. Johan J McKetta, Piping Design Handbook, CRC Press, 1992.

Course Outline

Project-I	**PROJ-I**	**CHP 716**
Course Title	Short Title	Course Code

Course Description:

The course intends to develop the abilities among students of providing research, industrial solutions and work in multidisciplinary subjects. The objective of the course is to apply the concepts of Chemical Engineering for providing green and clean technology.

	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, LAB Entrepreneurship, Minor Project.

General Objectives:

1. To identify, formulate, design and provide the solution to various chemical engineering problems.
2. To demonstrate the ability to perform the task with multidisciplinary teams.
3. To demonstrate the computational skills using various scientific techniques.

Learning Outcomes:

At the end of course students will be able to provide analytical, experimental solutions to meet the global challenges and will exhibit their ability to present an explanatory report. The course will reveal the abilities of the students to provide helpful keys for industrial and social safety and environmental issues and also will demonstrate the understanding of professional and ethical responsibilities.

BE Chemical Engineering **Semester – VII**

Project-I

(Course Content)

Teaching Scheme		**Examination Scheme**	
Practical	: 2 hours/ week	Internal Continuous Assessment (ICA)	: 25 Marks
		End Semester Examination (ESE) (OR)	: 25 Marks

Course Content:

- Every student shall undertake the Project-I in semester VII. It is expected that the broad area of Project-I shall be finalized by the student in the beginning of the VII semester and Minor project undertaken in VI semester may be a part of Project -I.
- Each student shall work on an approved project, a group of **05 students (maximum)** shall be allotted for the each Project-I and same group for Project-II.
- Project-I may involve some investigation of fabrication, design or investigation of a technical problem that may take design, experimental or analytical character or combine element of these areas. The project work shall involve sufficient work so that students get acquainted with different aspects of fabrication, design or analysis.
- Each group of students is required to maintain separate log book for documenting various activities of Project-I.
- The three member committee appointed by Head of the department shall be constituted for finalizing the topics of Project-I. Maximum four Project groups shall be assigned to one teaching staff.

Guidelines for Internal Continuous Assessment (ICA):

Assessment of the project for award of ICA marks shall be done jointly by the guide and departmental committee as per the guidelines given below.

Assessment Sheet for Project-I

Name of the Project: ____

Name of the Guide: ____

SN	**Exam Seat No**	**Name of Student**	**Project Selection Based on Literature Survey**	**Documentation**	**Design /Experimentation /Fabrication etc.**	**Presentation**	**Total Marks**
			10	05	05	05	25

Course Outline

Seminar-II	**SMNR-II**	**CHP 717**
Course Title	Short Title	Course Code

Course Description:

The course intends develop ability among the students to explore recent changes, development in the technologies, unified approach and improvement in the technical ability. The course aims to encourage students for communicating the technological developments formally and informally.

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

Prerequisite Course (s): Industrial Training/EDP/Special Study, Minor Project, Seminar-I.

General Objectives:

1. To develop technical and communication skills.
2. To build up the ability, to present the ideas by logical, lucid notional endorsement.
3. To develop an ability for understanding of professional and ethical responsibilities.

Learning Outcomes:

Students completing this course will demonstrate their ability to work by exploring the avenues of Chemical Engineering. It will bring on the knowledge of latest and future trends and developments in the field of Chemical Engineering and Allied Engineering branches. The students will be able to create and develop new ideas and commitment to reveal self education, social values through lifelong learning.

BE Chemical Engineering **Semester – VII**

Seminar- II

(Course Content)

Teaching Scheme
Practical: 2 hours/ week

Examination Scheme
Internal Continuous Assessment (ICA): 25 Marks

Course Content:

1	For Seminar-II every student will individually study a topic assigned to him / her and submit a report and shall deliver a Seminar on the topic during the semester - VII
2	The three-member committee appointed by Head of the department shall be constituted for finalizing the topics of Seminar-II. Seminar shall be related to present scenario of any challenges , innovations to meet the global standards of his choice approved by the committee
3	Seminar topic should not be repeated and registration of the same shall be done on first come first serve basis
4	Topic of Seminar shall be registered within a two weeks from commencement of Semester - VII and shall be approved by the committee
5	Maximum six seminar supervision shall be allotted to each teacher
6	At the end of semester, student should submit the seminar report (paper bound copy) in following format: a. Size of report shall be of minimum 25 pages. b. Student should preferably refer minimum five reference books / magazines/standard research papers. c. Format of Report i. Introduction ii. Literature survey iii. Theory 1) Implementation 2) Methodology 3) Application 4) Advantages, Disadvantages

	iv. Future scope v. Conclusion

Guidelines for Internal Continuous Assessment (ICA):

ICA shall be based on evaluation of student performance by a seminar presented by the student. 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.

Assessment Sheet for Seminar-II

Title of Seminar: ____

Name of Guide: ____

SN	Exam Seat No	Name of Student	Topic Selection	Literature survey	Report writing	Depth of understanding	Presentation	Total
			5	5	5	5	5	25

Course Outline

Industrial Visit	**IV**	**CHP 718**
Course Title	Short Title	Course Code

Course Description:

The course aims to provide general overview, trends and developments happening in the field of Chemical Engineering and Allied Industries. It aims to understand the Chemical Engineering Principles executed for economic and societal development. The visit aims to make them friendly about the industrial culture and managerial responsibilities.

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

Prerequisite Course (s): Chemical Engineering Processes-I, Chemical Engineering Processes-II, Industrial Economics & Management, Process Engineering Economics & Costing, Process Equipment Design-I & II

General Objectives:

1. To develop a desire for gaining, up-to-date knowledge about the Industrial development.
2. To identify the industrial problems and provide various Chemical Engineering Solutions.
3. To build up skilled, devoted engineers for societal growth.

Learning Outcomes:

At the end of this course, students will be aware of current and future trends of Chemical Industries. The students will be able to gain new knowledge, skills and various industrial procedures adopted for product development. It will help them to understand the challenges faced by the Industries and need of today's Chemical Engineering Industry.

Course Content:

Industrial Visit

- Student shall undergo industrial visit (3 industries) for a minimum period of one day during summer vacations between sixth semester and seventh semester.
- The industries in which industrial visit is taken should be a medium or large scale industry
- The paper bound report on training must be submitted by the student in the beginning of eighth semester along with a certificate from the company where the student took training.
- Every student should write the report separately.
- Institute / Department/T&P Cell have to assist the students for finding Industries for the visit.
- Students must take prior permission from Department before joining for Industrial visit.

OR

EDP (Entrepreneurship Development Program)

- Student has to participate in Entrepreneurship Development Program for a minimum period of One week during summer vacations between seventh semester and eighth semester.
- Every student must submit the paper bound report based on the program in the beginning of eighth semester along with a certificate (Course / Program completion) from the program organizers.
- Every student should write the report separately.
- Institute / Department may arrange Entrepreneurship Development Program at their campus.
- Students must take prior permission from Department before attending any Entrepreneurship Development Program.

OR

Special Study

- Student has to submit name of three topics of his interest to the department.
- Special study in a group shall not be allowed.
- The three-member committee appointed by Head of Department shall allot one topic out of the three topics submitted by the student.
- Every student must submit the paper bound report based on special study at the end of seventh semester.

- Department should allot guide to all such students, for monitoring their progress and guide them for literature survey / report writing etc.
- Evaluation of special study shall be done based on presentation made by student, followed by brief question answer session.

Assessment shall be based on the active participation of the students in the Industrial Training / EDP / Special study and based on knowledge / skill acquired by the student. The three-member committee appointed by Head of Department in consultation with the Principal shall assess the reports and award marks based on following:

(a) Report	10 marks.
(b) Presentation	10 marks.
(c) Viva-voce at the time of presentation	05 marks.

Total: 25 marks.

Syllabus

(With effect from 2015-16)

B.E. Chemical Engineering

Semester-VIII

Final Year Chemical Engineering

CGPA Pattern

Faculty of Engineering and Technology

North Maharashtra University, Jalgaon

Course Outline

Computer Aided Process Equipment Design Modeling & Simulation	**CAPEDMS**	**CHL 801**
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 & II, Process Heat Transfer, Mass Transfer-I & II.

General Objective:

1. To study the Shell and tube heat exchanger and batch reactor.
2. To study the Single Effect Evaporator and Distillation Column.
3. To study the absorption column and rotary dryer.
4. To study the lumped parameter model. Modeling difficulties in CSTR.
5. To study the modeling of constant hold up three CSTR in series.
6. To study introduce the chemical engineering simulation, and steps of simulation Process.
7. To study the Simulation of CSTR with second order irreversible exothermic reaction using Runga-Kutta Method.
8. To study the Modeling for Catalyst Decay in a CSTR.

Learning Outcomes:

At the end of the course students will be able to display the ability of using Chemical Engineering concepts in designing and providing computer aided solutions to various unit operations and unit processes. The students will demonstrate the computational skills using engineering softwares and also the ability to perform the task with multidisciplinary teams.

BE Chemical Engineering **Semester – VIII**

Computer Aided Process Equipment Design Modeling & Simulation

(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)	: 25 Marks

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

Computer Aided Design:

Shell and Tube Heat Exchanger. Basic Theory, Types of heat exchanger its major characteristics and application. The rating and sizing method and various steps of design of heat exchanger. Flow sheet of optimal design of heat exchanger. Kern Methods of shell and tube side Design. Total pressure drop Delta P_T, shell side pressure drop, Baffles and Tube arrangement, standard coding and its layout, Fluids in a shell and tube Heat exchanger. Double pipe heat exchanger. LMTD and correction factor and writing of C ++Program.

Batch Reactor -Isothermal and non-isothermal Heating and Cooling medium.

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

Computer Aided Design:

Single Effect Evaporator. (SEE) Boiling point rise and duhring Rule, hydrostatic head effect, Use of vacuum in evaporator system. Types of evaporator- single effect evaporator. Assumption of evaporator. Numerical based on single effect evaporator with C++ programs, difference of SEE and Multiple effect evaporator MEE).

Distillation Column: Steps of distillation column , material and energy balance, dew point and bubble point, MESH equation, Ideal binary distillation column, multicomponent non ideal distillation column, batch distillation with hold up, Relative volatility, Smoker equation and MacCabe- Thiele diagram, q-line equations and numerical on C++ program.

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

Computer Aided Design:

Absorption Column: Introduction, steps of designing absorption column. Types of packing, Rate of absorption, Height of column based on liquid film conditions, pressure drop and flooding co relation. Numerical based on C++ program

Rotary Dryer: Classification types of rotary dryers, rates of drying, Material Balance and Energy Balance of continuous rotary dryer. Numerical based on C++ program.

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

Introduction to Lumped Parameter Model.

Modeling of An Activated Sludge Process as a continuous Operation by Recycling Biological Sludge. Modeling Difficulties in C.S.T.R. (Isothermal and Non Isothermal). Modeling of Constant Hold up Three CSTR's in Series. Modeling of minimizing the yield of intermediate product. (Optimal residence time). Modeling for Evaluation of the Adiabatic Equilibrium Temperature. Modeling for Catalyst Decay in a Fluidized Bed Modeled as a CSTR.

Modeling for Evaluation of Conversion with Catalyst Decay in Batch Reactor.

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

Introduction of the Chemical Engineering Simulation. Simulation Language. When to Use Simulation? Steps of Simulation Process. Chemical Engineering Application of Simulation Techniques. Advantage and Limitation of Simulation Technique. Simulation of Ammonia Production System. Simulation of Catalyst Temperature by Newton-Raphson Method. Simulation of CSTR By Euler's Method. Simulation of CSTR with Second Order Irreversible Exothermic Reaction Using Runga-Kutta Method.

Textbooks:

1. W. L. Luyben , Process Modeling Simulation and Control for Chemical Engineers; McGraw Hill 1988.
2. B.C. Bhattacharya & C. M. Narayan, Computer Aided Design of Chemical Process Equipment: 1st Edition, 1992, NCBA, Calcutta.

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 Plant Design and Project Engineering	**CPDPE**	**CHL 802**
Course Title	Short Title	Course Code

Course Description:

This course describes to use appropriate terminology of chemical plant design and project engineering for possible commercialization of chemical plant. It illustrates role of chemical engineer in chemical plant design aspects with the project engineering.

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

Prerequisite Course (s): Applied Physical chemistry, Process Calculation, Process Heat Transfer, Chemical Reaction Engineering – I & II, Mass Transfer I & II, Process Equipment Design I & II.

General Objectives:

1. To study the role of Chemical Engineer in Chemical Plant Design.
2. To study the Development of the project.
3. To study the Process Design: Choice of process continuous Vs. Batch processing.
4. To study the Reactors for gas-liquid reactions.
5. To study the Preparation and Deactivation of catalyst.
6. To study the Determination of surface area and Pore volume of catalyst.
7. To study the solid catalyzed reactor.
8. To study the Diffusion and reaction in spherical catalyst pellets.
9. To study the design of Moving Bed Reactor, Fluidized Bed Reactor and Slurry Bed Reactor.
10. To study the design of Trickle bed reactors, Isothermal and Adiabatic fixed bed reactor.

Learning Outcomes:

At the end of the course students will understand the role of chemical engineer in chemical plant design. The students will apply their basic knowledge of mathematics, sciences and engineering to develop process design of chemical plant with appropriate plant layout and location by reducing the cost of piping and adopting the tool of management for planning, scheduling and controlling like PERT and CPM network analysis with overall safety for the sustainable plant design.

BE Chemical Engineering **Semester – VIII**

Chemical Plant Design and Project Engineering

(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 Engineering Plant Design and Project Engineering. The role of Chemical Engineer in Chemical Plant Design. Chemical Engineering Design, need for Plant Design, Process Design.

Development of the project: Evaluation of a process, process research, research evaluation, process development, preliminary engineering studies, pilot plant, semi-commercial plant, commercial plant and commercial plant design factors.

Technical factors, economic factor, safety considerations, legal phases, sources of information.

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

Process Design: Choice of process continuous Vs. Batch processing.

Process Equipments and Materials: Selection of Materials, Plan for Selection of Materials.

Selection of Process Equipments, Equipment selection procedures, standard versus special equipment.

Scale up method, types of flow sheet, development of process flow sheet from process information.

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

Plant Layout : Introduction, planning-layout, factors in planning-layout, methods of layout planning, area concept, two dimensional layouts, scale models, principles of plant layout, safety, utilities & material handling equipments , railroads and roads, etc. Plant layout for Benzene Hexachloride process.

Locating the Chemical Plant: Introduction, summary of factors in plant location. Economic location, plant location factors, raw material supply, market and transportation, power and fuel, water supply, temperature, plant measures for conservation of water, legal restriction, federal pollution act, climate, labour, community and site characteristics and waste disposal.

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

Site preparations and Structures: Introduction, Site Preparation, Surface Evaluation, Foundation and Shape of Foundation, Machinery and Equipment Foundations, Supports, Outdoor Plants, Selection Building types, Building design principles, Flooring , walls, Roof, safety and higher protection conditioning , heating and ventilation. Cost Consideration for Plant Sites and Structures

New Development in Management techniques (PERT & CPM).

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

Process Auxiliaries : Introduction, Piping, Explanation of CODES, Selection of Piping, Pipe strength, Wall thickness, Nominal Pipe Size (NPS), Criteria for Selection of Materials, Pipe sizing by ID, Choosing the final pipe size, Process steam piping, piping layout, piping insulation.

methods of providing flexibility for piping.

Textbooks:

1. F.C. Vilbrandt and C.E. Dryden, “Chemical Engineering Plant Design”, McGraw Hill, New Delhi.
2. Peter M. S. and K.D. Timmerhaus, “Plant Design and Economics for Chemical Engineers”, McGraw Hill.
3. Modes J. and Philips, Rheinhold, Project Engineering with CPM and PERT, Van Nostrand Reinhold Co., 1970

References:

1. Perry’s Chemical Engineer’s handbook, McGraw-Hill: New York, 2008

Elective-II
Course Outline

Industrial Pollution and Control | **IP&C** | **CHL 803**

Course Title | Short Title | Course Code

Course Description:

This course describes Industrial Pollution and its control by various methods such as physical, chemical and biological. It also includes information regarding Water (Prevention and Control of Pollution) Act, 1997, Air (Prevention and control of Pollution) Act, 1981.The design of water and air pollution control equipment is included in this course.

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

Prerequisite Course (s): Applied Physical Chemistry, Mechanical Operation, Applied Organic Chemistry and Environmental Science.

General Objective:

1. To study types of Pollution &Pollution control aspects.
2. To study Water (Prevention and Control of Pollution) Act,1997, Air (Prevention and control of
3. Pollution) Act, 1981.
4. To study Waste Water Treatment Processes.
5. To learn about removal of mercury& measurement of Mercury.
6. To study the removal of nitrogen by Physico-chemical processes and Biological methods
7. To study the treatment of Phenolic Effluents.
8. To learn about pollution control in fertilizer industry, petroleum and petrochemical units
9. To study the treatment of distillery waste.

Learning Outcomes:

Students will be able to understand the processes, pollution prevention and waste management techniques which is used in industry. Students will be able to know the types of processes that take place in industry and review the types of emissions that can occur. Students will understand the general activities and processes used in industries, the ways in which wastes are produced, pollution control and waste minimization techniques.

BE Chemical Engineering **Semester – VIII**

Industrial Pollution and Control

(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**

Types of Pollution. Introduction: Pollution control aspects. Environmental Legislation: Water (Prevention and Control of Pollution) Act,1997, Air (Prevention and control of Pollution) Act, 1981. Industrial Waste Water Analysis. Industrial Gaseous Effluent Analysis.

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

Introduction to removal of BOD, Biological oxidation units: Activated Sludge Process; Trickling Biological Filters; Waste Stabilisation Ponds. Anaerobic Treatment. Numerical Examples based on removal of BOD. Removal of Chromium. Introduction to removal of Chromium. Control Methods, Reduction precipitation, Ion Exchange, Reverse Osmosis, Lime coagulation and adsorption

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

Removal of Mercury: Introduction of removal of mercury, Measurement of Mercury, Ventron mercury removal process. Removal of ammonia/urea: Introduction to removal of ammonia/urea, Methods for removal of nitrogen, Physico-chemical processes, Biological methods

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

Treatment of Phenolic Effluents: Introduction to Treatments of Phenolic Effluents, Sources of phenols. Treatments/Removal Methods: Steam Gas Stripping. Adsorption/Ion Exchange; Extraction of phenols using Phenosolvants, Biological Methods of Treatment. Removal of particulate matter: Introduction to removal of particulate matter, Gravity settling chamber, solid traps, cyclone separators, fibre filters, fabric filters, liquid scrubbers and ESP. Numerical Examples based on settling chamber, cyclone separators, fiber filter and ESP.

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

Pollution control in process industries: Introduction to pollution control, Pollution control aspects of fertilizer industry: Introduction to pollution control in fertilizer industry. Removal of carbon in ammonia plant effluents by scrubbing with liquids using vacuum filtration, Removal of oil in ammonia plant effluents, Removal of hydrogen sulphide in ammonia plant effluents. Pollution control in petroleum and petrochemical units: Introduction Refinery Liquid based treatment methods: Oxidation pond treatment, disposal of sludges. Treatment of liquid effluents from petrochemical industries.

Textbooks:

1. S. P. Mahajan, Pollution control in process industries, Tata McGraw-Hill Publication.
2. M. N. Rao&A K. Datta, Waste Water Treatment: IBH Pub., Delhi.

References:

1. M. Narayana Rao and A.K.Datta,Waste water treatment ,Oxford and IHB publ. New Delhi.
2. Swamy AVN, Industrial Pollution Control and Engineering., Galgotia publications, 2005. Hyderabad.

Elective-II

Course Outline

Advanced Separation Techniques | **AST** | **CHL 804**

Advanced Separation Techniques	**AST**	**CHL 804**
Course Title	Short Title	Course Code

Course Description:

The objective of the course is to give a thorough understanding of the strategies employed for developing safe separation methods for the chemical analysis. The intention behind the course is to transmit the essential knowledge for critically evaluating the performance of an analytical procedure during chemical separations.

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

Prerequisite Course (s): Mass Transfer I & II, Mechanical Operations.

General Objective:

1. To introduce basics of separation techniques.
2. To learn Mechanism of Separation.
3. To learn Selection of separation processes.
4. To learn Azeotropic Distillation.
5. To learn Extractive Distillation.
6. To learn concept in super critical fluid extraction.
7. To learn Phase equilibria characteristics.
8. To study enhanced distillation & reactive distillation techniques.
9. To study membrane separation processes.
10. To study Biochemical separation processes.

Learning Outcomes:

At the end of the course students will gain a fundamental understanding of the theoretical basis of analytical separation process in terms of equilibrium and thermodynamic driving forces, and other physical chemical aspects of separations. Students will also gain practical knowledge of experimental methods and analytical instrumentation for carrying out analytical separations using gas and liquid chromatography. Students will also understand and will be able to apply distillation, extraction, and solid phase extraction for sample cleanup prior to chromatographic methods. Students will be able to select and apply appropriate separation methods to the analysis of real world problems. Students will learn meaningful interpretation of data from analytical separation method and they will understand approaches for the validation of analytical methods based on separations.

BE Chemical Engineering **Semester – VIII**

Advanced Separation Techniques

(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**

Separation Processes: Industrial Chemical Processes, Mechanism of Separation.

Separation by phase addition or creation. Separation by barrier. Separation by solid agent. Separation by external field or gradient. Component Recoveries and product purities. Separation power. Selection of feasible separation processes.

Crystallization from the melt: Introduction.

Progressive freezing: component Separation by progressive freezing, Pertient variables in progressive freezing. Applications.

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

Enhanced distillation: Introduction. Azeotropism.

Azeotropic distillation: Introduction, exploitation of homogeneous azeotropes, exploitation of pressure sensitivity, exploitation of boundary curvature, Exploitation of azeotropy and liquid Extractive distillation: Introduction, solvent effect in extractive distillation, extractive distillation, design and optimization, solvent screening and selection extractive distillation by salt effects.

Reactive distillation: Introduction, simulation, modeling and design feasibility, Mechanical design and implementation issues, process applications.

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

Supercritical fluid separation processes: Introduction. Physical properties of pure supercritical fluids; thermodynamic properties and transport properties. Process concept in super critical fluid extraction. Phase equilibria: Liquid- Fluid equilibria, Solid- Fluid equilibria, Polymer- Fluid equilibria and the Glass Transition, Cosolvents and surfactants, phase equilibria models.

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

Ultra filtration: Process description, UF membranes, membrane characterization, process limitations, process configurations, Energy requirements, Design and economics.

Microfiltrations: process description, Examples, MF membranes, membrane characterization, process limitations, Equipments configurations, process Applications and Economics.

Gas- Separations membranes: Process descriptions, examples, Basic principles of operations, selectivity and permeability, Gas- Separation membranes, membrane system design features, energy requirements and economics.

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

Biochemical separation processes: Introduction.

Initial product harvest and concentration: centrifugation, Filtration, Selection of cell separation Unit operation, Cell disruption, protein refolding.

Initial purification: Precipitation, Extraction, Adsorption, Membrane processes.

Final Purification and product formulation.: Chromatography, Lyophilization and drying.

Integration of fermentation and downstream processing operations.

Textbook:

1. Richardson and Coulson, Chemical Engineering, Vol. II, Butterworth-Heinmann (Elsevier) (Fifth Edition).

References:

1. Perry Robert H. and Green Don W. Perry’s chemical Engineers Handbook 7th edition. McGraw Hill Publication, New York.
2. Seader J. D. and Henley Ernest J, Separation Process Principles. John Wiley and Sons, Inc, New York.
3. Ladisch Michael R., Bioseparations Engineering, Principles, Practice and Economics, Wiley Interscience, John Wiley and Sons, Inc. Publications New York.
4. Long Robert B. Separation Process in Waste Minimization .Marcel Dekker, Inc, New York.

Elective-II

Course Outline

Polymer Technology	**PT**	**CHL 805**
Course Title	Short Title	Course Code

Course Description:

The main objective of this course is to equip students with scientific knowledge and technical skills that are in line with current advancements in the field of polymer and related industries.

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

Prerequisite Course (s): Applied organic chemistry

General Objective:

1. To introduce basics of polymer science & technology.
2. To study the importance of molecular weight & its determination.
3. To study the glass transition temperature & its relation with molecular weight of polymers.
4. To study the different thermal analysis techniques & mechanical properties of polymers.
5. To study the different polymer processing techniques.
6. To study the manufacturing techniques of industrially important polymers.

Learning Outcomes:

At the end of the course Students will understand the significance of molecular weight and thermal analysis in polymer processing & technology, fundamental aspects of polymer science and engineering both from an academic and an industry point of view and able to identify the different polymer processing techniques useful for manufacturing finished desired plastic articles. The students will also learn how to translate the scientific knowledge into development of products.

BE Chemical Engineering **Semester – VIII**

Polymer Technology

(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 polymers and their classification, functionality, oligomer, polymer , repeating units, Types of polymerization. Addition Polymerization, Condensation Polymerization. Mechanism of polymerization. Bulk, solution, suspension and emulsion polymerization techniques. Co-polymerization.

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

Molecular weight & degree of polymerization, Significance of molecular weight of polymers, Average molecular weight and molecular weight distribution in polymers, measurements of number, average by Cryoscopy; Ebulliometry, Membrane osmometry, Vapor pressure osmometry and End group analysis. Measurement of viscosity, average molecular weight by viscometry.

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

Glass transition temperature, Factors influencing glass transition temperature, Glass transition temperature & molecular weight, Glass transition temperatures & plasticizers. Thermal analysis of polymer by differential scattering calorimeter; TGA, TMA and HDT. Mechanical properties like tensile strength, Young’s Modulus, hardness, etc.

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

Polymer processing& techniques, Compounding, Calendaring, Die casting, Rotational casting, Film casting, Injection moulding, Blow moulding, Extrusion moulding, Thermoforming, Foaming.

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

Properties, applications and manufacturing techniques of Polyethylene, Polypropylene, PVC, Phenol formaldehyde, Urea formaldehyde, Epoxy polymers, Styrene-Butadiene rubber (SBR), Nylon-6, 6 , Viscose Rayon.

Textbook:

1. V. R. Gowarikar, N. V. Vishwanathan, JaydevSreedhar, Polymer Science; New Age International (P) Limited, New Delhi.

References:

1. B. K. Sharma, Polymer Science, Goel Publishing House; Meerut
2. Malcolm P. Stevens, Polymer chemistry, Oxford university press
3. Fried W. Billmeyar, Text book of polymer science, John Willey and Sons
4. M. Gopalarao, Dryden’s Outlines of Chemical Technology; 3rd edn; East West Press.

Elective-II

Course Outline

Oil Technology	**OIT**	**CHL 806**
Course Title	Short Title	Course Code

Course Description:

The purpose of this course is to expose students to the oils and fats methods used in industries and research. This course prepares the student to take up such challenges in his profession and understand important principles and present economic principles and their applications in the field of Chemical Engineering and Technology

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

Prerequisite Course (s): Fluid Flow Operation, Mass Transfer –I, Process Heat Transfer, Mass Transfer-II, Chemical Reaction Engineering –I & II.

General Objective:

1. To introduce concepts of importance of oils, fats and waxes.
2. To study scales of production various oils and its plant capacity.
3. To study presence of adulteration in other vegetable oils
4. To study factors affecting solvent extraction plant and VOR
5. To study methods of vegetable oil refining
6. To study the bi products from refining.
7. To study various analysis of oils, soaps and detergents.
8. To estimate optimum time and utility for production
9. To study the safety during processes.

Learning Outcomes:

At the end of the course students will be able to understand the various factors responsible for establishing a chemical industry such as SEP, VOR, Soap & detergent industries. The students will be capable of applying their process engineering knowledge by allocating resources to obtain maximum productivity.. The students will exhibit their ability to identify, formulate, and solve engineering problems during productions.

BE Chemical Engineering **Semester – VIII**

Oil Technology

(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**

What are oils, Fats and Waxes?. Fatty acid composition and classification of oil and fats, sources, types, nomenclature, structures ,Non-glycerides, constituents and their importance, toxic constituents and detoxification. Physical and Chemical characteristics of Groundnut oil, Cottonseed, sunflower, soybean oil, linseed oil, rice bran oil. Utilization of Fats and oil in soap and oleo chemical Industries.

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

Chemical reactions of fats and fatty acids like dehydration, sulphation & sulphonation, esterification, interesterification, hydrolysis and hydrogenation, Isomerisation and polymerization, Nutritional significance of oils and fats. Waxes, Oxidation, Autoxidation, Rancidity, Antioxidants, etc.

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

Elementary analysis of oils ,fats and waxes, Physical and Chemical analysis of oils and fats, thiocyanogen value, acetyl and hydroxyl values, peroxide value, Reichert Meissel, Polenske and Kirschner values etc. Thin layer, column and Gas liquid chromatography; BIS. standards for oils and oil cakes, detection of adulteration in oils and fats.

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

Manufacture of soaps and detergents. Liquid Detergents, Industrial applications of surfactants. Manufacture and analysis of butter, Margarine, vanaspati and other fat blends, Analysis of soaps and detergents, BIS standards for soaps and detergents, Classification of surfactants, Raw materials for soaps and detergents,

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

Mechanical and solvent extractions of oils, Degumming, Refining, Bleaching, Deodorization of oil and fats, hydrogenation and Vanaspati, cooking and salad oils, Confectionary fats, Animal Fats, Oleo chemicals : Production and Separation of fatty acids, Glycerol –recovery and uses, Bio- diesel, Types of Varnish, Alkyd resins, etc.

Textbooks:

1. Bailey's A. E, Industrial oils and Fats ,Edition 6, Vol. I, II and III, Edited by Feireidoom Shahidi (2005).
2. Break and Bhatia, Handbook of Industrial Oil and Fat Products, CBS Publishers and Distributors, New Delhi. Vol 1 to 4.
3. NIIR BOARD, Hand book on Soaps, Detergents and acid Slurry, 2nd Edition , Publisher- Asia Pacific Business Press Inc., Delhi.
4. NIIR BOARD, Hand book on Herbal Products, 2 vols. Publisher- Asia Pacific Business Press Inc., Delhi.
5. NIIR BOARD, Essential oil Hand book, Publisher- Asia Pacific Business Press Inc., Delhi.
6. Fryer Perecival Technical Hand book of oils, fats and waxes, Vols 2, published by, Cambridge University Press.

References:

1. Technical Hand book of oils, fats and waxes, Vols 2, published by, Cambridge university, Press.
2. Devidson , Synthetic Detergent and Analysis , Published by John Wiley.I

Elective-III

Course Outline

Mathematical Methods in Chemical Engineering	**MMC**	**CHL 807**
Course Title	Short Title	Course Code

Course Description:

The Course consists of mathematical methods used in Chemical Engineering. It includes various methods for Root Finding, Solution of Simultaneous Linear Equation also it includes Solution of L.P.P. by Analytical Method and Graphical Method. Students will also learn about Chemical engineering optimization.

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

Prerequisite Course (S): Engineering Mathematics- I, II, III, Process Equipment Design-I & II.

General Objectives:

1. To introduce basic methods, to solve mathematical problems.
2. To learn how to develop numerical methods and estimate numerical errors.
3. To choose the most appropriate numerical method for its solution based on characteristics of the problem.
4. Identify and classify the numerical problem to be solved.
5. Analyze the accuracy of the numerical solution and identify alternate strategies and methods to achieve greater accuracy when it is needed.
6. To develop an ability to identify chemical engineering problems.
7. Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.

8. Formulate and solve process design problems, based on economic analysis and using mathematical models of chemical processes.
9. Optimum design of chemical processing equipment and plants.
10. Allocation of resources or services among several activities to maximize the benefit.

Learning Outcomes:

By the end of the course the students will reveal an ability to apply knowledge of mathematics, science, and engineering to design , analyze and interpret data which is used for designing a system, component, or process to meet desired needs within economic constraints. Students exhibit their ability to identify, formulate, and solve engineering problems using Root finding methods, higher-order Root finding Methods such as Newton’s method, Newton-Raphson's method. Using Interpolation & Extrapolation students will apply the knowledge of mathematical technique to solve industrial problems. The students will demonstrate the ability of formulating and solving the LPP and will provide optimum equipment design.

BE Chemical Engineering **Semester – VIII**

Mathematical Methods in Chemical Engineering

(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**

Root Finding Methods : Bisection Method, Regula-falsi Method, Newton-Raphson Method, Direct Integration Method, Muller's Method.

Solution Of Simultaneous Linear Equation: Gauss Elimination Method, Matrix Inversion Method, Gauss Jordan Method, Jacobi's Iteration Method, Gauss Seidal Method.

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

Interpolation & Extrapolation: Newtons-Gregory Forward Interpolation Formula, Newtons-Gregory Backward Interpolation Formula, Stirling's Formula, Central Difference Interpolation Formula, Choice of an Interpolation Formula.

Linear Programming (L.P.): Introduction to L.P., Formulation of L.P. Problems (L.P.P)/L.P. Models.

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

Solution of L.P.P. by Analytical Method (containing two variables), Solution of L.P .P. By Graphical Method. Solution of L.P.P. with application of simplex technique.

Chemical Engineering Optimization-I : The Optimum Diameter To height ratio for Large Oil Storage Vessel for Cost Minimization, Optimization of dimensions of an open rectangular Tank.

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

Chemical engineering optimization-II: Optimization of diameter and length of heat exchanger, Optimization of outlet temperature for counter-current arrangement in heat exchanger, Optimum thickness of insulation, Optimum (economical) pumping temperature for pumping of oil, Optimization of dimension of rotary dryer, Optimum dimensions and optimum outlet temperature of air preheater.

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

Chemical engineering optimization-III: Optimization of kinetics of consecutive reactions.
Optimum residence time for maximum yield in ideal isothermal batch reactor, optimization in refinery blending operation, optimization to get maximum yield with respect to reactor volume, optimization of dimensions of straight rectangular Fin, Optimum proportions of a pressure vessel, optimum size of pressure vessels.

Textbooks:

1. T.F. Edgar and B.M. Himellblau, Optimization of Chemical Processes, International Edition. McGraw Hill, 1989.
2. P.K. Gupta and D.S. Hira, Operation research 1st edition reprint, S. Chand & Company NewDelhi.1997.
3. B.S. Grewal Numerical Methods In Engg. & Science, Khanna Publications; Delhi.
4. G.K.Roy, Solved Problems In Chemical Engg, Khanna Publications, New Delhi.
5. S.D. Dawande, Process Equipment Design (Vol. I & II), Denett & Co., Nagpur.
6. B.C. Bhattacharya, Introduction to Chemical Equipment Design (Mechanical Aspects), CBS Publisher and Distributors, New Delhi.

References:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publisher,New Delhi
2. S. Pushpavanam, Mathematical Methods in Chemical Engineering, PHI Learning Pvt. Ltd.
3. S.S. Sastry, Introduction To methods Of Numerical Analysis, Prentice Hall.
4. Jenson V.G., Jeffreys G.V., Mathematical Methods in Chemical Engineering, Elsevier Publications.

Elective-III

Course Outline

Advance Catalysis	**AC**	**CHL 808**
Course Title	Short Title	Course Code

Course Description:

This course describes to use appropriate terminology of application of advance catalysis for possible commercialization of chemical processes. It illustrate show a chemical engineer is able to use his know how in development of chemical processes using advance catalysis.

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

Prerequisite Course (s): Applied Physical Chemistry, Mechanical Operation, Chemical Engineering Thermodynamics, Chemical Reaction Engineering – I & II, Mass Transfer I & II, Process Equipment Design I & II.

General Objectives:

1. To study the Homogeneous and Heterogeneous Catalysis.
2. To study the Catalyst Components and Catalyst treatment.
3. To study the Introduction, Definition, Advantages and Application of Supported Catalysts.
4. To study the Design and Development of Supported Catalysts.
5. To study the Regeneration of Catalysis: Fluid Catalytic Cracking Unit.
6. To study the Regeneration Processes.
7. To study the Catalysis in Petroleum Industries.
8. To study the Catalysis in Petrochemical Industries.
9. To study the Introduction, Importance and Types of biocatalysts.
10. To study the Classification of Microbial Cell and Methods and Techniques of immobilization.

Learning Outcomes:

Through this course, Students will be capable to study heterogeneous catalysis, kinetics of elementary steps, overall reactions, and evaluation of kinetic parameters with the tools, skills and knowledge and will be able to apply advanced reactive systems analysis. Students will be able to do the technical and economic evaluation of chemical processes and operations. The course will develop the ability of students to apply the theory of catalysis to various chemical industries.

BE Chemical Engineering **Semester – VIII**

Advance Catalysis

(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**

Catalysis: Introduction, History.

Homogeneous Catalysis: Introduction, Characterization of solution Processes, Examples of solution catalysis: Acid – base catalysis, Organometallic Catalysis.

Heterogeneous Catalysis: Introduction, Characterization of Surface Processes, Properties of Solid Catalysts, Influence of Mass Transport on Catalyst Performance.

Catalyst Components: Catalytically active species, Supports, Binders, Promoters.

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

Supported Catalysts: Introduction, Definition of Supported Catalysts. Advantages of Supported Catalysts: Separability, Cost, Catalyst activity, Catalyst Selectivity.

Support Materials for the Catalyst, Composition, Size and Shape, Surface Area., Porosity and Pore size. Attrition Loss, Density, Cost and quality.

Design and Development of Supported Catalysts: Preparation and Manufacture, Catalyst Preparation Methods, Catalysts from Physical Mixtures, Impregnated Catalysts, Ion exchange Catalysts. Testing and evaluation of Supported Catalysts, Application of Supported Catalysts.

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

Regeneration of Catalysts:

Fluid Catalytic Cracking Unit: Process Description, Heat Balance, Coke formation, Coke burning, CO Combustion, Environmental aspects. Regenerator Operating Parameters. Influence of Regenerator design on Catalyst Fluidization, Equipment/Unit Operation in Cracking Units.

Noble and Base Metal Catalysis: Noble Metal Catalysis, Deactivation, Regeneration,Regeneration Processes such as continuous Catalyst Regeneration, Fixed Bed Semi Regenerative Process, Cyclic or swing, Reactor for regeneration. Base Metal Catalysis: Process and Catalyst Description.

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

Catalysis in Petroleum and Petrochemical Industries:

Applications of zeolites in Petrochemical Refining. Improving quality of Petroleum fuels throughCatalysis. O-xylene isomerization over Nickel containing SAPO-5 molecular sieves.Pd-sulfonatedPolysiloxane catalyst for etherification of FCC light gasoline. Oxidation of Ethylbenzene catalyzed by Soluble Cobalt (III) complexes. Comparative evaluation of various catalysts used for removal of NOx from air streams.

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

Biocatalysts: Introduction and importance of biocatalysts. Type of biocatalysts.

Enzymes: Definition, Sources of Enzymes, production of Enzymes. Formation of enzyme substrate complex.Applications.

Simple enzyme kinetics.Derivation of Michaelis Menten equation. Evaluation of parameters of Michaelis Menten equation. Effect of Temperature and pH on enzyme Kinetics.

Microbial Cell: Classification of cells. Requirement for the growth of cells and growth Media.

Textbooks:

1. Bhattacharya KG and Talukdar A K, Catalysis in Petroleum and Petrochemical Industries. Narosa Publishing House, New Delhi.
2. Richardson J.F. and Peacock D.G. Richardson and Coulson's, Chemical Engineering, Volume-III, Asian Books Pvt. Ltd., New Delhi.
3. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals; McGraw Hill Publication.

References:

1. Kirk Othmer, Encyclopedia of Chemical Technology, 4th edition, Volume-V. John Wiley and sons New York.

Elective-III

Course Outline

Plant Utility	**PU**	**CHL 809**
Course Title	Short Title	Course Code

Course Description:

This course covers the requirement of different utilities for the process plant, along with its generation and its effective utilization. Main utilities required for processes are water, steam, air and refrigeration. Steam and non- steam heating media are important for conversion of raw material to products in reactors and to elevate the temperature in the chemical processes. Refrigeration is important to maintain the temperature in the process plant. Compressed air, process air is used in processes & in instrument air is used in pneumatic devices & controls.

	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, Chemical Engineering Thermodynamics.

General Objectives:

1. To study Steam generation and its application in chemical process plants.
2. To study types of compressors and vacuum pumps & method of vacuum development
3. To understand characteristics of refrigeration system& production of liquid N_2 and O_2.
4. To understand basic calculations involved in steam generation and refrigeration
5. To study cryogenics used in chemical process plant
6. To understand insulation for meeting the process equipment requirement
7. To study Properties, use, Sources and methods of generation of inert gases

Learning Outcomes:

After successful completion of course the student will be able to understand and identify different utilities required for chemical plants and criteria for selecting the equipments. Students demonstrate the ability to perform the task by identifying, formulating, designing and providing the various chemical engineering utilities.

BE Chemical Engineering **Semester–VIII**

Plant Utility

(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**

Steam: Steam generation and its application in chemical process plants, Design of efficient steam heating systems, Steam economy, condensate utilization, steam traps, Selection and application, waste heat utilization.

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

Compressors And Vacuum Pumps: Types of compressors and vacuum pumps, Methods of vacuum development and their limitations , Materials handling under vacuum, piping systems , Lubrication in compressors and pumps.

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

Refrigeration Systems: Refrigeration system and their characteristics, cryogenics, the characteristics and production of liquid N_2 and O_2. Load calculation, humidification and de-humidification equipments. Drying and cooling tower.

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

Insulation: Importance of insulation for meeting for the process equipment .Fitting and valves Insulation for high, intermediate, low temperatures .Determination of optimum insulation thickness.

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

Inert Gases: Properties of inert gases & their use , Sources and methods of generation . Comparison of nitro generation routes .Operational, maintenance and safety aspects.

Textbooks:

1. Jack Broughton, Process utility systems, Institution of Chemical Engineers U.K.
2. Reid, Prausnitz Poling; The properties of gases & liquids, IV^{th} ed. McGraw Hill international edition.
3. S.C. Arora& S. Domkumdwar; A course in refrigeration and air conditioning; Dhanpat Rai & Co. (P)Ltd.
4. Stoccker, W.F., Refrigeration and Air Conditioning, Mc-Graw Hill, 1983.
5. Jorgenson, R., Fan Engineering, Buffalo Rorge Co., 1983.

References:

1. Lyle, O., Efficient Use of Steam, HMSO, 1974.

Elective-III

Course Outline

Intellectual Property Rights	**IPR**	**CHL 810**
Course Title	Short Title	Course Code

Course Description:

This course is introduced for learning the basic fundamentals of Intellectual property rights and Entrepreneurship to undergraduate students. The goals of the course are to understand the basic knowledge of intellectual property rights, trademarks, chemical safety & chemical ethics and entrepreneurship.

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

Prerequisite Course (s): 12^{th} Std. Science and SE and TE Chemical Engineering Courses.

General Objectives:

The objective of the course is to provide the basic knowledge of IPR and Entrepreneurship, Intellectual property, trademarks, chemical safety and entrepreneurship

Learning Outcomes:

After successful completion of this course the students will be able to choose which type of IPR they should apply for. The course will help to understand various ethical issues regarding the field and Aspects of Studying Intellectual Property Rights students will able to adopt environment friendly approach industrially. Student will able to understand the basics of marketing management. A commitment to reveal self education, social values by providing the services to society through lifelong learning.

BE Chemical Engineering **Semester–VIII**

Intellectual Property Rights

(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**

Overview of Intellectual Property: Introduction and the need for intellectual property right (IPR), IPR in India – Genesis and Development, IPR in abroad, some important examples of IPR. Patents: Macro economic impact of the patent system, Patent and kind of inventions protected by a patent, Patent document, How to protect your inventions? Granting of patent, Rights of a patent, How extensive is patent protection? Why protect inventions by patents?

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

Searching a patent, Drafting of a patent, Filing of a patent, The different layers of the international patent system (national, regional and international options), Utility models, Differences between a utility model and a patent? Trade secrets and know - how agreements.

Copyright- What is copyright? What is covered by copyright? How long does copyright last? Why protect copyright?

Related Rights **-** What are related rights? Distinction between related rights and copyright? Rights covered by copyright?

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

Trademarks: What is a trademark? Rights of trademark? What kind of signs can be used as trademarks? Types of trademark, Function does a trademark perform, How is a trademark protected?
How is a trademark registered? How long is a registered trademark protected for? How extensive is trademark protection? What are well-known marks and how are they protected? Domain name and how does it relate to trademarks?

Geographical Indications: What is a geographical indication? How is a geographical indication protected? Why protect geographical indications?

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

Industrial Designs: What is an industrial design? How can industrial designs be protected? What kind of protection is provided by industrial designs? How long does the protection last? Why protect industrial designs?

New Plant Varieties: Why protect new varieties of plants? How can new plants be protected? What protection does the breeder get? How long do the breeder's rights last? How extensive is plant variety protection?

Unfair Competition: What is unfair competition? Relationship between unfair competition and intellectual property laws?

Enforcement of Intellectual Property Rights: Infringement of intellectual property rights. Enforcement Measures

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

Intellectual Property: Overview of Biotechnology and Intellectual Property, Biotechnology Research and Intellectual Property Rights Management, Licensing and Enforcing Intellectual Property, Commercializing Biotechnology Invention, Case studies of Biotechnology, Case studies of patents in other areas

Textbooks:

1. T. M Murray and M.J. Mehlman, Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons 2000.

References:

1. P.N. Cheremisinoff, R.P. Ouellette and R.M. Bartholomew, Biotechnology Applications and Research, Technomic Publishing Co., Inc. USA, 1985.
2. D. Balasubramaniam, C.F.A. Bryce, K. Dharmalingam, J. Green and K. Jayaraman, Concepts in Biotechnology, University Press (Orient Longman Ltd.), 2002.

3. Bourgagaize, Jewell and Buiser, Biotechnology: Demystifying the Concepts, Wesley Longman, USA, 2000.
4. Ajit Parulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd, 2006.
5. B.L.Wadehra; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000.
6. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010.

Course Outline

Lab Computer Aided Process Equipment Design Modeling & Simulation	**Lab CAPEDMS**	**CHP 811**
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. The intent of this course is to help to understand concepts in modeling of process equipment design.

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

Prerequisite Course (s): Process Equipment Design-I, Process Heat Transfer, Mass Transfer-I, Chemical Reaction Engineering-I & II.

General Objective:

1. To study the Shell and tube heat exchanger and batch reactor.
2. To study the Single Effect Evaporator and Distillation Column.
3. To study the absorption column and rotary dryer.
4. To study the lumped parameter model. modeling difficulties in CSTR.
5. To study the modeling of constant hold up three CSTR in series.
6. To study introduce the chemical engineering simulation, and steps of simulation Process.
7. To study the Simulation of CSTR with second order irreversible exothermic reaction using Runga-KuttaMethod.
8. To study the Modeling for Catalyst Decay in a CSTR.

Learning Outcomes:

At the end of the course students will be able to display and demonstrate the ability of using Chemical Engineering concepts in designing and providing computer aided solutions to various unit operations and unit processes with the help of C/C++. The students will demonstrate the computational skills using engineering software's and also the ability to perform the task with multidisciplinary teams.

Course Content:

List of Practical Experiments:

1. Computer aided design of shell & tube heat exchanger.
2. Computer aided design of single effect evaporator.
3. Computer aided design of rotary dryer.
4. Simulation of ammonia production system.
5. Simulation of catalyst temperature by Newton Raphson method.
6. Simulation of Reactor Design.
7. Computer control heat exchanger.
8. Computer Aided Design of absorber.

References:

1. W. L. Luyben , Process Modeling Simulation and Control for Chemical Engineers; 1988 McGraw Hill.
2. B.C. Bhattacharya & C. M. Narayan, Computer Aided Design of Chemical Process Equipment : 1st Edition, 1992, NCBA, Calcutta.

Note: Students can use only C And / Or C++ Programming Language for the Above Syllabus.

Lab Chemical Plant Design and Project Engineering	**Lab CPDPE**	**CHP 812**
Course Title	Short Title	Course Code

Course Description:

This course illustrates practical aspect of chemical plant design and project engineering and its application to start the commercial plant. It helps the students to understand various processes used in industries. It illustrates role of chemical engineer in chemical plant design aspects with the project engineering.

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

Prerequisite Course (s): Applied Physical chemistry, Process Calculation, Process Heat Transfer, Chemical Reaction Engineering – I & II, Mass Transfer I & II, Process Equipment Design I & II, Process Engineering Economics & Costing, Industrial Economics & Management

General Objectives:

1. To accustom the students' skills with the development of the project
2. To develop skills in students for the process design.
3. To provide the students with fundamental theoretical concepts and practical analysis skills associated with plant layout and piping.
4. To provide the students with fundamental theoretical concepts and practical analysis skills associated with network analysis using PERT and CPM method for planning, scheduling and controlling chemical projects.

Learning Outcomes:

At the end of the course students will understand the role of chemical engineer in chemical plant design. The students will apply their basic knowledge of mathematics, sciences and engineering to develop process design of chemical plant and also display the research by designing, conducting, interpreting and analyzing experimental data for preparing reports with appropriate plant layout and location by reducing the cost of piping and adopting the tool of management for planning, scheduling and controlling like PERT and CPM network analysis with overall safety for the sustainable plant design.

<u>Course Content:</u>

(Any five Drawing sheets of half imperial size /Assignments/Experiments based on above syllabus)

List of drawing sheets:

1. Process flow diagram of Manufacturing of Benzene Hexa Chloride (BHC)
2. Process flow diagram of Manufacturing of Nitric Acid
3. Plant Layout for Manufacturing of Benzene Hexa Chloride (BHC)
4. Plant Layout for Manufacturing of Nitric Acid
5. Piping diagram for Manufacturing of Nitric Acid
6. Piping diagram for Manufacturing of Benzene Hexa Chloride (BHC)
7. Network Analysis Numerical : PERT & CPM

References:

1. F.C. Vilbrandt and C.E. Dryden, Chemical Engineering Plant Design McGraw Hill, New Delhi.
2. Peter M. S. and K.D. Timmerhaus, Plant Design and Economics for Chemical Engineers. McGraw Hill.
3. Modes J. and Philips, Rheinhold, Project Engineering with CPM and PERT, Van Nostrand Reinhold Co., 1970
4. Perry’s Chemical Engineer’s handbook, McGraw Hill : New York, 2008

Elective-II

Course Outline

Lab Industrial Pollution Control	Lab IPC	CHP 813
Course Title	Short Title	Course Code

Course Description:

This course illustrates practical aspect of Industrial Pollution Control in chemical plant and its need in industries. It helps the students to understand various processes used in treatment of waste in industries.

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

Prerequisite Course (s): Applied Physical chemistry, Biochemical Engineering, Process Calculation, Process Heat Transfer, Chemical Reaction Engineering – I & II, Mass Transfer I & II, Process Equipment Design I & II.

General Objectives:

1. To study types of Pollution &Pollution control aspects.
2. To study Water (Prevention and Control of Pollution) Act, 1997, Air (Prevention and control of Pollution) Act, 1981.
3. To study Waste Water Treatment Processes.
4. To learn about removal of mercury& measurement of Mercury.
5. To study the removal of nitrogen by Physico-chemical processes and Biological methods.
6. To study the treatment of Phenolic Effluents.
7. To learn about pollution control in fertilizer industry, petroleum and petrochemical units.
8. To study the treatment of distillery waste.

Learning Outcomes:

Students will be able to understand the processes, pollution prevention and waste management techniques which is used in industry. Students will be able to know the types of processes that take place in industry and review the types of emissions that can occur. Students will understand the general activities and processes used in industries, the ways in which wastes are produced pollution control and waste minimization techniques.

Course Content:

(Any Eight Experiments/Assignments from the following)

List of Experiments:

1. Determination of dissolved oxygen.
2. Determination of BOD.
3. Determination of phenol.
4. Determination of COD.
5. Determination of metal (any one) in waste water.
6. Determination of chloride ion in given water.
7. Determination of turbidity in given sample.
8. Measurement of particulate matter in air.
9. Measurement of gaseous pollutant (any one) in air.
10. Measurement of various types of residues or solids in the given sample.

References:

1. S. P. Mahajan, Pollution control in process industries, Tata McGraw-Hill Publication
2. M. N. Rao & A K. Datta, Waste Water Treatment: IBH Pub., Delhi

Elective-II

Course Outline

Lab Advanced Separation Techniques	**Lab AST**	**CHP 814**
Course Title	Short Title	Course Code

Course Description: This course intended to fulfill the need for comprehensive laboratory course in Advanced Separation Techniques.

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

Prerequisite Course (s): Lab Mass Transfer-I & II

General Objectives:

1. To introduce planning, safety concepts and experimental techniques for pollution free chemical separations.
2. To provide students with an understanding of the relationship between separation technology principles and performance of actual experimental laboratory operations.
3. To inculcate critical thinking abilities in students for separation of chemicals

Learning Outcomes:

Students completing this course will able to apply the principles of separation techniques studied during theory course in the laboratories for pollution free chemical separations. They will also identify the particular technique suitable for separation, from their theoretical knowledge.

Course Content:

(Any eight experiments/assignments from the above theory syllabus)

References for Practicals:

Standard laboratory manual for practices.

Elective-II

Course Outline

Lab Polymer Technology	**Lab PT**	**CHP 815**
Course Title	Short Title	Course Code

Course Description: This course intended to fulfill the need for comprehensive laboratory course in polymer technology.

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

Prerequisite Course (s): Lab Applied organic chemistry.

General Objectives:

1. To train the students for analysis of polymers & plastic materials with due care and precautions.
2. To develop the students' skills in applying practical knowledge for the laboratory scale synthesis of polymers.

Learning Outcomes:

Students completing this laboratory course will able to apply the knowledge of quantitative analysis which is required during characterization of polymer samples. Through laboratory synthesis of polymers they will also understand the various polymer manufacturing processes carried out in the polymerization industries.

Course Content:

(Any eight Experiments/Assignments from the following)

List of Experiments:

1. Determination of molecular weight of a polymer by viscosity measurements, (Any Two).
2. Preparation of phenol formaldehyde resin.
3. Preparation of urea formaldehyde resin.
4. Preparation of Nylon 6:6.
5. Determination of the Saponification value of given plastic material.
6. Determination of the Acid value of given plastic material, (Any Two).
7. Determination of the Hydroxyl value of given plastic.
8. Determination of the Carbonyl value of given plastic.

References for Practicals:

S.K.Bhasin, Sudha Rani, Laboratory manual on Engineering Chemistry: Dhanpat Rai Publishing Compony, New Delhi

Elective-II

Course Outline

Lab Oil Technology	**Lab OIT**	**CHP 816**
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): Fluid Flow Operation, Mass Transfer –I, Process Heat Transfer, Mass Transfer-II, Chemical Reaction Engineering –I & II

General Objectives:

1. To study the analysis of raw materials and final products.
2. To study various products from oil and fatty acids
3. To study ideal batch reaction some oleo chemicals.

Learning Outcomes:

Students will demonstrate the concepts of chemical reaction engineering using knowledge of basic process engineering and technology. The students will be able to design various reactions during experimental data.

<u>Course Content:</u>

(Any eight experiments from the following)

List of Experiments:

1. Determination of free fatty acids.
2. Determination of Iodine Value.
3. Determination of Saponification Value.
4. Determination of Unsaponifiable Matter.
5. Determination of Peroxide Value.
6. Preparation of detergent powder and its analysis.
7. Determination of Total Fatty matter of soap.
8. Determination of glycerol.
9. Preparation of Varnish.
10. Determination of Reichert Meissel Value.

References for Practical:

1. British Indian standard Books. Analysis of oils fats and waxes.
2. NIIR BOARD, Hand book on Soaps, Detergents and acid Slurry, 2^{nd} Edition , Publisher- Asia Pacific Business Press Inc., Delhi.

Course Outline

Industrial Lecture	**IL**	**CHP 817**
Course Title	Short Title	Course Code

Course Description:

The course inculcates into the students the knowledge about technologies development in industrial sector. The course also develops the management and administration skills in the students and also helps to know the expectations of the industrialists from the fresh engineers.

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	Hours per Week	No. Of Weeks	Total Hours	Semester Credits
Lecture	**1**	**15**	**1**	**2**

Course Objectives:

1. To increase Industry-Institute Interaction.
2. To make aware the students about the developments and challenges in the Industry.
3. To encourage the participation of students for development of technology .

Course Outcomes:

At the end of course the students will understand the need, requirement and expectation of industry from fresh engineers and in turn will learn about the skills required by the industry. The students will be in a position to manage the various activities in the industry related to production, quality control, purchase, marketing, research, human resource, taxation, administration etc.

They will be able to identify, formulate, and solve engineering problems by understanding professional and ethical responsibility. They will develop the ability to understand the environmental issues for green and clean technologies. They will also gain the knowledge for contribution in economic development by improving the productivity of the industrial processes.

Industrial Lecture
(Course Contents)

Semester-VIII **Examination Scheme:**

Teaching Scheme: **(ICA) Internal Continuous Assessment: 50Marks**

Lecture: 1 Hrs/Week

1. There is a need to create avenues for a close academia and industry interaction through all the phases of technology development, starting from concept to commercialization.
2. Minimum 6 lectures to be delivered by experts from the industry in alternate weeks. Next week group discussion on the lecture delivered.
3. Student should submit assignment in hard copy on the topic of industry lecture. The number of assignment should be equal to number of industry lecture.

Guide lines for ICA: Assessment of the Industrial Lecture for award of ICA marks shall be done jointly departmental committee as per attendance in industrial lecture and overall performance in semester**.**

PROJECT – II

Project-II	**PROJ-II**	**CHP 818**
Course Title	Short Title	Course Code

Course Description:

The course explores the knowledge of designing, experimentation and analysis of data. The course intends to present a complete explanation for technical & societal problems by applying the chemical engineering knowledge. The course develops an ability to provide feasible technological solutions to meet economical & societal issues.

Laboratory	Hours per Week	No. Of Weeks	Total Hours	Semester Credits
	4	**15**	**48**	**6**

Prerequisite Course (s): Knowledge of science, mathematics, computer programming and core subject of engineering.

Course Objectives:

1. To develop ability to work in group
2. To develop feasible engineering solutions .
3. To abridge a gap between academia and society

Course Outcomes:

At the end of the course students will be able to develop the ideas and knowledge related to contemporary issues. They will illustrate to provide a complete mechanism for stable industrial and research solution**.** The students will reveal their commitment for making world better to live.

Project-II
(Lab Course Contents)

Semester-VIII **Examination Scheme:**

Teaching Scheme: Internal Continuous Assessment (ICA) : 75Marks

Practical: 2 Hrs/Week End Semester Examination OR (ESE) : 75Marks

- Every student of shall undertake the Project-II in semester VIII.
- Each student shall work on an approved project, a group of **05 students (maximum)** shall be allotted for the each Project-II as same group for Project-I.
- Project-II may involve fabrication, design or investigation of a technical problem that may take design, experimental or analytical character or combine element of these areas. The project work shall involve sufficient work so that students get acquainted with different aspects of fabrication, design or analysis, testing, their result and conclusion.
- Each student group is required to maintain log book for documenting various activities of Project-II.
- The three-member committee appointed by Head of the department shall be constituted for finalizing the topics of Project-II. Maximum four Project-II groups shall be assigned to one teaching staff.

Guide lines for ICA: Assessment of the project for award of ICA marks shall be done jointly by the guide and departmental committee as per the guidelines given below.

Assessment Sheet for Project-II

Name of the Project: ____

Name of the Guide: ____

SN	Exam Seat No	Name of Student	Literature Survey	Design /Experimentation /Fabrication etc.	Result and conclusion	Project Report	Presentation	Total Marks
			10	25	20	10	10	75