Bharati Vidyapeeth

(Deemed to be University)

Faculty of Engineering and Technology

Programme: B. Tech. (Chemical) (2021 Course)

Amended Curriculum Structure

B. Tech. (Chemical) semester VII and VIII Curriculum Syllabus

Bharati Vidyapeeth
(Deemed to be University)
Faculty of Engineering and Technology

Program: B. Tech. (Chemical) Semester – VII CBCS 2021 Course

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hours/week)			Examination Scheme (Marks)						Credits			
			L	P/D	T	UE	IA	TW	OR	PR	Total	L	P	T	Total
1		Elective – I	4	2	-	60	40	25	25	-	150	4	1	-	5
2		Chemical Process Equipment Design and Drawing	4	2	-	60	40	25	25	-	150	4	1	-	5
3		Chemical Process Control and Automation	4	2	-	60	40	25	-	25	150	4	1	-	5
4		Plant Utility and Process Safety*	4	-	-	60	40	-	-	-	100	4	-	-	4
5		Chemical Process Simulation- I	-	2	-	-	-	25	25	-	50	-	1	-	1
6		Project: Stage-I	-	2	-	-	-	50	50	-	100	-	2	-	2
7		Internship	-	-	-	-	-	25	25	-	50	-	3	-	3
Total			**16**	**10**	**-**	**240**	**160**	**175**	**125**	**25**	**750**	**16**	9	**-**	**25**

*** Industry Taught Course V**

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hours/week)			Examination Scheme (Marks)						Credits			
			L	P/D	T	UE	IA	TW	OR	PR	Total	L	P	T	Total
8	ADD-on	MOOC-III	-	-	-	-	-	-	-	-	-	-	-		2

Program: B. Tech. (Chemical) Semester – VIII CBCS 2021 Course

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hours/week)			Examination Scheme (Marks)						Credits			
			L	P/D	T	UE	IA	TW	OR	PR	Total	L	P	T	Total
1		Elective – II	4	2	-	60	40	25	25	-	150	4	1	-	5
2		Chemical Project Engineering and Economics	4	2	-	60	40	25	25	-	150	4	1	-	5
3		Optimization Techniques in Chemical Engineering	4	-	-	60	40	-	-	-	100	4	-		4
4		Industrial Management*	4	-	-	60	40	-	-	-	100	4	-	-	4
5		Chemical Process Simulation- II	-	2	-	-	-	25	25	-	50	-	1	-	1
7		Project: Stage-II	-	4	-	-	-	100	100	-	200	-	6	-	6
Total			**16**	**10**	**-**	**240**	**160**	**175**	**175**	**-**	**750**	**16**	9	**-**	**25**

*** Industry Taught Course VI**

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hours/week)			Examination Scheme (Marks)						Credits			
			L	P/D	T	UE	IA	TW	OR	PR	Total	L	P	T	Total
8	ADD-on	Social Activities- II	-	-	-	-	-	-	-	-	-	-	-		2

Programme: B. Tech Chemical (2021)

Semester- VII (Chemical)

ELECTIVE-I: POLYMER TECHNOLOGY					
Designation: Elective					
Pre-requisite Courses: Basic chemistry, Physical chemistry, Chemical Reaction Engineering, Chemical Engineering Thermodynamics					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 4 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Practical	: 2 Hour /Week	Continuous Assessment	: 40 Marks	TW/Practical	: 01
		Term-work (TW)	: 50 Marks	Tutorial	:
		Total	: 150 Marks	Total credits	: 05

Course Outcomes:

After completion of the course students would be able to:

1	Explain basics of polymers and their classifications
2	Explain various polymer properties and the their effect on engineering properties
3	Determine suitable process for polymer synthesis and describe its mechanism
4	Analyze polymer characteristics and discuss its effect on properties
5	Explain the formation of composites and blends in polymers
6	Explain the methods of polymer compounding and processing

Topics covered

UNIT-I	**Introduction to polymers** Introduction, polymer microstructure, homopolymers-heteropolymers, monomers as building block of polymers, historical development, classifications of polymers and polymerization reactions, chain growth and step growth polymerization, mechanism of polymerization, polymer liquids and polymer solids	**(08 Hours)**
UNIT-II	**Polymer properties** Molecular weight of polymers (Mw, Mn, Mv), Molecular weight distribution, determination of molecular weights, polymer morphology, polymer structure – linear, branched and crosslinked, presence of functionality, chemical bonding in polymers, stereoisomerism, effect these factors on chemical, thermal and mechanical properties of polymers	**(08 Hours)**
UNIT-III	**Synthesis of polymers** Polymerization techniques: bulk, solution, suspension, emulsion polymerization with their merits and demerits, kinetics of polymerization; free radical chain polymerization, cationic polymerization, anionic polymerization, polycondensation, co-polymerization and its kinetics, Smith Ewarts kinetics for emulsion polymerization, continuous emulsion polymerization, Ziegler-Natta catalyst	**(08 Hours)**
UNIT-IV	**Polymer structure and effect on properties** Chemical and geometrical structure of polymer molecules, microstructure based on chemical structure, microstructure based on geometrical structure,	**(08 Hours)**

	Glass transition temperature, factors influencing glass transition – molecular weight, plasticisers, copolymer concentration, and their effect on polymer properties; crystallinity, effect of presence of crystallinity on polymer properties	
UNIT-V	**Polymer composite and blends** Difference between blends and composites, their significance, choice of polymers for blending, blend miscibility-miscible and immiscible blends, thermodynamics, phase morphology, polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends, FRP, particulate, long and short fibre reinforced composites.	**(08 Hours)**
UNIT-VI	**Polymer processing and compounding** Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization. Methods of processing: Compression moulding, transfer moulding, injection moulding, blow moulding, reaction injection moulding, extrusion, pultrusion, calendaring, rotational moulding, thermoforming, rubber processing in two-roll mill, internal mixer.	**(08 Hours)**

Text Books/References:

1	Billmeyer F. W.: Text book for Polymer Science, John Wiley and Sons, USA, 2004
2	Gowarikar V. R., Viswanathan N. V., Shreedhar J.: Polymer Science, Wiley Eastern Limited, Singapore, 1986
3	Odion G. G.: Principles of Polymerizations; Odion G. G.; John Wiley and Sons, USA, 2004
4	Ram A.: Fundamentals of Polymer Engineering, Springer USA, 1997
5	Rubinstein M., Colby R. H.: Polymer Physics, 1st Ed. OUP UK, 2003
6	Mark J. E.: The Polymer data Handbook, 3rd. Ed., Oxford University Press, UK 2009

Project based learning: Below is the list of possible topics, which is for guidance faculty can design and provide relevant topics in addition to these

1	Define the properties and qualities required in a material to be used as monomer. Prepare a report on the monomers and their effect on the polymerization.
2	Prepare a report on preparation of polymer, its property assessment and optimization towards desired application
3	Investigate the property modification and its effects on the applicability. Define and discuss the methodology for polymer property modification and its effects on applicability
4	Consider different applications and design the polymer as material for the system, design and property modification of the polymer towards applicability of the same.
5	Develop the synthetic system and its kinetics for different polymeric systems to define the controlling parameters and factors controlling polymer synthesis. Prepare a report on the same
6	Define the factors and parameters affecting the selection of polymerization reactor and define their controls based upon the polymer in hand
7	Prepare a report on the formation of Ziegler Natta catalyst and its effect on polymerization and property attenuation.
8	Design the system for the synthesis of polymers by Emulsion polymerization and define the controlling parameters based upon the Smith Ewartz kinetics
9	Defining the methodology towards property modification and write a report on the property modification through blending or composite formation, material selection and formation methodology towards desired application.
10	Prepare a report on moulding and shaping of the polymer material and strategies for the desired application.

Syllabus for Unit Test:	
Unit Test : I	Units : I, II, and III
Unit Test : II	UNIT : IV, V, and VI

ELECTIVE-I : PETROLEUM REFINERY ENGINEERING					
Designation: Professional Core					
Pre-requisite Courses: Basic knowledge of Chemical Process Industry, Mass Transfer					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 04Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Practical	: 02Hours/Week	Internal Assessment	: 40 Marks	Tutorial	: -
Total	: 06 Hours/Week	Term-work (TW)	: 25 Marks	Practical	: 01
		Practical/Oral	: 25 Marks	Total Credits	: 05
		Total	: 150Marks		

Course Outcomes	
1	Know the composition of crude oil and its products, along with its properties and characterization methods.
2	Demonstrate knowledge of petroleum products, quality control and understand processing of crude oil.
3	Understand the thermal and catalytic cracking process.
4	Learn the process of catalytic reforming, Hydrotreating and Hydrocracking.
5	Get conversant with the process of purification and fractionation of crude oil.
6	Analyze theoretical and practice skills in environmental issues of petroleum refinery.

Topics Covered		
UNIT-I	**Introduction** Introduction to petroleum refinery; Classification of Crude oil; Characterization of crude oil; Composition of crude Physical properties: Crude oil; analysis and distillation; Introduction to refinery "feedstock/s" and refinery products; ASTM nomenclature (ASTM test numbers and their meaning) Introduction to various codes required for petroleum industry.	**(08 Hours)**
UNIT-II	**Evaluation of crude oil properties and Design of crude oil distillation column** Dehydration and desalting of crude; Crude Assay ASTM TBP distillations evaluation of crude oil properties; API gravity various average boiling points and mid percent curves; Evaluation of properties of crude oil and its fractions; Design concept of crude oil distillation column design.	**(08 Hours)**
UNIT-III	**Thermal and Catalytic cracking** Coking and thermal process; delayed coking; Catalytic cracking; cracking reactions; cracking feedstock; Effect of process; FCC cracking; catalyst ; New designs for fluidized bed catalytic cracking.	**(08 Hours)**
UNIT-IV	**Catalytic Reforming** Objective and application of catalytic reforming; process reforming Catalysts; Reformer feed; reforming reactor design; continuous and semi regenerative process; Hydrotreating and Hydrocracking reactions.	**(08 Hours)**
UNIT-V	**Isomerization, Alkylation and Polymerization**	**(08 Hours)**

	Isomerization process, Reactions; Effects of process variables; Alkylation process; Feedstock, reactions, products, catalysts and effect of process variables; Polymerization: Objectives, process, Reactions, catalysts and effect of process variables; Visbreaking	
UNIT-VI	**Environmental issues and New Trends in petroleum refinery operations** Ecological consideration in petroleum refinery; Waste water treatment; control of air pollution; New trends in refinery; Alternative energy sources; Safety aspects in petroleum industry	**(08 Hours)**

Project Based Learning	
1	Write a report on petroleum refining and energy demand in current year.
2	Discover the methods used to create clean and reformulated fuels
3	Evaluate the use of catalysts in petroleum refining..
4	Estimate refinery CAPEX and OPEX
5	Give power point presentation on vertical integration in petroleum industry
6	Learning on different areas of study in upstream, midstream and downstream industry.
7	Analyze worldwide distribution of oil and gas reserves in current year.
8	Understand basic procedures and role of all fundamental systems used in petroleum drilling..
9	Apply a critical-thinking and problem-solving approach towards the principles of petroleum engineering.
10	Specify materials for construction and estimate the cost of investments for crude pil distillation column.
11	Write a technical report on your visit to a petroleum refinery.
12	Give power point presentation on knowledge of safety and pollution control in the refining industries.
13	Group discussion on the recent advances in petroleum refinery processes.
14	Make a complete chart of operations involved in petroleum industry.
15	Assess the economic environment of the petroleum industry.
*Students in a group of 3 to 4 shall complete any one project from the above list.	
Term Work	
Term work will consist of the seminars on the following topics.	
1	New Catalyst used in petroleum industry.
2	Recent method used in reforming.
3	Use of Pengtool for the petroleum calculations.
4	Ecological considerations in petroleum industry.
5	Difference between petroleum and petrochemical industry.
6	CAPEX and OPEX in refinery.
7	Colour codes used in petroleum industry.
Te1xt Books/References	
1	B.K.Bhaskar Rao , “Modern Petroleum Refining Processes”, 2ndEd., Oxford and IBH publishing Co. Pvt. Ltd., New Delhi 1990.
2	W.C. Edmister, “Applied Hydrocarbon Thermodynamics”, Gulf Publishing, Houstan, Texas, 1961.
3	S. Kumar, “Gas Production Engineering”, Gulf publishing Co., 1987.
4	B. Graham, Moody, “Petroleum exploration hand book” McGraw-Hill Inc.,US , 1961

5	C.L.William ,C.P.Garry, M.D.Lorenz, "Standard Handbook of petroleum and Natural Gas Engineering" 3nd Edition. Gulf Profession, 2016
6	W.L. Nelson, "Petroleum Refinery Engineering", McGraw Hill, 1964.

Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

Elective-I: Advanced Oxidation Processes					
Designation: Professional Elective					
Pre-requisite Courses: Waste water treatment and Engineering Chemistry					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 04Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Practical	: 02Hours/Week	Internal Assessment	: 40 Marks	Term-work	: 00
Total	: 06 Hours/Week	Term-work (TW)	: 25 Marks	Practical/Oral	: 01
		Practical/Oral	: 25 Marks	Total Credits	: 05
		Total	: 150 Marks		

Course Outcomes	
1	Demonstrate basics of advanced oxidation processes (AOPs)
2	Apply the method of ozonation and photon induced AOPs
3	Learn the method of heterogeneous photo-catalysis and its mechanism
4	Understand the method of homogeneous and heterogeneous Fenton processes and its mechanism
5	Analyse various emerging AOPs and their mechanism
6	Describe the industrial applications of AOPs

Topics Covered		
UNIT-I	**Introduction to advanced oxidation processes (AOPs)** Conventional waste water treatment processes, Fundamentals and background of AOPs for water and wastewater treatment, basic reaction mechanism of AOPs, Role of hydroxyl radicals and their generation, Reaction kinetics and degradation mechanisms of organic pollutants by hydroxyl radicals, Effects of process parameters and scavenging media on degradation efficiency, oxidation potential of AOPs, merits and demerits of various AOPs	**(08 Hours)**
UNIT-II	**Ozonation and Photo induced AOPs** Ozonation: background and fundamentals, reaction kinetics and mechanisms, Application of homogeneous and heterogeneous catalytic ozonation in water treatment; Fundamentals of UV irradiation: Absorption and bond dissociation energy, UV sources and their characteristics, Choice of photo source–used in AOPs; Photo induced AOPs: Mechanism of photo induced AOPs Oxidation using ultraviolet irradiation and hydrogen peroxide (UV/H_2O_2), oxidation using ultraviolet irradiation and ozone (UV/Ozone), oxidation using combination of ultraviolet irradiation, hydrogen peroxide and ozone (UV/H_2O_2 /Ozone).	**(08 Hours)**
UNIT-III	**Heterogeneous Photo-Catalysis** Fundamentals of semiconductor photo-catalysis: various semiconductor particles used in photocatalytic applications, visible light driven photo-catalysts, photocatalytic reactions and kinetic studies and introduction to nano photo-catalysis; Photocatalytic reactors: solar energy driven or artificial light photo reactors, solar collectors, design of slurry or supported catalyst reactors, comparing reactor efficiencies and reuse of catalyst.	**(08 Hours)**
UNIT-IV	**Homogeneous and Heterogeneous Fenton processes** Fenton process; photo-Fenton process; advanced Fenton process; the mechanism of Fenton based processes; merits and demerits of homogeneous	**(08 Hours)**

	and heterogeneous Fenton processes.	
UNIT-V	**Emerging AOPs** Electrochemical oxidation; Ultrasound processes; principles of sonochemistry and acoustic cavitation; ultrasound cavitation and its combination with other AOPs; synergistic and antagonistic effects; hydrodynamic cavitation and its combination with other AOPs.	**(08 Hours)**
UNIT-VI	**Industrial applications of AOPs** Application of AOPs for industries such as textile, petroleum, pharmaceutical, petrochemical industry etc.; Decontamination of ground water; Cost or economic analysis of various AOPs.	**(08 Hours)**

Project Based Learning	
1.	Preparation of technical report based on industrial applications of advanced oxidation processes
2.	Preparation of power point presentation based on recent trends in photocatalysis
3.	Group project on the application of ultraviolet irradiation and hydrogen peroxide for the degradation of dyes
4.	Study any three recent research papers related to advanced oxidation processes and prepare/present power point presentation.
5.	Group discussions on any of the following topics: a) Merits and demerits of various AOPs **b)** Ozonation and Photo induced AOPs
6.	Determine the ultrasonic power density of given ultrasonic processor
7.	Visit to nearby waste water treatment plant and a prepare a detail report.
8.	Determine the hydraulic characteristics of any cavitating device
9.	Prepare a technical report on recent trends in waste water treatment by hydrodynamic cavitation
10.	Industrial case study - Application of AOPs in textile/ petroleum/ pharmaceutical industry

Term Work	
Term work will consist of the Seminar:	
	Seminar should be based on recent advances in AOPs. Students may undertake studies in water and waste water treatment using AOPs. Design and scale-up aspects can be studied in detail. Term work should be based on the technical report on these studies carried out by individual or by a group of students.

Text Books/References	
1	Simon Parsons, Advanced oxidation processes for water and wastewater treatment, IWA Publishing, 2004.
2	Thomas Oppenlander, Photochemical Purification of Water and Air: Advanced Oxidation Processes (AOPs): Principles, Reaction Mechanisms, Reactor Concepts, Wiley-VCH Publishing, 2003.
3	Vincenzo Belgiorno, Vincenzo Naddeo and Luigi Rizzo, Water, wastewater and soil treatment by Advanced Oxidation Processes (AOP), Lulu Enterprises, 2011.

4	Jean-Pierre Franc, Jean-Marie Michel, “Fundamentals of Cavitation”, Kluwer Academic Publishers, Dordrecht.
5	T. J. Mason and J. P. Lorimer, “Applied sonochemistry: Uses of power ultrasound in chemistry and processing”, Wiley-VCH publishers.

Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

Elective I: Natural Products

Designation: ProfessionalElective

Pre-requisite Courses: Students should have basic knowledge ofChemistry and analytical Techniques

Teaching Scheme	**Examination Scheme**	**Credits Allotted**
Lectures : 04Hours/Week	End Semester Examination : 60 Marks	Theory : 04
Practical : 02Hours/Week	Internal Assessment : 40 Marks	Practical : 01
Total : 06Hours/Week	Term work / oral :50 Marks	Total Credits : 05
	Total : 150 Marks	

Course Outcomes

1	Recognize natural products and classify them.
2	Elaborate technology involved in natural product extraction.
3	Elaborate types of modifications for natural products.
4	Elucidate applications in chemical and allied industry.
5	Elucidatemechanism in biosynthesis.
6	Elaborate process development studies in any natural product.

Topics Covered

UNIT-I	**Introduction to Natural Products** Classification of natural products; Characterisation: Methods of characterisation, physical, analytical, chromatographic, spectroscopic. Determination of carbon structure; Identification of functional groups by various methods such as IR, NMR and chemical	**(08 Hours)**
UNIT-II	**Technology involved** Isolation and purification of natural products; Solvent extraction method applied for extraction of phytochemicals; Steam distillation; Soxlet extraction; Percolation; Supercritical fluid extraction;Ultra sound extraction; Microwave assisted extraction of polyphenols.	**(08 Hours)**
UNIT-III	**Modifications to natural products** Structural modification of natural products: structural simplification, case study; Substitution for discovery of novel compounds, ligand modification, biosynthetic modification.	**(08 Hours)**
UNIT-IV	**Application of Natural Products** Applications in textile industry; food industry; cosmetic industry and pharma industry. Examples of different natural products as a raw material for synthesis of drugs.	**(08 Hours)**
UNIT-V	**Application to Biosynthesis** Biosynthetic mechanism: method, isolation, identification; Synthesis of aromatic compounds;phenyl propanoids and flavanoid compounds.	**(08 Hours)**
UNIT-VI	**Process Development studies** Identification of product; selection of product recovery technique; flow sheet of unit operations and processes for achieving finished product; operation parameters; total cost estimation. Market status and intellectual property rights for natural products; limitations to natural products.	**(08 Hours)**

Project Based Learning	
1.	Select any specific natural product and do the characterisation using any chemical technique
2.	Draw a pfd of unit operation and processes involved in any specific natural product industry.
3.	Group discussion on isolation and purification of poly phenols
4.	Literature survey for chemicals obtained from plant pigments.
5.	Collect data for extraction of natural products in food industry.
6.	Experiment for solvent extraction of any natural product selected.
7.	Preparation of a brief report onin bio synthesis of natural product.
8.	Group discussion and presentation for modification in natural products.
9.	Process development studies for selection of any natural product with presentation
10.	Cost estimation and limitation studies for a given natural product
	Term Work:
	Term work will consist of the seminar report prepared and presented by selecting topic from any unit in consultation with faculty.
Text Books/References	
1	I. L. Finar,Organic Chemistry: Stereochemistry & the Chemistry of NaturalProducts, Vol.II., Pearson Education India, 5th Ed. ISBN: 81-7758-541-X.
2	H. Bart & S. Pilz, Industrial Scale Natural Products Extraction, Wiley-VCH Verlag& Co., Germany, 2011. ISBN: 978-3-527-32504-7.
3	O. Sticher, Natural product isolation, Natural Product Reporter, 25, 517–554, 2008, (http://disruptechno2.free.fr/FMS/Natural%20product%20isolation%20(Otto20Sticher).p df)
4	J. Apsimon, The Total synthesis of Natural Products, Wiley-Interscience, 1993, ISBN 047158083X.

Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

CHEMICAL PROCESS EQUIPMENT DESIGN AND DRAWING

Designation: Professional Core

Pre-requisite Courses: Material and energy balance calculations, Mass transfer, and Chemical reaction engineering

Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 03 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 03
Practical	: 02 Hours/Week	Continuous Assessment	: 40 Marks	TW/PR	: 01
Total	: 05 Hours/Week	Term-work (TW)	: 25 Marks	Total Credits	: 05
		Practical/Oral	: 25 Marks		
		Total	: 150 Marks		

Course Outcomes

1	Apply and understand different codes for equipment design.
2	Deign different heads used for equipments
3	Design different columns used in distillation/Absorption.
4	Identify and design different packings used in packed columns.
5	Design Dryers and Filters.
6	Design different equipments like cyclone separator, gravity thickener, decanter, fluid –fluid separator, electrostatic precipitator, cooling towers, evaporators, dryers, crystallizers.

Topics Covered

UNIT-I	**Introduction to Process Equipment Design** Introduction to various mechanical properties of materials to be used as material of construction, resistance of metals to corrosion under varying conditions of temperature and pressure etc. Theories of failures, application and use of various codes and standards in design. Representation of different utilities and symbols, General design procedure, equipment classification, study of design parameters such as maximum working pressure, design pressure, design temperature, design stress & factor of safety, design of wall thickness & minimum actual thickness, corrosion allowance, design loading, possions ratio.	**(06 Hours)**
UNIT-II	**Design of pressure vessels and storage tank** Design of pressure vessels and storage tank: Vessels subjected to internal pressure and combined loading, cylindrical and spherical shell, resultant stresses induced in pressure vessel, stresses in high pressure vessels, optimum vessel size, design of various heads & closures such as flat head, torrispherial head, elliptical head, hemispherical head, and conical head. Design of storage tank, types of storage tank, types of roof for storage tank, types of losses in floating roof tank, estimation of nozzle diameter for drain in storage tank.	**(06 Hours)**
UNIT-III	**Tray Column Design** Design of plate column- distillation columns, design variables in distillation, design methods for binary systems, plate efficiency, approximate column sizing, plate Contactors, plate hydraulic design.	**(06 Hours)**

UNIT-IV	**Packed Column Design** Choices of packing, types of packing, packed bed height (distillation and absorption), HETP, HTU, NTU, Cornell's method, Onda's method, column diameter, column internals, column auxiliaries.	**(06 Hours)**
UNIT-V	**Filters & Dryers:** Various types of filters like vacuum filters, pressure filters, centrifuges and rotary drum filters, design of rotary drum filters, including design of drum, shaft, bearing and drive system. Types of dryers, batch type dryers, continuous dryers.	**(06 Hours)**
UNIT-VI	Design of some novel separation equipments Design of some separation equipment like cyclone separator, gravity thickener, decanter, fluid –fluid separator, electrostatic precipitator, Adsorption column, Ion exchange equipment	**(06 Hours)**

Project Based Learning	
1	Prepare a report on advance equipments which are newly introduced
2	Prepare a report on different codes and symbols used in design of a particular plant.
3	Prepare a model for any of the equipment
4	Group discussions on the following topics: a) Advances in equipment design. b) Distillation column selection and sizing. c) Packed column Vs Plate column.
5	Visit to any one chemical process industry and present a report on different equipments utilized for processing.
6	With the help of this subject knowledge, write a guideline report on how you would apply your concepts in designing a economic plant layout for any industry.
7	Prepare a report on advance equipments which are newly introduced in the current year.
8	Group presentation (seminar) on equipment selection and design..
Term Work:	
Term work will consist of the Practicals and drawings listed below, out of which any eight are to be done by students. Any one drawing in Autocad.	
1	Detailed design and drawing of enclosures and supports
2	Design and drawing of pressure vessels.
3	Design and drawing of storage tanks.
4	Detailed design and drawing of distillation column.
5	Detailed design and drawing of absorption column..
6	Study various packings.
7	Design and calculations of packed column.
8	Detailed design and drawing of spray dryer..
9	Design and drawing of rotary filter.
10	Study the conditions of stress analysis of columns.
Text Books/References	
1	Joshi. M.V, and Mahajani. V.V, "Process Equipment Design," 3rd Edn. Macmillan India Limited, New Delhi, 1996
2	Bownell, L.E., and Young, E.M., "*Process Equipment Design"*, Wiley Eastern, 1968.
3	Sinnott. R.K, Coulson & Richardson's, "Chemical Engineering", Volume 6, 3rd Edn., Butterworth

	Heinemann, New Delhi, 1999.
4	Bhattacharya B C, Chemical Equipment Design , CBS publishers.
5	Dawande S D, " Process Equipment Design" DENETT publishers
Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

CHEMICAL PROCESS CONTROL AND AUTOMATION			
Designation: Professional Core			
Course Pre-requisites:			
Students should have			
1.	Basic knowledge of Mathematics.		
2.	Chemical Process Instrumentation		
TEACHING SCHEME:		**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Lectures: 4Hours/Week		End Semester Examination: 60 Marks	Theory : 04
Tutorial : 2 Hour /Week		Internal Assessment : 40 Marks	TW/Practical : 01
Total : 6 Hour /Week		Term-work (TW) : 25 Marks	Total Credits : 05
		Practical/Oral : 25 Marks	
		Total : 150 Marks	
Course Outcomes:			
After completion of the course students will be able to			
1.	To give details of basic control action and develop mathematical models for control purpose.		
2.	To illustrate behavior of chemical processes and elucidate transient response of system.		
3.	To express stability of the system and analyze frequency response of process.		
4.	To analyze advanced control system.		
5.	To apply knowledge for controller multivariable control system.		
6.	To analyze digital control system.		
Topics covered			
UNIT-I	**Open Loop Response of Simple Systems:** Dynamics of first order systems using transfer functions; Various first order responses such as, a thermometer bulb. General response to step, ramp, impulse, and sinusoidal inputs; Concentration and temperature responses of a stirred tank **Dynamic Behavior of Chemical Processes:** Linearization of liquid level systems**:** Response of a pressure system, second order systems, the manometer; Response of interacting and non interacting systems. Transfer functions and the input-output models. Dynamics and analysis of first, second and higher order systems.		**(08 Hours)**
UNIT-II	**Transient Response of Control Systems:** Servo and regulated operation, General equations for the transient response, proportional control of a signal capacity process; Integral control, Proportional-integral control and derivative action. **Stability:** Concept of stability, Stability criterion, Routh test for stability.		**(08 Hours)**

UNIT-III	**Root Locus Analysis:** Concept of root locus, Locus diagram. **Frequency Response Analysis:** First order systems, Bode diagram, and Complex numbers to get frequency response. Nyquist plot. Tuning rules: Ziegler Nichols method, Cohen coon method etc.	**(08 Hours)**
UNIT-IV	**Advanced Control Schemes:** Controller selection and tuning, Control valve characteristics and sizing, cascade control, Feed forward and ratio control, inferential control and adaptive control. All control with chemical engineering applications	**(08 Hours)**
UNIT-V	**Multivariable control system** State space analysis, vector matrix analysis of control system, state space representation of transfer function, controllability and observability, pole placement design, state observer and observer design **MIMO control system** Transfer function, input output pairing, ineractions, transient response and stability, RGA and loop pairing and decoupling	**(08 Hours)**
UNIT-VI	**Digital control system;** Digital approximation of classical controls. Computer process control and block diagram, computer control loops Introduction to DDC, DCS, PLC and SCADA Systems.	**(08 Hours)**

List of Experiments:

Term work will consist of the experiments listed below, of which at least eight should be performed in laboratory by the students.

1.	To study the closed loop pressure control for P control action and calculate offset.
2.	To study the closed loop pressure control for PI action PID action.
3.	To study optimizing performance for pressure control trainer by using tuning technique with help of PID action.
4.	To study closed loop system for servo problem having PI action consideration.
5.	To study the closed loop flow controller
6.	To study the closed loop level controller
7.	To study the ratio controller
8.	To study the cascade controller
9.	Root locus analysis on software (Ex. MATLAB)
10.	Bode plot on software (Ex. MATLAB)
11.	Nyquist plot on software (Ex. MATLAB)
12.	PID control loop simulation for a first order process (Ex. SIMULINK)

Project based learnings:

1.	Students have to visit chemical industry and prepare a detailed report on various controllers used in industry.
2.	Watch NPTEL video and make report on various topics in process dynamics and control
3.	Group discussions on controllers used for chemical processes.
4.	To find Transfer Function for 1st order and 2nd order process.
5.	Draw the Control Loop and Block Diagram for different chemical processes.

6.	Solve numerical questions in last three year question papers.
7.	Give details on Advance Controllers.
8.	Give details on Digital Controllers.
9.	Elucidate IMC Controller in Detail.
10.	Explicate MPC Controller in Detail.
11.	Clarify process Identification of any Chemical Process in detail
12.	Enlighten Optimal control of any one Chemical Process.
Text Books/References:	
1	G. Stephanopoulos, *Chemical Process Control: An introduction to theory and practice,* Prentice Hall, New Jersey, 1984.
2	P. Harriott, *Process Control, Reprint of text,*ed. Tata McGraw Hill, 1983.
3	D. R. Coughanowr, *Process system analysis and control*, 2nded, McGraw Hill, 1991.
4	Seborg, D.E., Edgar, T.F. and Mellichamp, "Process dynamics and control," Wiley, New York, D.A. 2003.
Syllabus for Unit Test:	
Unit Test -I	UNIT – I , II, III
Unit Test -II	UNIT – IV, V, VI

PLANT UTILITY AND PROCESS SAFETY					
Designation: Professional Core					
Pre-requisite Courses: Mechanical operations, Fluid dynamics, Heat transfer, Mass Transfer, Reaction Engineering					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 4 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Tutorial	: 1 Hour /Week	Continuous Assessment	: 40 Marks	TW/Practical	:
		Term-work (TW)	: Marks	Tutorial	: 01
		Total	: 100Marks	Total credits	: 05

Course Outcomes:	
After completion of the course students would be able to:	
1	Identify the common utilities required for Chemical Plant.
2	Express various types of boilers and their selection.
3	Analyze the importance of insulation and air pressure in process.
4	Identify and analyze the hazards.
5	Integrate the theoretical and practice knowledge to understand hazards activities.
6	Implement the safety designs and procedures.

Topics covered		
UNIT-I	**Identification of Common Plant Utilities** Role and importance of pant utilities in chemical plants, Water, compressed air, steam, vacuum, refrigeration, venting, flaring and pollution abating. Water and its quality, storage and distribution for cooling and fire fighting, Water resource management.	**(08 Hours)**
UNIT-II	**Steam Generation and Utilization** Steam generation and its application in chemical process plants, distribution and utilization; Types of boilers and their operation; steam economy, Steam condensers and condensate utilization, Steam generation by utilizing process waste heat using thermic fluids, Selection and sizing of boilers; waste heat boilers.	**(08 Hours)**
UNIT-III	**Fluid moving: Compressors, Blowers and Vacuum Pumps** Compressors, blowers and vacuum pumps and their performance characteristics; Methods of developing vacuum and their limitations, material handling under vacuum, Creation of low pressure/vacuum by pumps and ejectors. **Refrigeration and HVAC** Fundamentals of refrigeration, refrigerant management and safety, Selection of refrigerants; Processes of HVAC, Psychometric Chart and Air-Conditioning System, Ventilation and Indoor Air Quality.	**(08 Hours)**
UNIT-IV	**Elements of Safety** Elements of safety, safety and site selection; Plant layout and unit plot planning; Definition of risk and hazard, Identification and assessment of the hazards, distinction between hazards and risk, Industrial hygiene, toxicological studies, Hazard operability (HAZOP) hazard analysis (HAZAN); Safety Integrity Level (SIL) Studies; Technology selection and transfer, choosing the right process.	**(08 Hours)**

UNIT-V	**Safety in Chemical Processes** Introduction, Chemical Process classification, Process design and safety parameters, Safety parameters in the process design of phenol from cumene, safety in polyvinyl chloride plant. **Chemicals and their Hazards** Material Safety data sheet, Material safety parameters analysis, Acetonitrile, acetyl chloride, butyl amine, acrylamide, acrylonitrile, allyl alcohol, benzene, bromine, isopropyl alcohol, acetaldehyde, ethylene oxide, butane, n-hexane, anhydrous ammonia, acetone, toluene, p-xylene, acetic acid, monochloro benzene, oleum, carbon monoxide.	**(08 Hours)**
UNIT-VI	**Safety Procedures and Designs** Process Safety Hierarchy, Process Safety Strategies, Managing Safety, Safety Reviews and Accident Investigations, Designs for Process Safety, Inherently Safer Designs, Controls: Double Block and Bleed, Safeguards or Redundancy, Block Valves, Explosion Suppression, Designs for Runaway Reactions.	**(08 Hours)**

Text Books/References:

1	Sathiyamoorthy M.: Chemical Plant Utilities, Lambert Academic Publishing India, 2016
2	Coker A. K.: Ludwig's Applied Process Design for Chemical and Petrochemical Plants, Vol. 1, 4th Ed., Elsevier, USA, 2007
3	McKetta J. J.: Encyclopedia of Chemical Processing and Design, Vol. 44, CRC Academic Press, USA, 1993
4	McDowall R.: Fundamentals of HVAC Systems, 1st Ed., Butterworth-Heinemann Elsevier, 2006
5	Crowl D. A., Louvar J. F.: Chemical Process Safety Fundamentals with Applications, 3rd Ed. Prentice Hall USA, 2011
6	Kletz T. A.: Hazop and Hazan: Identifying and Assessing Process Industry Hazards", Fouth Edition, CRC Press, 1999
	.

Project based learning: Below is the list of possible topics, which is for guidance faculty can design and provide relevant topics in addition to these

1	Prepare a report on safety issues of any one particular industry.
2	Prepare Utility Line Diagram (ULD) for typical process.
3	Write a report on HAZOP study of one particular hazard.
4	Prepare a report on the color codes for utility pipelines in chemical plants.
5	Enhancement in collaborative learning is done through, group assignments on the topic of chemicals and their possible hazards, MSDS study and Hazard reduction and safety mechanism that will be given to encourage students to work with classmates to discuss and complete a report
6	Write a report on " Importance of Industrial Hygiene in Chemical Industry"
7	Group discussions on any of the following topics: a) Importance of various utilities in chemical industries. b) Process safety in petroleum industry c) HAZOP Vs HAZAN
8	Design a manual for application of utilities for various plants.
9	With the help of this subject knowledge, write a guideline report on how you would apply your concepts in industry.
10	Write a technical report on HAZAN study of any one particular threat.
11	Elaborate the role of safety engineer in Chemical industry.
12	Organizing a industrial visit to nearby industry to understand the plant utilities and safety measures.
13	Write a report on your visit to research and development laboratory of national/international

	repute.
Syllabus for Unit Test:	
Unit Test : I	Units : I, II, and III
Unit Test : II	UNIT : IV, V, and VI

Chemical Process Simulation I			
Designation: Professional Core			
Pre-requisite Courses: Fundamentals ofComputer, Mechanical operations, Heat Transfer, Fluid Flow, Mass Transfer, Thermodynamics and Chemical reaction engineering.			
Teaching Scheme		**Examination Scheme**	**Credits Allotted**
Practical : 02Hours/Week		TW :25 Marks	
		Practical/Oral :25 Marks	Practical/Oral : 01
		Total : 50 Marks	Total Credits : 01
Course Outcomes:			
After completion of the course students would be able to:			
1	Develop a process flow diagram for a given system.		
2	Design simulation programs involving small unit operations.		
3	Simulate reactors and estimate parameters.		
4	Design and simulate heat exchangers		
5	Develop a simulation model for separation of binary/ternary components.		
6	Apply all fundamental knowledge to build a simulation environment for a given problem.		
Topics Covered			
UNIT-I	**Getting started with ASPEN** Features of ASPEN software, component selection, property method defining, Analysis of components, azeotrope search and plots, building a pfd, toggle between all icons and their features, setting up a property environment 1. Program for PFD building of any process.		
UNIT-II	**Using model palette of different unit operations and building a simulation case,** Selection of small unit operations, accessing inbuilt library, adding new component to library 2. Programs for estimating property of components 3. Programs based on simulation of flash drum. 4. Programs on small unit operations.		
UNIT-III	**Simulation of Reactors** Simulation using different reactor models. Entering kinetic data in reaction tab, building simulation for any reactor and simulating for optimized values. Comparing the results with different models. 5. Simulation using R Stoic/ RCSTR/ Rplug flow model Model 6. Case study selecting any example and simulating.		
UNIT-IV	**Simulation of heat exchanger** Design of heat exchangers: model building, adding utilities, specifying all details, estimating optimised values. 7. Simulation of shell and Tube heat exchanger		
UNIT-V	**Simulation of Distillation Models** Simulation using different distillation column models. 8. Simulation using DSTWU model. 9. Simulation using RADFRAC model		
UNIT-VI	**Application to Chemical Engineering** Applications of ASPEN Plus to solve chemical engineering examples 10. Simulation of any case study involving all unit operations and processes. 11. Optimizing the variables.		
Term Work			

Term work will consist of the programs/practical's listed above, out of which any eight programs/practical's are to be performed in laboratory by the students.	
Text Books/References:	
1	R. Schefflan,Teach Yourself the basics of Aspen Plus, Wiley-AIChE, 2nd Edition 2016.
2	K. Al-Mallah, Aspen Plus: Chemical Engineering Applications, Wiley, 2016.
3	J. Haydary, Chemical Process Design and Simulation, Wiley, 2019.
4	A. Jana, Process Simulation and Control using Aspen, PHI learning, 2nd Edition, New Delhi, 2012.

PROJECT: STAGE-I					
Designation: Professional Core					
Pre-requisite Courses: Knowledge of chemistry, Material and energy balance calculations, Mass transfer, and Chemical reaction engineering, Equipment design, etc.					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Practical	: 02Hours/Week	Term-work (TW)	: 50 Marks	TW/Oral	: 03
Total	: 02 Hours/Week	Practical/Oral	: 50 Marks	Total Credits	: 03
		Total	: 100 Marks		

Course Objectives	
1	Fabrication of the experimental setup/new system and/or purchase of standard components
2	Pilot run and/or validation of new system for its performance
3	Modifying the system if required to improve its performance
4	Detailed parametric studies of the modified system and analyzing the results
5	Writing technical report, research article and/or filing a patent

Course Contents

Students need to approach to the guide after guide allotment using standard procedure. Guide will elaborate the project to students and decide the objectives and the plan of work.

Minimum number of in-sem. project presentations: 03

Parameters for evaluation of project in University examination

Idea of Project/Topic, Technical content, Innovation, Experinnentation/Model development/Software development/Simulation development, etc., Participation as an Individual, Research Potential, Project Hardware/Software, Fabrication/Model/Equipment development, Data Analysis, Attendance, Timely completion, Report writing, Presentation

Progress report card will be issued to each student to monitor the progress of work.

Assessment and progressive evaluation of the project will be done by the committee consisting of senior faculty members. The record of progressive evaluation shall be submitted in the department at the end of the semester and made available at time of university examination.

INTERNSHIP

Designation: Professional Core

Pre-requisite Courses: Knowledge of chemistry, Material and energy balance calculations, Mass transfer, and Chemical reaction engineering, Equipment design, etc.

Teaching Scheme	Examination Scheme		Credits Allotted	
--	Term-work (TW)	: 25 Marks	TW/Oral	: 03
	Practical/Oral	: 25 Marks	Total Credits	: 03
	Total	: 50 Marks		

Course Objectives

1	Make students familiar with industry environment
2	Take up on-site assignment as trainees or interns in order to bridge the gap between theory and industrial practices
3	To apply theory learned in classroom to industrial practices
4	To impart the report writing skills.

Course Contents

Internship of 60 days is added as an integral component of curriculum to bridge the gap between classroom theory and industrial practice. It is expected that students shall undergo Internship in reputed industrial organization after semester VI.

It is mandatory for students to undergo in –plant training after completion semester VI in reputed industrial organization. The students shall submit the Intern Certificate issued by the industry organization as well as a technical report not exceeding 30 pages within stipulated time to be eligible for making a presentation before the committee constituted by the department. On the basis of daily work carried out in the industry, student shall prepare record book. This record book shall be checked and signed by his/her supervisor from the industrywhere he/she is doing internship on daily basis.

University examination carries 50 Marks and after successful completion, student may be awarded 3 credits for the internship work. Marks will be awarded out of maximum 50 and three credits will be given upon completion of internship towards the degree requirements, as per the regulations. Internship will ultimately assist students to apply theory learned in classroom to industrial practices so as to understand engineering/technical solutions in a global, economic, environmental and societal context.

Programme: B. Tech Chemical (2021)

Semester- VIII (Chemical)

ELECTIVE-II: Nanomaterials Synthesis and Applications					
Designation: Elective					
Pre-requisite Courses: Basic chemistry, Physical chemistry, Mass transfer, Fluid flow operations, Chemical Engineering Thermodynamics					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 4 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Practical	: 2 Hour /Week	Continuous Assessment	: 40 Marks	TW/Practical	: 01
		Term-work (TW)	: 50 Marks	Tutorial	:
		Total	: 150Marks	Total credits	: 05

Course Outcomes:	
After completion of the course students would be able to:	
1	Define the importance of nanotechnology and their property optimization
2	Design the methodology for synthesis of nanomaterials
3	Determine suitable process for analysis of nanomaterials and evaluate their properties
4	Define the applications of nanomaterials and their property requirements for desired applications
5	Explain environmental issues and risks involved during nanomaterial applications and design safe pathway
6	Define suitable methodology for design of product from nanomaterials

Topics covered		
UNIT-I	**Introduction toNano-Materials** Importance of Nanotechnology, opportunity at the nano scale, length and time scale in structures, energy landscapes, interdynamic aspects of inter molecular forces, classification based on the dimensionality, nanoparticles, nanoclusters, nanotubes, nanowires and nanodots, semiconductor nanocrystals carbon nanotubes, influence of nano structuring on mechanical, optical, electronic, magnetic and chemical properties	**(08 Hours)**
UNIT-II	**Nanomaterials synthesis** Synthesis and processing, method of nano structuredmaterial preparation – mechanical grinding, wet chemical synthesis, sol-gel processing, gasphase synthesis, gas condensation processing, chemical vapor condensation, nano compositesynthesis – processing Biological methods of synthesis: Use of bacteria, fungi, Actinomycetes for nanoparticlesynthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; S-layerproteins, Viruses as components for the formation of nanostructured materials; Synthesis processand application, Role of plants in nanoparticle synthesis	**(08 Hours)**
UNIT-III	**Analysis of nanomaterial properties** X-ray Diffraction, Thermal Analysis Methods, Differential Thermal Analysis and Differential scanning calorimetry, Spectroscopic techniques, UV-Visible Spectroscopy, IR Spectroscopy, Microwave Spectroscopy, Raman Spectroscopy, Electron Spin Resonance Spectroscopy, NMR Spectroscopy-	**(08 Hours)**

	Particle size characterization: Zeta Potential Measurement, Particle size Analysis, X-ray Photoelectron spectroscopy, Optical microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy	
UNIT-IV	**Applications of nanonaterials** Industrial applications of nanomaterials, in the areas of electronics, photonics, biology, healthand environment, medicine, defence, chemicals, catalysts, textiles, etc. Application ofnanotechnology in remediation of pollution, photocatalysis and other nanocatalysts, greenhousegases, global warming.	**(08 Hours)**
UNIT-V	**Environmental aspects and risk analysis of nanomaterials** Identification of Nano-specific risks, responding to the challenge, human health hazard, risk reduction, standards, safety, transportation of nanoparticles, emergency responders. Riskassessment, environmental impact, predicting hazard, environmental and policy making, ecotoxicitymeasurement of nanomaterials, vacuum packaging under inert gas atmosphere, methodology for stabilization, human safety in nanomaterial processing area.	**(08 Hours)**
UNIT-VI	**Product Development with Nanomaterials** Criteria for selection of product, product development process, design for manufacture,estimate the manufacturing cost, reduce the support cost, prototyping, economics of product development projects, elements of economic analysis, financial models, sensitive analysis and influence of the quantitative factors	**(08 Hours)**

Text Books/References:	
1	P.P. Simeonova, N. Opopol and M.I. Luster, Nanotechnology - Toxicological Issues andEnvironmental Safety, Springer USA 2006.
2	Mick Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons, BurkarRaguse,Nanotechnology:Basic sciences and emerging technologies, Overseas Press, 2005
3	Charles P. Poole, Frank J. Owens, Introduction to Nanotechnology‖, Wiley Interscience, USA 2003.
4	Mark A. Ratner, Daniel Ratner, Nanotechnology: A gentle introduction to the next Big Idea‖, 1st Ed. Prentice Hall P7R:USA, 2002
5	G. Cao and Y.Wang, Nanostructures and Nanomaterials: synthesis, properties and applications, 2nd Ed., World Scientific, Singapore, 2011
6	H. S. Nalwa, Encyclopedia of nanoscience and nanotechnology, American ScientificPublishers, USA 2007
7	Willard, H. H, Merritt Jr., L. L, Dean, J. A., Settle Jr., F. A, Instrumental methods of analysis, Van NostrandNew York, N.Y. USA, 2014

Project based learning: Below is the list of possible topics, which is for guidance faculty can design and provide relevant topics in addition to these	
1	Prepare a report on detail of Nano material, preparation, characterization, module and process design for anyone application
2	Technical interview based on knowledge of Nano technology.
3	Students have to study any five NPTEL/you-tube videos related to Nano technology and prepare/present power point presentation.
4	Group discussions on Nano science and technology related topics.
5	Prepare a report on innovations in Nano technology and their practical importance.

6	Students have to study any five research papers related to specific topic and prepare/present power point presentation
7	With the help of this subject knowledge, write a report on how you would apply your concepts in industry.
8	Case study on emerging trends in process/product innovation considering nano-technology.
9	Students have to visit chemical industry and make a detailed report on nano-technologies used in the process.
10	Write a report on your visit to research and development laboratory of national/international repute.
11	Write a report on nano-technologies for addressing the problems of Water and Energy.

Syllabus for Unit Test:	
Unit Test : I	Units : I, II, and III
Unit Test : II	UNIT : IV, V, and VI

ELECTIVE-II: MEMBRANE SEPARATION					
Designation: Elective					
Pre-requisite Courses: Basic chemistry, Physical chemistry, Mass transfer, Fluid flow operations, Chemical Engineering Thermodynamics					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 4 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Practical	: 2 Hour /Week	Continuous Assessment	: 40 Marks	TW/Practical	: 01
		Term-work (TW)	: 50 Marks	Tutorial	:
		Total	: 150 Marks	Total credits	: 05

Course Outcomes:	
After completion of the course students would be able to:	
1	Explain basics of membrane and select proper material depending upon application
2	Explain the methods of membrane preparation and characterization
3	Determine suitable process for size based separation and explain its transport mechanism
4	Define the transport through non-porous membranes and define membranes for desired application
5	Explain basics and preparation of membrane for other specialized membrane processes
6	Design suitable module and parameters for the desired application

Topics covered		
UNIT-I	**Introduction and Membrane Materials** Introduction, historical development of membrane processes, definition of membrane, permeation, retention and selectivity, membrane processes, their categorization, material for membrane preparation, polymeric material, inorganic materials, mechanical, thermal and chemical stability of membrane based on material, choice of polymer for membrane preparation based on application	**(08 Hours)**
UNIT-II	**Membrane Preparation and Characterizations** Preparation of synthetic membranes: phase inversion membranes, preparation of composite membranes, preparation of inorganic membranes Characterization: Porous membranes – electron microscopy, atomic force microscopy, mercury intrusion, bubble point method, permeability method, solute rejection characteristic; non-porous membranes – permeability, surface analysis, wide angle X-ray, DCS/DTA, density measurement	**(08 Hours)**
UNIT-III	**Processes using porous membranes** Transport mechanism in porous membranes – Knudsen flow, friction model, sieving mechanism Processes: Microfiltration – membranes details, characteristics, industrial applications; Ultrafiltration - membranes details, characteristics, industrial applications; Nano-filtration - membranes details, characteristics, industrial applications.	**(08 Hours)**
UNIT-IV	**Solution-diffusion based membrane processes** Transport mechanism – Solution-diffusion mechanism, solubility, diffusivity, effect of temperature, interaction polymer crystallinity of solubility and diffusivity; Free volume theory Processes: Reverse osmosis - membranes details, characteristics, industrial	**(08 Hours)**

	applications; Gas separation - membranes details, characteristics, industrial applications; Pervaporation - membranes details, characteristics, industrial applications	
UNIT-V	**Other membrane processes** Dialysis - membranes details, their preparation, characteristics, transport mechanism, industrial applications; Electrodialysis - membranes details, their preparation, characteristics, industrial applications; Membrane distillation - membranes details, their preparation, characteristics, industrial applications; Membrane bioreactor - membranes details, their preparation, characteristics, industrial applications; Liquid membranes - membranes details, ionic liquids, their preparation, characteristics, industrial applications; ion exchange - membranes details, their preparation, characteristics, industrial applications	**(08 Hours)**
UNIT-VI	**Membrane modules and process design** Selection of process depending upon applications, plate and frame module, spiral wound module, tubular module, capillary module, hollow fiber module, comparison between module configuration, system design, cross flow operations, hybrid dead end/cross flow operations, cascade operations, Process parameters, Energy requirements	**(08 Hours)**

Text Books/References:	
1	Mulder M.: Basic Principle of Membrane Technology, Kluwer Academic Press Springer Nature Switzerland AG, 1996
2	Baker R. W.: Membrane Technology and Applications, John Wiley and Sons, Ltd. USA, 2004
3	Porter M. C.: Handbook of Industrial Membrane Technology, Noyes Publications, Switzerland, 1991
4	Baker R. W., Cussler E. L., Eykamp W., Koros W. J., Riley R. L., Strathman H.: Membrane Separation Systems – Recent Developments and Future Directions, Noyes Data Corporation, USA, 1991
5	Nunes S. P., Peinemann K.-V., Membrane Technology in the Chemical Industry, Wiley-VCH Verlag GMBH Germany, 2001
Project based learning: Below is the list of possible topics, which is for guidance faculty can design and provide relevant topics in addition to these	
1	Prepare a report on detail of membrane material, preparation, characterization, module and process design for anyone application
2	Technical interview based on knowledge of membrane technology.
3	Students have to study any five NPTEL/you-tube videos related to membrane technology and prepare/present power point presentation.
4	Group discussions on membrane science and technology related topics.
5	Prepare a report on innovations in membrane technology and their practical importance.
6	Students have to study any five research papers related to specific topic and prepare/present power point presentation
7	With the help of this subject knowledge, write a report on how you would apply your concepts in industry.
8	Case study on emerging trends in process/product innovation considering membrane technology.
9	Students have to visit chemical industry and make a detailed report on membrane technologies used in the process.
10	Write a report on your visit to research and development laboratory of national/international repute.
11	Write a report on membrane technologies for addressing the problems of Water and Energy.

Syllabus for Unit Test:	
Unit Test : I	Units : I, II, and III
Unit Test : II	UNIT : IV, V, and VI

Artificial Intelligence					
Designation: Professional Elective					
Pre-requisite Courses: Basic knowledge of Engineering Mathematics, Computer Programming					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 04 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Practical	: 02 Hours/Week	Internal Assessment	: 40 Marks	TW/OR	: 01
Total	: 06 Hours/Week	Termwork	: 25 Marks	Total Credits	: 05
		Termwork and Oral	: 25 Marks		
		Total	: 150 Marks		

Course Outcomes	
After completion of the course students would be able to	
1	Formulate problem statement of chemical engineering process using artificial intelligence.
2	Apply formalisms of artificial intelligence to chemical engineering processes.
3	Estimate artificial neural network modeling parameters for chemical process.
4	Estimate genetic programming modeling parameters for chemical process.
5	Estimate principle components for a given system/process data.
6	Estimate economic artificial intelligence based optimization procedure for chemical process.

Topics Covered		
UNIT-I	**Introduction** Introduction to Artificial Intelligence (AI); Applications of AI to Chemical Engineering; Introduction to various AI- based formalisms; Principal component analysis; Cause and effect relationships. Black box modelling.	**(08 Hours)**
UNIT-II	**AI-based Modelling Formalisms** Introduction to various AI- based modelling formalisms; Artificial Neural Networks (ANNs); Genetic Programming (GP); Support Vector Regression; Fuzzy Logic (FL); Applications of these formalisms to Chemical engineering.	**(08 Hours)**
UNIT-III	**Artificial Neural Networks (ANNs)** Biological background; ANN classification; Computational properties of ANNs; Modelling a single neuron; Building blocks of feed-forward neural network: Bias, Processing elements, Input layer, hidden layer, Output layer, Learning rate, Momentum, Transfer function; Error back propagation.	**(08 Hours)**
UNIT-IV	**Genetic Programming (GP)** Introduction to evolutionary algorithms; Dependent variables; Independent variables; Mathematical operators; Initial population; Candidate solution; Tree structure; Initialization; Fitness evaluation and selection; Crossover; Mutation.	**(08 Hours)**
UNIT-V	**Evolutionary Algorithms (EA)** Introduction to stochastic evolutionary algorithms; Applications; Genetic algorithms; Particle Swarm method; Ant Colony method.	**(08 Hours)**
UNIT-VI	**Applications and Case Studies** Chemical Engineering based different case studies solution using AI-based	**(08 Hours)**

	modelling and optimization formalisms	
***Project Based Learning**		
1.	Group discussions on any of the following topics: a) Role of Artificial Intelligence in Chemical Engineering b) Phenomenological, empirical and AI-based modelling c) Artificial Intelligence and Chemical Industries	
2.	Make a complete chart of various AI based modeling formalisms with suitable schematics.	
3.	Preparation of seminar report and oral presentation based on recent advances in Chemical Engineering with Artificial Intelligence.	
4.	Students have to study any five NPTEL videos related to Artificial Intelligence and prepare/present power point presentation.	
5.	Solving numerical based on core chemical engineering process problems using AI formalisms.	
6.	Collect and read recent research papers on Artificial Neural Network and chemical process modelling and prepare summery report.	
7.	Collect and read recent research papers on Genetic Programming and chemical process modelling and prepare summery report.	
8.	Analyse the results for case study with Principal Component Analysis and interpret the results.	
9.	Prepare question bank with appropriate answers based on the whole subject renewable energy.	
10.	Enhancement in collaborative learning is done through, group assignments that will be given to encourage students to work with classmates to discuss and complete homework assignments.	
*Students in a group of 3 to 4 shall complete any one project from the above list.		
Termwork:		
Oral examination will be based on the assessment of the term-work (duly certified by the teacher and HOD). The term-work shall consist of case study solved using AI-based formalisms mentioned in the syllabus OR term-work shall be based on the technical report/seminar based AI-based studies carried out by individual or small group of students.		
Text Books/References		
1	C.M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, Oxford, 1995.	
2	S.S. Tambe, P.B. Deshpande, B.D. Kulkarni, Elements of Artificial Neural Networks with Selected Applications in Chemical Engineering, and Chemical & Biological Sciences, Simulation & Advanced Controls, Inc., Louisville, 1996.	
3	J. Koza, Genetic Programming: On the Programming of Computers by Means of Natural Selection, MIT Press, Cambridge, M.A, 1992.	
4	V. Vapnik, The Nature of Statistical Learning Theory, Springer-Verlag, New York, 1995.	
5	K. Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice-Hall, New Delhi, 1995.	
6	D.E. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, Reading, MA, 1989.	

Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

ELECTIVE-II : BIO-SEPARATIONS

Designation: Professional Core

Pre-requisite Courses: Basic knowledge of Biology, Analytical chemistry and techniques.

Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 04Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Practical	: 02Hours/Week	Internal Assessment	: 40 Marks	Tutorial	: -
Total	: 06 Hours/Week	Term-work (TW)	: 25 Marks	Practical	: 01
		Practical/Oral	: 25 Marks	Total Credits	: 05
		Total	: 150Marks		

Course Outcomes

1	Define concept of bio-separation, physico-chemical basis of bio-separation.
2	Learn low resolution bio-separation techniques.
3	Analyze high resolution bio-separation techniques.
4	Learn separation techniques like precipitation, crystallization, etc.
5	Identify the emerging bio-separation techniques like expanded-bed chromatography, hybrid bioseparations, etc.
6	Apply bio-separation knowledge for purification of β amylase, aspartic acid, etc.

Topics Covered

UNIT-I	**Introduction to Bio-separation** An overview of bio-separation; Separation of cells and other insolubles from fermented broth; bioproduct purification; characteristics of biological mixtures; Broad categories of bioproducts; essential stages in downstream processing; basic unit operations in downstream processing; physico-chemical basis of bio-separation.	**(08 Hours)**
UNIT-II	**Low resolution Bio-separation techniques** Cell disruption, Centrifugation; Liquid-liquid extraction; Leaching; Filtration; Supercritical fluid extraction; Micro-filtration; Ultra-filtration; Adsorption; Sedimentation	**(08 Hours)**
UNIT-III	**High resolution Bio-separation techniques** Ultra-centrifugation**;** Different electrophoresis techniques viz. Isoelectric focusing; Affinity separation; Chromatographic techniques viz. Paper, Gel; Ion exchange; Affinity; GLC; HPLC; Dialysis.	**(08 Hours)**
UNIT-IV	**Other separation techniques** Zone refining; Molecular sieves; Adductive crystallization; Reactive extraction; Precipitation method using ammonium sulfate; organic solvents; high molecular weight polymers; Reverse osmosis; Foam separation; Aqueous two phase systems.	**(08 Hours)**
UNIT-V	**Emerging bio-separation techniques** Membrane and monolith chromatography; Expanded-bed chromatography; High-resolution ultrafiltration; Hybrid bio-separations; Introduction to SEP box and Hyphenated techniques.	**(08 Hours)**

UNIT-VI	**Applications of Bio-separation -case studies** Purification of β amylase; aspartic acid; insulin; Food and Beverages; Beer; Citric acid; Bio-chemicals: Butanol.	**(08 Hours)**

Project Based Learning	
1.	Write a report on the recent advances in chromatographic processes with reference to the current year.
2.	Evaluate efficiencies of different chromatographic techniques.
3.	Search out some industries related to bio-separation.
4.	Write a technical report on your visit to a process industry.
5.	List out all the principles of the analytical techniques.
6.	Perform any one chromatographic technique.
7.	Find out different types of proteins with structure.
8.	Prepare a report on downstream processing.
9.	Give fifteen minutes presentation (seminar) on particular topic and prepare a report.
10.	Group discussion on merits and de-merits of bio-separation.
*Students in a group of 3 to 4 shall complete any one project from the above list.	
Term Work	
Term work will consist of the seminars on the following topics.	
1	Gas chromatography.
2	Membrane separation and its application in industry.
3	Sedimentation and its application in industry.
4	Reactive extraction.
5	Material analysis using paper chromatography
6	High-resolution ultrafiltration.
7	Gel electrophoresis
8	Molecular sieves.
9	Centrifugation.
10	Adductive crystallization
Te1xt Books/References	
1	P.A.Belter, E.L. Cussler and S.H.Wei, "Bio-separation–Downstream Processing for Biotechnology", Wiley India Pvt. Ltd., 2011.
2	N.K.Prasad, "Downstream Process Technology-A New Horizon in Biotechnology", Prentice Hall of India, New Delhi, 2012.
3	M.D.Pauline, "Bioprocess Engineering Principles", Academic Press, London, USA, 2012.
4	B Sivasankar, "Bio-separations: Principles and Techniques", Phi Learning Pvt. Ltd., 2009.
5	A. Kumar, A. Awasthi , "Bio-separation Engineering: Comprehensive DSP Volumen" I.K International Publishing House Pvt. Ltd., New Delhi, 2009.
Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

Chemical Project Engineering and Economics

Designation: Professional Core

Pre-requisite Courses: Basic knowledge of engineering mathematics, core Chemical Engineering subjects, and process modeling

Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 04 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Drawings	: 02 Hours/Week	Internal Assessment	: 40 Marks	Practical	: 01
Total	: 06 Hours/Week	Term-work	: 25 Marks	Total Credits	: 05
		Oral	: 25 Marks		
		Total	: 150 Marks		

Course Outcomes

After completion of the course students would be able to

1	Formulate preliminary techno economic feasibility report.
2	Elaborate the criteria for process selection and justification of the selected chemical process.
3	Estimate the total product cost.
4	Estimate the depreciation charges for various assets.
5	Evaluate the break even chart and its significance.
6	Estimate the critical path method (CPM) for project planning of given chemical process.

Topics Covered

UNIT-I	**Introduction** Plant design and development : Design basis, process selection, material of construction, plant location, plant layout and installation, plant operation and control, safety, start up, shut down and operating guidelines; Preliminary techno economic feasibility report.	**(08 Hours)**
UNIT-II	**Optimization and feasibility of plant design** Preliminary design: Design and selection of process equipments, standard versus special equipment selection criteria, specification sheets; Comparison of different processes; Importance of laboratory development and pilot plant; utilities; Complete engineering flow sheet drawing; Flow diagrams: Process flow diagram, qualitative flow diagram, quantitative flow diagram.	**(08 Hours)**
UNIT-III	**Cost estimation** Cash flow and cumulative cash position for industrial operations; Factors affecting investment and production cost; Capital investments: Fixed capital investment, working capital, method for estimating capital investment; Estimation of total product cost: Direct production cost, fixed charges, plant overhead costs, administrative expenses, distribution and marketing expenses; Cost indexes.	**(08 Hours)**
UNIT-IV	**Depreciation** Introduction; Basic terminologies related to depreciation; Types of depreciation: Functional depreciation, physical depreciation; Methods for determining depreciation: Straight line method, Declining balance method, Double declining balance method, Sum of the years digits method, Sinking fund method.	**(08 Hours)**

UNIT-V	**Interest and investment costs** Types of interest; Present worth and discount; Annuities: Relation between amount of ordinary annuity and the periodic payments, present worth of an annuity; Balance sheet; Evaluation of break even point and its significance; Profitability, Alternative investments and replacement: Methods for profitability evaluation, % rate of return, practical factors in alternative investment and replacement studies	**(08 Hours)**
UNIT-VI	**CPM and PERT** Bar charts; Milestone charts; Introduction to Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT); Applications of CPM and PERT; Basic Steps in PERT / CPM: Planning, scheduling, allocation of resources, controlling; Network Diagram Representation: Activity, classification of activities, event, classification of events, sequencing; Rules for drawing network diagram; Common errors in drawing networks; Advantages of CPM and PERT project planning; Detail calculation procedure of CPM and PERT project planning.	**(08 Hours)**

***Project Based Learning**	
1.	Preparation of quantitative flow diagram for any process plant
2.	Preparation of feasibility report for any chemical product/process
3.	Preparation of critical path network for specific case study/chemical process
4.	Preparation of project evaluation and review technique for specific case study/chemical process
5.	Students have to study any five NPTEL videos related to Chemical Project Engineering and Economics and prepare/present power point presentation.
6.	Group discussions on any of the following topics: a) Importance of project engineering techniques in chemical industries. b) Critical path method and project evaluation and review technique c) Role of economics in chemical process design
7.	Read recent research papers related to this subject area and prepare report
8.	Prepare question bank with appropriate answers based on Chemical Project Engineering and Economics
9.	Solving numerical based on core chemical engineering using optimization methods
10.	Enhancement in collaborative learning is done through, group assignments that will be given to encourage students to work with classmates to discuss and complete homework assignments.
*Students in a group of 3 to 4 shall complete any one project from the above list.	

Termwork	
Term work will consist of any six drawings of following:	
1	Process flow diagram
2	Plant layout and elevations
3	Utility Diagram

4	Cumulative cash position for industrial operations
5	Break Even Chart
6	Critical Path Method (CPM)
7	Project Evaluation and Review Technique (PERT)
Text Books/References	
1	T. F. Edgar and D. M. Himmblblau, Optimization of Chemical Processes, 2nd Ed., Tata-McGraw Hill Publications, 2001.
2	S. C. Chapra and R.P. Canale, Numerical Methods for Engineers, 6th Ed., Tata-McGraw Hill Publications, 2015.
3	A. Ravindran, K. M. Ragsdell, and G. V. Reklaitis, Engineering Optimization: Methods and Applications, 2nd Ed., Wiley India, 2006.
4	S. S. Rao, Engineering Optimization: Theory and Practice, 4th Ed., John Wiley & Sons, Inc, 2009.
5	M. S. Peters and K. D. Timmerhaus, Plant Design and economics for chemical engineers, Mc Graw Hill Publications, 2002.
Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

Optimization Techniques in Chemical Engineering					
Designation: Professional Core					
Pre-requisite Courses: Basic knowledge of engineering mathematics, core Chemical Engineering subjects, and process modeling					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 04 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Total	: 04 Hours/Week	Internal Assessment	: 40 Marks	Total Credits	: 04
		Total	: 100 Marks		

Course Outcomes	
After completion of the course students would be able to	
1	Formulate statement of optimization problem
2	Apply methods for unconstrained single variable optimization
3	Apply methods for unconstrained multivariable optimization
4	Elaborate economic optimization procedure for chemical engineering problems
5	Estimate optimum design procedure for chemical engineering problems
6	Estimate economic optimization procedure for process equipments

Topics Covered		
UNIT-I	**Introduction** Introduction to Optimization; Statement of optimization problems; Classification of optimization problems; Examples from engineering applications; Review of linear algebra	**(08 Hours)**
UNIT-II	**Unconstrained Single Variable Optimization** Methods and Applications: Region elimination methods; Methods requiring derivatives: Newton-Raphson method, Bisection method, Secant method	**(08 Hours)**
UNIT-III	**Unconstrained Multivariable Optimization** Gradient Based Methods: Cauchy's method, Newton's method, Marquardt method	**(08 Hours)**
UNIT-IV	**Numerical Methods for Optimizing a Function of One Variable:** Core Chemical Engineering problem solution using following methods: Unconstraint One Dimension Methods: Newton's Method, Quadratic Interpolation, Cubic Interpolation; Unconstraint Multiple Variable: Random search, Grid search, Simplex search, Quasi Newton method	
UNIT-V	**Economic Optimization and Optimum Design** Nature of optimization; Uni-variable and multivariable systems; Analytical, graphical and incremental methods of solution; Lagrange multiplier method; Linear programming; Other techniques and strategies establishing optimum conditions; Break even chart for production schedule; Optimum production rates in plant operation; Optimum conditions in batch and cyclic operation; Critical path method; Project evaluation and review technique.	**(08 Hours)**
UNIT-VI	**Optimisation of Different Process Equipment**	**(08 Hours)**

	Transportation systems; Heat exchangers; Evaporators; Mass transfer equipments and reactors; Determination of height and diameter of different process equipments at conditions of optimum cost; Pinch technology analysis; Preparation of techno-economic feasibility report.	

***Project Based Learning**	
1.	Determination of height and diameter of different process equipments for optimum cost
2.	Preparation of feasibility report for any chemical product/process
3.	Preparation of critical path network for specific case study/chemical process
4.	Preparation of project evaluation and review technique for specific case study/chemical process
5.	Students have to study any five NPTEL videos related to Optimization in Chemical Engineering and prepare/present power point presentation.
6.	Group discussions on any of the following topics: a) Importance of optimization technique in chemical industries. b) Critical path method and project evaluation and review technique c) Role of optimization in process design
7.	Read recent research papers related to this subject area and prepare report
8.	Prepare question bank with appropriate answers based on optimization techniques in chemical engineering
9.	Solving numerical based on core chemical engineering using optimization methods
10.	Enhancement in collaborative learning is done through, group assignments that will be given to encourage students to work with classmates to discuss and complete homework assignments.
*Students in a group of 3 to 4 shall complete any one project from the above list.	

Text Books/References	
1	T. F. Edgar and D. M. Himmblblau, Optimization of Chemical Processes, 2nd Ed., Tata-McGraw Hill Publications, 2001.
2	S. C. Chapra and R.P. Canale, Numerical Methods for Engineers, 6th Ed., Tata-McGraw Hill Publications, 2015.
3	A. Ravindran, K. M. Ragsdell, and G. V. Reklaitis, Engineering Optimization: Methods and Applications, 2nd Ed., Wiley India, 2006.
4	S. S. Rao, Engineering Optimization: Theory and Practice, 4th Ed., John Wiley & Sons, Inc, 2009.
5	M. S. Peters and K. D. Timmerhaus, Plant Design and economics for chemical engineers, Mc Graw Hill Publications, 2002.

Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

Industrial Management					
Designation: Professional Core					
Pre-requisite Courses: Concept of Management					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Lectures	: 04 Hours/Week	End Semester Examination	: 60 Marks	Theory	: 04
Total	: 04 Hours/Week	Internal Assessment	: 40 Marks	Total Credits	: 04
		Total	: 100 Marks		

Course Outcomes	
After completion of the course students would be able to	
1	Know the types of business.
2	Understand the types of organization
3	Understand the forms of ownership.
4	Know the concepts of material management.
5	Know the concepts quality management.
6	Know the various acts

Topics Covered		
UNIT-I	**Outline of Business** Types of Business, Industrial sectors Globalization Management Process, Principles of Management, Functions of Management Types of organization, Departmentation, Principles of Organization, Forms of ownership	**(08 Hours)**
UNIT-II	**Financial Management** Objectives & Functions, Capital Generation & (06 Hours) Management, Budgets and accounts, Taxation (Excise Tax, Service Tax, Income Tax, Value Added Tax and Custom Duty)	**(08 Hours)**
UNIT-III	**Material management** Definition, functions, importance, relationship with other departments, purchasing systems, purchase procedure, Storekeeping , classification of stores as centralized and decentralized with their advantages, disadvantages and application in actual practice, Material Resource Planning (MRP)	**(08 Hours)**
UNIT-IV	**Quality Management** Quality Control, Quality Circle, Quality Assurance, Total Quality and TQM, Kaizen,5'S',6 Sigma	**(08 Hours)**
UNIT-V	**Production planning and Control** Need and importance. Scheduling- meaning and need for productivity and utilization. Gantt chart- Format and method to prepare. Critical ratio scheduling-method.	**(08 Hours)**
UNIT-VI	**Recent Trends in IM** ERP (Enterprise resource planning) - concept, features and applications, Important	**(08 Hours)**

	features of MS Project. Logistics- concept need and benefits. Just in Time (JIT)-concept and benefits. Supply chain management-concept and benefits.	

***Project Based Learning**	
1.	Given the data, prepare the network diagram and determine critical path
2.	Given the data, prepare the scheduling using Gantt chart
3.	Perform value analysis for given case
4.	Globalization in India
5.	Different principals of management.
6.	Various types of organization
7.	Various forms of ownership
8.	Capital Generation for an organization.
9.	ABC Analysis. 8. Standard purchase
10.	Material Resource Planning (MRP), Enterprise Resource Planning (ERP)
*Students in a group of 3 to 4 shall complete any one project from the above list.	

Text Books/References	
1	CPM & PERT principles and Applications. L.S.Srinath.
2	Modern Production Management. Buffa.
3	Materials Management. N. Nair. iv. Industrial Engineering & Management. O. P. Khanna. v. Value Analysis. Mikes.
4	Khanna. O.P., "Industrial Engineering & Management" Dhanpat Rai & Sons New Delhi.
5	Banga T. R. and Sharma S.C. "Industrial Engineering & Management" Khanna Publication
6	Saxena, S.C." Business Administration & Management" SahityaBhavan Agra
7	Newman W.H., Warren E. K. and McGil A. R., "The process of Management" Prentice- Hall

Syllabus for Unit Tests	
Unit Test I	Units I, II, and III
Unit Test II	Units IV, V, and VI

Chemical Process Simulation II

Designation: Professional Core

Pre-requisite Courses: Fundamentals ofComputer, Mechanical operations, Heat Transfer, Fluid Flow, Mass Transfer, Thermodynamics and Chemical reaction engineering.

Teaching Scheme	**Examination Scheme**	**Credits Allotted**
Practical : 02Hours/Week	TW :25Marks	
	Practical/Oral :25 Marks	Practical/Oral : 01
	Total : 50 Marks	Total Credits : 01

Course Outcomes:

After completion of the course students would be able to:

1	Develop a process flow diagram for a given system.
2	Design simulation programs involving small unit operations.
3	Simulate reactors and estimate parameters.
4	Design and simulate heat exchangers
5	Develop a simulation model for separation of binary/ternary components.
6	Apply all fundamental knowledge to build a simulation environment for a given problem.

Topics Covered

UNIT-I	**VLE data estimation** Estimation of VLE data for different binary mixtures at isothermal and isobaric conditions 1. Program/ simulation applying different activity Coefficient models 2. Estimation of binary interaction parameters
UNIT-II	**Simulation of Separation Units** 3. Process, design of absorption/ Distillation column 4. Estimating HTU, NTU, HETP absorption column 5. Estimating design parameters of distillation column
UNIT-III	**Simulation of Reactors** Simulation of batch, semi-batch and continuous stirred reactors. 6.Estimating conversion/purity/selectivity in batch reactor 7. Case study selecting any example
UNIT-IV	**Simulation of Reactor + Separator unit** Theoretical calculation for reactor separator unit, variable selection for design. 8. Optimization of the reactor + Separator unit.
UNIT-V	**Application to Chemical Engineering** Solving real case studies in chemical engineering. 9. Simulation of any case study involving all unit operations and processes. 10. Optimizing the variables.
UNIT-VI	**Computational Fluid Dynamics Basics** Introduction to CFD approach, advantages of CFD, applications, equation structure overview. Governing equations of fluid dynamics, mass, energy and momentum, boundary conditions, time-averaged equations for turbulent Flow, partial differential equations on CFD, elliptic, parabolic and hyperbolic equations. 11. Programs based on Fundamentals in CFD Programming. 12. Programs based on governing equations

Term Work

Term work will consist of the programs/practical's listed above, out of which any eight programs/practical's are to be performed in laboratory by the students.

Text Books/References:	
1	A. Finlayson, Introduction to chemical engineering computing. John Wiley & Sons, 2012
2	W. L. Luyben, Process Modeling Simulation and Control for Chemical Engineers,McGraw Hill, 1990.
3	J. Haydary, Chemical Process Design and Simulation, Wiley, 2019.
4	A. Jana, Amiya K. Chemical process modelling and computer simulation. PHI Learning Pvt. Ltd. 2011.
5.	D. Himmelblau, K.B. Bischoff, Process Analysis and Simulation, John Wiley & Sons, 1968

PROJECT: STAGE-II					
Designation: Professional Core					
Pre-requisite Courses: Knowledge of chemistry, Material and energy balance calculations, Mass transfer, and Chemical reaction engineering, Equipment design, etc.					
Teaching Scheme		**Examination Scheme**		**Credits Allotted**	
Practical	: 04 Hours/Week	Term-work (TW)	: 100 Marks	TW/Oral	: 06
Total	: 04 Hours/Week	Practical/Oral	: 100 Marks	Total Credits	: 06
		Total	: 200 Marks		

Course Outcomes	
1	Fabrication of the experimental setup/new system and/or purchase of standard components
2	Pilot run and/or validation of new system for its performance
3	Modifying the system if required to improve its performance
4	Detailed parametric studies of the modified system and analyzing the results
5	Writing technical report, research article and/or filing a patent

Course Contents

Students need to approach to the guide after guide allotment using standard procedure. Guide will elaborate the project to students and decide the objectives and the plan of work.

Minimum number of in-sem. project presentations: 03

Parameters for evaluation of project in University examination

Idea of Project/Topic, Technical content, Innovation, Experinnentation/Model development/Software development/Simulation development, etc., Participation as an Individual, Research Potential, Project Hardware/Software, Fabrication/Model/Equipment development, Data Analysis, Attendance, Timely completion, Report writing, Presentation

Progress report card will be issued to each student to monitor the progress of work.

Assessment and progressive evaluation of the project will be done by the committee consisting of senior faculty members. The record of progressive evaluation shall be submitted in the department at the end of the semester and made available at time of university examination.