DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
FINAL YEAR B. TECH
Scheme of Teaching and Examination: Semester- VII (Chemical Engineering)
To be implemented from Academic Year 2023-24

Course Code	Course Title	Teaching Scheme with Credits (Hours / Week)				Examination Scheme (Marks)					
						Theory			Practical		
		L	T	P	Total Credits	Scheme	Max. marks	Min. Passing $	Scheme	Max. marks	Min. Passing
CH411	Biochemical Engineering	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH412	Elective-I	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH413	Process Equipment Design	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH414	Industrial Economics and Management	03	-	-	03	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH415	Process Modeling and Simulation	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH413L	Process Equipment Design Laboratory	-	-	02	01	-	-	-	IPE	50	20
									EPE	50	20
CH415L	Process Modeling and Simulation Laboratory	-	-	02	01				IPE	50	20
CH416T	Comprehensive Tests		01	-	01	-	-	-	IPE	50	20
CH417L	Major Project-Phase I	-	-	02	01	-	-	-	IOE	50	20
CH418	Internship II	-	-	-	02	-	-	-	EOE	50	20
	Total	**19**	**01**	**06**	**25**	-	**500**	-	-	**300**	-

Audit Course V											
HS411	Introduction to Indian Constitution	**02**	-	-	-	Institute Level	--	---	---	-----	-----

$ In theory student should appear for the CIE (Mid Semester Exam), submit the assignment and must secure 40% marks in SEE.
Total contact hours per week: **26+2=28 and Total Credits=25**

CIE:	Continuous Internal Evaluation	SEE:	Semester End Examination
IPE:	Internal Practical Evaluation	EPE:	External Practical Examination
IOE:	Internal Oral Evaluation	EOE:	External Oral Examination

Note: **1.** Tutorials and Practical to be conducted in batches with batch strength not exceeding 15 students.

DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
FINAL YEAR B.TECH

Scheme of Teaching with Credits: Semester- VII (Chemical Engineering)
To be implemented from Academic Year 2023-24

Course Code	Course Title	Teaching Scheme with Credits (Hours / Week)			
		L	T	P	Credits
CH411	Biochemical Engineering	04	-	-	04
CH412	Elective-I	04	-	-	04
CH413	Process Equipment Design	04	-	-	04
CH414	Industrial Economics and Management	03	-	-	03
CH415	Process Modeling and Simulation	04	-	-	04
CH413L	Process Equipment Design Laboratory	-	-	02	01
CH415L	Process Modeling and Simulation Laboratory			02	01
CH416T	Comprehensive Tests		01	-	01
CH417L	Major Project-Phase I	-	-	02	01
CH418	Internship II	-	-	-	02
	Total	**19**	**01**	**06**	**25**

Audit Course V

HS411	Introduction to Indian Constitution	**02**	-		Nil

Total contact hours per week: **26+2=28 and Total Credits=25**

CH412 ELECTIVE-I

Elective –I is a pool of various courses from the Program domain. The list is as below:

CH412.1 Petroleum Refinery Engineering, CH412.2 Advanced Separation Techniques CH412.3 Polymer Chemistry, CH412.4 Introduction to Food Process Engineering, CH412.5 Green Chemistry and Catalysis, CH412.6 Environmental Science and Microbiology, CH412.7 Drugs and Pharmaceutical Technology, CH412.8 Advanced Spectroscopy, CH412.9 Molecular Quantum Mechanics, CH412.10 Statistical Methods in Engineering

Teaching Scheme: L: 4 hours/week **Credits: 4**

DEPARTMENT OF TECHNOLOGY,
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FINAL YEAR B.TECH

Scheme of Teaching and Examination: Semester- VIII (Chemical Engineering)
To be implemented from Academic Year 2023-24

Course Code	Course Title	Teaching Scheme with Credits (Hours / Week)				Examination Scheme (Marks)					
						Theory			Practical		
		L	T	P	Total	Scheme	Max. marks	Min. Passing	Scheme	Max. marks	Min. Passing
CH421	Elective-II (Open Elective)	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH422	Energy Resources and Utilization	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH423	Process Economics and Project Engineering	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH424	Special Chemical Technologies	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH425	Transport Phenomena	04	-	-	04	CIE	30	40	-	-	-
						SEE	70		-	-	-
CH426L	Piping & Instrumentation Design and Drawing	-	-	02	01	-	-	-	IOE	50	20
CH427L	Plant Design and Drawing	-	-	02	01	-	-	-	EPE	50	20
CH428T	Seminar	-	01	-	01				IOE	50	20
CH429L	Major Project-Phase II	-	-	04	02	-	-	-	IPE	50	20
						-	-	-	EPE	100	40
	Total	**20**	**01**	**08**	**25**	-	**500**	-	-	**300**	-

Audit Course VI											
HS421	Professional Ethics	**02**	-	-	-	Institute Level	-	-	-	-	-

$ In theory student should appear for the CIE (Mid Semester Exam), submit the assignment and must secure 40% marks in SEE.

Total contact hours per week: **29+2=31 and Total Credits=25**

CIE: Continuous Internal Evaluation SEE: Semester End Examination
IPE: Internal Practical Evaluation (Based on Project Work) EOE: External Oral Examination
IOE: Internal Oral Evaluation EPE: External Practical Examination (Based on Project Work)

Note: **1.** Tutorials and Practical to be conducted in batches with batch strength not exceeding 15 Students.

DEPARTMENT OF TECHNOLOGY,
SHIVAJI UNIVERSITY KOLHAPUR
FINAL YEAR B.TECH

Scheme of Teaching with Credits: Semester VIII (Chemical Engineering)
To be implemented from Academic Year 2023-24

Course Code	Course Title	Teaching Scheme with Credits (Hours / Week)			
		L	T	P	Credits
CH421	Elective-II (Open Elective)	04	-	-	04
CH422	Energy Resources and Utilization	04	-	-	04
CH423	Process Economics and Project Engineering	04	-	-	04
CH424	Special Chemical Technologies	04	-	-	04
CH425	Transport Phenomena	04	-	-	04
CH426L	Piping & Instrumentation Design and Drawing	-	-	02	01
CH427L	Plant Design and Drawing	-	-	02	01
CH428T	Seminar	-	01	-	01
CH429L	Major Project-Phase II	-	-	04	02
	Total	**20**	**01**	**08**	**25**

Audit Course VI					
HS421	Professional Ethics	**02**	-	-	-

Total contact hours per week: **29+2=31 and Total Credits=25**

CH421 ELECTIVE-II (OPEN ELECTIVE)

Elective –II is also termed as Open Elective with the motive that besides pool of the Program domain electives, the students are free to choose an elective from any other Program at the institute. The pool is as below:

CH421.1 Petrochemical Technology, CH421.2. Industrial Biotechnology, CH421.3. Polymer Technology, CH421.4 Food Process Technology, CH421.5 Interfacial Science and Engineering, CH421.6 Environmental Chemistry and Biochemistry, CH421.7 Advanced Materials, CH421.8 Project Management, CH421.9 CFD Applications in Chemical Processes, CH421.10 Open Elective (to be chosen from any of the specialized UG Program available on the campus)

Teaching Scheme: L: 4 hours/week **Credits: 4**

The interested students have to choose the elective from the above mentioned list of electives. In case of the open elective chosen from the other program, the students have to contact the concerned course teacher and attend the classes in the respective course which will be taught by the concerned teacher.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering) Part IV, Semester VII**				
Course Title	:	**Biochemical Engineering**			***Course Code*** :	CH411
Teaching Scheme (Hours)	:	Lecture =04 Hours/Week Tutorial = Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	CH212, CH312, CH315, CH412.2				
Course Domain	:	Program Core				

Course Rationale: The purpose of this course is to introduce and make aware the students about different metabolic pathways of cell, enzymatic kinetics for biochemical reaction, reactor types, principles of biochemical reactor analysis and design, growth characteristics of microbial cells, biochemical separation processes.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain basic concepts of biochemical engineering and genetic engineering.	1.	Rephrase basic concepts of biochemical engineering and genetic engineering.
2.	Discuss the different biological metabolic pathways of the cell.	2.	Recognize the different biological metabolic pathways of the cell.
3.	Explain the enzymatic kinetics for the enzyme catalyzed reactions.	3.	Develop the design equation for enzyme catalyzed reactions.
4.	Impart knowledge of microbial growth characteristics of cell.	4.	Explain the concept of microbial growth characteristics of cell.
5.	Elaborate various bioreactor system along with design and analysis	5.	Identify good bioreactor system for enzyme catalyzed reaction
6.	Illustrate the different processes for separation of biochemical product	6.	Differentiate between the processes for separation of biochemical product

Curriculum Content	**Hours**
Unit I: Introduction to Biochemical engineering Biochemical Engineering - the interaction of two disciplines, Comparison of chemical and biochemical process, Basic concepts of microbiology, Role of biochemical engineers in development of modern formation industry, Future development, Principles of genetic Engineering, Recombinant DNA technology.	06
Unit II: Metabolic pathways and energetic of the cell Concept of energy coupling, ATP and NAD, Photosynthesis, Carbon metabolism, EMP pathway, HMP pathway, Citric acid (TCA) cycle and electron transport chain, Production of amino acids, Nucleotides, Antibiotics.	08
Unit III: Kinetics of enzyme catalyzed reactions The enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, determination of elementary step rate constants, Modulation and regulation of enzyme activity, inhibitors on enzyme activity, Enzyme deactivation, Effect of pH and temperature on enzyme activity, Industrial applications of enzymes.	10
Unit IV: Typical growth characteristics of microbial cells Factors affecting growth, Batch and Continuous cell growth, nutrient media, enrichment	10

culture, culture production and preservation, Immobilization Technology –Techniques of immobilization, characteristics and applications, Reactors for immobilized enzyme systems.	
Unit V: Stoichiometry of microbial growth and product formation Introduction, Stoichiometric calculations, elemental balances, degree of reduction, Theoretical predictions of yield coefficients.	06
Unit VI: Introduction to bioreactors and separation processes Classification and characterization of different bioreactors, Design and analysis of Bioreactors - CSTR and Air Lift Reactor, Scale up considerations of bioprocesses, Selection of cell separation Unit operation, Initial and final purification, Product formation, Integration of fermentation and downstream processing operations.	08

Suggested Text Books:	
1.	M. L. Shuler and F. Kargi, "Bioprocess engineering basic concepts", 2nd Edition, Prentice Hall, New Jersey, 1992.
2.	Mukesh Doble, Sathyanarayana N, "Biochemical Engineering", Gummai, Prentice Hall, 2007
3.	D. G. Rao, "Introduction to Biochemical Engineering", Tata McGraw Hill, 2005.
4.	G. D. Najafpour, "Biochemical Engineering and Biotechnology",1st edition, Elsevier,2015
Suggested Reference Books:	
1.	Trevan, Boffey, Goulding and Stanbury, "Biotechnology", Tata McGraw Hill Publishing Co., New Delhi, 1987
2.	S. Aaiba, "Biochemical Engineering", Academic Press, 1965
3.	J. E. Bailey and D. F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill, 1986

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering) Part IV, Semester VII**					
Course Title	:	**Petroleum Refinery Engineering (Elective-I)**			***Course Code***	:	CH412.1
Teaching Scheme (Hours)	:	Lecture =04 Hours/Week Tutorial =Nil			***Total Credits***	:	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2023
Pre-requisites *(If any)*	:	CH211, CH315					
Course Domain	:	Core Elective					

Course Rationale: This elective course provides an overview of the integrated petroleum refining industry, its feedstock, and the processes used to transform crude oil and intermediate streams into finished products. It covers hydrocarbon and non-hydrocarbon chemistry, crude oil properties, and petroleum product quality. Each refining process is displayed and includes a description and conditions of operation, feedstock and catalyst selection, product yield, process parameters, plant performance, product yield and property relationships. This course provides key insights into primary and secondary processes for petroleum products.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Elaborate the formation, exploration and drilling operation of oil and gas.	1.	Describe the formation, exploration and drilling operation of oil and gas.
2.	Explain the different crude oil distillation and transportation.	2.	Recognize the different crude oil distillation and transportation.
3.	Describe the various cracking processes of crude oil.	3.	Distinguish between the various cracking processes of crude oil.
4.	Illustrate the petroleum product quality improvement process.	4.	Recognize importance of improvement process of petroleum product.
5.	Impart knowledge of Lube oil & Bitumen manufacturing processes.	5.	Explain Lube oil & Bitumen manufacturing processes.
6.	Explain the corrosion control and operation of petroleum processing equipment with examples.	6.	Interpret about the corrosion control and operation of petroleum process equipment.

Curriculum Content	**Hours**
Unit I: Introduction Genesis, Occurrence, Exploration of crude oil and gas, Drilling of crude oil, Composition and evaluation of crude oil, Testing of petroleum products.	08
Unit II: Crude oil distillation and transportation Electrical desalting process, Refining of petroleum – Atmospheric and vacuum distillation, Pipeline transportation and its method, Flow properties, Pumpability characteristics of waxy crude oil.	08
Unit III: Cracking processes Thermal cracking, Vis-breaking, Coking, Fluid catalytic cracking, Catalytic reforming, Hydro Cracking.	10
Unit IV: Finishing process Hydrogen sulphide removal process, Sulphur conversion process, Sweetening, Solvent	10

Extraction, Hydro treating process.	
Unit V: Lube oil and bitumen Solvent deasphalting, extraction, Solvent dewaxing, Hydro finishing process, Manufacture of bitumen.	08
Unit VI: Corrosion control, design and operation of petroleum processing equipment Types and forms of corrosion, corrosion control in crude oil distillation, cracking process, design of atmospheric and vacuum distillation column.	08

Suggested Text Books:	
1.	B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.
2.	Ram Prasad, "Petroleum refining technology",1st Edition, Khanna Publishers 2008.
3.	Gary, J.H., Handwerk, G.E., & Kaiser, M.J, "Petroleum Refining: Technology and Economics", CRC Press, 5th edition, 2007.
4.	Speight, J.G, "The Chemistry and Technology of Petroleum", CRC Press, 4th edition, 2014.
Suggested Reference Books:	
1.	W. L. Nelson, "Petroleum Refinery Engineering", 4th Edition, McGraw Hill, New York, 1985.
2.	R. A. Meyers, "Handbook of Petroleum Refining Processes", McGraw Hill, 1986.
3.	G. D. Hobson and W. Phol, "Modern Petroleum Technology", Applied science Publishers, 4th Edition, 1975.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**				
Course Title	:	**Advanced Separation Techniques (Elective-I)**			***Course Code*** :	CH412.2
Teaching Scheme (Hours)	:	Lecture =04 Hours/Week Tutorial =Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	CH315, CH323, CH425				
Course Domain	:	Core Elective				

Course Rationale: This course aims to extend student knowledge of basic fluid separation processes to more complex systems commonly encountered in the chemical processing industry. To improve the existing practical knowledge of students in extraction technology. To introduce more sophisticated and sensitive extraction.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the need for various separation techniques.	1.	Summarize the various separation techniques and their standards.
2.	Explain the need for various separation techniques.	2.	Understand the need for various separation techniques.
3.	Discuss the principles and processes of membrane separation to design a membrane unit to achieve a specified separation.	3.	Choose the membranes for various industrial applications.
4.	Find the new trends used in separation techniques.	4.	Apply their minds to selection of different industrial separation techniques.
5.	Elaborate on the various enhanced techniques for the separation of liquid mixtures.	5.	Interpret the nature of the separation of liquid mixtures with enhanced techniques.
6.	Describe the fundamentals of downstream processing for biochemical product recovery.	6.	Outline various features of biochemical processes.

Curriculum Content	**Hours**
Unit I: Introduction: Fundamentals of separation processes and basic concepts. Introduction to separation techniques and classifications, separation factor. Review of basic mass-transfer concepts: diffusion coefficients, diffusion in fluids and porous solids, steady-state and unsteady state mass transfer.	07
Unit II: Membrane based Separation processes: Definition and classification of membrane processes and membrane modules. Types of Membrane materials, phase inversion membranes, preparation technique for immersion precipitation, preparation technique for composite membranes, Synthesis and characterization of membranes, driving forces in membrane separation processes, Concept of concentration polarization and membrane fouling, pressure driven membrane processes and their industrial applications.	10
Unit III: Chromatographic separation processes, Adsorption and Ion exchange and	12

Cryogenic gas separation: Basic concept of chromatography, phenomena and characterization. Various chromatography options. Typical chromatographic separation systems for preparative chromatography. Applications of chromatography in enzymes and other Industrial separations. Adsorption and ion exchange equilibria, equilibrium and kinetics, Various isotherms. Contact filtration, design of fixed bed adsorber including breakthrough curve. Pressure swing and vacuum swing adsorption. Introduction to the cryogenic gas separation and purification systems, separation of air, hydrogen and helium, gas purification methods.	
Unit IV: Electric field assisted separation processes: Introduction, Electro dialysis, process parameters, membranes for Electro dialysis, applications, Electrophoretic Separation Methods, Forces in Electrophoresis, Gel membrane and paper electrophoresis, Zonal electrophoresis.	06
Unit V: Supercritical fluid separation processes: Working Principal, Advantages & Disadvantages of supercritical solvents over conventional liquid solvents, Advantage & Disadvantages of supercritical extraction over liquid- liquid extraction, Decaffeination, ROSE process, Commercial applications of supercritical extraction.	07
Unit VI: Separation processes in biochemical industry: 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.	10

Suggested Text Books:	
1.	Nath. K, "Membrane Separation Processes", PHI Pvt. Ltd.,2008
2.	Coulson & Richardson, "Chemical Engineering", vol. 3", Pergamon.
3.	Treybal, R. E., "Mass Transfer Operations", McGraw Hill., 3rd edition
4.	Scott, RTW. "Liquid Chromatography Column Theory", Wiley, 1992.
5.	Hoffman, E.J. "Membrane Separation Technology". Gulf Professional Publishing.
6.	Nath, K. "Membrane Separation Process". Prentice Hall of India.
7.	W. S. Winston Ho, Sirkar, K. K, "Membrane Handbook". Van Nostrand Reinhold Publication.
Suggested Reference Books:	
1.	Perry. R. H., Green. D., "Perry's Chemical Engineers' Handbook". McGraw-Hill Education, New York.
2.	Seader. J. D., Henley. E. J. "Separation Process Principles". John Wiley and Sons, Inc., New York.
3.	Ladisch, M. R. "Bioseparations Engineering: Principles, Practice, and Economics". Wiley Interscience, John Wiley and Sons, Inc., New York.
4.	Long, R.B. "Separation Processes in Waste Minimization". Marcel Dekker, Inc., New York
5.	R. F. Barron, "Cryogenic Systems", Oxford University Press, New York, 1999

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**				
Course Title	:	**Polymer Chemistry (Elective-I)**		***Course Code***	:	CH412.3
Teaching Scheme (Hours)	:	Lecture = 04 Hours/Week Tutorial = Nil		***Total Credits***	:	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2023
Pre-requisites *(If any)*	:	BS-12A2, CH312, CH321					
Course Domain	:	Core Elective					

Course Rationale: This course will help students to learn about polymers, one of the most significant modern materials. Course will introduce the polymers, its classification followed by the synthesis, its characterization. It will also help them to understand the uses and future scope and challenges in the field.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce the course with respect to scope of Polymer Chemistry.	1.	Recall the scope of Polymer Chemistry.
2.	Explain different polymerization techniques and different methods of polymerization.	2.	Understand the different polymerization techniques and methods of polymerization.
3.	Discuss the idea for determination of molecular weight determination.	3.	Relate different molecular weight determination method used for polymers.
4.	Elaborate different types of fiber forming synthetic polymer, properties of the forming synthetic.	4.	Classify the different types of polymer and their applications.
5.	Explain polymer future trends in plastics fiber & elastomers.	5.	Recognize details of the application of polymers present and future.

Curriculum Content	**Hours**
Unit I: Scope of Polymer Chemistry: Macromolecular concept, definition of monomers, homopolymers and copolymers, Chemistry of important monomers, Thermosets, Thermoplastic, Elastomers (f), rubbers, plastics, fibers, adhesives, Classification of Polymers.	08
Unit II: Condensation polymerization: Mechanism, kinetic and molecular weight build up, Bulk solution, Emulsion and suspension polymerization, comparison of condensation and addition polymerization.	10
Unit III: Addition polymerization: Type of addition polymerization, Radical, cationic and anionic polymerization, Mechanism and kinetics of polymerization, Copolymerization, Stereo-Regular polymerization, Block and Graft polymerization.	10
Unit IV: Characterization of molecular weight polymers: Concept of average molecular weight of polymers Molecular Weight Distribution,	10

Polydispersity index, End-Group analysis method, Viscosity of measurement method, GPC technology for measurement.	
Unit V: Properties of polymers: Glass transition temperature, factors affecting glass transition temperature, melting point and factors affecting it, Factors affecting Tensile strength, yield strength, modulus, density, impact strength.	06
Unit VI: Applications of Polymers: Application of polymers present and future, Fiber forming synthetic polymer. Properties of fiber forming synthetic polymer, Future trends in plastic fibre and elastomers.	08

Suggested Text Books:	
1.	F.W. Billmeyer, "Text Book of Polymer science" Wiley & sons.
2.	V.R. Gowariker, N. V. Vishwanathan, Jaydev Sreedhar, "Polymer Science" New Age International Publishers.
3.	Odian, G. "Principles of Polymerization". Wiley, 4th edition,2004.
4.	Hiemenz. P.C., & Lodge. T.P. "Polymer Chemistry", CRC Press, 2nd edition,2007.
Suggested Reference Books:	
1.	B.K. Sharma, "Polymer chemistry", Krishna Prakashan
2.	M.S. Bhatnagar, "Text Book of polymer", S. Chand Publishing

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**				
Course Title	:	**Introduction to Food Process Engineering (Elective-I)**		*Course Code*	:	CH412.4
Teaching Scheme (Hours)	:	Lecture=04 Hours/Week Tutorial= Nil		***Total Credits***	:	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	BS-11A2, BS-12A2,CH412, CH425				
Course Domain	:	Core Elective				

Course Rationale: This course aims to extend students' knowledge of food chemistry, processes and equipment used for the different unit operations in food processing industry. Solve and evaluate the problems regarding food processing operations that can affect the quality of foods.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Develop an understanding of different unit operations applicable in food process industries.	1.	Explain different unit operations applicable in food process industries.
2.	Distinguish the different flow patterns in food processing.	2.	Identify the different flow patterns in food processing.
3.	Elaborate the different preservation techniques used in food industries.	3.	Classify the different preservation techniques used in food industries.
4.	Understand the operations and techniques used for packaging and storage of food	4.	Describe the operations and techniques used for packaging and storage of food.
5.	Interpret the different harvesting techniques in food processing.	5.	Differentiate the different harvesting techniques in food processing.
6.	Explain the concept of supercritical extraction.	6.	Rephrase the concept of supercritical extraction.

Curriculum Content	**Hours**
Unit I: Food chemistry Lipids, proteins, carbohydrates, composition of foods nutrition. Food Microbiology: Introduction growth factors, degradation and spoilage of foods epidemiology of food borne diseases, food infections, Food Biotechnology: Fermentation and enzymatic processes, Aseptic Techniques: Food handling, food sterilization, sterilization of food processing equipment.	08
Unit II: Transport Phenomena in food processing Non-Newtonian flow heat transfer simultaneous heat and momentum transfer, thermal time distribution mixing, unit operations in food systems, evaporation. Principles of evaporation, types and selection of evaporators, mass and energy balance. Design of single and multiple effect evaporators, applications in food industries.	08
Unit III: Preservation techniques Study of different preservation techniques like: Thermal, Dehydration, microwave irradiation cold fermentation and by chemicals. Stokes line and anti-stokes line.	08
Unit IV: Packaging and storage	08

Principles, shelf life, canning, modified atmosphere packaging refrigeration. Refrigeration system and its components. Selection of a refrigerant. Cold–storage plants, Freezing: Food Freezing systems, Frozen food properties, Calculation of freezing time by Plank's equation and other modified methods.	
Unit V: Post Harvesting Techniques Grain drying and storage fruit and vegetable processing seafood and meat processing, Principles of drying, drying rate kinetics, Dehydration systems, dehydration system, design by mass and energy balance, drying time prediction.	08
Unit VI: Supercritical extraction Study of basic concepts of supercritical fluid extraction. Flavors, spices and essence extraction using SFE techniques.	08

Suggested Text Books:	
1.	R. Paul Singh and Demis R. Heldman, Introduction to Food Engineering, 2nd edition, AcademicPress, 1993.
2.	Ernest L. Watson and John C Harper, Elements of Food Engineering, 2nd edition, Von Nostrand Reinhold Co., 1987
3.	Singh, R.P., & Heldman, D.R., "Introduction to Food Engineering", Academic Press,2001
4.	Smith. R., "Introduction to Food Process Engineering", Springer,2014
Suggested Reference Books:	
1.	R. Macrae, R. K. Robinson, and M. J. Sadler, Encyclopedia of Food Science, Food Technology and Nutrition, Vol. 8, Academic Press 1993.
2.	Akash Pare, B. L. Mandhyan, Food Process Engineering and Technology**,** New India Publishing Agency, 2020.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**					
Course Title	:	**Green Chemistry and Catalysis (Elective-I)**			***Course Code***	:	CH412.5
Teaching Scheme (Hours)	:	Lecture =04 Hours/Week Tutorial = Nil			***Total Credits***	:	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2023
Pre-requisites *(If any)*	:	CH211, CH221, CH312					
Course Domain	:	Core Elective					

Course Rationale: This course will introduce the principles and fundamental concepts of green chemistry, and provide examples of commercial applications of green chemistry. The course will be especially pertinent for students studying chemistry, medicinal chemistry, chemical engineering, and environmental sciences.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Elaborate about the environmental status, public awareness in evolution.	1.	Understand the environmental status and evolution.
2.	Explain the principles involved in green chemistry, bio-catalytic reactions.	2.	Describe the Pollution and its prevention measures.
3.	Discuss about green analytical method	3.	Categorize the various analytical green methods.
4.	Describe the greenhouse effect & its control measures.	4.	Interpret the control measures of greenhouse effect by understanding it.
5.	Summarize the concept of catalyst preparation.	5.	Develop detailed understanding of selected industrial catalytic process.
6.	Illustrate about the catalyst deactivation and selectivity.	6.	Understand about the catalyst deactivation.

Curriculum Content	**Hours**
Unit I: Introduction-Current status of chemistry and the Environment, Evolution of the Environmental movement, Public awareness, Dilution is the solution to pollution, Pollution prevention.	08
Unit II: Principles Green Chemistry, Principles of Green Chemistry , Why is this new area of Chemistry getting to much attention, Why should chemist pursue the Goals of Green Chemistry, The roots of innovation, Limitations.	08
Unit III: Green Analytical Methods Future trends in Green Chemistry, Green analytical methods, Redox reagents, Green catalysts, Green Nano-synthesis, Green polymer chemistry, Exploring nature, Biomimetic, Proliferation of solvent-less reactions, Non-covalent derivatization, Biomass conversion, emission control.	10
Unit IV: Green House Effect Greenhouse effect and Global Warming, How the greenhouse effect is produced, Major sources of greenhouse gases, Emissions of CO_2, Impact of greenhouse effect on global climate, Control and remedial measures of greenhouse effect, Global warming a serious threat - Important points.	10
Unit V: Introduction to catalysis Review of chemical kinetics, homogeneous catalysis, acid base catalysis, Enzymatic	08

reaction kinetics and design for enzymatic reaction, Heterogeneous catalysis: reaction rates and selectivity, Fixed bed and fluidized bed catalytic reactors.	
Unit VI: Catalyst Deactivation Catalyst deactivation with separable kinetics, Reactor Design with and without catalyst deactivation, temperature-time trajectories, effect of deactivation on selectivity, determination of order of deactivation by integral and differential methods.	08

Suggested Text Books:	
1.	V. Kumar, "An Introduction to Green Chemistry", Vishal publishing Co. 2nd Edition, 2010.
2.	Rashmi Sanghi, M.M Srivastava, "Green Chemistry", 4th Edition, 2009
3.	H. S. Fogler, "Elements of Chemical Reaction Engineering", PHI, 3rd Edition ,2002
4.	J. M. Thomas and W. J. Thomas, Introduction of the Principles of Heterogeneous Catalysis, Academic Press, 1967
Suggested Reference Books:	
1.	Anastas & Warner, Green Chemistry: Theory & Practice ,Oxford Univ. Press, New York,1998
2.	O. Levenspiel, Chemical Reaction Engineering, John Wiley, 3rd Edition, 1999
3.	C. N. Satterfield and T.K. Sherwood, The Role of Diffusion in Catalysis, Addison Wesley, 1963
4.	P. H. Emmett, Catalysis, Reinhold, 1954

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**				
Course Title	:	**Environmental Science and Microbiology (Elective-I)**			***Course Code*** :	CH412.6
Teaching Scheme (Hours)	:	Lecture = 04Hours/Week Tutorial = Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	HS221, CH324				
Course Domain	:	Core Elective				

Course Rationale: This course covers the concepts that are important in environmental microbiology, microbial ecology, and biotechnology. Particular emphasis in these courses is placed on the application of molecular biology to microbial ecology.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss the role of microbes in biogeochemical processes in different ecosystems.	1.	Understand the role of microbes in biogeochemical processes in different ecosystems.
2.	Explain the processes and changes in the environment.	2.	Describe the processes and changes in the environment.
3.	Explain the ecological problems.	3.	Develop detailed understanding of the ecological problems.
4.	Discuss the different type of environmental problems.	4.	Acquire skills required to research and analyze environmental issues scientifically.
5.	Interpret about the microbial ecology.	5.	Apply skills during their careers that may involve environmental problems and/or issues.

Curriculum Content	**Hours**
Unit I: Environmental segments Lithosphere, Hydrosphere, Biosphere, Composition of Atmosphere, Troposphere, Stratosphere, Mesosphere. Thermosphere, Chemical species and particulars in atmosphere, ions radical particles Reactions in atmosphere.	13
Unit II: Principle of Ecology Definition of Ecology and environment, kind of ecology, environmental and eco-factors, climate factor, medium factor, biotic factor, Ecosystem and its components, Nutrient cycle in ecosystem, carbon nitrogen, sulphur and phosphorous cycle (brief details).	13
Unit III: Water chemistry Hydraulic cycle, specification of water, physical and chemical properties of water, chemistry of pollution due to detergents, pesticides, polymers trace organic metals, petroleum and radioactive components.	13
Unit IV: Environmental Microbiology Basic principle of microbial transformation of organic matter. Biodegradation acclimatization of waster and microbial inhibition. Species of algae and their significance in water engineering. Eutrophication. Water borne diseases and their control. Role of microorganism in water and waste water engineering, Role of microorganism in air	13

pollution control (Bio filters and bio scrubbers).	
Suggested Text Books:	
1.	A. K. Datta, “Introduction to Environmental Science & Engineering”, Oxford & IBH, New Delhi
2.	V. Subramanian, “Text book of Environmental Science”, Narosa
3.	Cunningham.W. P, & Cunningham. M.A, "Principles of Environmental Science: Inquiry and Applications", McGraw-Hill Education,2019
4.	Zimmer. C., & Wright.R.T., “Environmental Science: Toward a Sustainable Future", Pearson,2016
Suggested Reference Books:	
1.	Purohit, A.P., & Purohit, S.H. "Textbook of Microbiology". Agro Publication.
2.	Davis, G.B., & Cornwell, D.A. "Introduction to Environmental Science & Environmental Engineering". McGraw Hill Inst.
3.	Botkin, D.B., & Keller, E.A. "Environmental Science". Wiley & Sons, New York.

Class, Part & Semester	**:**	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**					
Course Title	**:**	**Drugs and Pharmaceutical Technology (Elective-I)**			***Course Code*:**	**:**	CH412.7
Teaching Scheme (Hours)	**:**	Lecture= 04 Hours/weeks Tutorial= Nil			***Total Credits***	**:**	04
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	3 hours
Revision	**:**	Fourth			***Month***	**:**	June 2023
Pre-requisites *(If any)*	**:**	CH221, CH315, CH323, CH324					
Course Domain	**:**	Core Elective					

Course Rationale: The particular course covers various aspects of Pharmaceutical Industry from stand point of Chemical Engineering. Chemical Engineers have great deal of scope to serve the pharmaceutical industry especially for pharmaceutical production. The design of this course is such that Chemical Engineering graduates opting for this course will have better acquaintance of drugs discovery, design, development, various unit processes and operations involved in pharmaceutical manufacturing. Learning this course will make it easy for the chemical engineering graduate to enter and work efficiently in this vast sector.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Elaborate about history of pharma Industry.	1.	Realize pharma as a major sector for their studies and profession as well.
2.	Explain drug discovery, design and development process.	2.	Understand basics of discovery, design and development of drugs.
3.	List and explain unit processes involved in pharmaceutical manufacturing.	3.	Describe unit processes involved in pharmaceutical manufacturing.
4.	Describe pharmaceutical dosage forms and techniques of making the same.	4.	Distinguish between dosage forms and identify various techniques of making the same.
5.	Quote about GMPs and other quality controls aspects pertaining to pharmaceuticals.	5.	Recognize importance of GMPs and other quality control aspects of pharmaceuticals.
6.	State and explain pharmaceuticals with examples.	6.	Identify various pharmaceuticals with their applications.

Curriculum Content	***Hours***
Unit I: Development of drugs and Pharmaceutical industry Organic therapeutic agent's uses and economics. Drug metabolism physio chemical principles, pharmacokinetics, and action of drugs of human bodies (Pharmacodynamics).	10
Unit II: Chemical conversion processes Thermal conversion, Thermochemical conversion Biochemical conversion, Chemical conversion namely Alkylation, carboxylation, condensation and cyclisation, dehydration, Esterification (alcoholism) halogenations, oxidation, sulfonation, complex chemical conversion such as fermentation.	10

Unit III: Compressed tablets Wet granulation, dry granulation, direct compression, tablet formulations, coating, pills, capsules, sustained action dosage forms. Parenteral solutions, oral liquids, injections, Cermet's, standard requirements of hygiene and good manufacturing practice. (GMP).	08
Unit IV: Miscellaneous topics Vitamins, Cold and flu remedies, laxatives, analgesic, non-steroidal contraceptives, external antiseptics, antacids.	08
Unit V: Pharmaceutical Products Synthetic, Semi synthetics and Natural drugs Antibiotics, Biologicals, Hormones, vitamins, preservatives.	08
Unit VI: Analytical methods and limit tests Volumetric analysis, Electrochemical Analysis, Colorimetric Analysis, UV-Visible Analysis, Flurometric analysis, Raman Spectroscopy, FTIR, Introduction to Chromatography. Limit test for Chlorides, Sulphates, Iron, Heavy Metals and Arsenic.	08

Suggested Text Books:

1.	E.A. Rawlines Bertleys," Text books of pharmaceuticals" 3rd Edition, Billlieere Tincall, London, 1977.
2.	Vyas, S.P., & Khar, R.K, "Targeted and Controlled Drug Delivery: Novel Carrier Systems". CBS Publishers & Distributors, 1st edition,2007
3.	Sinko, P.J, "Martin's Physical Pharmacy and Pharmaceutical Sciences". Lippincott Williams & Wilkins, 6th edition,2013
4.	Florence, A.T., & Attwood, D, "Physicochemical Principles of Pharmacy", Pharmaceutical Press, 6th edition,2017

Suggested Reference Books:

1.	S.H. Yalkorsky and J. Swarbrick, "Drug and pharmaceutical Science" Volume I, II, III, IV, V, VI, and VII Marcel Dekar Inc. New York 1975.
2.	Remingtons, "Pharmaceutical Science", Mack Publishing Co, 1975.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**				
Course Title	:	**Advanced Spectroscopy (Elective-I)**			***Course Code*** :	CH412.8
Teaching Scheme (Hours)	:	Lecture =04 Hours/Week Tutorial =Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	BS-11A2, BS-12A2, CH211, CH221				
Course Domain	:	Core Elective				

Course Rationale: This course aims to extend students' knowledge of basic fluid separation processes to more complex systems commonly encountered in the chemical processing industry. To improve the existing practical knowledge of students in extraction technology. To introduce more sophisticated and sensitive extraction.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Develop an understanding of modern spectroscopic techniques.	1.	Use spectroscopic equipment such as MS, IR, NMR spectrometers.
2.	Understand the advantages of spectroscopic information.	2.	Identify organic compounds by analysis and interpretation of spectral data.
3.	Elaborate on multi pulse NMR and 2D spectroscopes achieve a specified separation.	3.	Discuss common terms in NMR spectroscopy such as chemical shift, coupling constant and anisotropy.
4.	Understand the operation of a mass spectrometer and the interpretation of the mass spectral data.	4.	Describe how common terms in NMR spectroscopy affect bimolecular structure.
5.	Discuss the molecular structure of unknown from analysis of the spectroscopic data.	5.	Explain formation of different types of ions, rearrangements, fragmentation of alkanes, alkyl aromatics, alcohols and ketones.
6.	Discuss various modern spectroscopic techniques.	6.	Understand various modern spectroscopic techniques.

Curriculum Content	**Hours**
Unit I: **Fundamentals of Spectroscopy** Electromagnetic Radiation: Properties, Various energy levels, Interaction of photons with matter, absorbance, transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules. Beer-Lambert's law, Limitations, Deviations. Nephelometry and turbidimetry, Duboscq colorimetry, Estimation of inorganic ions such as Fe, Ni using Beer-Lambert's Law. Selection of instrumental methods, Instrumental errors.	09
Unit II: Ultraviolet and visible spectroscopy (UV-VIS Spectroscopy) Principles of radiation, Frank Condon principle, Various electronic transitions (185-800 nm), Beer-Lambert law, Instrumentation of single beam and double beam spectrophotometer – Woodward-Fieser rule, Applications of UV-Visible spectroscopy.	09

Unit III: IR and RAMAN Spectroscopy Principles of IR spectra, Instrumentation of IR spectroscopy, Force constant, Effect of hydrogen bonding, Applications of IR spectroscopy. Raman spectroscopy: Principle – Stokes line and anti-stokes line, Instrumentation, Applications of Raman spectroscopy.	09
Unit IV: ^{1}H NMR and ^{13}C Spectroscopy General introduction and definition: Chemical shift, Spin-spin interaction, shielding mechanism, Coupling constants. Nuclear Over Hauser Effect (NOE). Instrumentation of 1H NMR and 13C spectroscopy.	08
Unit V: Mass Spectroscopy Principle, working of mass spectrometer (double beam). Formation of different types of ions, McLafferty rearrangement, fragmentation of alkanes, alkyl aromatics, alcohols and ketones, simple applications, simple structural problems based on IR, UV, NMR and MS.	09
Unit VI: Imaging Techniques Scanning electron microscopy, Energy dispersive X-ray spectroscopy, Transmission electron microscopy atomic force microscopy, Scanning-tunneling microscopy, X-ray photoelectron spectroscopy.	08

Suggested Text Books:	
1.	Hollas, J.M, "Modern Spectroscopy". Wiley, 4th edition,2004
2.	Nakamoto, K, "Infrared and Raman Spectra of Inorganic and Coordination Compounds". Wiley, 6th edition,2008
3.	Skoog, D.A., Holler, F.J., & Crouch, S.R,"Principles of Instrumental Analysis". Cengage Learning, 6th edition,2007
4.	Juzenas, P., et al., "Handbook of Biomedical Optics". CRC Press, 1st edition,2007
Suggested Reference Books:	
1.	Willard, H.H., Merritt, L.L., Dean, J.A., & Settle. F.A, "Instrumental Methods of Analysis". 7th Edition. Cengage Learning,2007
2.	Kalsi. P.S, "Applications of Spectroscopic Techniques in Organic Chemistry".
3.	Banwell. C.N., & McCash. E.M., "Fundamentals of Molecular Spectroscopy". 4th Edition. Tata McGraw Hill,2010.

Class, Part & Semester	**:**	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**					
Course Title	**:**	**Molecular Quantum Mechanics (Elective-I)**			***Course Code***	**:**	CH412.9
Teaching Scheme (Hours)	**:**	Lecture =04 Hours/Week Tutorial =Nil			***Total Credits***	**:**	04
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2023
Pre-requisites *(If any)*	**:**	BS-11A2,CH211,CH221					
Course Domain	**:**	Core Elective					

Course Rationale: The course covers two fields, quantum mechanics and quantum chemistry. The quantum mechanics component deals with the basic equations that control the behaviour of microscopic particles. The quantum chemistry component addresses how these basic equations control the behavior of atoms and molecules.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Elaborate various essential mathematical concepts.	1.	Understand the basics of quantum mechanics.
2.	List out postulates of quantum mechanics and Schrodinger equation; its application on some model systems.	2.	Describe the quantum mechanical principles of atoms and molecular systems.
3.	Explain the new trends used in electron spin and electron system.	3.	Understand the concept of wave function.
4.	Describe about the generation of optimized orbitals.	4.	Correlate the orbital and electron energy.
5.	Discuss the basics of Molecular Structure.	5.	Name the symmetrical properties of molecular wave functions.
6.	Relate the different methods for electronic structure of non-linear molecule.	6.	Recognize the electronic structure of atoms and chemical bonding.

Curriculum Content	**Hours**
Unit I: **Fundamentals of Spectroscopy** Electromagnetic Radiation: Properties, Various energy levels, Interaction of photons with matter, absorbance, transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules. Beer-Lambert's law, Limitations, Deviations. Nephelometry and turbidimetry, Duboscq colorimetry, Estimation of inorganic ions such as Fe, Ni using Beer-Lambert's Law. Selection of instrumental methods, Instrumental errors.	08
Unit II: Approximate solutions to the Schrodinger equation The Variation method (Time independent and Time Dependent), Time independent perturbation theory (non-degenerate and degenerate), Time dependent perturbation theory.	07
Unit III: Electron Spin and Many - Electron Systems The Antisymmetry Principle, Spin angular momenta and their Operators, The Orbital Approximation (Slater determinant, Pauli exclusion principle), Two electron wave	10

functions.	
Unit IV: The Hartree-Fock Self-Consistent Field Method The generation of Optimized orbitals, Koopmans's Theorem (The Physical Significance of Orbital Energies), The electron correlation energy, Density matrix analysis of the Hartree-Fock Approximation, Natural orbitals, The matrix solution of the Hartree- Fock Equations (Roothaan's equations).	10
Unit V: Introduction to Molecular Structure The Born-Oppenheimer Approximation, Solution of the Nuclear Equation, Molecular Hartree- Fock Calculations. Electronic Structure of Linear Molecule, The MO-LCAO Approximation, The Hydrogen Molecule Ion, The Hydrogen molecule, Molecular Configuration, Interactions, The Valence Bond Method, Molecular Perturbation Calculations.	09
Unit VI: Electronic Structure of Non-linear Molecule The AHn molecule: Methane, Ammonia and Water, Hybrid Orbitals: The Ethylene and Benzene Molecules. Semi empirical Molecular Orbital Methods I - PI Electron Systems: The Huckel Approximation for Conjugated Hydrocarbons, The Pariser-Parr-Pople Method. Semi empirical Molecular Orbital Methods II- All valence Electron systems: The Extended Hückel Method, The CNDO Method.	08

Suggested Text Books:	
1.	Atkins. P.W., & Friedman. R.S, "Molecular Quantum Mechanics", Oxford University Press,2010
2.	Levine. I.N, "Quantum Chemistry", Pearson Education, 7th edition.
3.	Szabo, A., & Ostlund, N.S. (1989). "Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory". Dover Publications.
4.	Pilar, F.L. (2013). "Elementary Quantum Chemistry". Dover Publications, 2nd edition.
Suggested Reference Books:	
1.	McQuarrie.D. A, "Quantum Chemistry", Oxford University Press,1983
2.	Levine. I.N, "Quantum Chemistry", Allyn and Bacon Inc., 3rd Edition.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**				
Course Title	:	**Statistical Methods in Engineering (Elective-I)**			***Course Code*** :	CH412.10
Teaching Scheme (Hours)	:	Lecture=04 Hours/Week Tutorial=Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	BS-11A1, BS-12A1				
Course Domain	:	Core Elective				

Course Rationale: This course introduces various standard experimental designs and methods to analyze the data and design the parameters of the systems such that the measure of performances is optimized.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Introduce the fundamental principles of numerical and statistical methods.	1.	Solve problems using numerical methods.
2.	Introduce the basic concepts of measures of central tendency	2.	Understand the basic concepts of measures of central tendency
3.	Explain the concepts of statistics such as central dispersion, correlation and regression	3.	Understand the concepts of statistics such as central dispersion, correlation and regression
4.	Illustrate the use of probability and discrete distributions in engineering problems	4.	Apply the rule of probability and discrete distributions in solving problems
5.	Discuss Combinatorial Analysis in detail.	5.	Estimate Combinatorial Analysis in detail.
6.	Describe the probability distributions and testing of hypothesis	6.	Gain knowledge in probability distributions and testing of hypothesis

Curriculum Content	**Hours**
Unit I: Meaning of the word Statistics Scope of Statistics in Engineering fields; Types of Data: Primary and Secondary; Classification of data: Discrete and continuous frequency distribution, inclusive and exclusive methods of classification, Tabulation of statistical data; Graphical presentation of data: Bar Charts, Pie Chart, Line Chart, Histogram, ogive curves.	08
Unit II: Concept of measures of central tendency Requirements of good statistical average; Arithmetic Mean (A.M), Median, Mode, and Quartiles: Definition, Effect of change of origin and scale property; Numerical examples.	07
Unit III: Concept of dispersion Absolute and Relative measures of dispersion, Requirements of a good measure of dispersion. Range, Coefficient of range, Quartile Deviation (Semi-interquartile range), Coefficient of Q.D. Mean Deviation, Coefficient of M.D., Minimal property of M.D., Standard Deviation, Variance, Coefficient of Variation; Numerical examples.	08
Unit IV: Concept of correlation between two variables Types of correlation, Scatter diagram, its utility. Karl Pearson's coefficient of correlation (r): Definition, Computation for Ungrouped, Interpretation when r = -1, 0, 1 and Properties	10

of r. Spearman's rank correlation coefficient: Definition, Computation (for with and without ties). Illustrative examples; Concept of regression, Equations of lines of regression, Regression coefficients (bxy, byx) and Properties; Numerical examples.	
Unit V: Combinatorial Analysis Principles of counting, Permutation and Combination; Probability. Random experiment, sample space and classification of sample spaces, Classical definition of probability, Properties, Empirical definition of probability, Axiomatic definition of probability, Conditional probability, Multiplication law of probability, Baye's theorem, Independence of events and Numerical examples. Random variable, Probability mass function, Cumulative distribution function, Mathematical expectation, Variance, Definition and properties of Bernoulli, Binomial, Poisson distribution, Probability density function, Cumulative distribution function of a continuous random variable, Mathematical expectation and variance, Definition and properties of Uniform, Exponential and Normal distributions**.**	10
Unit VI : Basic concepts of hypothesis Level of significance, Critical region, p-value, One sided and two sided tests, Procedure of testing of hypothesis, Large sample tests for mean and proportion, Exact sample tests, Chi-square test for variance, Goodness of fit, Independence of attributes, t test for mean, equality of two population means and paired t-test. Numerical exam.	09

Suggested Text Books:	
1.	Montgomery. D.C., Runger. G.C., & Hubele. N.F,"Engineering Statistics", Wiley, 5th edition,2011.
2.	Walpole. R.E., Myers. R.H., Myers. S.L., & Ye. K, "Probability & Statistics for Engineers & Scientists". Pearson, 9th edition,2011.
3.	Devore, J.L, "Probability and Statistics for Engineering and the Sciences", Cengage Learning, 9th edition, 2015.
4.	Ryan, T.P, "Statistical Methods for Quality Improvement". Wiley, 3rd edition,2012.
Suggested Reference Books:	
1.	Johnson, R.A., & Wichern D.W,"Applied Multivariate Statistical Analysis",6th Edition. Pearson,2007
2.	Lind, D.A., Marchal, W.G., & Wathen, S.A, "Statistical Techniques in Business and Economics",17th Edition. McGraw-Hill Education,2017

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering) Part IV, Semester VII**					
Course Title	:	**Process Equipment Design**			***Course Code*:**	:	CH413
Teaching Scheme (Hours)	:	Lecture=04 Hours/Week Tutorial=Nil			***Total Credits***	:	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE= 70	Grand Total=100	***Duration of SEE***	:	3 hours
Revision	:	Fourth			***Month***	:	June 2023
Pre-requisites *(If any)*	:	CH215, CH223, CH312, CH315, CH323					
Course Domain	:	Program Core					

***Course Rationale*:** The present course enables one to learn about the complete process design of Pressure vessel, Storage vessel, Reactor, Heat Exchanger, Evaporator, Packed column and Distillation column.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss design parameter basics i.e. commonly used in process equipment's design	1.	Identify various design preliminaries
2.	Describe design of pressure vessels subjected to internal and external pressures	2.	Evaluate and design various parts of Pressure Vessel.
3.	Illustrate design of special vessels (e.g. tall vessels) and various parts of vessels	3.	Design storage vessel and Tall Vessel
4.	Impart knowledge of shell & tube heat exchanger design.	4.	Develop a design for Heat Exchanger and Evaporator.
5.	Demonstrate design of reactor and agitator system	5.	Formulate reactor systems and agitator system.
6.	Elaborate equipment testing methods related to process hazard & its safety	6.	Express different safety measures.

Curriculum Content	***Hours***
Unit I: Design Preliminaries Design codes, Maximum working pressure, Design pressure, Design temperature, Various mechanical properties of the material, Different methods of fabrication, Different types of welding joints, Joint efficiency, Weld joint efficiency factor, Radiography, Design stress, & factor of safety, Corrosion allowance & their types, Design wall thickness.	06
Unit II: Design of Pressure Vessel and storage vessels Classification of pressure vessels, Codes and Standards for pressure vessels, Design of pressure vessels under internal and external pressures, Design of thick-walled high pressure vessels, Design of Gasket, Flanges, Nozzle, Design of spherical vessels, Numerical, Storage of fluids, Different types of storage vessels, Design of cylindrical storage vessels with roof.	10
Unit III: Tall Vessels & Support for Process Vessels Define tall vessel & their types, Stress distribution in design of tall vessel, Support & their classifications, Design of Bracket Support, Lug Support, Skirt Support & Saddle support.	08

Unit IV: Design of Heat Exchanger and Evaporator Types of heat exchangers, Special type of heat exchangers, Design of Shell & Tube Heat Exchanger, Types of evaporators, Entrainment Separators, Design of Standard Short Tube, Vertical Evaporator.	10
Unit V: Design of Reaction Vessel and Agitator Classification of reaction vessel, Heating systems, Design consideration, Types of agitators, Baffling, Power requirements for agitation, Design of agitation system components.	08
Unit VI: Equipment testing methods, Process Hazards & Safety Hydrostatic Pressure test, Pneumatic pressure test, Dye penetrant test, Magnetic test, Ultrasonic test, Freon test, Radiography test, Hazards in Process Industry, Analysis of Hazards, Safety Measures, Safety measures in Equipment Design, Pressure Relief Devices.	08

Text Books

1.	Bhattacharya, B.C, "Introduction to Chemical Equipment Design". Mechanical Aspects,1985
2.	Joshi, M.V, "Process Equipment Design", McMillan India Ltd,1981.
3.	Dawande. S.D, "Process Design of Equipment", Central Techno Publication, 1st Edition,1999.
4.	Brownell, L.E., & Young, E.H, "Process Equipment Design" ,2nd Edition, Wiley,1979.

Reference Books:

1.	R. K. Sinnott, “Coulson & Richardson’s Chemical Engineering (Vol. VI) Chemical Engineering Design ", Elsevier Butterworth-Heinemann,4th edition, 2005
2.	Mahajani. S. M, & Sharma, A, "Process Equipment Design”,1st Edition, Prentice-Hall of India,2010

Class, Part & Semester	**:**	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**				
Course Title	**:**	**Industrial Economics and Management**			***Course Code*** **:**	CH414
Teaching Scheme (Hours)	**:**	Lecture = 03Hours/Week Tutorial =Nil			***Total Credits*** **:**	03
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** **:**	03 Hrs.
Revision	**:**	Fourth			***Month*** **:**	June 2023
Pre-requisites *(If any)*	**:**	BS-11A1, BS-12A1, CH421.8				
Course Domain	**:**	Program Core				

Course Rationale: This course provides basic knowledge about the concepts of economics and management. The emphasis is deal with various concepts related to economic problems, national income, inflation, food processing industries, principles of management, production, finance, and marketing management and its relevance.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Interpret basic knowledge about Demand Analysis and Forecasting.	1.	Express the basic economic problems as well as trends of GDP in the economy.
2.	Impart the knowledge of Market and Inflation.	2.	Compare the different types of markets and examine the concepts relating to inflation.
3.	List and explain the structure of industrialization and industrial productivity.	3.	Evaluate the present status of industrialization in India and the effect of LPG policy.
4.	Explain the principles of management.	4.	Apply management principles in the effective development.
5.	Analyze the production and material management techniques.	5.	Identify the production management techniques in the industry.
6.	Illustrate financial and marketing management concepts in business decisions.	6.	Apply financial and marketing management concepts in business decisions.

Curriculum Content	**Hours**
Unit I: Demand Analysis and Forecasting Economic problem, law of diminishing utility, consumer surplus. Demand: concepts, types of demand, demand function, law of demand and determinant of demand, Forecasting concept, types, steps and techniques of demand forecasting.	06
Unit II: Market and Inflation Concepts of costs, cost curves and revenue curves of a firm Market, break-even point Market: Meaning, types of market – Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition. Inflation: Causes, measurement, effects, controlling of inflation. Index Numbers.	08
Unit III: Industrialization	08

Industrialization: Need, Importance and Problems, Classification of Industries: role, problems and remedies, Industrial Productivity: norms, measurement, importance and Factors affecting productivity. New Economic Reforms: Liberalization, Privatization and Globalization GATT, WTO agreement, Foreign exchange.	
Unit IV: Principles of Management Definition, nature, levels of management, functions of management. Planning Nature, importance, types of plans, planning process, decision making. Organization: Principles of organization, organizational structure. Directing, Theories of Motivation, Communication: process and barriers, Leadership styles, Controlling: Control techniques.	07
Unit V: Production Management Production Management: Definition, Objectives, Functions and Scope, Production Planning and Control; its significance, stages in production planning and control. Concepts of material management and inventory control: importance and various methods.	05
Unit VI: Financial and Marketing Management Financial Management: Scope and importance, capital structure planning, working capital management, sources of funds. Marketing Management: Definition of marketing, marketing concept, objectives and functions of marketing. Marketing Research – Meaning; Definition; objectives; Importance; Limitations. Advertising – meaning, objectives, functions.	06

Suggested Text Books:	
1.	Divedi, D.N, "Managerial Economics". Vikas, New Delhi,2003
2.	Ahuja, H.L, "Advanced Economic Theory". S. Chand Publication, New Delhi,2017
3.	Gupta, R.S., Sharma, B.D., Bhalla, N.S, "Principles and Practice of Management". Kalyani Publishers,2018
4.	Pugel. T.A, "International Economics". McGraw-Hill Education, 16th edition,2016
Suggested Reference Books:	
1.	Koutsoyiannis, "Modern Microeconomics". Macmillan Press Ltd.,2008
2.	Jhingan, M.L,"Principles of Economics" (Hindi and English), Vikas, New Delhi,2019
3.	Seth, M.L., "Principles of Economics" (Hindi and English), Laxmi Narayan, Agra, 2020
4.	Ahuja, H.L., "Economic Environment of Business - Macroeconomic Analysis" S. Chand Publication, New Delhi,2019.
5.	Ahuja, H.L., "Macro Economics Theory and Policy" S. Chand Publication, New Delhi,2019.
6.	Chopra, P.N, "Principles of Economics", Kalyani Publishers.
7.	Dutt, R., & Sundhram, K.P.M, "Indian Economy".
8.	Prasad, L.M.,"Principles & Practices of Management" Sultan Chand & Sons.
9.	Sherlikar.S.A., "Marketing Management", Himalaya Publishing House, Bombay
10.	Pandey, I.M., "Financial Management" Vikas Publishing House, New Delhi.

Class, Part & Semester	**:**	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**					
Course Title	**:**	**Process Modeling and Simulation**			***Course Code***	**:**	CH415
Teaching Scheme (Hours)	**:**	Lecture = 04Hours/Week Tutorial = Nil			***Total Credits***	**:**	04
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	**Duration of SEE**	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2023
Pre-requisites *(If any)*	**:**	CH213, CH212, CH222, CH224, CH315, CH312, CH323, CH321					
Course Domain	**:**	Program Core					

Course Rationale: This is a core subject of Chemical Engineering and is essential for understanding of modeling & simulation techniques of chemical processes and to gain skills for use of process simulators.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain basic concepts of modeling and simulation of chemical engineering systems.	1.	Explain the fundamentals of mathematical modeling.
2.	Demonstrate mathematical models for different chemical engineering processes.	2.	Develop the mathematical model for various chemical processes.
3.	Illustrate simulation basics and demonstrate simulation of chemical engineering processes.	3.	Create simulation models of various types of chemical engineering processes.
4.	Explain mathematical methods for solution of developed mathematical models.	4.	Solve the mathematical models using numerical methods.
5.	Impart knowledge of different process simulation soft wares for flow sheet simulation.	5.	Simulate different chemical process in simulation software.

Curriculum Content	**Hours**
Unit I: Introduction Use and scope of mathematical modeling, Principles of model formulation, Models and their classification, Degree-of-freedom analysis, Selection of design variables.	06
Unit II: Fundamental Laws and Review of numerical techniques, Equations of continuity, energy, momentum, and state, Transport properties, Equilibrium and chemical kinetics, Review of thermodynamic correlations for the estimation of physical properties e.g. phase equilibria, bubble and dew points, Review of numerical techniques: Iterative methods, solution of linear simultaneous algebraic equations, numerical solution of integral and differential equations.	10
Unit III: Basic models of flow system, Basic models of mixing systems, Basic models of simultaneous heat and mass transfer.	04
Unit IV: Modeling of Specific Systems: constant volume CSTRS, Gas phase pressurized CSTR, non-isothermal CSTR, single component vaporizer, batch reactor, Plug flow reactor, reactor with mass transfer, ideal binary distillation column.	11
Unit V: Mathematical modelling of evaporator and Heat Exchanger: Mathematical modeling of Shell and Tube Heat Exchanger, Double pipe heat exchanger, Multiple effect evaporator system. Analysis and modeling of evaporators using Newton	11

Raphson's method (without boiling point rise), Modelling of multiple effect evaporators with boiling point rise.	
Unit VI: Introduction and use of process simulation soft wares for flow sheet simulation. Tools of simulation, Case studies: VLE dew point, bubble point calculations, binary distillation column, countercurrent heat exchanger.	08

Suggested Text Books:	
1.	Lubyen W. L., "Process Modeling, Simulation and Control for Chemical Engineers", McGraw-Hill, New York, 1989.
2.	Mickley H. S., Sherwood T. S., Reed C. E., "Application of Mathematical Modeling in Chemical Engineering", Tata-McGraw-Hill, New Delhi, 2002.
3.	K. Balu and K. Padmanabhan, "Modeling and analysis of Chemical Engineering processes", International private limited, 2007
4.	Seider. W.D., Seader, J.D., & Lewin, D.R, "Product and Process Design Principles: Synthesis, Analysis, and Evaluation". Wiley, 4th edition, 2017
Suggested Reference Books:	
1.	Turton, R., Bailie. R.C., Whiting, W.B., & Shaeiwitz, J.A, "Analysis, Synthesis, and Design of Chemical Processes". Pearson, 5th edition,2018
2.	Biegler. L.T., Grossmann, I.E., & Westerberg, A.W, "Systematic Methods of Chemical Process Design". Prentice Hall, 3rd edition,2011,

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering) Part IV, Semester VII**				
Course Title	:	**Process Equipment Design Laboratory**			***Course Code*** :	CH413L
Teaching Scheme (Hours)	:	Practical = 2Hours/Week			***Total Credits*** :	01
Evaluation Scheme (Marks)	:	IPE = 50	EPE =50	Grand Total = 100	***Duration of EPE*** :	02Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	CH215, CH223, CH312, CH315, CH323				
Course Domain	:	Program Core				

Course Rationale: The present course enables one to learn about the complete process design of pressure vessel, storage vessel, reactor Heat Exchanger, Evaporator, Packed column and Distillation column.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain basic Standard equipment symbols and instrumentation symbols used in the chemical process industry.	1.	Identify equipment and process involved in process flow diagrams.
2.	Discuss how to design and draw Heads and closures, Keys and couplings, Supports for vessels.	2.	Design and draw Heads and closures, Keys and couplings, Supports for vessels.
3.	Elaborate the design details of Unit operations for systematic drawing.	3.	Understand the basic concepts and operations of various chemical equipment's and flow sheets related to chemical engineering design and drawing.

General Instructions: Any 8 experiments to be performed from the list, any 2 experiments to be studied as demonstration.

Sr.No.	***List of Experiments***
1.	Standard equipment symbols , Standard instrumentation symbols
2.	Heads or closures and Flanges
3.	Design of Pressure Vessel
4.	Design of Storage Vessel
5.	Design of Supports-Bracket, Lug, skirt and Saddle support
6.	Design of Fractional distillation column
7.	Design of heat exchangers- Shell and tube heat exchanger
8.	Design of reaction vessel
9.	Design of evaporator
10.	Design of agitation system
11.	Design of Absorption tower

Suggested Text Books/ Reference Books/Manual	
1.	B. C. Bhattacharya, "Introduction to chemical equipment design" ,Mechanical Aspects, 1985.
2.	M. V. Joshi, "Process equipment design" McMillan India Ltd. 1981.
3.	Dr. S.D. Dawande, "Process Design of Equipment", Central Techno Publication, 1st Edition, 1999.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering) Part IV, Semester VII**			
Course Title	:	**Process Modeling and Simulation Laboratory**	***Course Code***	:	CH415L
Teaching Scheme (Hours)	:	Practical =02 Hours/Week	***Total Credits***	:	01
Evaluation Scheme (Marks)	:	IPE = 50 Grand Total= 50	***Duration of EPE***	:	02Hrs.
Revision	:	Fourth	***Month***	:	June 2023
Pre-requisites *(If any)*	:	CH213, CH212, CH222, CH224, CH315, CH312, CH323, CH321			
Course Domain	:	Program Core			

Course Rationale: This is a core Chemical Engineering laboratory course and is essential for understanding of modeling & simulation techniques of chemical processes and to gain skills for use of process simulators.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Impart knowledge on simulation packages and tools.	1.	Explain the fundamentals of simulation tools and process simulators.
2.	Demonstrate and Explain computational tools and commercial/Free process simulators with hands on experience.	2.	Use computational tools and commercial/Free packages to solve process simulation problems.
3.	Explain numerical techniques to solve chemical engineering mathematical model problems.	3.	Implement the numerical techniques to solve the chemical engineering mathematical model problems.

General Instructions: Any 8 experiments to be performed from the list.

Sr. No.	***List of Experiments***
1.	Estimation of Thermodynamic properties and Vapour liquid Equilibria
2.	Mass and Energy balances
3.	Simulation of a pump
4.	Design & Simulation of a heat exchanger
5.	Design & Simulation of distillation column
6.	Design & Simulation of an evaporator
7.	Simulation of a flow sheet
8.	Optimization of process parameters in a flow sheet
9.	Simulation of an absorber
10.	Design of reactors

Suggested Text Books/ Reference Books/Manual

1.	Lubyen W. L., "Process Modeling, Simulation and Control for Chemical Engineers", McGraw-Hill, New York, 1989.
2.	Mickley H. S., Sherwood T. S., Reed C. E., "Application of Mathematical Modeling in

	Chemical Engineering", Tata-McGraw-Hill, New Delhi, 2002.
3.	K. Balu and K. Padmanabhan, "Modeling and analysis of Chemical Engineering processes", International private limited, 2007

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering) Part IV, Semester VII**			
Course Title	:	**Comprehensive Test**	***Course Code***	:	CH416T
Teaching Scheme (Hours)	:	Tutorial =01 Hour/Week	***Total Credits***	:	01
Evaluation Scheme (Marks)	:	IPE = 50 Grand Total =50	***Duration of IPE***	:	-
Revision	:	Fourth	***Month***	:	June 2023
Pre-requisites *(If any)*	:	Core course Knowledge from previous Semesters			
Course Domain	:	Program Core			

Course Rationale: This course will help students to test knowledge across one or more general fields of study. This will test the students how they are ready for the next step of their career.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Revise all the core courses learnt during program studies.	1.	Understand the basic concept and will able to solve the numerical questions.
2.	Assess the overall level of proficiency and the scholastic attainment.	2.	Solve engineering problems & improve overall level of proficiency.
3.	Help student to apply knowledge and information acquired during program studies.	3.	Learn to solve multiple-choice questions.

Curriculum Content

The objectives of the comprehensive test are to assess the overall level of proficiency and the scholastic attainment of the student in the various core courses of studies till the completion of the program. It is executed by conducting weekly tests. The faculty members will guide the student in preparing for the weekly tests, primarily of multiple choice-based questions. The particular assessment shall be treated under the head of Internal Practical Evaluation (IPE) of 50 marks. The average of the all the tests will be the final score under IPE head.

1. Mechanical Operation
2. Fluid Flow Operations
3. Heat Transfer Operations
4. Chemical Process Calculations
5. Mass Transfer Operations
6. Chemical Reaction Engineering
7. Process Instrumentation & Control
8. Organic and Inorganic Chemical Technology

Suggested Text Books:

1. McCabe, W.L., & Smith, J.C, "Unit Operations of Chemical Engineering", McGraw Hill Book Co., International Ed., 7th edition,2004.
2. Himmelblau. D.M, "Basic Principles and Calculations in Chemical Engineering", Prentice Hall of India Pvt. Ltd, 6th edition,2008.
3. Smith, J.M., & Van Ness, H.C, "Introduction to Chemical Engineering, Thermodynamics", International student edition, McGraw Hill publication, 6th edition,2005.

4.	Treybal, R.E,"Mass Transfer Operations l", McGraw Hill,3rd edition,1980,
5.	Stephanopoulos, G.,"Chemical Process Control: An Introduction to Theory and Practice".
6.	Eckman, D.P., "Industrial Instrumentation", Willey Eastern Ltd, New Delhi,1984
7.	Fogler, S.H,"Elements of Chemical Reaction Engineering", PHI,3rd edition,1998.
8.	Austin, G.T, "Shreve's Chemical Process Industries", McGraw Hill Book Company.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**			
Course Title	:	**Major Project-Phase I**	***Course Code***	:	CH417L
Teaching Scheme (Hours)		Practical=2 hours/week	***Total Credits***	:	01
Evaluation Scheme (Marks)	:	IOE = 50 / Grand Total =50	***Duration of IOE***	:	-
Revision	:	Fourth	***Month***	:	June 2023
Pre-requisites *(If any)*	:	Core course Knowledge from all semester courses			
Course Domain	:	Research competency			

Course Rationale: Project Work aims at developing innovative skills in the students whereby they apply the knowledge and skills gained through the course work in the solution of particular problem or by undertaking a project. The project report is expected to show the clarity of thought and expression, critical appreciation of existing literature and analytical, experimental skills. This can be carried out either in the institute or at any other industry/research laboratory in India or Abroad under the supervision of guide(s) for the stipulated period.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss the role and importance of research in the engineering sciences.	1.	Explain research concepts and issues.
2.	Develop the ability to undertake problem identification, formulation and solution.	2.	Identify advanced topic in chemical engineering based on the technology, its application, and its future potential.
3.	Demonstrate a technical knowledge of the selected project topic focused on solutions to industrial, societal, and environmental problems with the application of sustainable technology.	3.	Apply their knowledge of basic science and engineering fundamentals in their project work, which should be focused on solutions to industrial, societal, and environmental problems with the application of sustainable technology.
4.	Explain the need of profitability analysis for the selected product and technical/economic feasibility study.	4.	Carry out profitability analysis for the selected product.
5.	Communicate the literature and previous studies concerning the problem.	5.	Understand the literature and previous studies concerning the problem.

Course Description:

The students are required to carry out one of the following projects related to field of chemical engineering.

1. Process based Project: Manufacture of product.

2. Equipment based Project: Detailed design and fabrication of the equipment for a given capacity.

3. Experiment based Project: Experimental investigation of basic or applied research problem.

4. Industrial Problems: Any problem or project directly related to existing plants for modification of process or equipment or regarding pollution control and energy conservation under the guidance of one

or more faculty members.

The activity will be undertaken at the beginning of the seventh semester in consultation with concerned guide and it must be completed in eighth semester. The project work is to be carried out by a group of students (not more than four students in a group).

The students will submit the report to the respective guide, present their work at the end of Semester. They need to cover the following aspects related to their project topic:

• Introduction to the Project topic

• Detailed Literature Survey on the topic.

• Plan/outline of the Project work.

• Submitting requirements for execution the project work.

Based on the first phase work, it is desirable that the project group will publish a review article in a reputed and relevant Journal. The project group has to deliver Project Progress presentation using LCD provided by the institute.

A research and review committee of internal teachers will evaluate the project progress. The committee includes concerned guide, the Program Coordinator, one senior teacher from the Program. This particular activity is assigned 50 marks as an IOE. The committee will evaluate the performance of the project group.

For submission of Project Report, the students will follow one specific format recommended by the Program Advisory Board

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**				
Course Title	:	**Internship II**		***Course Code***	:	CH418
Teaching Scheme (Hours)	:	Lecture=Nil Tutorial= Nil		***Total Credits***	:	02
Evaluation Scheme (Marks)	:	EOE=50	Grand Total =50	***Duration of EOE***	:	2 Hrs.
Revision	:	Fourth		***Month***	:	June 2023
Pre-requisites *(If any)*	:	NA				
Course Domain	:	Program Core				

Course Rationale: This course aims to extend students' knowledge to the 'real' working environment and be acquainted with the organization structure, business operations and administrative functions.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Develop an understanding of hands-on experience in the students' related field so that they can relate and reinforce.	1.	Understand concept of self-study and critical thinking.
2.	Relate their own knowledge about the course that hasbeen taught at the university.	2.	Apply their own knowledge about the course that has been taught at the university.
3.	Illustrate concept of collaboration between industry and the universityin promoting a knowledgeable society.	3.	Develop synergetic collaboration between industry and the university in promoting a knowledgeable society.
4.	Write technical documents and give oral presentations related to the work completed.	4.	Apply their technical knowledge for oral presentation and writing reports.

Curriculum Content

The primary objective of internship is to expose students to meaningful and relevant workplace attachment to better connect their learning to the workplace and deepen their skills, so that they are better prepared for their transition to the workplace after graduation. As a part of the B. Tech Chemical Engineering curriculum, 'CH418 Internship II' is similar to a practical course, which the students of Chemical Engineering must undergo in reputed Private / Public Sector / Government organization / companies as an Internship of minimum Four weeks after the VI Semester End Examination i.e. during the summer session aftertheir Third Year B. Tech and Prior to the commencement of Final Year B. Tech.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VII**						
Course Title	:	**Introduction to Indian Constitution**				***Course Code***	:	HS411
Teaching Scheme (Hours)	:	Lectures= 02 Hours/Week				***Credits***	:	Nil
Evaluation Scheme (Marks)	:	Assignments= 50	Viva voce =25	Written Test =25	Grand Total =100	***Duration of Exam***	:	Not Applicable
Revision	:	Fourth				***Month***	:	June 2023
Pre-requisites	:	It has no any pre-requisites. Every citizen of the country ought to study the course content.						
Course Domain	:	Audit Course at institute level , Humanities & Social Science						

Course Rationale: As a citizen of India, every student should have basic knowledge about Indian constitution. Every student should know the importance of Fundamental rights, Fundamental duties as well as Directive Principles. This course fulfills all these requirements. This course also includes knowledge about state as well as union legislature, judiciary and executive. It helps to understand emergency provisions, electoral process and amendment procedures. This course is helpful for the students to be legally updated.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Familiarize students with the preamble	1.	Get associated with Indian Constitution
2.	Describe fundamental rights & duties of citizens.	2.	Understand their fundamental duties and rights.
3.	Explain union and state executives.	3.	Recognize union and state executives.
4.	Discuss constitutional provisions.	4.	Interpret about constitutional provisions.
5.	Illustrate electoral process.	5.	Understand and follow the electoral process
6.	Summarize role of democracy in social welfare.	6.	Realize importance of democracy in social welfare.

Curriculum Content	***Hours***
Unit I: Introduction to Preamble and Fundamental Rights Preamble to the constitution of India. Fundamental rights under Part – III – details of Exercise of rights, Limitations & Important cases.	04
Unit II: Fundamental Duties and Directive Principles. Relevance of Directive principles of State Policy under Part – IV. Fundamental duties & their significance.	05
Unit III: Union Legislature, Judiciary & Executive. President, Prime Minister, Parliament & the Supreme Court of India.	04
Unit IV: State Legislature, Judiciary & Executive. Governors, Chief Minister, State Legislator and High Courts.	05
Unit V: Constitutional Provisions. Provisions for Scheduled Castes & Tribes, Women & Children & Backward classes. Emergency Provisions.	05

Unit VI: Electoral process & Amendment procedures: Constitution of election commission, system of adult suffrage, procedure for amendment. 42nd, 44th, 74th, 76th, 86th and 91st Constitutional amendments.	05

Suggested Text Books:	
1.	Durga Das Basu: "Introduction to the Constitution of India" Prentice-Hall EEE, 19th/20th Edition, 2001.
2.	R.C. Agarwal: "Indian Political System". S. Chand and Company, New Delhi, 1997.
3.	Maciver and Page: "Society: An Introduction Analysis",Mac Milan India Ltd., New Delhi.
Suggested Reference Books:	
1.	M.V. Pylee, "An Introduction to the Constitution of India". Vikas Publishing, 2002.
2.	Brij Kishore Sharma, "Introduction to the Constitution of India",Prentice Hall of India, New Delhi.
3.	U.R. Gahai, "Indian Political System". New Academic Publishing House, Jalandhar, 1998.
4.	R.N. Sharma, "Indian Social Problems", Media Promoters and Publishers Pvt. Ltd.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Petrochemical Technology (Elective-II)**			***Course Code*** :	CH421.1
Teaching Scheme (Hours)	:	Lecture =04Hours/Week Tutorial = Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	CH214,CH224,CH225,CH315,CH324				
Course Domain	:	Open Elective				

Course Rationale: This course provides an overview of the petrochemical industry, its raw materials, and the processes used to transform crude oil and intermediate streams into finished products. Discuss generational change in the petrochemical industry. This course explores the potential of the petrochemical industry, focusing on the production of petrochemicals from various feedstocks.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Elaborate about history and future scope of Petrochemical Industry.	1.	Understand the history and future scope of Petrochemical Industry.
2.	Explain about the importance of first generation petrochemicals.	2.	Recognize importance of first generation petrochemicals.
3.	List and explain the production of second generation of petrochemicals with proper flow diagram.	3.	Describe techniques of separation of gases of the first generation of petrochemical.
4.	Describe about the plastic and polymers.	4.	Draw a flow sheet of production of second and third generation of petrochemical.
5.	Illustrate the detergents and explosive.	5.	Develop understanding about petrochemical product like surfactant, polymer, RDX and TNT
6.	Discuss the challenges and opportunities of petrochemical industries.	6.	Realize challenges and opportunities of petrochemical industry.

Curriculum Content	***Hours***
Unit I: General Introduction History, Economics and future of petrochemicals, Energy crisis and petrochemical industry, Feedstocks for petrochemicals, Purification of gases, Sources and classification of petrochemicals.	07
Unit II: First generation petrochemicals Alkanes - C1, C2, C3, C4 petrochemicals, alkenes - C2, C3, C4, petrochemicals, alkynes -C2, C3, C4 petrochemicals, B-T-X aromatics, diene based petrochemicals.	08
Unit III: Second generation petrochemicals Synthesis gas, methanol, formaldehyde chloromethane, ethanol, acetaldehyde, acetic acid, acetic anhydride, isopropyl alcohol, ethylene oxide, propylene oxide, acetone, vinyl chloride, phenol, aniline and styrene.	10
Unit IV: Third generation petrochemicals Plastics, rubbers and fibres, olefinic polymers, polyethylene, polypropylene, polyisobutylene,	10

diene polymers - polybutadiene, neoprene, polyisoprene, SBR, synthetic fibres.	
Unit V: Miscellaneous petrochemicals Petroleum proteins, synthetic detergents, resin and rubber chemicals, explosives - TNT and RDX.	10
Unit VI: Challenges and opportunities of petrochemical industry Shortage of petroleum crude, Dependence on Foreign Countries, Price Hike, Exploration of New Reserves, Lack of Market-Determined Pricing System, Compatibility with refinery infrastructure	07

Suggested Text Books:	
1.	Bhaskara Rao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.
2.	Sukumar Maiti, "Introduction to Petrochemicals", 2nd Edition, Oxford and IBH Publishers, 2002.
3.	H. Steines, "Introduction to petrochemical Industry", Pergamon, 1961
4.	G. D. Hobson and W. Pohl, "Modern Petroleum Technology", 4th Edition. Applied Science Publishers, 1975.
Suggested Reference Books:	
1.	Margaret Wells, "Handbook of Petrochemicals and Processes", 2nd Edition. Ash Gate Publishing Limited, 2002.
2.	Sami Matar and Lewis F. Hatch, "Chemistry of Petrochemical Processes", 2nd Edition. Gulf Publishing Company, 2000.
3.	C.E. Dryden: "Outlines of Chemical Technology", 2nd Edition. Affiliated East-West Press, 1993.
4.	Richard Frank Goldsten and A. Lawrence Waddams, "The Petroleum Chemical Industry". E&FN Spon Ltd., 1967.
5.	G.T. Austin: "Shreve's Chemical Process Industries", 5th Edition. McGraw Hill, 1986.

Class, Part & Semester	**:**	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	**:**	**Industrial Biotechnology (Elective-II)**		***Course Code***	**:**	CH421.2
Teaching Scheme (Hours)	**:**	Lecture = 04 Hours/Week Tutorial =Nil		***Total Credits***	**:**	04
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2023
Pre-requisites *(If any)*	**:**	CH324, CH411, CH412.4					
Course Domain	**:**	Open Elective					

Course Rationale: The course covers basic fundamental concept of enzymes and microbes for the manufacturing of products, which have a huge industrial significance. It uniquely blends the science and engineering with various biochemical processes to obtain products of diverse fields such as chemicals, food, bio-energy etc.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss the basic concept of enzyme technology.	1.	Demonstrate the knowledge of biotechnology in various fields.
2.	Explain the concept of biotechnology and its significant applications.	2.	Understand cell function and metabolism process.
3.	Discuss the role of biotechnology in medical field and industrial genetics.	3.	Describe about other uses of biotechnology in medical field and industrial genetics.
4.	Explain the importance of biotechnology in agricultural, food and beverage industries, and chemical industries.	4.	Understand how biotechnology helps in agricultural, food and beverage industry, chemical industries.

Curriculum Content	**Hours**
Unit I: Introduction Basic concepts in biotechnology and historical development, Biotechnology an interdisciplinary pursuit – public perception of biotechnology –Biotechnology and developing world – Ethics of biotechnology – future and scope of biotechnology, Role of chemical engineering in biotechnology., Cell structure and function, Prokaryotes and Eukaryotes, Structure and function of microbial (Bacteria, yeast, fungi, algae, virus).	10
Unit II: General requirements of Fermentation Process An overview of aerobic and anaerobic fermentation processes and their application in industry; basic design and construction of fermenter and its auxiliaries, sensors and monitoring instruments, media design and sterilization for fermentation processes.	10
Unit III: Solid and liquid substrate fermentation Cheese production – single cell protein (SCP) – mushroom production – soya sauce production –leaching of metals – vitamin C and vitamin B12 production – sewage treatment – biogas production – ethanol from molasses.	10
Unit IV: Genetics and biotechnology The role of genes within cells, elucidation of the genetic code, genetic elements that control	10

gene expression, methods of creating recombinant DNA molecules, safety guidelines of recombinant DNA research, plasmid and phage vectors.	
Unit V: Food and Medicine biotechnology Biotechnology in relation to the food industry, types of microorganisms brewing and alcoholic beverages – wine production –beer production. Antibiotics – penicillin production, vaccines and monoclonal antibodies, human insulin production.	08
Unit VI: Future scope of Biotechnology	04

Suggested Text Books:	
1.	John E. Smith, Biotechnology, 3rd edition, Cambridge University Press,5th edition,2012.
2.	Chisti.Y., Industrial Biotechnology: Sustainable Growth and Economic Success, Wiley,2011
3.	Singh, A., & Ward, O. P, Industrial Biotechnology: Microorganisms. Wiley-VCH,2019.
4.	Flickinger, M. C., & Drew, S. W, Industrial Biotechnology: Sustainable Production and Bioresource Utilization. Wiley,2017.
Suggested Reference Books:	
1.	Atkinson. B and Mavituna. F, Biochemical Engineering and Biotechnology Handbook, McGraw Hill Millan, 1993.
2.	J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill, 1986.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Polymer Technology (Elective-II)**			***Course Code***	: CH421.3
Teaching Scheme (Hours)	:	Lecture = 04 Hours/Week Tutorial = Nil			***Total Credits***	: 04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	: 03 Hrs.
Revision	:	Fourth			***Month***	: June 2023
Pre-requisites *(If any)*	:	BS-12A2, CH312, CH321				
Course Domain	:	Open Elective				

Course Rationale: This course will help students to learn about polymers, one of the most significant modern materials. Course will introduce different types of polymers and method of polymerization. It will also help them to understand the role of additives in the polymers and uses of different polymers.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Introduce classification of polymers, concept of average molecular weight and its determination.	1.	Understand classification of polymers, concept of average molecular weight and its determination.
2.	Explain difference between natural and man-made polymers.	2.	Compare between natural and man-made polymers.
3.	Brief about the polymerization methods and polymerization kinetics.	3.	Recognize different polymerization methods and polymerization kinetics.
4.	Illustrate degradation of polymers, role of the additives in the polymers & uses.	4.	Describe degradation of polymers, role of the additives in the polymers & uses.
5.	Elaborate manufacturing, properties & uses of different polymers and compounding of polymer resins.	5.	Understand manufacturing, properties & uses of different polymers and compounding of polymer resins.

Curriculum Content	***Hours***
Unit I: Introduction: Definitions: polymer& macromolecule, monomer, functionality, average functionality, copolymer, polymer Blend, plastic and resin. Classification of polymers: based on source, structure, applications, thermal behavior, and mode of polymerization. Concept of average molecular weight of polymers, molecular weight distribution, poly disparity index. Determination of average molecular weights: End group analysis, osmometry, light scattering techniques, viscometer, and Gel permeation chromatography.	10
Unit II: Natural Polymers: Brief study of i) Natural rubber ii) Shellac iii) Rosin iv) Cellulose v) Proteins.	04
Unit III: Mechanism and kinetics: Addition or chain polymerization a) Free radical addition polymerization b) Ionic addition Polymerization c) Coordination polymerization. d) Coordination or step growth or condensation polymerization.	08
Unit IV: Methods of polymerization: Mass or Bulk polymerization process, solution polymerization process, suspension	10

polymerization process and emulsion polymerization method comparison of merits and demerits of these methods. Properties of polymers: Crystalline and amorphous status, melting and glass transition temperatures and their determination, effect of polymer structure on mechanical, physical, chemical and thermal properties.	
Unit V: Degradation of polymers Role of the following additives in the polymers: i) Fillers and reinforcing fillers ii) Plasticizers iii) Lubricants iv)Antioxidants and UV stabilizers v) Blowing agents vi) Coupling agents vii) Flame retardants viii) Inhibitors **Brief description of manufacture, properties and uses:** i) Polyethylene (HDPE&LDPE), ii) Polypropylene iii) Polyvinylchloride iv) Polystyrene v) Polytetrafluoroethylene vi) Polymethyl methacrylate vii) Polyvinyl acetate & Polyvinyl alcohol.	10
Unit VI: Brief description of manufacture, properties and uses: i) Polyesters (Polyethylene terephthalate polycarbonate and unsaturated polyesters) ii) Nylon (Nylon 66) iii) Phenol- Formaldehyde resins iv) Epoxy resins v) Polyurethane vi) Silicones **Compounding of polymer resins, brief description:** i) Compression and transfer moulding ii) Injection moulding iii) Extrusion iv) Blow moulding v) Calendaring vi) Laminating and pultrusion.	10

Suggested Text Books:	
1.	J.A. Brydson, "Plastic materials", Newnes-Butterwarths, 2nd edition,1980
2.	Fred W. Billmeyer, "Text book of polymer science", Wiley & sons,3rd edition,1984
3.	B.K. Sharma, "Polymer chemistry", Krishna Prakashan, 3rd edition,2019.
4.	J.H. Brydson and C.C. Gosselin, "Introduction to plastics", Newnes, London,1968
Suggested Reference Books:	
1.	C.C. Winding and G.D.Hiatt, "Polymeric Materials", McGraw Hill Book Co..1961
2.	V.R. Gowariker, N.V. Viswanathan, Jaydev Sreedhar, "Polymer Science" New Age International Publishers,1986

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Food Process Technology (Elective-II)**			***Course Code***	: CH421.4
Teaching Scheme (Hours)	:	Lecture=04Hours/Week Tutorial= Nil			***Total Credits***	: 04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	: 03 Hrs.
Revision	:	Fourth			***Month***	: June 2023
Pre-requisites *(If any)*	:	BS-11A2, BS-12A2, CH324, CH412, CH425				
Course Domain	:	Open Elective				

Course Rationale: This course aims to extend students' knowledge of food chemistry, aspects of food industry and techniques used for the packaging and storage of food and production of different food products.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Develop an understanding of aspects of food industry.	1.	Interpret the aspects of food industry.
2.	Understand the different factors relative to food processing.	2.	Identify the different factors relative to food processing.
3.	Elaborate the different food processing operations in food industries.	3.	Explain the different food processing operations in food industries.
4.	Understand the operations and techniques used for packaging and storage of food.	4.	Describe the operations and techniques used for packaging and storage of food.
5.	Interpret the production of different food products.	5.	Discuss the production of different food products.
6.	Understand the threats and challenges in food industries.	6.	Identify threats and challenges in food industries.

Curriculum Content	***Hours***
Unit I: An overview General aspects of food industry; world food needs and Indian situation.	06
Unit II: Food constituents, quality and derivative factors Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their control	09
Unit III: General engineering aspects and processing methods Preliminary processing methods; conversion and preservation operations.	08
Unit IV: Packaging and storage Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.	09
Unit V: Production and utilization of food products Cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products.	10

Unit VI: Threats and challenges before the Food Processing Industry Availability of raw materials, Storage Infrastructure, adequate connectivity.		06
Suggested Text Books:		
1.	Heid, J.L, Joslyn, M.A., "Fundamentals of Food Processing Operation ", The AVI Publishing Co., Westport, 1967.	
2.	Heldman D.R.; "Food Process Engineering ", The AVI Publishing Co., Westport, 1975.	
3.	Charm, S.E., " The Fundamentals of Food Engineering ", The AVI Publishing Co., Westport, 1963	
4.	Fellows, P, Food Processing Technology: Principles and Practice (4th edition). Woodhead Publishing,2016.	
Suggested Reference Books:		
1.	Potter, N.N.; "Food Science ", The AVI Publishing Co., Westport, 1963.	
2.	R. Macrae, R. K. Robinson, and M. J. Sadler, Encyclopedia of Food Science, Food Technology and Nutrition,Vol. 8, Academic Press 1993.	

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Interfacial Science and Engineering (Elective-II)**			***Course Code*** :	CH421.5
Teaching Scheme (Hours)	:	Lecture=04 Hours/week Tutorial=Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	BS-11A2, CH212, CH222				
Course Domain	:	Open Elective				

Course Rationale: This course will aim at introducing the basic concept of colloid and interface science, properties, behavior and interactions. It explores the application of surface and colloid chemistry principles to technologies involving particulate dispersions, emulsions, foams, aerosols, water-soluble polymers, wetting, flocculation, flotation, separation, and stabilization. The goal is to provide a background in surface and colloidal science and give the student a solid framework for applying knowledge in colloid and surface science to the solution of practical problems and the development of new technologies.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Introduce students with various aspects of interfacial sciences and its associated phenomenon.	1.	Understand various aspects of interfacial sciences and its associated phenomenon.
2.	Explain Interfacial rheology and transport processes.	2.	Recognize the nomenclature, concepts and tools of colloid and interface science and engineering.
3.	Discuss experimental techniques for measuring surface and interfacial.	3.	Apply experimental techniques for measuring surface and interfacial tension for classic and modern theoretical models.
4.	Introduce students with various intermolecular and surface forces.	4.	Evaluate when stable emulsions will be formed using DLVO and DLVO like theories.
5.	Discuss applications of fluid-solid interfaces.	5.	Select suitable surfactants for specific applications in Nano fluids & advanced & functional materials.
6.	Discuss the engineering aspects of fluid-fluid and fluid-solid interfaces and Surface energy.	6.	Interpret the engineering aspects of fluid-fluid and fluid-solid interfaces and Surface energy.

Curriculum Content	***Hours***
Unit I: Basic concepts of Colloids and Interfaces Introduction, Examples of Interfacial Phenomena, Solid-Fluid Interfaces, Colloids. Properties of Colloid Dispersions: Introduction, Sedimentation under Gravity, Sedimentation in a Centrifugal Field, B Motion, Osmotic pressure, Optical properties, Electrical Properties, Rheological Properties of Colloid Dispersions.	10
Unit II: Interfacial rheology and transport processes Surface shear viscosity; Surface dilatational viscosity; Boussinesq number; Interfacial tension gradient and Marangoni effect; Gibbs and Marangoni elasticity; Boussinesq Scriven model; Interfacial turbulence; Motion of drops in a liquid; Thin liquid films; Disjoining pressure and	12

body-force models; Stability of thin liquid film; Black films. Emulsions: Preparation, characterization and applications; Ostwald ripening; Flocculation and coalescence; Micro-emulsions: characterization and properties; Stability of micro emulsions; Foams: preparation, characterization and stability; Structure of foams.	
Unit III: Surface and Interfacial Tension Introduction, Surface tension, Interfacial Tension, Contact Angle and Wetting, Shape of the Surfaces and interfaces. Measurement of Surface and Interfacial Tension, Measurement of Contact Angle.	09
Unit IV: Introduction to intermolecular and surface forces Van der Waals forces; Electrostatic double layer force; Disjoining pressure; DLVO theory; Non-DLVO forces. Chemical vapor deposition, molecular beam epitaxy, sputtering and atomic layer deposition techniques; Applications of fluid-solid interfaces in crystallization, development of ceramic materials, catalysts, electronic products and Nano-materials.	11
Unit V: Adsorption at interfaces Introduction, The Gibbs Dividing surface, Gibbs Adsorption Equation, Langmuir and Frumkin Adsorption Isotherms, Surface Equation of state (EOS), Effect of Salt on Adsorption of Surfactants. Adsorption Isotherms incorporating the Electrostatic Effects, Calculation of Free energy of Adsorption.	10

Suggested Text Books:	
1.	Kund and Jain, "Physical Chemistry". S. Chand and Company, New Delhi, 1996.
2.	Puri B.H., Sharma L.R., and M.S. Prathama: "Principles of Physical Chemistry". S. Chand and Company, New Delhi, 2001.
3.	Paul C. Hiemenz and Marcel Dekker: "Principles of Colloid and Surface Chemistry". 2nd edition onwards, 1986.
4.	Arthur W. Adamson: "Physical Chemistry of Surfaces". 5th edition. Wiley, 1990.
5.	Robert J. Hunter: "Foundations of Colloid Science". Clarendon, Oxford, Volume 1, 1989.
6.	W.B. Russel, D.A. Saville, and W.R. Schowalter: "Colloidal Dispersions". Cambridge University Press, 1989.
Suggested Reference Books:	
1.	B.S. Bahl, Arun Bahl, and G.D. Tuli, "Essentials of Physical Chemistry". S. Chand and Company, New Delhi, 2005.
2.	Gordon M. Barrow, “Physical Chemistry". Sixth Edition. Tata McGraw Hill, 1998.
3.	Peter Atkins & Julio de Paula, “Atkins' Physical Chemistry". 7th Edition. Oxford University Press, 2002.
4.	Cotton & Wilkinson: "Inorganic Chemistry". Wiley Eastern Ltd, 1986.
5.	Puri & Sharma, “Advanced Inorganic Chemistry". Shobhanlal Nagin Chand, 1996.
6.	Jacon N. Israelachvili, “Intermolecular and Surface Forces". Academic Press, 1992.
7.	Carel J. van Oss, "Interfacial Forces in Aqueous Media". Marcel Dekker or Taylor Francis, 1994.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Environmental Chemistry and Biochemistry (Elective-II)**			***Course Code*** :	CH421.6
Teaching Scheme (Hours)	:	Lecture = 04Hours/Week Tutorial =Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	CH211, CH221				
Course Domain	:	Open Elective				

Course Rationale: This course covers the basic concept of cell structure, noise effect, and toxic materials in the field of environmental engineering.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Discuss the fundamental of biochemistry.	1.	Analyze expertise relevant to the professional practice of environmental science & Biochemistry.
2.	Interpret the fundamental of environmental chemistry.	2.	Develop an understanding of the range and chemistry of compounds in the hydrosphere and Geosphere.
3.	Explain the concept of noise pollution and environmental toxicology.	3.	Establish an appreciation of the role of chemistry in environmental science.
4.	Illustrate the future scope of Environmental Sciences.	4.	Understand the role of the chemist in measurement and problem solving in environmental studies.

Curriculum Content	**Hours**
Unit I: Biochemistry Structure of Cell, Structure and function of biologically important compounds such as carbohydrates protein, Lipids enzymes and Amino acids, Nucleic acids.	10
Unit II: Environmental Chemistry Basics	08
Unit III: Noise Pollution Introduction, the describe scale, effects of noise – physiological and psychological effects, Measurement of noise levels, Noise control in industrial establishments.	08
Unit IV: Environmental Toxicology Classification of toxic materials, toxicity testing, toxic effects of hydrocarbons, alcohols, aldehydes, ketones, amines.	10
Unit V: Environmental Toxicology and Control Toxic effects and control of metal pollutants like Hg, Col, Pb, V, Cr, Co, etc. Disease measurement and control of occupational diseases.	08
Unit VI: Future scope of Environmental Sciences	08

Suggested Text Books:

1. S. M. Khopkar, “Environmental Pollution Monitoring & Control”, New Age

2.	T. G. Spiro, W. M. Stigliani, “Chemistry of Environment”, PHI.
3.	Manahan, S. E, "Environmental Chemistry". 9th edition. CRC Press, 2010.
4.	Sharma, B. K., "Environmental Chemistry". 2nd edition. Goel Publishing House, 2008.
Suggested Reference Books:	
1.	A. K. Das, “Textbook on Medical Aspects of Bioinorganic Chemistry”, CBS
2.	Nelson Cox and Lehninger, “Biochemistry”
3.	M. Ather & S. B. Vohra, “Heavy Metal & Environment”, New Age
4.	S. S. Dara, “Environmental Chemistry” latest edition

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering),Part IV, Semester VIII**				
Course Title	:	**Advanced Material (Elective-II)**			***Course Code*** :	CH421.7
Teaching Scheme (Hours)	:	Lecture = 04Hours/Week Tutorial = Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	CH223, CH313				
Course Domain	:	Open Elective				

Course Rationale: This course provides students with a fundamental understanding of physical and chemical properties of advanced materials and their applications. Topics include metallic, polymeric, ceramic and composite materials.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Elaborate the various advanced metallic materials.	1.	Identify various types of advanced materials such as polymers, ceramics and composites.
2.	Discuss about the advanced polymeric material.	2.	Understand the properties of various advanced polymeric.
3.	Illustrate the classification of ceramic materials.	3.	Classify the ceramic materials and their applications in various fields.
4.	Explain the classification of composite materials.	4.	Acquire knowledge of different types of composite materials and their properties and applications.
5.	Describe the fabrication methods of the advanced materials.	5.	Understand the fabrication of various composite materials.
6.	State and explain properties and application of nanomaterials.	6.	Acquire knowledge of types of nanomaterial and their applications in various fields.

Curriculum Content	***Hours***
Unit I: Advanced Metallic Materials Stainless Steels: Types, properties of stainless steels, corrosion resistance and selection of stainless steels, failure of stainless steels. High Temperature Alloys: Properties and types. Titanium Alloys and Cobalt-Chromium Alloys: Composition, properties and applications. Nitinol as Shape Memory Alloy and its applications.	08
Unit II: Advanced Polymeric Materials Structure, preparation, and application of various conducting polymers, high temperature polymers and liquid crystal polymers. Biomedical applications of polymers such as hydrogels, polyethylene, polyurethanes, polyamides and silicone rubber.	08
Unit III: Ceramic Materials Properties of ceramic materials, classification of ceramic materials, ceramic crystal structures. Behaviour of ceramic materials: dielectric, semiconductor, ferroelectric, magnetic, and mechanical behaviour. Preparation and application of ceramic materials: Alumina, Partially Stabilized Zirconia, Sialon, Silicon Nitride, Silicon Carbide. Processing of Ceramics.	08

Unit IV: Composite Materials and fiber reinforced plastic processing Necessity of composite materials, classification of composite materials, types of matrix materials and reinforcements, reinforcement mechanism, choosing material for matrix and reinforcement. Fiber Reinforced Plastic Processing: Open Moulding Processes: Filament Winding Process Closed Moulding Processes: Pultrusion and Pulforming, Sheet Moulding Compound Process Carbon-Carbon Composites: Fabrication and Properties.	10
Unit V: Metal and ceramic composites Advantage of metal composite over metal, types of reinforcement and matrix fabrication types, various fabrication processes: diffusion bonding process, in-situ process, mechanical behaviour and properties. Ceramic Composites: Matrices and reinforcements, mechanical properties, fabrication methods: Slurry infiltration processes, chemical vapour infiltration process.	10
Unit VI: Carbon Nanotubes, Nano shells, Nano sensors and Thin film coating Synthesis, properties and applications. Nano shells: Types, properties and applications. Nano sensors: Assembly methods, Nano sensors based on optical, quantum size, electrochemical and physical properties. Thin Film Coatings: Physical and chemical vapour deposition coatings, hard facing, thermal spraying, diffusion process, useful material for appearance, corrosion and wear.	08

Suggested Text Books:	
1.	B.K. Agrawal, "Introduction to Engineering Materials", Tata McGraw Hill Education Pvt. Ltd., 2012.
2.	A.K. Bhargava, "Engineering Material: Polymers, Ceramics and Composites", PHI Learning Pvt. Ltd., 2nd Edition 2012.
3.	Dr. H.K. Shivanand and B.V. Babu Kiran, "Composite Material," Asian Books Private Limited, 2010.
4.	T. Pradeep, "Nano: The Essentials", Tata McGraw-Hill Education Pvt. Ltd., 2010.
Suggested Reference Books:	
1.	William Smith, Javed Hasemi, Ravi Prakash, Material Science and Engineering, Tata McGraw Hill Education Company Ltd., 2006.
2.	Kenneth G. Budinski, Michael K. Budinski, "Engineering Materials Properties and Selection", 8th Edition, Prentice Hall.
3.	Bowden M.J. and Tumber S.R., "Polymer of High Technology, Electronics and Photonics", ACS Symposium Series, ACS, 1987.
4.	Dyson, R.W., "Engineering Polymers", Chapman and Hall, 1st Edition, 1990.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Project Management (Elective-II)**			***Course Code*** :	CH421.8
Teaching Scheme (Hours)	:	Lecture=04 Hours/Week Tutorial=Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	CH423				
Course Domain	:	Open Elective				

Course Rationale: This course will equip the students to various feasibility analysis – Market, Technical, Financial and Economic. To equip them with the knowledge and skills required to be successful in applying Project Management. To make them understand techniques for Project planning, scheduling and Execution Control.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Elaborate about project management system.	1.	Understand the basics of project management principles and practices.
2.	Explain the actual organizational structure.	2.	Recall the organizational structure.
3.	Illustrate about the skills required for project and programme manager.	3.	Function effectively with a project team.
4.	Describe the function of management.	4.	Interpret effective Functioning of management.
5.	Discuss the professional responsibility and performance measurement criteria.	5.	Understand the professional responsibility and performance measurement criteria.
6.	Explain the project graphics and cost control management.	6.	Improve the ability with respect to project graphics.

Curriculum Content	**Hours**
Unit I: Project Management growth Concept and Definition, General System Management, Project management, Resistance to Change, System programmed Project product verses project management a definition focus of success, Face of failure, Project life cycle, Project management methodologies, and Corporate culture.	08
Unit II: Organizational structure Introduction, organizational work flow, Traditional organization, Developing work, integration position, Project coordinator, Projected organization, Matrix structure, Strong weak balanced matrix, Project management Expertise, Studying tips for the PMF (Project Management Certificate Exam).	08
Unit III: Organizing and staffing the project office and team The staffing environment, Selecting the project manager, Skill requirement for project and programme manager, Organizational staffing progress, The project office, Project organizational chart.	10
Unit IV: Management function Controlling, Directing, Project Authority, Interpersonal life cycle, leadership in a project management environment, life cycle leadership, organizational impact ,employee manager problem, management pit falls, Communication, Human behavior education, Management	10

policies and procedure.	
Unit V: Special Topic Performance measurement, Financial compensation and rewards, Critical Issues with rewarding project team, mega Project, Morality, Ethics and corporate culture, Professional responsibility, Internal Partnership, External Partnership, Training and education, Integrated project team, Virtual project team, Break through Project.	08
Unit VI: Project Graphics and cost control Customer reporting, Bar chart, Presentation technique, Logic diagram/ Networking. Understanding Control, The operating Cycle, Cost amount codes, Budgets, The Earned Value Management System, Variance and Earned Value, The Lost Base done, The lost overrun dilemma, Recording material Lost, Material Accounting Criteria, Cost Control Problem.	08

Suggested Text Books:	
1.	Mantel, Samuel, Meredith and others, Project Management: Core Text Book, Wiley India Pvt. Ltd., 1st edition, 2006.
2.	S. Choudhary, "Project Management", McGraw Hill India, 1st edition, 2004.
3.	Harolad Kerzner, "A system Approach to planning, Scheduling, Controlling", 10th edition. Wiley
Suggested Reference Books:	
1.	Crary L Richardson and Brad M. Jackson, "Project Management Theory and Practices", CRC press, Taylor and Francis Group, Boca Raton London, New York, 3rd Edition, 2019.
2.	John M Nicholas, Herman Steyn, "Project Management for Engineering, Business and Technology", 4th edition, 2012.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**CFD Applications in Chemical Processes (Elective-II)**			***Course Code*** :	CH421.9
Teaching Scheme (Hours)	:	Lecture=04Hours/Week Tutorial=Nil			***Total Credits*** :	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE*** :	03 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	CH212, CH214, CH222				
Course Domain	:	Open Elective course				

Course Rationale: This course covers the basic concept of CFD. It will give the idea about the finite difference and finite volume methods. Solve the mathematical models using various algorithms.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Brief introduction of CFD along with chemical engineering application.	1.	Solve the transport equations using suitable boundary conditions.
2.	State the methods of finite difference and volume in CFD modeling.	2.	Formulate and Solve fluid flow problems using finite difference and Finite Volume methods.
3.	Elaborate the mesh generation.	3.	Describe the mesh generation criteria.
4.	Discuss mathematical models for various CFD applications such as Navier-Stokes equations and turbulence models.	4.	Solve Navier-Stokes equation for incompressible flows using SIMPLE algorithm.
5.	Explain the CFD Solution Procedure.	5.	Generate and optimize the numerical mesh.
6.	Discuss the different case studies related to heat and momentum operations.	6.	Simulate simple CFD models and analyze its results.

Curriculum Content	**Hours**
Unit I: Introduction Illustration of the CFD approach, CFD as an engineering analysis tool, Review of governing equations, Modeling in engineering, Partial differential equations- Parabolic, Hyperbolic and Elliptic equation, CFD application in Chemical Engineering, CFD software packages and tools.	10
Unit II: Principles of Solution of the Governing Equations Finite difference and Finite volume Methods, Convergence, Consistency, Error and Stability, Accuracy, Boundary conditions, CFD model formulation.	08
Unit III: Mesh generation Overview of mesh generation, Structured and Unstructured mesh, Guideline on mesh quality and design, Mesh refinement and adaptation.	08
Unit IV: Solution Algorithms Discretization schemes for pressure, momentum and energy equations - Explicit and implicit Schemes, First order upwind scheme, second order upwind scheme, QUICK scheme, SIMPLE, SIMPLER and MAC algorithm, pressure-velocity coupling algorithms, velocity-stream function approach, solution of Navier-Stokes equations.	10
Unit V: CFD Solution Procedure Problem setup – creation of geometry, mesh generation, selection of physics and fluid properties, initialization, solution control and convergence monitoring, results reports and	08

visualization.	
Unit VI: Case Studies Benchmarking, validation, Simulation of CFD problems by use of general CFD software, Simulation of coupled heat, mass and momentum transfer problem	08

Suggested Text Books:	
1.	P.S. Ghosdastidar, Computer Simulation of Flow and Heat Transfer, Tata McGraw-Hill, 1998
2.	Muralidhar K., and Sundararajan T. Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 1995
3.	T. K. Sengupta, Fundamentals of Computational Fluid Dynamics, University Press,2004
Suggested Reference Books:	
1.	P. Niyogi, S. K. Chakrabarty, and M. K. Laha, "Introduction to Computational Fluid Dynamics". Pearson Education, 2006.
2.	J. Li, G. H. Yeoh, C. Liu, "A Computational Fluid Dynamics". Elsevier, 2008.
3.	S. V. Patankar, "Numerical Heat Transfer and Fluid Flow". Taylor and Francis, 1978.
4.	S. K. Gupta, "Numerical Methods for Engineers". New Age Publishers, 2nd Edition, 1995.
5.	J.D. Anderson, "Computational Fluid Dynamics, McGraw Hill, 1995.

CH421.10 Open Elective (to be chosen from any of the specialized UG Program available on the campus)

Class, Part & Semester	**:**	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**					
Course Title	**:**	**Energy Resources and Utilization**			***Course Code***	**:**	CH422
Teaching Scheme (Hours)	**:**	Lecture=04 Hours/Week Tutorial = Nil			***Total Credits***	**:**	04
Evaluation Scheme (Marks)	**:**	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	**:**	03 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2023
Pre-requisites *(If any)*	**:**	CH212, CH222, CH224, CH321, CH411					
Course Domain	**:**	Program Core					

Course Rationale: The course will cover energy resources and their role in modern society, with both national and global perspectives. The present and future impacts of nuclear and fossil fuels on the environment will be explored. Energy technologies and use of solar, wind, hydro and biomass energy resources will be introduced, and the relationship between public policy and resource usage will be discussed.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the importance energy security for sustainable development and its fundamentals.	1.	Understand the importance energy security for sustainable development and its fundamentals.
2.	Impart knowledge about Conventional and Non-conventional energy resources sources	2.	Identify Conventional and Non-conventional energy resources sources.
3.	Show the different energy resources and their analysis.	3.	Calculate the energy content of various energy resources, and compare & analyze their values.
4.	Describe the importance of non-renewable energy resources and power generation.	4.	Understand the importance of non-renewable energy resources and power generation.
5.	Explain the role of chemical engineer as an energy auditor.	5.	Understand the role of chemical engineer as an energy auditor.
6.	Design and operate a plant with maximum energy efficiency and recovery.	6.	Perform design and operation of a plant with maximum energy efficiency and recovery.

Curriculum Content	***Hours***
Unit I: Introduction: Energy Needs of Growing Economy, Long Term Energy Scenario, Energy statistics in India and world, Energy and Environment: Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Kyoto Protocol, Global warming, Fossil and Processed Fuel.	06
Unit II: Conventional and Non-conventional energy resources: Solid fuels: Coal- origin, classification, coal washing and blending; Carbonization; Manufacture of coke and recovery of by-products; Coal gasification; Wood, charcoal, biomass, solid wastes, briquettes; Pyrolysis, gasification & liquefaction of solid fuels to secondary fuels; Refuse derived fuels. Liquid fuels: Petroleum- origin and production of petroleum; Distillation products and uses; Fuel oils, shale oils; Gasohol. Gaseous fuels: Natural gas, liquefied petroleum gas, coal gas, producer gas, water gas.	10
Unit III: Proximate and ultimate analysis of fuels: Calorific value; Specification and testing of petroleum fuels. Combustion of solid, liquid and gaseous fuels; Types of burners.	08

Unit IV: Renewable energy sources and power generation: Nuclear energy**:** Fission and fusion reactions; Nuclear reactors for power generation. Hydrogen production, storage and use. Solar energy: Solar radiation and its measurement; Theory and performance of solar collectors; Solar cells. Introduction to wind, tidal and geothermal energy; OTEC and MHD; Energy from biomass.	10
Unit V: Combined heat and power generation: Introduction, Technology of CHP Systems, Balancing Heat and Power Loads, Economic Incentives for Further CHP systems, Technical Potential for Further CHP systems. Good Housekeeping (Minor) Conservation Measures.	10
Unit VI: Energy utilization: A synergetic approach to the utilization of various energy resources with examples. Energy conservation; Energy audits. Environmental issues related to energy resources.	08

Suggested Text Books:	
1.	Boyle. G., Everett, B., & Ramage, J., "Energy Systems and Sustainability: Power for a Sustainable Future", Oxford University Press.
2.	Twidell, J., & Weir. T., "Renewable Energy Resources",3rd edition, Routledge, 2015.
3.	Turner. R. E., "Energy Technology and Economics: Principles and Applications", CRC Press.
4.	Tester. J. W., et al.: "Sustainable Energy: Choosing Among Options", 2nd edition, The MIT Press, 2012.
Suggested Reference Books:	
1.	W. F. Kenny, Energy Conservation in the Process Industries, Academic Press Inc. (London) Ltd.,1984
2.	Boustead, N. and Hancock, G. F.: "Handbook of Industrial Energy Analysis". Ellis Horwood Ltd., Chichester (UK), 1979.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**					
Course Title	:	**Process Economics and Project Engineering**			***Course Code***	:	CH423
Teaching Scheme (Hours)	:	Lecture=04 Hours/Week Tutorial = Nil			***Total Credits***	:	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2023
Pre-requisites *(If any)*	:	BS-11A1, CH311, CH313, CH324					
Course Domain	:	Program Core					

Course Rationale This course introduces a theoretical understanding of cost estimation, investment cost, depreciation and project conception.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Develop the skills about selection of plant capacity and location.	1.	Acquire the knowledge of selection of plant capacity, location, raw materials.
2.	Discuss about the investment and production cost.	2.	Apply the concepts of cost estimation for project appraisal.
3.	Describe about the different type of interest, type of taxes and insurance.	3.	Recognize and calculate the interest and taxes.
4.	Elaborate the type of depreciation and its method.	4.	Understand about the depreciation.
5.	Introduce Profitability, Alternative Investment and Replacement.	5.	Describe Profitability, Alternative Investment and Replacement.
6.	Illustrate the project conception, planning, engineering and management.	6.	Identify the plant layout and manipulate the process optimization, project planning, scheduling.

Curriculum Content	***Hours***
Unit I: Introduction Scales of Production, Selection of Plant Capacity, Plant Location. Availability of Raw Materials, Energy Gestation Period. Expansion, Diversification and Obsolescence. Scope for Standardization in Design and Production. Economics of Research and Development. Indian Chemical Industry, Current status and trends.	08
Unit II: Cost Estimation Factors Affecting Investment and Production Cost. Capital Investment, Fixed Investment and Working Capital. Estimating Equipment Cost by 6/10 Factor Rule Method of Estimating Capital Investment. Different Costs Involved in Total Product Cost. Computer Atomization in Costing.	10
Unit III: Interest and Investment Cost Simple and Compound Interest, Nominal and Effective Rates of Interest, Continuous Interest, Ordinary Annuity, Perpetuities and Capital Costs Taxes and Insurances: Types of Taxes and Tax Returns. Types of Insurance and Legal Responsibility.	08
Unit IV: Depreciation Types of Depreciation, Service Life, Salvage Value, Present Value. Methods of Determining Depreciation, Single Unit and Group Depreciation. Causes of Obsolescence and Inadequacy.	08

Unit V: Profitability, Alternative Investment and Replacement Mathematical Methods of Profitability Evaluation, Cash Flow Diagram. Break Even Analyses, Balance Sheet, Pricing Issue Method and Income Statement.	08
Unit VI: Project conception, Planning, Engineering and Management Project conception and definition, Causes for time and cost over runs of a Project, Process Optimization, and Selection of Alternative Processes Equipment Project engineering: Management and Organization, Project Planning, Scheduling and Controlling, Use of BAR chart, CPM and PERT Techniques, General site considerations, Plant Location and Site Selection, Site Layout, Plant Layout, Battery Limits and Off Site Facilities.	10

Suggested Text Books:	
1.	Peters, M. S., Timmerhaus, K. D., & West, R. E, "Plant Design and Economics for Chemical Engineers". McGraw-Hill Education, 2003.
2.	Seider, W. D., Seader, J. D., & Lewin, D. R, "Product and Process Design Principles: Synthesis, Analysis, and Evaluation". Wiley, 2017.
3.	Smith, R., Van Ness, H., & Abbott, M, "Introduction to Chemical Engineering Thermodynamics". McGraw-Hill Education, 2004.
4.	Peters, M. S., & Timmerhaus, K. D, "Plant Design and Economics for Chemical Engineers". 5th Edition. McGraw-Hill Education, 2003
Suggested Reference Books:	
1.	Ulrich. G. D., & Vasudevan. P. T., "Chemical Engineering Process Design and Economics: A Practical Guide", Wiley, 2016.
2.	Towler. G., & Sinnot. R., "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design", Elsevier, 2013.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Special Chemical Technologies**		***Course Code*:**	:	CH424
Teaching Scheme (Hours)	:	Lecture= 04 Hours/week Tutorial = Nil		***Total Credits***	:	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE= 70 Grand Total=100	***Duration of Exam***	:	3 Hrs
Revision	:	Fourth		***Month***	:	June 2023
Pre-requisites (If any)	:	CH313, CH324				
Course Domain	:	Program Core				

Course Rationale: Through studies hitherto, students have already gone through Inorganic and Organic Chemical Technologies. In addition, they have almost learnt the necessary engineering behind all these products and technologies. However, there are few industries that remained untouched namely textile sector particularly its wet processing wing, the agrochemical and wood industry and sugar industry. So studies in these three industries from Chemical Engineering stand point are covered through this course. Also in the present scenario, there are possible applications of nanoscience and technology. So to meet that requirement there is scope to study the nanotechnology as a part of this course. Finally, green chemistry and green technology as an urgent necessity of the hour so there is good space for the same through this course.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain principles of green chemistry and engineering.	1.	Understand importance of green aspects in product and process design.
2.	Discuss sugar industry processes and operations.	2.	Outline unit operations underlying sugar industry.
3.	Describe textile wet processing operations.	3.	Interpret textile wet processing in terms of Chemical Engineering.
4.	Elaborate Nano science and technology basics and applications.	4.	Relate nanotechnology for Chemical Industry.
5.	Introduce agrochemical and wood industry.	5.	Recognize their role in agrochemical and wood industry.
6.	Explain Chemical Engineer's role towards environment and sustainability.	6.	Apply their domain knowledge for environment care and sustainable development.

Curriculum Content	***Hours***
Unit I: Green Technology Green Chemistry: An overview introduction, underlying philosophy and focus, Twelve principles of green chemistry, Ecological Threats & Green Chemistry, The Greenhouse Effect, Climate Change, photochemical smog, Pragmatic Green, Chemistry Challenges, Old Technology vis-à-vis Green Technology: Suitable examples, to understand comparative advantage of Green Technology over Old one, Renewable, resources, Process intensification ,Carbon credits .Green Chemistry & Nonconventional Fuels, Green chemistry in batteries, production and recycling, Fuel cell and electric vehicles, Solar energy and hydrogen production, biodiesel, bio-hydrogen, Green Chemistry & Sustainable development, Esterification: trans esterification, autogeneous pressure of	10

methanol, trans esterification under supercritical conditions Optimization: catalyst concentration, methanol to oil ratio, reaction temperature, reaction time.	
Unit II: Sugar Technology Sugar Industry in India: Chemical and physical properties of sucrose and reducing sugars. Sources for sucrose. Formation of sucrose plants. Non-sugar compounds of sugarcane. Inorganic constituents of sugar cane juices and sugars analytical methods used in sugar industry. Purification: Chemical technology of the purification process. Fundamental reactions and physical chemistry aspects of clarification, liming, sulphitation and carbonation process. Filtration of sugar juice. Evaporation: Evaporation of sugar juice. Heat transfer in evaporations. Evaporation equipment and auxiliaries. Evaporation: Methods of obtaining steam, and quality of steam. Steam economy. Chemistry of the evaporation process. Crystallography: Solubility of sucrose. Nucleation in super saturated solutions – kinetics and growth of crystallization. Chemistry of crystallization. Crystallography: Control methods and equipment in sugar crystallization, technology of sugar crystallization. Evaporation and circulation in vacuum pans. Centrifugation: Theory of the centrifugal process, centrifugal operation. Centrifugation: Engineering principles of sugar centrifuges and the centrifugal equipment and auxiliaries. Production of final molasses and molasses's utilization. Grading of sugar.	12
Unit III: Textile wet processing technology (Textile Chemistry) Brief introduction to textile industry. Study of various steps involved in the chemical processing of textiles (pretreatments and after treatments like dyeing, printing and finishing.) Chemistry and processes for desizing, scouring, bleaching and mercerization. Study of applications of reactive, vat and other classes of dyestuff on various textiles. Study of all the above treatments in chemical processing of textiles from stand point of Unit operations of chemical engineering.	10
Unit IV: Nanotechnology Introduction to Nanotechnology, Nanotechnology-Definition, Classification and Applications, Processes for producing ultrafine powders-mechanical grinding, wet chemical synthesis of nanomaterials. Gas phase synthesis of nano materials, gas condensation processes, chemical vapour condensation, laser ablation. Special nanomaterials, characterization and Applications for Carbon nanotubes, nano composites, nano fluids-An overview over preparation, properties, applications. Nano electronics: Introduction – micro, nano fabrication: Optical lithography, Electron beam lithography, Atomic lithography, Molecular beam epitaxy, MEMS, NEMS –A	10
Unit V: Agrochemical Industries and Wood and Wood Chemical industry Insecticides, pesticides, Herbicides, plant growth, Nutrients and regulators, compound Fertilizers, Bio fertilizers, complex fertilizers, and various grades of N.P.K. fertilizer. Composite wood, plywood etc.; Manufacture of oleoresin, turpentine, methanol, rosin, and tall oil; Ethanol production; Essential oils, perfumes, flavours and cosmetics.	10

Text Books:

1.	Yaws. C. L., "Specialty Chemicals Source Book", 4th edition,Gulf Publishing Company, 2018.
2.	Klein, R., "Handbook of Specialty Elastomers",2nd edition, CRC Press, 2017.
3.	Margaritis, A., & Merchant. R., "Biotechnology in the Chemical Industry: Towards a Green and Sustainable Future", Springer, 2017.

4.	Rashid. H.,"Nanotechnology in Industrial Wastewater Treatment", CRC Press, 2016
Reference Books:	
1.	Kotelnikov. A., & Matveeva. V., "Chemistry of Energy Conversion", De Gruyter, 2016.
2.	Hocking. M. B., "Chemical Technology in the Pre-Treatment Processes of Textiles", Woodhead Publishing, 2014.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**					
Course Title	:	**Transport Phenomena**			***Course Code***	:	CH425
Teaching Scheme (Hours)	:	Lecture =04 Hours/Week Tutorial = Nil			***Total Credits***	:	04
Evaluation Scheme (Marks)	:	CIE=30 (20+10)	SEE = 70	Grand Total =100	***Duration of SEE***	:	03 Hrs.
Revision	:	Fourth			***Month***	:	June 2023
Pre-requisites *(If any)*	:	CH212, CH222, CH214, CH224, CH315, CH323					
Course Domain	:	Program Core					

Course Rationale: The purpose of this course is to introduce and make aware the students about different flow patterns for various types of geometries. It is the application of common principles to the study of mass transfer, heat transfer, and fluid mechanics.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain different terms for flow through different geometries.	1.	Understand different terms for flow through different geometries.
2.	Discuss the different equations for the isothermal systems.	2.	Recognize the different equations for the isothermal systems.
3.	Understand the mass and energy balance for isothermal systems.	3.	Derive mass and energy balance equations for isothermal systems.
4.	Impart knowledge of interphase transport in non-isothermal Systems.	4.	Repharse the concept of interphase transport in non-isothermal Systems.
5.	Elaborate various mass transfer terms for falling liquid film.	5.	Identify various mass transfer terms for falling liquid film.
6.	Understand the concept of computational fluid dynamics and its applications.	6.	Explain the concept of computational fluid dynamics and its applications.

Curriculum Content	***Hours***
Unit I: Equations of Change and Velocity distribution Viscosity and the mechanism of momentum transport, Newton's law of viscosity, non-Newtonian fluids, pressure & temperature dependence of viscosity, estimation of viscosity from critical properties, Velocity distribution in laminar flow, Shell momentum balances, boundary conditions, flow of a falling film, flow through a circular tube, flow through annular, creeping flow along a solid sphere.	08
Unit II: Equations of change and Interphase transport for isothermal systems Time derivatives and vector notations, the equation of continuity, the equation of motion, the equations of change in curvilinear, co-ordinates, Inter phase transport in isothermal systems, Definition of friction factors, friction factors for flow in tubes, friction factors for flow around spheres, friction factors for packed column.	08
Unit III: Macroscopic balances for isothermal systems The Macroscopic mass balance, the macroscopic mechanical energy balances, estimation of friction loss, Thermal conductivity and the mechanism of energy transport, Fourier's law of heat conduction, temperature and pressure dependence of thermal conductivity in gases and liquids, theory of thermal conductivity of gases at low density.	08
Unit IV: Temperature distributions in solids and in laminar flow	

Shell energy balance, boundary conditions, Heat conduction with an electrical heat source, Heat conduction in cooling fins, heat conduction with exothermic reactions, Interphase Transport in Non isothermal Systems, Definition of heat transfer coefficients, Heat transfer coefficient for forced convection in tubes, Heat transfer coefficient for forced convection around submerged objects and through packed beds, Heat transfer coefficient for free convection, Heat transfer coefficient for condensation of pure vapors.	08
Unit V: Diffusivity and the mechanism of mass transports Definitions of concentrations, velocities & mass fluxes, Fick's law of diffusion, Temperature & pressure dependence of mass diffusivity, Maxwell's law of diffusion. Concentration distributions in solids and in a laminar flow, Shell mass balance, boundary conditions, diffusion through a stagnant gas film, Diffusion with heterogeneous chemical reaction, Diffusion with homogeneous chemical reaction, Diffusion in to a falling liquid film.	08
Unit VI: Introduction to the Computational Fluid Dynamics Philosophy of computational fluid dynamics, conservation principles of mass, energy, and momentum, simplified flow models such as incompressible, in viscid, potential and creeping flows, classification of flows, Grid Generation, Structured and unstructured grids, choice of grid, general transformation of equations, some modern developments in grid generation in solving engineering problems.	08

Suggested Text Books:	
1.	Bird, R. B., Stewart, W. E., & Lightfoot, E. N.: "Transport Phenomena". 2nd edition. Wiley, 2007.
2.	Geankoplis C. J, Transport Processes and Separation Process Principles, 4th Edition; Prentice Hall India, 2003
3.	Deen, W. M., "Analysis of Transport Phenomena". 2nd edition. Oxford University Press, 2012.
4.	Welty, J. R., Wicks, C. E., Wilson, R. E., & Rorrer, G. L.: "Fundamentals of Momentum, Heat, and Mass Transfer". 6th edition. Wiley, 2011.
Suggested Reference Books:	
1.	Cussler, E. L., "Diffusion: Mass Transfer in Fluid Systems",3rd edition, Cambridge University Press, 2009.
2.	Slattery, J. C, "Advanced Transport Phenomena: Fluid Mechanics and Convective Transport Processes", Cambridge University Press, 1999.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**					
Course Title	:	**Piping & Instrumentation Design and Drawing**			***Course Code***	:	CH426L
Teaching Scheme (Hours)	:	Practical=02 Hours/Week			***Total Credits***	:	01
Evaluation Scheme (Marks)	:	IOE=50	EPE- Nil	Grand Total =50	***Duration of IOE***	:	02 Hrs.
Revision	:	Fourth			Month	:	June 2023
Pre-requisites *(If any)*	:	CH214,CH224,CH311, CH313, CH315, CH323, CH324, CH325					
Course Domain	:	Program Core					

Course Rationale: This is a core subject of Chemical Engineering. The course introduces the various procedures involved in the development and engineering of Piping and Instrumentation Diagrams (P&IDs), Equipment Plot Plans, and Piping Arrangements.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain and Demonstrate identification and drawing ISA (Instrumentation Symbols and Identification) symbols.	1.	Identify and draw ISA (Instrumentation Symbols and Identification) symbols.
2.	Demonstrate common symbols used on piping and instrumentation diagrams.	2.	Identify common symbols used on piping and instrumentation diagrams.
3.	Illustrate drawing of basic flow sheet layouts.	3.	Draw basic flow sheet layouts.
4.	Describe and illustrate preparation of flow sheet (Piping and Instrumentation) diagrams.	4.	Prepare flow sheet (Piping and Instrumentation) diagrams.

General Instructions: Practical part for this course covers theory as well as practice related to following points:

1. Introduction to concept of PFD (Process Flow Diagram) & P&ID (Piping & Instrumentation Diagram), Heat & Mass balance. Need for P&ID's during the chemical plant design, precommissioning, commissioning and further operations & maintenance.

2. Components of typical P&ID (Legends used (Legend P&ID)), Contents of P&ID (Lines, instruments, valves, special parts, equipment, controls etc.), Standards for drafting of P&IDs: ASME, ISO

3. Preparation of the P&ID's: Inputs needed (PFD's, Heat & Mass balance & Process description), Sizing of lines, selection of material, fluid code design conditions), Defining instrumentation requirement, Controls requirement and definition, Interlock and safety devices. 4. Connections from one P&ID to other and rules.

5. Inter-connection P&ID's introduction & design aspects

6. Use of P&ID's for building plant: Piping, Instrumentation, Electrical

7. Tool used to prepare and draw P&ID's.

8. Study of actual P&ID's for a reference plant

9. Actual P&ID preparation (Practical with some case studies)	
Suggested Reference Books:	
1.	Geyer, J., & Geyer, E, "Industrial Instrumentation and Control: An Introduction to the Basic Principles", 2nd edition. CRC Press, 2016.
2.	Mehta, H, "Piping and Instrumentation Diagram Development: A Guide to Symbols and Drawing Practices", Momentum Press, 2019.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Plant Design & Drawing**			***Course Code***	: CH 427L
Teaching Scheme (Hours)	:	Practical = 02Hours/Week			***Total Credits***	: 01
Evaluation Scheme (Marks)	:	IPE =Nil IOE=Nil	EPE=50	Grand Total= 50	***Duration of EPE***	: 02Hrs.
Revision	:	Fourth			***Month***	: June 2023
Pre-requisites *(If any)*	:	CH214, CH215, CH312, CH314, CH315, CH321, CH323, CH325, CH413, HS317L				
Course Domain	:	Program Core				

Course Rationale: This course covers the terminology and concepts needed for equipment layout within the process plant and the building of a complete chemical process. The students will learn the importance of equipment placement, spacing and orientation as applied in chemical engineering and will appreciate the importance of safety in design and operation.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain the use of engineering symbols for development of PFDs and P&IDs to design process flow systems.	1.	Acquire the knowledge for development of PFDs and P&IDs.
2.	Discuss the basics for design as per the codes and standards for the plant design of equipment's used in the industry.	2.	Understand the basics for design as per the codes and standards for the plant design of equipment's used in the industry.
3.	Construct an equipment layout and tank-farm of a given process based on the process description.	3.	Draw and describe an equipment layout and tank-farm of a given process based on the process description.
4.	Describe the concepts of plant location and plant layout.	4.	Prepare the plant layouts and elevations.
5.	Explain utility, importance of process flow sheet, ULD and P&ID.	5.	State utility, importance of process flow sheet, ULD and P&ID.
6.	Describe about project feasibility reports and various clearances required to start an industry.	6.	Know the arrangement of tank, piping isometrics and stress analysis.

Sr. No.	***List of Experiments***
1.	Minimum six drawings of following i. Standard symbols as per IS code Process flow diagram. ii. Piping and instrumentation diagram. iii. Utility diagram. iv. Tank Farm. v. Plant layouts and elevations. vi. Piping GA drawing. vii. Piping isometrics. vii. Stress analysis
2.	Minimum two assignments based on theory.

Suggested Reference Books:	
1.	M. S. Peters & K. D. Timmerhaus, "Plant Design and economics for chemical engineers." Mc Graw Hill,2002.
2.	Richard Turton, R.C. Bailie, W.B. Whiting, J.A. Shaeiwitz, "Analysis, Synthesis and Design of Chemical Processes", Prentice Hall.
3.	R.K Sinnot," Coulson & Richardson's Chemical Engineering- Chemical Engineering Design", Vol. 6, Butterworth-Heinemann.
4.	Kalyanmoy Deb, "Optimization for Engineering Design-Algorithms and Examples", PHI Learning Private Limited.
5.	Srinath L. S., "PERT & CPM." affiliated East Press Pvt. Ltd., New York,1973.
6.	Perry J. H., "Chemical engineering handbook",7th edition, Mc Graw Hill,1997.

Class, Part & Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**				
Course Title	:	**Seminar**			***Course Code*** :	CH428T
Teaching Scheme (Hours)	:	Lecture=Nil Tutorial= 01Hour/Week			***Total Credits*** :	01
Evaluation Scheme (Marks)	:	IPE= Nil IOE= 50	EPE= Nil EOE=Nil	Grand Total =50	***Duration of IOE*** :	2 Hrs.
Revision	:	Fourth			***Month*** :	June 2023
Pre-requisites *(If any)*	:	HS212, Core course Knowledge from all semester courses				
Course Domain	:	Program Core				

Course Rationale: This course aims to extend students' knowledge for particular exercise to promote self-study, critical thinking and independent research ability.

Course Objectives: The Course Teacher will		***Course Outcomes****:* Students will be able to	
1.	Develop an understanding of self-study, critical thinking.	1.	Understand concept of self-study and critical thinking.
2.	Explain how to develop their own small conceptual or practical based projects individually or as a team.	2.	Identify & explain their own small conceptual or practical based projects individually or as a team.
3.	Develop the student's overall personality by carving their presentation, aptitude and research skills.	3.	Apply their presentation, aptitude and research skills.

Curriculum Content

1. Selecting the seminar topic.
2. Information retrieval (literature survey)
   a) Source of Information i.e. names of the journals, reports, books etc.
   b) Searching for the information i.e. referring to chemical abstracts etc.
3. Preparing the seminar report
4. Delivering the seminar

(The students will deliver minimum two seminars individually (each of 15 to 20 minutes). Prior to the seminar topic selection, the course in charge will guide them about searching of topic. One topic may be of a general nature but the other topic must be related to the Chemical Engineering field related case studies. The students have to submit the seminar reports on those two topics delivered by him/her as well as the summary of the topics delivered by the other students from the peer group i.e. the tutorial batch during the semester. The assessment of the term-work will be based on:

1. Attendance to the seminar
2. Performance of the seminar delivery
3. Seminar reports and
4. Participation in question– answer sessions during the seminar)

Class, Part & Semester	**:**	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**					
Course Title	**:**	**Major Project-Phase II**			***Course Code***	**:**	CH429L
Teaching Scheme (Hours)		Practical=04 Hours/week			***Total Credits***	**:**	02
Evaluation Scheme (Marks)	**:**	IPE=50	EPE=100	Grand Total =150	***Duration of Exam (in case of External Examination)***	**:**	02 Hrs.
Revision	**:**	Fourth			***Month***	**:**	June 2023
Pre-requisites *(If any)*	**:**	Core course Knowledge from all semester courses					
Course Domain	**:**	Research Competency					

Course Rationale: Project Work aims at developing innovative skills in the students whereby they apply the knowledge and skills gained through the course work in the solution of particular problem or by undertaking a project. The project may be theoretical, experimental or a combination. In few cases, the project may also involve sophisticated design work. The project report is expected to show the clarity of thought and expression, critical appreciation of existing literature and analytical, experimental skills. This can be carried out either in the institute or at any other industry/research laboratory in India or Abroad under the supervision of guide (s) for the stipulated period.

	Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to
1.	Explain their knowledge of basic science and engineering fundamentals required for project work.	1.	Apply their fundamental knowledge for demonstrating the depth technical competency in the area of chemical engineering.
2.	Demonstrate the ability to engage in design and to execute designs to an appropriate professional standard.	2.	Build hands on exposure for design of equipment related to their project work.
3.	Discuss about technical and non-technical environment.	3.	Apply oral, graphical and written communication in both technical and non-technical environment.
4.	Enable students to correlate class mode learning to real industrial as well as research applications.	4.	Understand real industrial as well as research applications.
5.	Facilitate the learning of proper report writing and comprehensive communications skills.	5.	Know about proper report writing and comprehensive communications skills.

Course Description:

In the second phase of the Project Work, all the project groups will carry out actual execution the work planned as stated as an outcome of the first phase in the seventh semester. They will submit the final project report in two hardbound copies along with soft copy to the guide. The guide will submit one copy to the Program office and the other copy will be owned by him/her. The report will be prepared in a standard format as provided by the Program Advisory Board.

Generally, the report will consist of problem definition, review of literature, selection of the process, computation of material and energy balances, process design of important equipment, detailed design of

one of the main equipment, plant location and layout, cost estimation, economic analysis, details of experimental set up, analysis of data, results and discussion, the related pollution control, safety and marketing aspects as applicable to the project topic chosen.

At the end of the project report, the conclusions and recommendations of the project work along with the bibliography in standard format will be mentioned. There may be little variation in project report writing depending on the nature of the respective project problem under investigation.

The objective of the project is to make use of the knowledge gained by the students at various stages of the B. Tech Program. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the students at the end of the studies. This particular activity will be for 50 marks as an Internal Practical Evaluation (IPE). The same research and review committee will carry out the assessment of the project groups.

For External Practical Examination (EPE) carrying 100 marks, there will be a panel of at least 3 external examiners to assess the project work. The research and review committee along with the external examiners will examine each of the project groups through VIVA VOCE and physical verification of the project models if any. The students group using the LCD will demonstrate their work to all the examiners.

Class, Part &Semester	:	**Final Year B. Tech (Chemical Engineering), Part IV, Semester VIII**						
Course Title	:	**Professional Ethics**				***Course Code*:**	:	HS421
Teaching Scheme (Hours)	:	Lecture = 2 Hours/Week				***Credits***	:	Nil
Evaluation Scheme (Marks)	:	Assignments: 50	Viva voce:25	Written Test :25	Grand Total :100	***Duration of Exam***	:	Not Applicable
Revision	:	Fourth				***Month***	:	June 2023
Pre-requisites	:	It does not require any pre-requisite as such but eager to know about our profession's connectivity, role and responsibility towards society and environment.						
Course Domain	:	Audit Course at institute level , Humanities & Social Science						

Course Rationale: The course is designed to provide an introduction to the role of the engineer in society; time value of money concepts and engineering economic decisions; engineering ethics; safety and risk assessment; the professional responsibilities of engineers; and the legal aspects of engineering.

Course Objectives: The Course Teacher will		***Course Outcomes:*** Students will be able to	
1.	Explain importance of engineers' connectivity with society and environment.	1.	Realize the role of engineers towards society and environment.
2.	Make students aware of ethics and responsibility of engineers as professionals.	2.	Demonstrate ethical practices and responsibility as a professional.
3.	Make them able to undergo ethical judgments and solve problems.	3.	Make ethical judgments and solve problems.
4.	Develop attitudes required of engineers and values shared by engineers.	4.	Get developed for engineers' attitude with sharing of values.
5.	Help them practice decision making & team players.	5.	Practice decision making and team culture.
6.	Describe importance of lifelong learning.	6	Follow lifelong learning attitude.

Curriculum Content	***Hours***
Unit I: Engineer, Society and Environment: Understanding of the relation between engineering and society/Environment, Understanding of the effects and impacts of science and technology on human society, Understanding the effects and impacts of science and technology on the natural environment, Understanding the characteristics of the modern globalized world.	07
Unit II: Ethics and engineering Profession: Understanding of ethics and responsibilities of engineers as Professionals, Understanding of the roles and responsibilities of engineers in Society, Understanding of the basic concepts and theories of ethics, Understanding the relation between law and ethics and having basic legal literacy, Understanding of the nature of professional ethics, Understanding of the purposes and roles of codes of ethics and those of conduct set by engineering societies and associations, Understanding of the social responsibility (SR) of organizations (companies in particular), Understanding of ethics in specific areas (and knowledge of concrete cases) , Understanding the nature of ethics in research and development.	07
Unit III: Ethical Perception and Problem solving: Ability to make ethical judgments and	06

solve problems, Understanding and application of methods to identify related factors in ethical issues and to make a structural analysis of them, Understanding and application of methods to analyze technical factors in ethical issues and make structural analysis of them, Understanding and application of methods to analyze organizational factors and provide organizational solutions, Ability to design one's conduct to solve ethical problems Based on the abilities to analyze factors gained through above topics, Comprehensive problem-solving capability.	
Unit IV: Engineer's attitude and Social Responsibility: Attitude required of engineers and values shared by engineers, Attitude to think autonomously and independently based on an understanding of the responsibility of an engineer, Attitude to accept a diversity of values (recognizing the existence of the various value systems different from their own as well as the multiplicity of values), Attitude to share values (such as safety emphasized in the codes of ethics) to which engineers should assign paramount importance, Attitude and willpower to act on ethical judgments of their own.	06

Suggested Text Books:	
1.	Fleddermann, C. D, "Engineering Ethics". Prentice Hall, New Mexico, 1999.
2.	Seth, M. L, "Principles of Economics". Lakshmi Narayan Agarwal, Agra,1968.
3.	Agarwal, A. N, "Indian Economy". Vikas Publishing House Pvt. Ltd., New Delhi,2017.
4.	Datta. R., and Sundharam, "Indian Economy", K. P. M., S. Chand & Co. Ltd., New Delhi.
Suggested Reference Books:	
1.	Harris, Jr., C.E., Pritchard, M.S., and Rabins, M.J. "Engineering Ethics: Concepts and Cases", Cengage Learning, 5th Edition, 2020.
2.	Prof. M P Raghavan, "Professional Ethics in Engineering", SCITECH Publication (India) Pvt. Ltd, 2nd Edition.

Equivalence of Final Year B. Tech (Chemical Engineering) Semester VII and VIII

The above syllabus structure is a revised version of the Final Year B. Tech (Chemical Technology) Program being conducted by Shivaji University at its Technology Department. This syllabus is to be implemented from June 2023, (Academic year 2023-24). The Equivalence for the subjects/courses of Chemical Technology at Final Year B Tech Semester VII and VIII pre-revised course under the faculty of Engineering and Technology is as follows. **One major change is in the name of the Program as B. Tech (Chemical Engineering) at the place of B. Tech (Chemical Technology).**

Final Year B. Tech Semester VII (Chemical Engineering)

Sr. No	Final Year B. Tech (Chemical Technology) Semester VII Pre-revised syllabus	Final Year B. Tech (Chemical Engineering) Semester VII Revised syllabus	Remark
1.	Biochemical Engineering	Biochemical Engineering	Contents are revised wherever necessary
2.	Elective-I	Elective-I	
3.	Industrial Economics and Management	Industrial Economics and Management	
4.	Major Project-Phase I	Major Project-Phase I	
5.	Internship II	Internship II	
6.	Process Equipment Design	Process Equipment Design	
7.	Process Equipment Design Laboratory	Process Equipment Design Laboratory	
8.	Process Modeling and Simulation	Process Modeling and Simulation	
9.	Process Modeling and Simulation Laboratory	Process Modeling and Simulation Laboratory	
10.	Comprehensive Tests	Comprehensive Tests	
11.	Audit Course V Introduction to Indian Constitution	Audit Course V Introduction to Indian Constitution	

Final Year B. Tech Semester VIII (Chemical Engineering)

Sr. No	Final Year B. Tech (Chemical Technology) Semester VIII Pre-revised syllabus	Final Year B. Tech (Chemical Engineering) Semester VIII Revised syllabus	Remark
1.	Energy Resources and Utilization	Energy Resources and Utilization	Contents are revised wherever necessary
2.	Elective-II (Open Elective)	Elective-II (Open Elective)	
3.	Special Chemical Technologies	Special Chemical Technologies	
4.	Transport Phenomena	Transport Phenomena	
5.	Major Project-Phase II	Major Project-Phase II	
6.	Process Economics and Project Engineering	Process Economics and Project Engineering	
7.	Piping & Instrumentation Design and Drawing	Piping & Instrumentation Design and Drawing	
8.	Plant Design and Drawing	Plant Design and Drawing	
9.	Seminar	Seminar	
10.	Audit Course VI Professional Ethics	Audit Course VI Professional Ethics	

Audit course have been assigned no any credits. The students will be evaluated for these courses by the concerned course in charge. There will be grade conferred to the student. The grade will be based on conversion of marks obtained out of 50. Obtaining passing grade is essential condition.