ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

B.E (Chemical Engineering)

Degree Program (FULL-TIME)

Choice Based Credit System (CBCS)

COURSES OF STUDY AND SCHEME OF EXAMINATIONS

(REGULATIONS 2025)

Curriculum for B.E (Chemical Engineering) 2025-26 onwards

ANNAMALAI UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

B.E (Four Year) Degree Program (FULL-TIME)

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COURSES OF STUDY AND SCHEME OF EXAMINATIONS (REGULATIONS 2025)

Curriculum for B.E (Chemical Engineering) 2025-26 onwards

SEMESTER I

Course Code	Category	Course	L	T	P/D	CA	FE	Total	Credits
25ETBS101	**BS-I**	Chemistry	3	0	-	25	75	100	3
25ETBS102	**BS-II**	Mathematics-I	3	1	-	25	75	100	4
25ETHS103	**HS-I**	Technical English	2	0	-	25	75	100	2
25ETES104	**ES-I**	Basic Civil Engineering	2	0	-	25	75	100	2
25ETES105	**ES-II**	Basic Mechanical Engineering	2	0	-	25	75	100	2
25ETEP106	**ESP-I**	Design thinking and idea lab	-	-	4	40	60	100	2
25ETEP107	**ESP-II**	Programming for problem solving Lab	-	-	3	40	60	100	1.5
25ETBP108	**BSP-I**	Chemistry Laboratory	-	-	3	40	60	100	1.5
25ETHS109	**HS-II**	Heritage of Tamils □□□□□□ □□□□	1	-	-	25	75	100	1
		NCC/NSS/YRC/Sports							2
								Total Credits	21

SEMESTER II

Course Code	Category	Course	L	T	P/D	CA	FE	Total	Credits
25ETBS201	BS-III	Physics	3	1	-	25	75	100	3
25ETBS202	BS-IV	Mathematics-II	3	1	-	25	75	100	4
25ETES203	ES-III	Basic Electrical Engg.	4	-	-	25	75	100	2
25ETES204	ES-IV	Environmental Studies	1	-	-	25	75	100	2
25ETHS205	HS-III	Universal Human Values	-	-	3	40	60	100	2
25ETEP206	ESP-III	Electrical Wiring and Earthing Practices Lab	-	-	3	40	60	100	1
25ETHP207	HSP-I	English Communication Lab	-	-	3	40	60	100	1.5
25ETBP208	BSP-II	Physics lab	2	-	3	40	60	100	1.5
25ETEP209	ESP-IV	Engineering Graphics & Design	-	-	6	40	60	100	3
25ETHS210	HS-IV	Tamils and Technology தமிழரும் தொழில்நுட்பமும்							1
								Total Credits	21

SEMESTER III									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
25CHBS301	BS-V	Material Technology	3	0	0	25	75	100	3
25CHES302	ES-V	Chemistry for Chemical Engineers	3	0	0	25	75	100	3
25CHPC303	PC-I	Chemical Technology	3	0	0	25	75	100	3
25CH PC304	PC-II	Chemical Process Calculations	3	0	0	25	75	100	3
25CHPC305	PC-III	Process Safety	3	0	0	25	75	100	3
25CHPC306	PC-IV	Chemical Engineering Thermodynamics – I	3	0	0	25	75	100	3
25CHPE307	PE-I	Professional Elective - I	3	0	0	25	75	100	3
25CHCP308	PCP-I	Organic & Physical Chemistry Laboratory	-	-	3	40	60	100	1.5
25CHCP309	PCP-II	Technical Analysis Laboratory	-	-	3	40	60	100	1.5
			Total Credits						**24**

SEMESTER IV									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
25CHBS401	BS-VI	Numerical Methods	3	0	0	25	75	100	3
25CHES402	ES-VI	Python for Chemical Engineering	3	0	0	25	75	100	3
25CHPC403	PC-V	Fluid Mechanics	3	0	0	25	75	100	3
25CHPC404	PC-VI	Heat Transfer	3	0	0	25	75	100	3
25CHPC405	PC-VII	Mass Transfer – I	3	0	0	25	75	100	3
25CHPC406	PC-VIII	Chemical Engineering Thermodynamics II	3	0	0	25	75	100	3
25CHPE407	PE-II	Professional Elective - II	-	-	3	40	60	100	3
25CHCP408	PCP-III	Fluid Mechanics Laboratory	-	-	3	40	60	100	1.5
25CHCP409	PCP-IV	Heat Transfer Laboratory	-	-	3	40	60	100	1.5
						Total Credits			**24**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming V Semester.									

SEMESTER V									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
25CHPC501	PC-IX	Particle Mechanics & Mechanical Operation	3	0	0	25	75	100	3
25CHPC502	PC-X	Chemical Reaction Engineering – I	3	0	0	25	75	100	3
25CHPC503	PC-XI	Mass Transfer – II	3	0	0	25	75	100	3
25CHPC504	PC-XII	Process Instrumentation	3	0	0	25	75	100	3
25CHPE505	PE-III	Professional Elective - III	3	0	0	25	75	100	3
25CHOE506	OE-I	Open Elective - I	3	0	0	25	75	100	3
25CHCP507	PCP-V	Particle Mechanics & Mechanical Operation Laboratory	-	-	3	40	60	100	1.5
25CHCP508	PCP-VI	Mass Transfer Laboratory	-	-	3	40	60	100	1.5
25ETIT509	IT-I	Industrial Training / Rural Internship/Innovation/ Entrepreneurship	***Four*** *weeks during the summer vacation at the end of* ***IV Semester***				100	100	**4.0**
						Total Credits			**25**

SEMESTER VI									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
25CHPC601	PC-XIII	Process Dynamics & Control	3	0	0	25	75	100	3
25CHPC602	PC-XIV	Chemical Reaction Engineering – II	3	0	0	25	75	100	3
25CHHS603	HS – V	Management for Engineers	3	0	0	25	75	100	3
25CHPE604	PE-IV	Professional Elective - IV	3	0	0	25	75	100	3
25CHPE605	PE-V	Professional Elective - V	3	-	-	25	75	100	3
25CHOE 606	OE-II	Open Elective - II	3	-	-	25	75	100	3
25CHCP607	PCP-VII	Chemical Reaction Engineering & Thermodynamics Laboratory	-	-	3	40	60	100	1.5
25CHCP608	PCP-VIII	Process Instrumentation & Control Laboratory	-	-	3	40	60	100	1.5
						Total Credits			**21**
Students must undergo Internship for 4 weeks during summer vacation which will be assessed in the forthcoming VII Semester.									

SEMESTER VII									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
25CHES701	ES -VII	Research Methodology	2	0	0	25	75	100	2
25CHPC02	PC-XV	Transport Phenomena	3	0	-	25	75	100	3
25CHPC703	PC-XVI	Process Engineering Economics	3	0	0	25	75	100	3
25CHPE704	PE-VI	Professional Elective - VI	3	-	-	25	75	100	3
25CHPE705	PE-VII	Professional Elective - VII	3	-	-	25	75	100	3
25CHOE706	OE-III	Open Elective - III	3	-	-	25	75	100	3
25CHCP707	PCP-IX	Chemical Process Simulation Laboratory	-	-	3	40	60	100	1.5
25CHCP708	PCP-X	Chemical Plant Design and Drawing Lab	-	-	3	40	60	100	1.5
25ETIT709	IT-II	Industrial Training / Rural Internship/ Innovation / Entrepreneurship	***Four*** *weeks during the summer vacation at the end of* ***VI Semester***				100	100	**4.0**
						Total Credits			**24**

SEMESTER VIII									
Course Code	**Category**	**Course**	**L**	**T**	**P**	**CA**	**FE**	**Total**	**Credits**
25 CHOE801	OE-IV	Open Elective-IV	3	-	-	25	75	100	3
25 CHOE802	OE-V	Open Elective-V	3	-	-	25	75	100	3
25 CHPV803	PV – I	Project Work and Viva-voce	-	PR 10	S 2	40	60	100	6
						Total Credits			**12**

L	No. of Lecture Hours	**TR**	No. of Hours for Discussion on Industrial Training
T	No. of Tutorial Hours	**S**	No. of Seminar Hours on Industrial Training / Project
P	No. of Practical Hours	**PR**	No. of Hours for Discussion on Project work
CA	Continuous Assessment Marks	**FE**	Final Examination Marks
Credits	Credit points allotted to that course	**Total**	Total Marks

PROFESSIONAL ELECTIVES

Professional Elective - I

1. Petroleum Refining Engineering
2. Biochemical Engineering
3. Environmental Engineering
4. Electrochemical Engineering

Professional Elective - II

5. Nuclear Engineering
6. Polymer Engineering
7. Air Pollution & Control
8. Chemical Plant Utilities

Professional Elective – III

9. Petrochemical Technology
10. Pulp and Paper Technology
11. Industrial Bio-technology
12. Wastewater Treatment Technology
13. Green Chemistry and Technology

Professional Elective - IV

14. Modern Separation Processes
15. Membrane Science and Engineering
16. Food Processing Technology
17. Fertilizer Technology

Professional Elective - V

18. Fluidization Engineering
19. Distillation
20. Mixing Theory and Practice
21. Technology of Fine and Specialty Chemicals

Professional Elective – VI

22. Computational Fluid Dynamics
23. Optimization of Chemical Processes
24. Operational Research
25. Process Modeling and Simulation
26. Hazardous Chemical Storage and Handling

Professional Elective – VII

27. Total Quality Management
28. Chemical Works Organization and Management
29. Entrepreneurship & Innovation: Building the Future
30. Industrial Relations and Organizational Development
31. AI and ML in Chemical Engineering
32. Pilot Plant and Scale Up Methods in Chemical Engineering

OPEN ELECTIVES

1. Solid Waste Management
2. Materials of Construction in the Process Industries
3. Project Engineering
4. Fuel Technology
5. Renewable Energy Technology
6. Hazardous Waste Management
7. Disaster Management
8. Human Factors Engineering, BBS and Occupational Health
9. Bioconversion and Processing of Waste
10. Intellectual Property Rights
11. Biology for Engineers
12. Machine Learning (Naan Mudhalvan) – V semester
13. Augmented and Virtual Reality (AR VR) Development (Naan Mudhalvan) – VI semester
14. Block Chain (Naan Mudhalvan) – VII semester
15. NCC Studies (Army Wing) – I

EXTRA ONE CREDIT COURSES

S.No.	Course Code	Course Name	Credits
1.	CHOCSCN	Health, Safety and Environment	1
2.	CHOCSCN	Explosions and Industrial Fire Safety	1

HONORS ELECTIVE COURSES

S.No.	Course Code	Course Name	Credits
1.	CHHE601	Advanced Heat Transfer	4
2.	CHHE602	Advanced Thermodynamics	3
3.	CHHE701	Advanced Process Control Systems	4
4.	CHHE702	Advanced Fluidization Engineering	3
5.	CHHE801	Applications of Nanotechnology In Chemical Engineering	3
6.	CHHE802	Heterogeneous Reactor Design	3

MINOR ENGINEERING COURSES

S.No.	Course Code	Course Name	Credits
1.	CHMI601	Basic Principles of Chemical Engineering	4
2.	CHMI602	Organic & Inorganic Chemical Technology	3
3.	CHMI701	Chemical Engineering Operations	4
4.	CHMI702	Basics of Fluid Mechanics	3
5.	CHMI801	Basic Principles of Chemical Reaction Engineering	3
6.	CHMI802	Process Engineering & Economics	3

VALUE ADDED COURSES

S.No.	Course Code	Course Name
1.	ECHEVAC01	Food Preservation Technology
2.	ECHEVAC02	Personal Protective Equipment (PPE) & First Aid
3.	ECHEVAC03	Fire Engineering and Explosion Control
4.	ECHEVAC04	Dairy Technology

INSTITUTIONAL VISION & MISSION

VISION

Providing world class quality education with strong ethical values to nurture and develop outstanding professionals fit for globally competitive environment.

MISSION

- Provide quality technical education with a sound footing on basic engineering principles, technical and managerial skills, and innovative research capabilities.
- Transform the students into outstanding professionals and technocrats with strong ethical values capable of creating, developing and managing global engineering enterprises.
- Develop a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the Industry and Society.
- Inculcate the importance and methodology of life-long learning to move forward with updated knowledge to face the challenges of tomorrow.

DEPARTMENT OF CHEMICAL ENGINEERING

VISION

Our vision is to be a leading Chemical Engineering Department in the Nation, to create and develop technocrats, entrepreneurs and business leaders

MISSION

The department fosters chemical engineering as a profession that interfaces engineering and all aspects of basic sciences to disseminate knowledge in order to prepare the students to be successful leaders and practitioners and to meet the present and future needs of the society by highest degree of standards and ethics.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To master the basic principles with ability to apply mathematics, physics, chemistry and biology and to understand and apply the same in the practice of modern technologies.

2. To excel in designing and optimization of the processes and systems by analysis and evaluation with the knowledge of basic engineering sciences of mass and energy balances: Thermodynamics of physical & chemical equilibria: heat, mass & Momentum transfer with economic principles.

3. To develop the ability to express ideas with understanding of social and cultural context of work associated with environmental, safety and economic aspects and high standards of ethical practice

4. To acquire the ability to solve problems in a broad range of career in multi-disciplinary professional team with effective management skills, moral responsibility applying critical thinking with leadership qualities at par with contemporary and global outlook.

5. The ability to cater the needs of Chemical industry, research organizations and academic institutes

PROGRAMME OUTCOMES (POs)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Mapping of PEO with POs											
PO → / PEO ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
PEO1	3	3	3	3	2	3	2	2	1	1	3
PEO2	3	3	3	3	2	3	2	2	1	1	3
PEO3	3	3	3	3	2	3	2	2	2	1	3
PEO4	3	3	3	3	2	3	2	2	2	1	3
PEO5	3	3	3	3	2	3	2	2	1	3	3

1–Slight, 2–Moderate, 3–Substantial

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Apply the basics and comprehensive knowledge in chemical engineering to analyze the problems in process industries to provide pragmatic solutions.

PSO 2: Investigate and demonstrate innovative practices to develop processes and products and provide services with optimal utilization of resources with sustainability and ethics.

PSO 3: Administer professional engineering competence to analyze and interpret data in engineering, economics and management to exhibit as an individual, leader and entrepreneur with ability to efficiently communicate, work effectively in diversified environments and pursue lifelong learning for careers in industry, academics and research.

THIRD SEMESTER

25CHBS301	MATERIAL TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To impart the basic concept of material science by understanding the various properties and heat treatment of engineering materials.
- To understand the selection of materials based on their properties for various engineering applications.

UNIT – I

Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Vander Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure-property-processing-performance relationships. Miller indices of directions and planes, packing of atoms inside solids, close-packed structures, structure of ceramics, ionic solids, glass and polymers, density of various materials.

UNIT-II

Imperfections in solids: vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults. Structure of materials and Strength of Materials: Yield strength, tensile strength and ductility of materials: stress strain behaviour of metals, ceramics and polymers, tensile test, plastic deformation, necking, creep behaviour and fatigue.

UNIT-III

Semi-crystalline materials: Classification, structure and configuration of ceramics, polymers, copolymers, liquid crystals and amphiphiles.

UNIT-IV

Non-crystalline/amorphous materials: Silicates, glass transition temperature, viscoelasticity. Polymer nano-composite materials: Nanocomposites, role of reinforcement-matrix interface strength on composite behavior

UNIT-V

Corrosion, Degradation and Recycling. Biomaterials, material related to catalyst such as zeolites, silica etc. and other selected materials. Introduction to experimental techniques: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties.

TEXT BOOKS:

1. V. Raghavan Materials Science and Engineering: A First Course, 5th Edition, 2004, prentice Hall India.
2. S. Upadhyaya and A. Upadhyaya, Material Science and Engineering, 2007, Anshan Publications.

REFERENCES:

1. R. A. L Jones, Soft Condensed Matter, 2002, Oxford University Press.
2. William D. Callister, David G. Rethwisch Materials Science and Engineering: An Introduction, Wiley Publisher.
3. B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, 2004, John Wiley & Sons.
4. Materials Science and Engineering, Raghavan, V, PHI
5. Material Science & Engineering, Upadhyaya, Anshan Publications
6. Testing of Metallic Materials, Suryanarayanan, A.V.K., Tata McGraw

COURSE OUTCOMES:

On completion of the course, students would be able to:

1. Obtain basic knowledge on materials such as bonding between atoms and packing of atoms inside solids.
2. Understand the Imperfections, structure and strength of materials.
3. Differentiate between Semi-crystalline materials, Ceramics and polymers.
4. Understand the Non-crystalline/amorphous material.
5. Possess knowledge on corrosion, biomaterials and experimental techniques for materials.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	-	-	-	-	-	-	-	-	2	-	-
CO2	3	-	-	-	-	-	-	-	-	1	2	-	-	-
CO3	3	2	3	-	-	-	-	-	-	-	3	3	-	-
CO4	3	3	3	-	-	-	-	-	-	2	3	3	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-	3	-	-

25CHES302	**CHEMISTRY FOR CHEMICAL ENGINEERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide the knowledge of basic chemistry to understand the fundamental principles of chemical engineering.
- To familiarize the basic terms of reaction engineering.
- To understand the basic concepts of reaction components and systems.

UNIT - I

Preparation, Physical & Chemical properties and Uses of Pyrrole, Furan, Furfural, Tetrahydro Furan, Thiophene, Indole, Pyridine, Quinoline and Isoquinoline.

Synthesis of Antimalarial drugs – isopentaquine and chloroquine Synthesis of Antibacterial drugs –Sulphaniliamide, Sulphapyridine, Sulphathiazole and Phenacetin.

UNIT - II

Carbohydrates – classification. Monosaccharides- reaction of Glucose and fructose, open chain and cyclic structures of glucose and fructose, mutarotation, epimerzation, Killiani- Fisher synthesis, Ruff degradation, conversion of aldoses to ketoses and Ketoses to aldoses. Disaccharides – properties and structure of sucrose. Polysaccharides – properties and structure of starch and cellulose.

UNIT - III

Elimination Reaction – E1,E2 elimination – Bredt's rule – Zartsev's rule – Condensation reaction – Benzoin Condensation – Aldol Condensation and Claisen Condensation – Preparation and synthetic uses of acetoacetic and malonic esters – Molecular rearrangement – Hofmann rearrangement – Schmidt rearrangement – Beckmann rearrangement.

UNIT – IV

Phase rule – Application of phase rule, two component systems, Eutectic point, Thermal analysis and behaviour of molten liquids. three component systems involving three liquids and two salts and water – separation.

Colloids Electrical properties of colloids, electrokinetic phenomenon – zeta potential – Donnan membrane equilibrium – gels and emulsion.

UNIT-V

Rate of reaction – Rate constants – Order and molecularity of reaction – First, second, third and zero order reactions – Method of determining order of reactions – Differential and integral rate expressions, Complex reactions – Reverse reactions – Parallel or side reactions, chain reactions, consecutive reactions and explosive reaction. Effect of temperature and solvent on reaction rate. Theories of reaction rates – Activated complex theory of Bi-molecular reactions, the lindemann theory of unimolecular reactions.

TEXT BOOKS:

1. Advance organic Chemistry – B.S. Bahl and Arun Bahl
2. Text book of organic chemistry – P.L.Soni
3. Principles of Physical Chemistry - B. R. Puri, L.R. Sharma, M.S. Pathania

REFERENCES:

1. R.P.Singh, Handbook of Chemistry, 3rd Edition, 2015, Arihant Publications
2. Jain & Jain, Engineering Chemistry, 16th Edition, 2015, Dhanpat Rai PulishingCompnay

COURSE OUTCOMES:

On completion of the course, students would be able to:

1. Describe the reaction of heterocyclic compounds and its application in synthesis of drugs.
2. Illustrate the chemistry of natural products.
3. Illustrate the migration of ions, atoms, chemical units from one molecule to another.
4. Illustrate the behaviour of liquid and solid mixture on boiling.
5. Analyse the kinetics of chemical reactions.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	1	1	-	-	-	-	-	-	1	1	-
CO2	1	1	1	1	1	-	-	-	-	-	1	1	1	1
CO3	2	3	2	1	1	-	-	-	-	-	-	2	1	-
CO4	2	1	2	1	1	-	-	-	-	-	1	1	1	-
CO5	3	2	1	1	1	-	-	-	-	-	-	1	2	1

25CHPC303	**CHEMICAL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To teach the basic concept of Chemical Engineering Profession Overview of Indian Chemical Industry.
- To impart the basic concepts of chemical technology
- To impart clear description of manufacturing processes of organic and Inorganic Chemicals and its applications.
- To understand unit operations involved in the physical separation of the products obtained during various unit processes.
- To learn the process flow sheet drawing for the manufacturing chemical processes.

UNIT -I

Chemical Engineer and Chemical Engineering Profession, Overview of Indian Chemical Industry, Global trends of chemicals, Life cycle assessment and environmental impact, Modern Chemical Engineering Plants: Batch to Continuous processing

UNIT -II

Industrial gases: Carbon dioxide, Hydrogen, Oxygen, Nitrogen and synthesis gas. Sulfur, Sulfuric Acid, Hydrochloric acid, Chlor-Alkali Industry: Sodium chloride, Soda ash, Sodium Bi-Carbonate, Chlorine, Caustic soda.

UNIT-III

Nitrogen Industry: Ammonia, Ammonium sulfate, Ammonium Nitrate, Ammonium Phosphate, Ammonium chloride, urea, Nitric acid, Nitro Phosphate, cyanamide. Phosphorous Industry- Phosphorus, phosphoric acid Calcium phosphate, Sodium phosphate, Di and Tri ammonium phosphate, Mixed Fertilizers and compound super phosphates

UNIT - IV

Silicate industry: Ceramics, Glass and Cement, paint, Varnish, Enamel and Lacquer, White lead, Zinc oxide, Lithophone, Titanium di oxide, Sugar, starch, glucose, pulp, paper, leather, glue and gelatin. Oils, fats, soaps, glycerin, synthetic detergents

UNIT - V

Plastics - Phenol, vinyl, and urea formaldehydes; polypropylene and silicone. Elastomers, Natural and Synthetic fibers, Cellulose acetate, viscose rayon, Nylon, polyester.

TEXT BOOKS:

1. Austin.G.T., Shreve's Chemical Process Industries, Fifth Edn., 1984, McGraw Hill.
2. Gopal Rao,M., and M. Sittig., Dryden's Outlines of Chemical Technology, 2nd edition, 1979 Affiliated East West Press.

REFERENCES:

1. Kirk and Othmer, Encyclopedia of Chemical Technology, 5th edition, 2005, John Wiley.
2. Pandey,GN., A Text Book of Chemical Technology, 1997, Vikas Publishing Comp.,Vol.II

COURSE OUTCOMES

On completion of the course, students would be able to:

1. Understand the concept of Chemical Engineering Profession.
2. Understand the manufacturing of various inorganic and organic chemicals of the various unit operations and processes.
3. Understand the various manufacturing processes.
4. Understand the manufacturing process of inorganic chemicals.
5. Draw the process Flow sheet and understand the major engineering problems encountered in the processes.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	-	-		-	-	-	-	2	3	-	-
CO2	3	3	3	-	1	-	-	-	-	1	2	3	-	-
CO3	3	3	3	-	1	-	-	-	-	-	2	3	-	-
CO4	3	3	3	-	1	-	-	-	-	-	2	3	-	-
CO5	3	3	3	-	1	-	-	-	-	-	2	3	-	-

25CHPC304	CHEMICAL PROCESS CALCULATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The course aims to

- Introduce the foundational principles of chemical engineering calculations
- Develop the ability to perform mass and energy balances on chemical processes
- Perform stoichiometric calculations involving limiting/reactant excess, percent conversion, and selectivity
- Understand conservation laws and their application to reactive and non-reactive systems
- Develop problem-solving skills relevant to process design and analysis

Unit-I

Introductory concepts of units and dimensions, physical quantities in chemical engineering, Dimensionless groups, Basic chemical calculations – Mole, atomic and molecular weight, Composition of mixtures and solutions - problems, Gases and gaseous mixtures, ideal gas law - problems, Gas – liquid system, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot.

UNIT-II

Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use. Material Balance: Introduction, Material balance without chemical reaction – Solving material balance for Distillation, Mixing, Absorption, Extraction, Evaporation, Drying, Solubility, Crystallization, Dissolution.

Unit-III

Concept of stoichiometry – Limiting and excess reactant, Material Balance with chemical reaction, Combustion – Basics and problems involving calculation of theoretical flame temperature.

Unit-IV

Material balances with Recycle, Bypass and Purging. Energy balance: Open and Closed system, Heat capacities of solids, liquids, gases and gas mixtures.

UNIT-V

Energy balances with chemical reaction: Calculation of enthalpy changes - Heat of reaction, Heat of formation, Heat of combustion, Hess's law of heat summation. Adiabatic temperature calculations, Energy balance during phase change operations. Case studies on Material and Energy Balances for multistage processes and complete plants on sugar industry, sulphuric acid manufacture and chlor-alkali industry.

TEXT BOOKS:

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, 2000, John Wiley & Sons.
2. Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, 2004, Tata McGraw Hill Publishing Company Ltd.

REFERENCES:

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., 2015, Pearson India Education Services.
2. K.A.Gavhane, Introduction to Process Calculations (Stoichiometry), 2016, Nirali Publications, Pune, India
3. Hougen, O. A., Watson, K. M., Ragatz, R. A., "Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, 2004, CBS Publishers & Distributors.

COURSE OUTCOMES:

After completing the course, the students will be able to:

1. Understand the fundamentals of Stoichiometry and process calculations and their applications to real time problems
2. Conversant in drawing the material balance for unit operations in chemical engineering and be able to apply them for design of equipment and process.
3. Understand and apply material balances derived from the governing equations for processes involving chemical reactions and combustion
4. Solve problems involving humidification, concepts of thermo-physics and heat capacities by drawing pertinent energy balances.
5. Understand and work on energy balances involving chemical reactions.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	-	-	1	-	-	-	-	3	3	2	-
CO2	3	2	1	-	-	1	-	-	-	-	3	3	2	-
CO3	3	2	1	-	-	1	-	-	-	-	3	3	2	-
CO4	3	2	1	-	-	1	-	-	-	-	3	3	2	-
CO5	3	2	1	-	-	1	-	-	-	-	3	3	2	-

25CHPC 305	**PROCESS SAFETY**	**L**	**P**	**O**	**C**
		3	**0**	**0**	**3**

Course Objectives

By the end of this course, students will be able to:

1. Identify the type of hazards and its nature and control measures.
2. Understand the types of fire and its extinguishing technique.

3. Understand the procedures to be followed in maintenance and protocol during emergencies.
4. Understand the necessity of risk analysis.
5. Recognize the different acts pertaining to factories.

Unit 1: Industrial Hazards

Physical Hazards – Chemical Hazards – Mechanical Hazards – Electrical Hazards - Biological Hazards – Radiation Hazards and its control techniques

Unit 2: Safety in Process Plants

Plant Layout for Safety – Fire –Chemistry of Fire – Classification of Fires – Types of fire extinguishers – Fire detection systems –Explosion - BLEVE – Confined and UVCE Maintenance of machines and equipment – Types of maintenance – Safety in Material Handling - Work Permit Systems – Onsite and Offsite Emergency Management and Plans

Unit 3: Loss prevention techniques and Risk Analysis

Hierarchy of hazard controls - Primary Hazard Analysis – Hazop Study – Fault Tree Analysis – Event Tree Analysis – Job Safety Analysis – Quantitative Risk Analysis - Safety Inspection – Accident Reporting and Investigation

Unit 4: Personal Protective Equipment and Handling of Hazardous Chemicals

PPE – Need and Selection – Respiratory PPE – Non Respiratory PPE – Types – Usage instructions of PPE – IS Standards of PPE – Maintenance of PPE, MSDS – Storage, Transportation and Handling of Hazardous Chemicals –Flammable-Corrosive-Reactive - Toxic-Irritants– Colour coding and Labelling

Unit 5: Case Studies and regulatory aspects

Analysis of major industrial accidents such as Bhobal, Flixborough, texas, Chernobial etc – Lesson learned form past incidents- Overview of relevant process safety regulations and enforcement (Factories act 1948, OSHA etc.,)

Text Books:

1. Frank P Lees, Loss Prevention in Process Industries, Vol. 1, 2 & 3, Butterworth-Heinemann Ltd., London (1991)
2. R. K. Jain & Sunil S Rao, Industrial Safety, Health and Environment Management Systems, Khanna Publishers, New Delhi (2006)
3. Grimaldi & Simonds, Safety Management, AITBS Publishers, New Delhi (2001)
4. Dr. B.K. Bhaskara Rao, Er. R.K. Jain, and Vineet Kumar, Safety in Chemical Plants/Industry and its Management, Khanna Publishers, New Delhi, 2010
5. The Factories Act with Amendments 1987, Government of India Publications, DGFASLI, Mumbai

Course Outcomes

1. Identify hazards in a given process and assess the same and provide solutions for operating safely.
2. Recognise the types of fire and explosion and act accordingly to minimize the severity of the incidents.
3. Carry out the risk analysis independently and also can play a role as a member in risk analysis team.
4. Explain the peer to understand the importance of PPE and the safe handling of hazardous chemicals.
5. Follow the statutory requirements to operate an industry pertaining to various acts.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	-	-	-	2	3	2	2	2	1	1	2	2	3
CO2	2	1	2	2	3	3	1	2	3	-	-	2	1	3
CO3	3	2	3	3	3	3	-	3	2	1	2	3	2	3
CO4	2	2	1	1	1	3	2	1	2	3	3	2	2	3
CO5	1	1	1	1	1	3	3	3	2	1	2	1	1	2

25CHPC306	**CHEMICAL ENGINEERING THERMODYNAMICS - I**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

To enable the students to understand

- the principles and application of the laws of thermodynamics, equations of state and phase equilibria for chemical engineering computations.
- the PVT behavior and other laws of thermodynamics
- the concept of entropy and method of calculating ideal work and lost work
- the thermodynamics applications in pumps, pipes, compressor etc.,

UNIT-I

Dimensions and Units, Temperature, Pressure, Work, Energy, Heat; Scope of thermodynamics, Energy conservation & first law of thermodynamics; State and path functions; Intensive and Extensive properties; Reversible and irreversible processes; Equilibrium; Phase Rule; Thermodynamic processes; Mass and energy balances for open systems.

UNIT-II

Phases, phase transitions, PVT behavior; Equations of state - Ideal gas law, Cubic equations of state - van der Waals, Virial, Redlich-Kwong equations; Reduced conditions & corresponding states theories; Compressibility factor;

UNIT-III

Second law of thermodynamics; Heat engines, Carnot's Theorem, Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work. Industrial application of second law of thermodynamics.

UNIT-IV

Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties, Residual properties, Industrial application of equation of state.

UNIT-V

Applications of Thermodynamics to flow processes-Pumps, Pipes, Nozzles, Compressors and Turbines. Principles of Liquefaction Processes.

TEXT BOOKS

1.J.M. Smith, H.C. Van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, 2005, McGraw-Hill International Edition.

REFERENCES

1. M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey .
2. Chemical Engineering Thermodynamics, YVC Rao, University Press

COURSE OUTCOMES

On completion of the course, students would be able to:

1. Apply mass and energy balances to closed and open systems
2. Evaluate the properties of non-ideal gases
3. Solve problems involving liquefaction, refrigeration and different power cycles.
4. Estimate thermodynamic properties of substances in gas and liquid states
5. Apply fundamental concepts of thermodynamics to engineering applications

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	-	-	-	2	-	-	-	-	3	2	2
CO2	3	3	3	-	-	-	2	-	-	-	-	3	2	2
CO3	3	3	3	-	-	-	2	-	-	-	-	3	2	2
CO4	3	3	3	3	-	-	2	-	-	-	-	3	2	2
CO5	3	3	3	-	-	-	2	-	-	-	2	3	2	2

25CHCP308	**ORGANIC & PHYSICAL CHEMISTRY LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSEOBJECTIVES:

- To learn basic principles involved in analysis and synthesis of different organic derivatives.
- To improve the practical knowledge on the properties and characteristics of solvents and mixtures

ORGANIC CHEMISTRY

Preparation of Compounds involving the following reactions:

1. Oxidation
2. Reduction
3. Bromination
4. Nitration
5. Sulfonation
6. Acetylation
7. Methylation
8. Hydrolysis
9. Diazotisation

Qualitative Analysis for the following compounds:

1. Aldehydes
2. Ketones
3. Acids
4. Esters
5. Amides
6. Amine
7. Ethers
8. Alcohol
9. hydrocarbons
10. sugars.

Determination of Physical constants- Boiling point and Melting point.

PHYSICAL CHEMISTRY

Determination of:

1. Molecular Weight-Rast's method, Freezing depression, Boiling point elevation, Transition temperature methods.
2. Phase rules- Two component system, Three component system, Phenol-water system.
3. Optical Experiments–Polarimetry, Refractometry.
4. Conductivity Experiments-Cell constant, Ostwald dilution law, Conductometric titration.
5. EMF-Single electropotentials, Concentration cells, Titrations, pH determination.
6. Surface tension
7. Viscosity

REFERENCES:

1. Alexander Findlay, Practical Physical Chemistry.
2. Daniels, Experimental Physical Chemistry.

COURSEOUTCOMES:

On completion of the course, students would be able to:

1. Synthesize and analyse organic derivatives quantitatively and qualitatively.
2. Analyzethepropertiesandcharacteristicsofchemicals,solventsandmixturesandtheir reactivity.
3. Demonstrateproceduresandinstrumentalmethodsinanalyticalandpracticaltasksof organic and physical chemistry.
4. Design and carry out experiments; record and analyse there results to get skilled in problem solving and analytical reasoning.
5. Communicate the scientific work in oral, written formats to explore areas of research with understanding of safe handling of chemicals and environmental issues of society.

Mapping with POs&PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	2	1	-	-	-	-	2	3	1	2
CO2	3	3	1	2	2	1	-	1	-	-	1	3	2	2
CO3	2	1	3	1	2	1	1	2	-	1	1	1	2	2
CO4	2	3	3	3	3	2	1	1	2	-	1	3	-	3
CO5	1	3	3	-	1	-	2	2	3	3	3	1	2	3

25CHCP309	**TECHNICAL ANALYSIS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

- To develop fundamental skills in qualitative and quantitative chemical analysis techniques.
- To understand and apply standard laboratory procedures for the identification and estimation of chemical substances.
- To gain proficiency in the use of analytical instruments such as spectrophotometers, pH meters, and conductivity meters.
- To interpret experimental data and calculate concentrations, purities, and other relevant parameters accurately.
- To ensure proper laboratory safety practices and chemical handling protocols are followed.

LIST OF EXPERIMENTS:

1. Proximate and Ultimate analysis of coal
2. Analysis of Water
3. Analysis of Common salt
4. Analysis of Bleaching powder
5. Analysis of Copper
6. Analysis of Mixed Acid
7. Analysis of Tannin
8. Analysis of Soap
9. Analysis of cement
10. Analysis of sugar
11. Viscosity Estimation.
12. Turbidity Meter.

Conduct an experiment to find the turbidity of the given sample of solution

COURSE OUTCOMES:

On completion of the course, students would be able to:

1. Acquire the knowledge to employ various techniques to analyze the compounds and salts
2. Acquire the knowledge to determine the Composition of various compounds and salts
3. Acquire knowledge to infer the results.
4. Acquire hands on training to use various equipment like viscometer and measure various properties like viscosity, molecular weight.
5. Use turbidity meter and determine the turbidity of the given material.

Mapping with POs & PSOs													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	-	-	-	-	2	2	-	-	2	3	-	-
CO2	2	-	-	-	-	2	2	-	-	2	3	-	-
CO3	2	-	-	-	-	2	2	-	-	2	3	-	-
CO4	3	-	-	-	-	-	2	-	-	2	1	-	-
CO5	3	-	-	-	-	-	2	-	-	2	1	-	-

FOURTH SEMESTER

25CHBS401	NUMERICAL METHODS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce students to numerical methods for solving chemical engineering problems based on different mathematical equations (e.g. linear/ non-linear algebraic equations, ordinary /partial differential equations)
- To equip students with the fundamental concepts and computational techniques of numerical methods, enabling them to model, analyze, and solve complex chemical engineering problems involving mass, energy, and momentum transfer.
- The course aims to develop proficiency in applying numerical tools for solving differential equations, linear and nonlinear systems, optimization problems, and data analysis relevant to chemical engineering processes.

UNIT-I

Introduction, Approximation and Concept of Error & Error Analysis, Linear Algebraic Equations: Methods like Gauss elimination, Gauss-Jordan, LU decomposition, Gauss – Jacobi, Gauss-Siedel method, Chemical Engineering problems involving solution of linear algebraic equations

UNIT-II

Root finding methods for solution on non-linear algebraic equations: Bisection, Iteration, Regula Falsi, Newton-Raphson and Secant methods, Chemical Engineering problems involving solution of non-linear equations

UNIT-III

Interpolation With equal intervals: Gregory – Newton forward and backward difference, Central difference formulae: - Gauss forward and backward interpolation: Interpolation with Unequal intervals: Gregory – Newton, Lagrange's interpolation

Numerical differentiation- Newton forward and backward difference, Bessel's formula: Numerical integration: Trapezoidal rule, Simpson's rule, Chemical Engineering problems involving interpolation, numerical differentiation and integration

UNIT-IV

Ordinary Differential Equations: Taylor's methods, Euler methods, Improved and Modified Euler's method, Runge-Kutta methods, Milne's Predictor Corrector method, Chemical Engineering problems involving single, and a system of ODEs.

UNIT-V

Introduction to Partial Differential Equations: Characterization of PDEs, Elliptic equation – solution by Laplace equation, Poisson's equation, Parabolic equation – Crank Nicholson Scheme (Heat conduction/diffusion equations), Hyperbolic equation

TEXT BOOK:

1. Gupta, S. K., "Numerical Methods for Engineers, 2012, New Academic Science.

2. Venkatraman M.K. “Numerical Methods in Science and Engineering” National Publishing Company, Chennai

REFERENCES:

1. S.C. Chapra& R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", 1985., McGraw Hill Book Company.
2. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., 2000., Brooks Coles.
3. Atkinson, K. E., "An Introduction to Numerical Analysis", 1978., John Wiley & Sons.
4. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, 2007, Cambridge University Press.
5. Numerical Methods for Engineers, Gupta, Newage Publishers
6. Numerical Methods for Engineers with Personal Computer Applications, S.C. Chapra, McGraw

COURSE OUTCOMES:

After completion of the course, the students will be able to:

1. Perform error analysis and solve linear system of equations in chemical engineering problems
2. Solve non-linear algebraic or transcendental equations by numerical methods and to implement these methods in chemical engineering applications
3. Demonstrate a function using an appropriate numerical method, to solve chemical engineering problems and calculate a definite integral to evaluate a derivative at a value using an appropriate numerical method
4. Solve ordinary differential equations using an appropriate numerical method and apply the same to solve chemical engineering problems
5. Examine the techniques to solve partial differential equations using suitable numerical methods

Mapping with POs & PSOs													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	-	2	-	-	-	-	-	-	3	-
CO2	3	3	3	-	2	-	-	-	-	-	-	3	-
CO3	3	3	3	-	2	-	-	-	-	-	-	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	3	2

25CHES402	**PYTHON FOR CHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To introduce data types, operators, input/output and assignment statements.
- To familiarize the conditional/decision-making and looping statements used in Python programming.

- To provide in-depth knowledge about the functions, lists, tuples, sets and dictionaries.
- To illustrate the use of open source python packages NumPy, Pandas, and Matplotlib.
- To study the applications of open source python packages like Cantera, IDEAS-PSE

UNIT I - Introduction to Python Programming

History of python-Getting started with python-Programming style-Programming errors. Elementary Programming: Writing a simple program-Reading input from the console-Identifiers-Variables, Assignment statements, and expressions-Simultaneous assignments-Named constants-Numeric data types and operators-Evaluating expressions and operator precedence-Augmented assignment operators-Type conversion and rounding.

Unit II – Conditional and Looping Statements

Boolean types, values, and expressions - Generating random numbers, if statements – if-else statements – Nested if and multi-way if-elif-else statements – Logical operators – Conditional expressions – Operator precedence and associativity-while loop-for loop – Nested loops-break and continue keywords.

UNIT III - Functions, Lists, Tuples, Sets and Dictionaries

Common python function -Strings and characters-Introduction to objects and methods. Defining a function–Calling a function–Functions with/without return values – Positional and keyword arguments – Passing arguments by reference values- Modularizing code-Returning multiple values-List basics-Processing two dimensional lists-Introduction to tuples, sets and dictionaries.

UNIT IV - Standard Python Packages (NumPy, Pandas and Matplotlib)

NumPy (Numerical Computing): Basics-Array creation-printing arrays-basic operations-universal functions-indexing, slicing and iterating-shape manipulation-copies and views. Pandas (Data Manipulation and Analysis): Basic data structure in pandas-Object creation-Viewing data-importing and exporting data. Matplotlib (Data visualization): Simple example-parts of a figure - types of inputs to plotting functions-coding styles-Styling artists-labeling plots-Axis scales and ticks.

Unit V - Packages for Chemical Engineering

Chemicals – Physical and chemical property estimation library, **Cantera** – Chemical kinetics, thermodynamics, and transport processes, **IDAES-PSE** – Advanced process systems

engineering framework for modeling, optimization, and control (built on Pyomo)

Text Books and User Guides:

1. Y. Daniel Liang, Introduction to Programming using Python, Pearson Education, 2013.
2. NumPy documentation, user guide: https://numpy.org/doc/stable/
3. Pandas documentation, user guide https://pandas.pydata.org/docs/
4. Matplotlib, user guide https://matplotlib.org/stable/index.html

Course Outcomes:

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

1. Understand the data types, operators, input/output and assignment statements used in Python programming.
2. Explain the usage of various conditional and looping statements in Python.
3. Build python programs using functions, lists, tuples, sets and dictionaries.
4. Develop a python program using the functions in Numpy, Pandas and Matplotlib.
5. Construct a program for solving real-life problems in chemical Engineering using special packages.

Mapping with POs & PSOs													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1	-	-	-	-	-	-	-	1	1	3
CO2	2	1	1	-	-	-	-	-	-	-	2	1	2
CO3	2	2	2	-	2	-	-	-	-	-	2	1	2
CO4	3	3	3	1	3	-	-	2	-	2	2	2	3
CO5	3	3	3	3	3	-	-	3	-	3	1	3	1

25CHPC403	**FLUID MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

To introduce the students to the fundamentals of the mechanics of fluids pertaining to

- fluid behavior in various systems.
- analyze, model, and solve problems involving fluid statics and dynamics, flow through pipes and channels, and transport phenomena relevant to chemical processes.
- emphasis is placed on applying these concepts to real-world engineering systems involving pumps, compressors, reactors, and heat exchangers.
- impart the techniques for flow measurement and instruments and equipment involved in transportation of fluids.

UNIT-I

Basic Concept of fluid mechanics

Definition of fluid - Classification of fluids – Newtonian fluid – Characteristic properties of fluids – Non -Newtonian Fluids and their classification. Kinematics of fluid flow-. Fluid statics: Pascal‟s law and Hydrostatic law of equilibrium Hydrostatic Equilibrium in a centrifugal field, Buoyancy and stability; Pressure and its measurement- Manometers

UNIT-II

Concept of Fluid Flow Phenomena

Equation of Continuity and its application, Introduction to boundary layer, boundary layer thickness under laminar and turbulent flow conditions. Equation of motion – Differential analysis: mass and momentum balances Derivation of Navier-Stokes equation, Euler‟s equation, Bernoulli‟s equation and its application in fluid flow.

Flow through Circular Pipes

Flow of fluids in Laminar regime – Velocity Profile, Shear Stress Distribution – Hagen–Poiseuille equation - Concept of average velocity – Concept of Kinetic energy correction factor, Concept of Fluid friction – Skin friction – Form friction – Factors affecting friction – Friction factor – Application of Moody‟s diagram, Minor losses and major losses during flow– Pipe, Fittings and Valves, Types of Fittings, valves characteristics and sizing of valves. Estimation of head loss from fittings and valves, Concept of minor losses and types of minor losses.

UNIT-III

Fluid Flow through Packed and Fluidized Bed

Flow past immersed bodies – Significance of form friction - Concept of Drag, Drag Coefficients and Particle Reynolds number - Drag Coefficient vs. Particle Reynolds number curves for regular and irregular shaped solid particles. Flow of fluids through packed beds – Packing and types of packing -Pressure drop across packed beds –Kozeny Carman equation – Ergun‟s equation - Loading and Flooding Packed Beds. Concept of Fluidization – Condition for Solid particles to be in a suspended condition in a flowing fluid – minimum fluidization velocity

UNIT-IV

Dimensional Analysis: Rayleigh method and Buckingham π theorem- Utility network in chemical process industries: Cooling water, Steam, Chilled water, Thermic fluid system

UNIT-V

Transportation and metering of Fluids:

Fluid Moving Machinery:

Pumps – Classification and working of Centrifugal Pumps and Positive Displacement Pumps Basic Principles of Centrifugal Pumps – Pump Characteristics – Concept of Specific Speed, Net Positive Suction Head – Factors influencing selection of pump. . Fans, Blowers and Compressors. Vacuum pumps – jet ejectors.

Metering of fluids:

Full bore meters – Venturi meter, Orifice meter, Rotameters, Vortex-Shedding meters, Magnetic meters and Coriolis meters. Insertion meters – Pitot Tube, Thermal meters, notches and weirs.

TEXT BOOKS:

1. M. White, Fluid Mechanics, 8th Edition, 2016, Tata-McGraw Hill.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, 2011, New Age International.
3. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, 2015, McGraw-Hill International Edition.

REFERENCES:

1. O. Wilkes, Fluid Mechanics for Chemical Engineers, 2005, Prentice Hall of India
2. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, 2010, Wiley-India

COURSE OUTCOMES:

On completion of the course, students would be able to:

1. Explain the properties of fluid and pressure drop in pipe lines
2. Bernoulli's Equation and engineering applications, Pressure drop in pipes and Fittings, Piping systems
3. Particle Dynamics, Boundary layer separation: skin and form drag, Flow through Fixed and Fluidised Beds, Flow through porous media
4. Analyze the different non-dimensional numbers based on the theorems and utility network in chemical process industry
5. Summarize the different types of Fluid moving machinery and flow measuring devices

Mapping with POs & PSOs													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	-	-	2	2	-	3	1
CO2	3	3	3	2	1	2	2	-	2	3	3	1	2
CO3	-	3	3	2	1	2	2	-	2	2	3	2	1
CO4	-	3	-	-	-	2	-	-	-	-	-	-	3
CO5	2	3	-	3	-	1	2	-	-	-	-	-	2

25CHPC404	HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic concepts of heat transfer pertaining with conduction in various geometry.
- To present the fundamentals of convection heat transfer and analogies between three types of transfer
- To understand the heat transfer coefficient and its calculation using the correlations for the design of various heat transfer equipment
- To understand the design aspects of finned tube heat exchanger, condenser and other compact heat exchangers.
- To learn about the radiative heat transfer, heat transfer evolved in agitated tanks, packed beds as well as fluidised bed and design aspects of evaporator and furnaces

UNIT-I

HeatTransfer Fundamentals: Modes of heat transfer, Steady State conduction, Fourier's law, Heat transfer in cartesian, cylindrical and spherical coordinate system, One dimensional problems, Heat transfer from extended surfaces, Insulation, Two and three dimensional problems, Unsteady state conduction.

UNIT-II

Convective heat transfer - natural and forced convection, Concept of heat transfer coefficient, LMTD and resistance, Dimensional analysis, Thermal boundary layer, Correlation in heat transfer without phase change, Analogy between momentum transport and heat transport.

UNIT-III

Design of heat transfer equipment - Double pipe heat exchanger, Shell and tube heat exchanger, Kern method, NTU - epsilon method for exchanger evaluation, construction aspects in brief, Bell Delware Method.

UNIT-IV

Design aspects of finned tube and compact heat exchangers, Basics of Heat transfer with phase change– Heat transfer in boiling liquids, Regimes of boiling heat transfer, Condensation, Design aspects of condensers, reboilers.

UNIT-V

Basics of Radiative heat transfer, Laws of radiation, Black body, Grey body, Emissive power, radiation between surfaces and non-black surfaces, Design aspects of Evaporators and Furnaces, Heat transfer in agitated tanks, packed beds and fluidised beds

TEXTBOOKS:

1. R.Welty, C.E. Wicks, R.E.Wilson, G. Rorrer, Fundamentals of Momentum, HeatandMassTransfer,4thEd.,2007,Wiley.
2. W. J. McCabe, J. Smith, P. Harriot, Unit Operations of Chemical Engineering,

Seventh Edition, 2005,McGrawHill.
3. Holman, J.P., S. Bhattacharya, Heat Transfer, 10th Ed.,2011,TataMcGraw-Hill.
4. D.Q.Kern,ProcessHeatTransfer,1997,Tata-McGrawHill.

REFERENCES:

1. Bejan,A.,A.D.Kraus,HeatTransferHandbook,2003,JohnWiley.
2. Process Heat Transfer and Chemical Equipment Design, D.C.Sikdar Khanna Publishing House
3. Heat Transfer: Principles and Applications, B.K.Dutta,PHI

COURSE OUTCOMES

On completion of the course the students are expected to:

1. Remember the basic concepts of different modes of heat transfer; understand the differential equations used in conduction for steady state as well as unsteady state heat transfer and apply the concepts for design in one dimensional, two and three dimensional and in extended surface heat transfer applications.
2. Remember the basic concepts of convective heat transfer; understand the mechanism of different types of convective heat transfer; apply and analyse the various analogies and correlations used in the design of the system.
3. Interpret the temperature changes in different types of heat exchanger; understand and apply the knowledge in the design of various types of heat exchanger and analyse for effective functioning of the equipment.
4. Remember and understand, the heat transfer in boiling liquids, condensing vapours and with phase changes; apply and analyse in the design of heat transfer equipment namely finned tube heat exchanger, plate heat exchanger and condenser.
5. Interpret the basic concepts in radiative heat transfer; apply the knowledge in the design of evaporator and furnace and study the heat transfer in agitated tanks, packed beds and fluidised beds.

Mapping with Pos & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	-	-	-	-	-	-	2	2	2	-	2
CO2	3	3	2	-	-	-	-	-	-	2	2	2	-	2
CO3	3	3	3	3	-	-	-	-	2	3	3	3	2	3
CO4	3	3	3	3	-	-	-	-	2	3	3	3	2	3
CO5	3	2	3	3	-	-	-	-	2	3	2	3	2	2

25CHPC405	**MASS TRANSFER - I**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

The course is aimed to:

- introduce the fundamental principles of mass transfer and diffusion in chemical engineering processes.
- learn and determine mass transfer rates under laminar and turbulent conditions
- analyze and design systems involving molecular diffusion, interphase mass transfer, and mass transfer coefficients.
- practical operations such as gas absorption, humidification, drying, and distillation.
- design of absorption columns, humidifiers, cooling towers, dryers and crystallizers.

Unit – I:
Principles of Diffusion and Mass Transfer between phases – Theory of Diffusion – Prediction of Diffusivities – Mass Transfer Theories – Mass Transfer Coefficients

Unit – II
Gas Absorption – Packings and Packed Tower Design considerations: loading and flooding zones, pressure drop and column diameter – Principles of Absorption – Absorption from Rich Gases, Operating lines from material balances, Number of equilibrium stages, Kremser equation, Stage efficiency and column performance – Mass Transfer Correlations – Rate based methods for packed columns (HTU, NTU) - Absorption with Chemical Reaction.

Unit – III
Humidification Operation – Definitions – Humidity Chart – Wet-bulb Temperature – Cooling Tower process design, mass and heat balance in bulk and interfaces, performance evaluation of cooling towers,

Unit – IV
Drying of Solids – Principles of Drying – Cross-Circulation Drying – Through-Circulation Drying – Drying Equipments- Process design of dryers, material and energy balances in direct dryers – Drying of bio products.

Unit – V
Crystallization - Crystal Geometry – Equilibria and Yields – Nucleation – Crystal Growth – Crystallization Equipment – Crystallizer Design-Crystal Size Distribution – Crystallization from Melts- Process design of crystallizers and their operation.

TEXT BOOKS
1. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, 2014, Tata McGraw Hill, India.

REFERENCES:
1. R. E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983
2. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980.
3. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.
4. Seader, J. D., Henley, E. J.,2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N. I.
Course Outcomes:

On completion of the course,the students will be able to:

1. Understand the fundamentals, types and mechanism of mass transfer operations and understand the theories of mass transfer.
2. Understand concept of theoretical stages and number of transfer units for height requirements in a gas absorption process
3. Understand the basics of humidification process and its applications
4. Understand the concept and mechanism of drying operations
5. Understand the concept of crystallization process and identification of suitable crystallizer

Mapping with POs & PSOs														
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	2	-	-	-	-	-	3	2	-
CO2	3	3	3	2	2	2	-	-	-	-	-	3	2	-
CO3	3	3	3	2	2	2	-	-	-	-	-	3	3	-
CO4	3	3	3	2	2	2	-	-	-	-	-	3	3	-
CO5	3	3	3	2	2	2	-	-	-	-	-	3	3	-

25CHPC406	**CHEMICAL ENGINEERING THERMODYNAMICS - II**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

To introduce the concepts of fugacity, activity coefficient, vapour-liquid equilibrium and reaction equilibrium and introduction to molecular thermodynamics.

UNIT-I

Review of first and second law of thermodynamics; Solution thermodynamics – Fundamental property relations; Phase equilibrium - Vapor-liquid equilibrium – Raoult's law - VLE computations for ideal solutions; Modified Raoult’s law – Positive and Negative Deviations.

UNIT-II

Free energy and chemical potential, partial properties, Gibbs Duhem equation – Criterion for phase equilibrium; Excess and residual properties; Fugacity and fugacity coefficient of pure species and species in solution, Activity and Activity Coefficient, VLE from K-value correlations; Flash calculations.

UNIT-III

Liquid phase properties from VLE, Lewis – Randall rule; Models for excess Gibbs energy, Margules, van Laar and Wilson. NRTL, UNIQUAC and UNIFAC model, Henry’s law; Infinite dilution activity coefficients. Heat effects and Property Change on Mixing.

UNIT-IV

Principles and Applications of Liquid-Liquid Equilibria and Solid-Liquid Equilibria.

UNIT-V

Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, Equilibrium Conversion of Single Reactions, Phase rule and Duhem's theorem for reacting systems, introduction to statistical thermodynamics.

TEXT BOOKS

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, 2005, McGraw-Hill International Edition.

REFERENCES:

1. S.Sandler, "Chemical, Biochemical and Engineering Thermodynamics", 4th edition,Wiley, India.
2. Y.V.C.Rao, "Chemical Engineering Thermodynamics", 1997, University Press, Hyderabad.

COURSE OUTCOME:

On completion of the course, the students would be able to:

1. Familiar with properties of solutions available in nature
2. Familiar with various reactions occurring in nature
3. Solve problems involving equilibria of different phases such as VLE, LLE, VLLE, SLE, SVE.
4. Apply the principles of thermodynamics in various field of applications
5. Solve problems involving reaction equilibria

Mapping with POs & PSOs														
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	3	2	-	-	2	-	-	-	-	3	2	3
CO2	2	3	3	2	-	-	2	-	-	-	-	2	2	3
CO3	3	2	2	3	-	-	2	-	-	-	-	2	2	3
CO4	3	3	2	2	-	-	2	-	-	-	-	2	2	3
CO5	3	2	2	3	-	-	2	-	-	-	-	2	2	3

25CHCP408	FLUID MECHANICS LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- To impart the students with the experimental knowledge to determine the flow characteristics of fluids
- To provide the students with the hands on training to analyze and assess the efficiency of the flow measuring devices and fluid transport machineries
- To inculcate practical knowledge on the measurement of Fluid Flow and their characteristics at different operating conditions.

LIST OF EXPERIMENTS

1. Reynolds apparatus
2. Bernoulis theorem apparatus
3. V- notch
4. Orifice meter
5. Pitot tube
6. Venturi meter
7. Friction in Pipeline
8. Friction in pipe fittings, sudden enlargement and contraction
9. Centrifugal pump
10. Variable speed centrifugal pump
11. Packed bed
12. Fluidized bed

COURSE OUTCOMES:

On completion of the course, the students are expected to

1. Identify, name, and characterize flow patterns and regimes.
2. Utilize basic measurement techniques of fluid mechanics.
3. Measure fluid pressure and relate it to flow velocity.
4. Demonstrate the ability to write clear lab reports.
5. Demonstrate the ability to produce a working model through hands on experience in fluid mechanics design and explain its operation in terms of what was learned in the course

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	1	2	2	-	2	2	3	2	3	2	-
CO2	3	3	-	1	2	2	-	2	2	3	2	3	2	-
CO3	3	3	-	2	2	2	-	2	2	3	2	3	2	-
CO4	3	3	3	2	2	2	-	3	2	3	2	3	2	2
CO5	3	3	3	2	2	2	-	3	2	3	2	3	3	3

25CHPC409	HEAT TRANSFER LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES:

- To experimentally investigate the fundamental modes of heat transfer—conduction, convection, and radiation—and to enhance understanding of heat transfer principles through hands-on experiments.
- The lab aims to develop students' skills in operating thermal equipment, analyzing experimental data, and relating theoretical concepts to practical applications in chemical and process industries.
- They will be able to identify the heat exchange properties of various metals

LIST OF EXPERIMENTS

1. Muffle Furnace
2. Forced convection
3. Jacketed Kettle
4. Horizontal Condenser
5. Critical Heat Flux Apparatus
6. Stefan-Boltzmann Apparatus
7. Parallel And Counter Flow Heat Exchanger
8. Natural Convection
9. Thermal Conductivity of Insulating Material
10. Emissivity Measurement
11. Drop Wise and Film Wise Condensation
12. Finned Tube Heat Exchanger

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Explain the fundamentals of heat transfer mechanisms in fluids and solids
2. Calculate heat transfer by conduction, different types of convection using classical Models for these phenomena
3. Illustrate applications in various heat transfer equipment in process industries
4. Determine important data for the design and operation of the heat transfer
5. Analyze the various heat exchangers performance

Mapping with Pos & PSOs														
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	1	1	2	-	-	1	2	2	-
CO2	3	2	2	2	-	1	1	2	-	-	1	2	2	-
CO3	3	2	2	2	-	1	1	2	-	-	1	2	2	-
CO4	3	2	2	2	-	1	1	2	-	-	1	2	2	-
CO5	3	2	2	2	-	1	1	2	-	-	1	2	2	-

FIFTH SEMESTER

25CHPC501	PARTICLE MECHANICS & MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the basic principles of mechanics of particles, including the study of forces, motions, and interactions at the particle level.
- To develop a strong understanding of kinematic and dynamic principles that govern the motion of individual particles and systems involving particles.
- To study the operation and analysis of mechanical systems involving particulate matter, including processes such as size reduction, screening, filtration, and mixing.
- To evaluate the significance of particle size distribution in various engineering applications, such as in powder handling, cement manufacturing, and pharmaceuticals.
- To develop problem-solving skills by working through real-world case studies and engineering problems related to particle mechanics and mechanical operations.

UNIT-I

Relevance of particle mechanics and mechanical operations in chemical engineering processes. Nano-particles and its properties. General characteristics of solids - Particle Shape, Size, Mixed Particle Sizes, Shape factor; Different techniques of size analysis - Cumulative and Differential Analysis; Various Mean Diameters; Surface area determination; Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT-II

Size reduction: Principles and Laws of size reduction, energy relationships in size reduction; Methods of size reduction - classification of equipments, crushers, grinders, cutting machines, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; Open and Closed Circuit Operation. Size enlargement - principle of granulation, briquetting, pelletisation, and flocculation.

UNIT-III

Settling - Motion of a Particle through a Fluid – Terminal Velocity–Free and Hindered Settling. Sedimentation: Gravity Sedimentation – Mechanism – Continuous Sedimentation – Thickener – Classifier and Clarifier –Equipment – Gravity Settling Tank –Elutriator – Cone Classifiers – Bowl Classifier – Centrifugal Classifier, Settling Area – Centrifuges. Industrial dust removing equipment, cyclones and hydro cyclones, bag filters, electrostatic and magnetic separators: Heavy media separations, floatation, jigging.

UNIT-IV

Filtration– Filter Media – Filter Aids – Principles of Cake Filtration – Constant Pressure Filtration – Constant Rate Filtration - Pressure Drop Through Filter Cake –Compressible and Incompressible Filter Cakes - Specific Cake Resistance - Filter Medium Resistance. Filtration Equipment – selection, operation of Filter Press, Leaf Filter, Rotary Continuous Filters. Principles of Centrifugal Filtration-Washing of Filter Cakes.

UNIT-V

Agitation and Mixing of Liquids – Principles of Agitation – Agitation Equipment –Impellers – Flow Pattern in Agitated Vessel - Power Consumption in Agitated vessel. Flow number – Power Correlation - Calculation of power consumption. Blending and mixing - Jet mixers – Motionless Mixers. Mixing of Solids: Mixtures for Cohesive solids – Power requirements Criteria for mixer effectiveness. Mixers for free flowing granular solids - Rate of mixing. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, conveyer selection, different types of conveyers and their performance characteristics

TEXTBOOKS

1. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition., 2014, McGrawHill.
2. Coulson and Richardson's Chemical Engineering, Vol. 2, 2012, Butterworth-Heinemann.

REFERENCES:

1. Badger and Banchero, Introduction to Chemical Engineering,
2. Rhodes ,M.J., Introduction to Particle Technology, 2nd edition, 2008, John Wiley, Chichester ; New York.
3. Unit Operations-I, Fluid Flow & Mechanical Operation, Gavhane, Nirali Prakashan
4. Unit Operations Vol.-I, K.A.Gavhane, Nirali Prakashan

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the characterization of particles and methods of screening of particles
2. Perform size reduction and size analysis of particles to meet the need of chemical industries
3. Evaluate the performance of settling and sedimentation equipments
4. Understand the filtration process and its equipment for effective filtration
5. Gain knowledge on mixing, agitation of solids, storage and transportation of solids

Mapping with POs & PSOs														
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	1	-	-	-	-	-	-	-	3	-	-
CO2	3	3	3	1	1	-	-	-	-	-	-	3	-	-
CO3	3	3	3	1	-	-	-	-	-	-	-	3	-	-
CO4	3	2	2	2	1	-	-	-	-	-	-	2	-	-
CO5	3	3	3	1	1	-	-	-	-	-	-	3	-	-

25CHPC502	**CHEMICAL REACTION ENGINEERING – I**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand the basic concepts of kinetics (homogeneous reactions) and rate laws
- To design and rating of ideal flow reactors
- To analyze and correlation of rate data
- To design the rate kinetics of multiple reactions
- To analyze the non-ideal flow Behavior in real reactor

UNIT-I

Kinetics of Homogeneous reactions: Reactions and reaction rates - stoichiometry, extent of reactions, conversion, Selectivity - Reaction rate fundamentals - elementary reaction sequences, steady state approximation and rate limiting step theory.

UNIT-II

Introduction to Reactor Design: Generalized material and energy balance- Sizing and analysis of ideal batch, mixed, plug flow and recycle reactors - design equations, graphical interpretation - solving design equations for constant and variable density systems, reactors in series and parallel-Isothermal, adiabatic and non-isothermal operation modes.

UNIT-III

Analysis and correlation of experimental kinetic data: Data collection & plotting, linearization of rate equations, differential and integral method of analysis.

UNIT-IV

Design for Parallel Reactions: Types of Multiple Reactions- Conversion, Selectivity and Yield-Maximizing the Desired Product in Parallel and Series Reactions.

UNIT-V

Non-idealities in chemical reactors: RTD-Axial dispersion models.

TEXT BOOKS

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, 2001, John Wiley & Sons.
2. Scott Fogler, H., Elements of Chemical Reaction Engineering, 2nd Edition, 2001, Prentice Hall.

REFERENCE BOOKS:

1. Lanny D. Schmidt, The Engineering of Chemical Reactions, 1998, (Oxford University Press)
2. Dawande S.D., Principles of Chemical Reaction Engineering,Central Techno Publications, Nagpur.
3. Gavhane, K. A., Chemical Reaction Engineering, volume-I, Nirali Prakashan.

COURSE OUTCOMES

Students will be able to

1. Develop the kinetic rate expression by applying reaction mechanism and analyze the steady-state approximation.
2. Design ideal reactors and evaluate reactor performance in series and parallel configurations.
3. Analyze and compare the different methods for determining rate laws based on experimental data.
4. Design reactor systems to optimize desired product formation in multiple reactions.
5. Analyze flow behavior and develop strategies to minimize non-ideal flow effects in reactor design.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	-	-	-	-	-	3	3	3	2
CO2	3	3	3	3	-	-	-	-	-	-	3	3	3	2
CO3	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	3	3	3	2
CO5	3	3	3	3	3	-	-	-	-	-	3	3	3	3

25CHPC503	**MASS TRANSFER – II**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

The course is aimed to

- understand the principles of mass transfer
- applications of conventional and less conventional separation techniques.
- develop knowledge, ability to work and operate on different types of downstream processes
- design of separation equipment

UNIT – I

Distillation - Vapour liquid equilibria - Principle of distillation - flash distillation, differential distillation, steam distillation, molecular distillation, multi stage continuous rectification.

UNIT - II

Fractionating column and multistage column- Number of theoretical stages by McCabe - Thiele method and Lewis - Sorel method- Operating and feed lines, Total reflux, minimum reflux ratio, optimum reflux ratio, Tray and column efficiency -Packed column distillation, Rate based methods: HETP, HTU- Azeotropic and Extractive distillation – Methods for multi-component distillation: Fenske- Underwood- Gilliland method.

UNIT – III

Liquid - liquid extraction – Equilibria - Solvent Characteristics - Stage Wise and Continuous Contact - Design Calculations – Extraction Equipment's. Introduction to reactive extraction, aqueous two phase extraction, extraction of biomolecules, supercritical extraction - Leaching – Unsteady State and Steady State operation - Equipment's for leaching.

UNIT – IV

Adsorption and Ion exchange- Types of adsorption, nature of adsorbents, adsorption and ion exchange equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed

adsorbers, break through curves – Scale- up and process alternatives, Adsorptive membranes, simulated- moving bed operation, modes of operation.

UNIT – V

Introduction to less conventional separation process and its applications –Types of separations: Dialysis - Osmosis - Reverse Osmosis - Ultra Filtration – Gas separation, vapour permeation and pervaporation– Electro Dialysis - Nano filtration. Transport through porous membranes, Resistance models, Liquid diffusion through pores, Gas diffusion through porous membranes - Transport through non-porous membranes- solution diffusion for liquid mixtures, gas mixtures, Concentration polarization and Fouling. Mambrane modules, arrangement of modules in cascades, performance criteria and design considerations.

TEXT BOOKS:

1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, 1993, McGraw Hill, New Delhi.
2. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, 2014, Tata McGraw Hill, India.
3. Binay K.Dutta, Principles of Mass Transfer and Separation Processes,2nd edition, 2007, Prentice Hall of India.
4. Seader, J. D., Henley, E. J.,2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N. I

REFERENCE BOOKS:

1. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, 1993, Prentice Hall, India.
2. AS. Foust, Principles of Unit Operations, 2nd Edition, 1980, Wiley, New York
3. Sherwood.T.K., Pigford.R.L and Cr.Wilke., Mass Transfer. McGraw Hill.
4. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.

COURSE OUTCOMES:

On completion of the course,the students are able to:

1. Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower.
2. Design and determine the number of trays for multicomponent distillation.
3. Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction and leaching operation.
4. Apply the concept of adsorption techniques in various separation process needed in process industries.
5. Examine the concept of various less conventional separation process and its applications.

Mapping with POs &PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	-	-	-	-	-	-	3	2	
CO2	3	3	3	2	2	-	-	-	-	-	-	3	2	
CO3	3	3	3	2	2	-	-	-	-	-	-	3	2	

CO4	3	3	3	2	2	-	-	-	-	-	-	3	2	
CO5	3	3	3	2	2	-	-	-	-	-	-	3	2	

25CHPC504	**PROCESS INSTRUMENTATION**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

Course Objectives

By the end of this course, students will be able to:

1. Understand the Fundamentals of Process Instrumentation
2. Explore Advanced Measurement Techniques and Smart Transmitters and the working principles of modern temperature, pressure, flow, and level sensors.
3. Apply Process Analytical Instrumentation and IIoT Concepts
4. Analyze Industrial Communication Protocols and Smart Data Acquisition
5. Implement Smart Instrumentation for Process Control and Automation

Unit I: Introduction to Process Instrumentation

Basics of Measurement & Instrumentation -Static and Dynamic Characteristics of Instruments - Classification of Instruments - Standards and Calibration - Error Analysis and Uncertainty in Measurements - Digital vs. Analog Sensors

Unit II: Sensors and Transducers

Principles of Sensors and Transducers - Temperature Measurement: Thermocouples, RTDs, Thermistors, and Pyrometers - Pressure Measurement: Manometers, Bourdon Tubes, Strain Gauges, and Piezoelectric Sensors - Ultrasonic and Electromagnetic Flowmeters - Level Measurement: Float, Conductivity, Ultrasonic, and Radar Level Sensors

Unit III: Analytical and Composition Measurements and IIoT Integration

pH Measurement and Conductivity Sensors - Gas and Liquid Chromatography - Spectroscopic Techniques (UV-Vis, IR, Mass Spectrometry) - Oxygen and Humidity Sensors - Industrial Applications of Analytical Instruments - Industrial IoT (IIoT) in Process Instrumentation

Unit IV: Signal Conditioning and Data Acquisition Systems

Signal Conditioning: Amplification, Filtering, and Isolation - Analog-to-Digital and Digital-to-Analog Converters - Data Acquisition Systems (DAQ) - Introduction to Process Control Systems (SCADA, DCS, and PLC) - Industrial Communication Protocols (HART, MODBUS, Fieldbus) - Fieldbus Systems and Industrial Ethernet for Smart Instrumentation

Unit V: Smart Instrumentation for Process Automation and Control

Smart Control Valves, Actuators, and Pneumatic Systems - AI-Enabled Instrumentation for Predictive Maintenance - Digital Twin Technology and Virtual Sensors in Process Industries - Case Studies: Smart Instrumentation in Refining, Petrochemical, and Pharmaceutical Industries

Textbooks:

1. B.G. Lipták, *Instrument Engineers' Handbook: Process Measurement and Analysis*, CRC Press.
2. R. Singh, *Industrial Instrumentation and Control*, McGraw-Hill.
3. R.K. Jain, *Mechanical and Industrial Measurements*, Khanna Publishers.

Reference Books:

1. W. Bolton, *Instrumentation and Control Systems*, Elsevier.
2. J. G. Webster, *Measurement, Instrumentation, and Sensors Handbook*, CRC Press.
3. B. G. Lipták, *Process Control and Optimization*, CRC Press.
4. K. F. Man, *Smart Instrumentation and IIoT for Process Industries*, Wiley.
5. F. Tao, *Digital Twin Technologies and Smart Manufacturing*, Academic Press.

Course Outcomes (COs):

1. Understand fundamental concepts of process instrumentation and sensors, both analog and digital, and analyze the characteristics and performance of instruments.
2. Explain the working principles of different sensors and transducers and selection of appropriate sensors for temperature, pressure, flow, and level measurement.
3. Understand principles of chemical and analytical instrumentation and the integration of IIoT in process instrumentation and data acquisition.
4. Explain signal conditioning techniques used in process instrumentation and understanding of data acquisition and process control systems
5. Analyze smart actuators evaluate the role of AI and digital twins in process instrumentation.

Mapping with Pos & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	3	2	1	1	1	2	2	3	3	2
CO2	3	3	3	2	3	2	1	1	1	2	2	3	3	2
CO3	3	3	3	2	3	2	1	1	1	2	2	3	3	2
CO4	3	3	3	2	3	2	1	1	1	2	2	3	3	2
CO5	3	3	3	2	3	3	1	1	1	3	3	3	3	2

25CHCP507	**PARTICLE MECHANICS & MECHANICAL OPERATIONS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSEOBJECTIVES:

Objectives of this course is to

- impart knowledge on different types of crushers and grinders
- Understand the fundamentals of fluid-particle mechanics
- Understand the concepts in industrial processes like packed bed operation, fluidized

operation,

- Understand the separation of particulates using processes using sedimentation, filtration, and cyclone separator

LIST OF EXPERIMENTS

1. Sieve Analysis
2. Vibrating Screen
3. Drop weight crusher
4. Double Roll Crusher
5. Jaw Crusher
6. Ball Mill
7. Settling
8. Sedimentation
9. Leaf Filter
10. Cyclone Separator
11. Froth Floatation apparatus

COURSE OUTCOMES:

On completion of the course, students will be able to:

1. Develop sound working knowledge on different types of crushing equipment's
2. Understand the separation characteristics of different mechanical separators
3. Assess the parameters of various filtration equipment and sedimentation
4. Understand fluid flow through packed and fluidized beds
5. Understand the industrial operations by performing the experiments

Mapping with POs &PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO8**	**PO8**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	3	-	-	-	-	3	-	2	3	2	3
CO2	3	2	3	3	-	-	-	-	3	-	2	3	2	3
CO3	3	3	2	2	-	-	-	-	3	-	1	3	2	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	3
CO5	3	3	3	3	-	-	-	-	3	-	-	3	3	3

25CHCP508	**MASS TRANSFER LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVE:

To provide practical understanding and experimental validation of mass transfer operations commonly used in chemical engineering. The laboratory focuses on enhancing students' knowledge of mass transfer principles by:

- Studying diffusion, mass transfer coefficients, and interphase mass transfer.
- Analyzing key operations such as distillation, absorption, extraction, drying, and leaching.

- Understanding the design and performance of mass transfer equipment like packed columns, tray columns, and dryers.
- Applying theoretical mass transfer models to interpret experimental results.

LIST OF EXPERIMENTS

1. Air Drying
2. Rotary Dryer
3. Simple Distillation
4. Steam Distillation
5. HETP Determination
6. Leaching Cross Current
7. Leaching Counter Current
8. Leaching Stage Wise
9. Adsorption-Isotherms
10. Adsorption in a Packed Bed
11. Surface Evaporation
12. Liquid-Liquid Extraction
13. LLE in Packed Bed
14. Vapor in Air Diffusion

TEXT BOOKS:

1. Binay K.Dutta, Principles of Mass Transfer and Separation Processes, 2nd edition,2007. Prentice Hall of India
2. R.E.Treybal, Mass Transfer Operations, 3rd Edition, 1993, McGraw Hill, New Delhi.
3. AS. Foust, Principles of Unit Operations, 2nd Edition, 1980, Wiley, New York.
4. W.L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, 2014, Tata McGraw Hill, India.

REFERENCES:

1. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, 1993, Prentice Hall,India.

COURSE OUTCOMES:

The students will be able to:

1. Memorize various fundamental concepts of mass transfer operations.
2. Describe various types of mass transfer equipment.
3. Design and operation of the process equipment.
4. Classify different types of downstream processing operations.
5. Select appropriate and economical separation operations based on process requirements.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	3	3	3	3

CO5	3	3	3	3	-	-	-	-	-	-	3	3	3	3

SIXTH SEMESTER

25CHPC601	PROCESS DYNAMICS & CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To introduce the fundamentals concepts of process control and then to develop mathematical models based on transfer function approach for single input single output (SISO) systems along with the dynamic response to different disturbances along with the ability.
- The course will teach the students to perform the stability analysis in transient and frequency domains, to select and utilize P, PI, and PID controllers for the control of process and to select proper controller tuning methods.
- The course will introduce more advanced concepts like Cascade control, feed-forward control, ratio control, etc. along with the concept of digital control system.

UNIT-I

Introductory Concepts: Characteristics of measuring elements, Need for control and automation, control logic, servo and regulatory control, block diagrams, control structures (feedback vs. feed forward), process and instrumentation diagrams. Laplace transforms, solution of ODEs using Laplace transform.

UNIT-II

Transfer function approach, response of first order systems: step, impulse and sinusoidal response, first order systems in series. Second order systems, higher order systems, transportation lag and dead time.

UNIT-III

Linear closed loop systems, development of block diagrams, classical feedback controllers. Final control element (control valves), block diagram reduction techniques. Closed loop response, servo and regulatory problems.

UNIT-IV

Stability analysis, Routh stability criterion. Introduction to frequency response, notion of stability. Bode diagrams and stability criterion, Bode and Nyquist plots, Nyquist stability criterion.

UNIT-V Controller tuning: Ziegler-Nichol's method and Cohen-Coon method. Introduction to advanced controllers: cascade control, feed forward control, ratio control, Dead time compensation and Internal model control. Introduction to digital control system, Programmable logic controller (PLC), Supervisory Control and Data Acquisition (SCADA) and Distributed Control System (DCS).

TEXT BOOKS:

1. Coughanowr, D. R., LeBlanc, S. Process Systems Analysis and Control, 3rd edition, 2018, McGraw-Hill.

REFERENCES:

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. Process Dynamics and Control, 2nd
2. edition, 2003, John Wiley.
3. Stephanopoulos, G. Chemical Process Control: An Introduction to Theory and Practice, 1984 Pearson Education.
4. D.C. Sikdar , Instrumentation and Process Control, , Khanna Publishing House
5. Instrumentation, Measurement and Analysis, Nakra, TMH

COURSE OUTCOMES

On completion of the course, the students would be able to:

1. Understand the basic terminologies used in Process Control along with the ability to solve the given Linear Differential Equation (LDE) using Laplace Transform technique.
2. Understand the significance of the transfer function of various forcing functions on process control systems and thus understand their process dynamics.
3. Develop Overall block diagram for any process control system and then to reduce the block diagram for Servo and Regulator problems along with working mechanism of various modes of classical controllers.
4. Access the stability of the any process control system using Routh, Bode and Nyquist stability criterion.
5. Tune a classical controllers to reject disturbances or managing operating point transitions and to know the operations of advance controllers along with understanding of digital control system.

Mapping with POs & PSOs														
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	-	-	-	2	-	-	-	3	3	2	3
CO2	3	3	2	-	1	-	2	-	-	-	3	3	2	3
CO3	3	3	2	-	1	-	2	-	-	-	3	3	2	3
CO4	3	3	2	-	1	3	2	3	3	3	3	3	2	3
CO5	3	3	2	-	-	3	2	3	3	3	3	3	2	3

25CHPC602	**CHEMICAL REACTION ENGINEERING - II**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

- To understand and analyze the kinetics aspects of catalysts.

- To analyze internal and external transport processes in gas-solid catalytic reactions.
- To apply rate equations for non-catalytic reactions in different reactor configurations.
- To design a multiphase Reactors.
- To calculate operating regime for a given fluid-fluid reaction.

UNIT-I

Introduction to Catalysis-homogeneous and heterogeneous catalysis-Characteristics and Preparation of catalysts - Physical and chemical adsorption-Adsorption Isotherms: Langmuir, Freundlich and Temkin- Physical properties of catalysts: Determination of BET surface area, pore volume and solid density of catalyst.

UNIT-II

Steps in a catalytic reaction-Kinetics of gas-solid catalyzed reaction: Langmuir-Hinshelwood and Eley-Rideal mechanism -Laboratory reactors for catalytic gas solid reactions: Batch reactor for both gas and solid, Basket type mixed flow reactor and Tubular flow reactors operated in a differential, integral and/or recycle manner-Design concepts

UNIT-III

Internal and External transport processes in gas-solid catalytic reaction-Effectiveness Factor-Performance of gas-solid catalytic reactors: Fixed bed and Fluidized bed reactors- Design concepts - G/L Reactions on Solid Catalyst: Trickle Beds -qualitative description-industrial importance.

UNIT-IV

Non-catalytic gas-solid reactions-Kinetic model for gas-solid reactions: Progressive conversion model and Shrinking unreacted-core model-Rate of reaction for shrinking spherical particles.

UNIT-V

Fluid-Fluid reactions: The Rate Equation for Straight Mass Transfer (Absorption) of A - The Rate Equation for Mass Transfer and Reaction -Enhancement factor and Interface behaviour - Performance of fluid-fluid reactors: spray column, packed column, plate column, static mixer and rotating disc contactor – qualitative description-industrial importance.

TEXT BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, 2001, John Wiley & Sons.
2. Scott Fogler, H., Elements of Chemical Reaction Engineering, 2nd Edition, 2001, Prentice Hall.
3. Smith, J. M., Chemical Engineering Kinetics, 3rd Edition, 1981, Mc Graw Hill

REFERENCE BOOKS:

1. Lanny D. Schmidt, The Engineering of Chemical Reactions, 1998, (Oxford University Press)
2. Dawande S.D., Principles of Chemical Reaction Engineering, Central Techno Publications, Nagpur.
3. Gavhane, K. A., Chemical Reaction Engineering, volume-I, Nirali Prakashan.
4. Gilbert F. Froment, Kenneth B. Bischoff, Juray De Wilde, Chemical Reactor Analysis and Design, 2010, John Wiley & Sons.
5. Heterogeneous Reactions, Vol. I and II – L. K. Doraiswamy, M. M. Sharma

6. Fluid Mixing and Gas Dispersion in Stirred Reactors – G. B. Tatterson
7. Fluidisation – D. Kunni and O. Levenspiel
8. Gas Liquid Reactions – P. V. Danckwerts
9. Fluidisation – J. F. Davidson and D. Harrison
10. Random Packings and Packed Tower Design – R. F. Strigel

COURSE OUTCOMES:

On completion of the course, the students will be able to

1. Develop the catalysts and demonstrate the characterization techniques.
2. Apply design concepts for catalytic reactors and evaluate reactor performance based on kinetic models.
3. Solve problems related to effectiveness factors and design catalytic reactors and calculate operating regime for a given reaction.
4. Create models for non-catalytic gas-solid reactions.
5. Design fluid-fluid reactors and compute intrinsic kinetics from the data.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	3	3	3	3

25CHHS 603	**MANAGEMENT FOR ENGINEERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. To provide engineers with an understanding of business and management principles.
2. To develop skills in leadership, decision-making, and strategic planning.
3. To integrate management knowledge into technical and engineering projects.
4. To introduce concepts of entrepreneurship, innovation, and business ethics.

Course Modules & Topics

Unit - I: Introduction to Management

Definition, Nature, and Scope of Management - Functions of Management: Planning, Organizing, Leading, Controlling - Evolution of Management Thought: Scientific Management, Administrative, Human Relations, and Modern Approaches - Roles of a Manager in Engineering and Technology Sectors

Unit - II: Organizational Behavior and Human Resource Management

Basics of Organizational Behavior: Personality, Perception, Attitudes, Motivation - Leadership and Decision-Making in Organizations - Teamwork and Group Dynamics in Engineering

Projects - Basics of Human Resource Management: Recruitment, Training, Performance Appraisal - Work Ethics and Employee Relations

Unit -III: Financial & Cost Management

Basics of Financial Accounting: Balance Sheet, Profit & Loss Statement - Cost Accounting for Engineers: Fixed, Variable, and Overhead Costs - Break-even Analysis and Budgeting - Capital Investment Decision-Making: NPV, IRR, Payback Period - Financial Planning in Engineering Projects

Unit - IV: Marketing & Operations Management

Basics of Marketing: Market Segmentation, Product Life Cycle, Branding - Marketing Strategies for Engineering Products - Basics of Operations Management: Supply Chain, Inventory Control, Lean Manufacturing - Quality Control and Six Sigma in Engineering

Unit - V: Entrepreneurship & Startups

Fundamentals of Entrepreneurship and Business Planning - Innovation and Design Thinking in Business - Legal Aspects of Starting a Business: Company Registration, Intellectual Property Rights (IPR) - Government Policies for Startups in Engineering - Case Studies of Successful Engineering Entrepreneurs

Learning Outcomes

1. Apply management principles in engineering projects.
2. Analyze financial reports and make cost-effective business decisions.
3. Understand marketing strategies for engineering products.
4. Develop a business plan and explore entrepreneurship opportunities.
5. Demonstrate leadership, teamwork, and ethical business practices.

Recommended Books

1. Robbins, S. P., & Coulter, M. (2021). Management (14th ed.). Pearson.
2. Koontz, H., &Weihrich, H. (2010). Essentials of management (8th ed.). McGraw-Hill Education.
3. Tripathi, P. C., & Reddy, P. N. (2012). Principles of management (5th ed.). Tata McGraw-Hill.
4. Robbins, S. P., & Judge, T. A. (2019). Organizational behavior (18th ed.). Pearson.
5. Dessler, G. (2020). Human resource management (16th ed.). Pearson.
6. Chandra, P. (2019). Financial management: Theory and practice (10th ed.). McGraw-Hill Education.
7. Pandey, I. M. (2015). Financial management (11th ed.). Vikas Publishing House.
8. Kotler, P., & Keller, K. L. (2016). Marketing management (15th ed.). Pearson.
9. Heizer, J., Render, B., & Munson, C. (2020). Operations management: Sustainability and supply chain management (13th ed.). Pearson.
10. Khanka, S. S. (2013). Entrepreneurship development (1st ed.). S. Chand Publishing.
11. Additional References
12. Griffin, R. W. (2022). Management (13th ed.). Cengage Learning.
13. Daft, R. L. (2020). Management (13th ed.). Cengage Learning.

14. Luthans, F. (2021). Organizational behavior (14th ed.). McGraw-Hill Education.
15. Noe, R. A., Hollenbeck, J. R., Gerhart, B., & Wright, P. M. (2021). Fundamentals of human resource management (8th ed.). McGraw-Hill Education.
16. Ross, S. A., Westerfield, R. W., & Jaffe, J. (2021). Corporate finance (13th ed.). McGraw-Hill Education.
17. Gitman, L. J., & Zutter, C. J. (2019). Principles of managerial finance (15th ed.). Pearson.
18. Lamb, C. W., Hair, J. F., & McDaniel, C. (2022). Marketing (14th ed.). Cengage Learning.
19. Chase, R. B., Jacobs, F. R., &Aquilano, N. J. (2020). Operations and supply chain management (15th ed.). McGraw-Hill Education.
20. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2020). Entrepreneurship (11th ed.). McGraw-Hill Education.
21. Scarborough, N. M., & Cornwall, J. R. (2019). Essentials of entrepreneurship and small business management (9th ed.). Pearson.
22. Gopalaswamy, A. K. (2020). Management case studies with Indian perspectives. Cengage Learning.
23. Subramanian, R. (2021). Business laws and management. Tata McGraw-Hill.
24. Dutta, A. K. (2019). Cases in financial management. Pearson India.
25. Reddy, Y. V. (2020). Economic policies and India's reform agenda: New thinking. Oxford University Press.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	3	3	3	3

25CHCP607	**CHEMICAL REACTION ENGINEERING & THERMODYNAMICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

The laboratory aims to provide hands-on experience with reactors and thermodynamic systems, enabling students to:

- Understand the kinetics of chemical reactions and reactor performance.
- Study different types of chemical reactors (batch, CSTR, PFR, etc.).
- Determine reaction rate constants and order of reactions.
- Analyze energy balances and thermodynamic parameters (e.g., enthalpy, entropy, and Gibbs free energy changes).
- Apply theoretical concepts to real-world chemical processes and enhance problem-solving skills through experimental data interpretation.

LIST OF EXPERIMENTS (THERMO)

1. Excess Property Determination
2. Heat of Solution by Solubility Method
3. Equilibrium Constant Determination
4. Liquid – Liquid Equilibrium
5. Vapour – Compression Refrigeration Test rig
6. Cottrel, Brown Boiling Point Apparatus
7. Isobaric VLE Data (Txy diagram)
8. Othmer VLE Still – Margules or Vanlaar Constant Determination
9. Test For Thermodynamic Consistency
10. Air water heat pump
11. Bomb Calorimeter
12. Junkar's Gas Calorimeter

LIST OF EXPERIMENTS (CRE)

1. Batch Reactor
2. Semibatch Reactor I
3. Semibatch Reactor II
4. Plug Flow Reactor
5. Continuous Stirred Tank Reactor
6. PFR & CSTR in series
7. Adiabatic Reactor
8. Residence Time Distribution Studies in CSTR
9. Residence Time Distribution Studies in Packed Bed Reactor

TEXT BOOK

1. Y. V. C. Rao, Introduction to Thermodynamics, 2004th Edition, Universities Press.
2. P.K.NagEngineering Thermodynamics, 2013, 5th Edition, Tata McGraw Hill.
3. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, 2001, John Wiley & Sons.
4. Scott Fogler, H., Elements of Chemical Reaction Engineering, 2nd Edition, 2001, Prentice Hall.

REFERENCE

1. D.B. Spalding & E.H. Cole " Engg. Thermodynamics". Edward Arnold.
2. G.A. Hawkins,." Engg. Thermodynamics" .John Wiley & Sons.
3. G.H. Van Wylen, & R.E. Sonntag, "Fundamentals of Classical Thermodynamics". .John Wiley & Sons.
4. Hollman ,J.P. " Thermodynamics". McGraw Hill
5. Lanny D. Schmidt, The Engineering of Chemical Reactions, 1998, (Oxford University Press)
6. Dawande S.D., Principles of Chemical Reaction Engineering, Central Techno Publications, Nagpur.
7. Gavhane, K. A., Chemical Reaction Engineering, volume-I, Nirali Prakashan.

Course Outcomes:

The students will be able to

1. To apply the principles of Chemical Engineering thermodynamics
2. To develop mathematical expressions of various phase and reaction equilibrium phenomena
3. To calculate phase equilibrium of binary/multi component systems using proper models
4. Describe the basics of chemical reaction system and its practical application and principles and apply these principles for the design of reactors and application in process industries
5. Develop skills to choose the right kind of reactor among single, multiple, flow reactor, etc. schemes.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO2	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	-	-	-	-	-	-	3	3	3	3

25CHCP608	PROCESS INSTRUMENTATION & CONTROL LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OBJECTIVES

- Objective of the course is to introduce the basics of instrumentation and process control through a hands-on practical experience.
- Principles of operation of different measuring devices for temperature, level, flow, pH, will be introduced to impart knowledge of transmitters, transducers, converters, control valves, digital and analog components related to PLC, DCS, SCADA systems.

LIST OF EXPERIMENTS

1. Calibration of Thermometers
2. First Order Thermal System (Ramp Input)
3. Dynamics of I Order system
4. Hysterisis Loop in throttling Valve
5. Interacting System
6. Second Order Thermal System
7. Current to Pneumatic (I/P) converter Characteristics
8. Non Interacting System
9. Tuning of Controller Using C-C Method
10. Pneumatic Control Valve Characteristics
11. Pulse input and response of a I Order System
12. Wheel Flow Meter Characteristics
13. PID Control using LCJ Software
14. Operation and Characteristics of R7 Capacitance type LJ
15. Operation of PLC using Ladder Programming
16. Stability Analysis of Plate Heal Exchanger.

REFERENCES:

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. "Process Dynamics and Control", 2nd edition, 2003, John Wiley.
2. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", 1984, Pearson Education.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Calculate the process design parameters for the given first and second order system and can able to develop model equation for the given process control system.
2. Predict output values for the given disturbances and can analyse the response the response of the given process control system for different types of inputs.
3. Calculate the static and dynamic characteristics of the given instruments and select the most appropriate instruments for the given purpose.
4. Propose the right type of controllers for the given process control system and also can able to justify the selection of the controllers.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	-	-	-	-	3	3	2	
CO2	3	3	2	2	-	-	-	-	-	-	3	3	2	
CO3	3	3	2	2	2	-	-	-	-	-	3	3	2	
CO4	3	3	2	2	-	-	-	-	-	-	3	3	2	
CO5	3	3	2	2	-	-	-	-	-	-	3	3	2	

SEVENTH SEMESTER

25CHES 701	RESEARCH METHODOLOGY	L	T	P	C
		2	0	0	2

25CHPC702	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the concept of transport phenomena, laws pertaining with transport properties, Newtonian and non-Newtonian fluids and rheological models
- To know about the Shell balance approach, to find out the momentum flux and velocity distribution for the fluids
- To learn about heat flux and temperature distribution for heat sources, additionally to study about mass flux and concentration profile of diffusion, system involving reaction
- To understand the role of conservation laws and equation of change in single and multicomponent systems
- To acquire the knowledge of turbulent phenomena and time smoothed equation of change in turbulent flow, furthermore to read the analogies between momentum, heat and mass transfer

UNIT - I

Importance of transport phenomena; analogous nature of transfer process; basic concepts, conservation laws; continuum concept, field, reference frames, substantial derivative and boundary conditions; differential, integral and experimental methods of analysis. Phenomenological laws of transport properties, Newtonian and non-Newtonian fluids; rheological models, theories of transport properties of gases and liquids, effect of pressure and temperature on transport properties.

UNIT – II

General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus.

UNIT – III

Heat flux and temperature distribution using shell balance method for heat sources such as electrical, nuclear viscous and chemical; forced and free convection. Mass flux and concentration profile using shell balance method for diffusion in stagnant gas, systems involving reaction and forced convection.

UNIT – IV

Conservation laws and equations of change; Development of equations of continuity, motion and energy in single & multi-components systems in rectangular co-ordinates. Forms of continuity, motion and energy equations in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems by applications of equation of change, scale factors & their applications in scale-up.

UNIT – V

Turbulent phenomena; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent; analysis of hydrodynamic, thermal and concentration boundary layer and their thicknesses over a flat surface. Development and applications of analogies between momentum and heat, momentum and mass transfer; Reynolds, Prandtl, Von Karman and Colburn analogies.

TEXT BOOKS:

1. R.B. Bird, W.E. Stewart and E.W. Lightfoot, "Transport Phenomena", John Wiley, Second
2. Edition 2006.
3. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach",Brodkey Publishing 2003.

REFERENCEBOOKS :

1. J.R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", V Edition. John Wiley, New York, 2007.
2. L.S.Sissom, and D.R.Pitts, "Elements of Transport Phenomena", McGraw Hill, New York, 1972.
3. R.W.Fahien, "Elementary Transport Phenomena", McGraw-Hill, New York, 1983.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Impart knowledge on the fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes.
2. Apply the shell balance approach to derive differential mass and heat balance equations for laminar flow system.
3. Develop the ability to model and analyze fluid flow, heat and mass transfer processes.
4. Examine simple and multi-dimensional mass transport problems
5. Apply different analogies to study the similarities in different transport phenomena.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	3	2	-	-	2	-	1	2	3	2	3	2	1
CO3	3	3	2	-	-	2	-	1	2	3	2	3	2	1
CO4	3	3	2	-	-	2	-	1	2	3	2	3	2	1
CO5	3	3	2	2	2	2	2	1	2	3	2	3	2	1

25CHPC703	**PROCESS ENGINEERING ECONOMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

The course is aimed to:

- understand the principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.
- describe the role of economic evaluation in decision making and design of processes with standard methodology.
- estimate the value of money, worth of equipment & processes with period with different methods.
- analyze and compare alternatives for equipment, processes and economic evaluation.
- identify, justify and design process plants and evaluate existing facilities with budgeting and benchmarking.

UNIT - I

Value of money and equivalence - Amortization – Depreciation.

UNIT - II

Capital requirements for process plants - Balance sheet chart - earnings, profits and returns - Economic production, Break even Analysis Charts.

UNIT- III

Cost accounting -Pre construction cost estimation - allocation of cost.

UNIT - IV

Economics of selecting alternatives:

Annual cost methods, Present worth method. Replacement, rate of return method and payout time method.

UNIT - V

Economic balance:

General principles and method economic balance in single variable operation and in two variable operation.

TEXT BOOKS:

1. Schweyer, Process Engineering Economics, 1955, Me Graw Hill.
2. Peter and Timmerhaus, Plant Design and Economics for Chemical Engineers 3rd ed. 1984.

REFERENCES:

1. S.N.Maheshwari, Principles of management Accounting, 2000, sultan Chand and sons , New Delhi.
2. Dhanasekaran. S, Muralikandhan. K, Mukundhan K.S, "Engineering Economics", scitech publications(India) Pvt Limited, Chennai-600017, Tamil Nadu, India.

COURSE OUTCOMES

On completion of the course, the students will be able to:

1. Calculate cost and asset accounting, time value of money, profitability, alternative investments, minimum attractive rate of return, sensitivity and risk.

2. Examine the production using economic concepts to predict and analyze the production.
3. Recommend most economical solution among alternatives in engineering problems.
4. Plan for an economical investment in process plants with fundamental knowledge encouraging them to be successful entrepreneurs.
5. Design and develop new process plant with economic evaluation.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	3	-	-	3	3	3	2	3	-	3
CO2	2	3	3	3		-	-	-	-	-	-	3	2	2
CO3	-	3	2	3	2	-	-	-	-	-	-	3	3	3
CO4	-	3	-	3	2	-	-	-	-	-	-	3	2	-
CO5	2	2	-	2	2	-	-	-	-	-	-	3	2	3

25CHCP707	**CHEMICAL PROCESS SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

To develop proficiency in the use of simulation tools for modelling, analyzing, and optimizing chemical processes. This laboratory aims to:

- Introduce students to industry-standard process simulation software
- Simulate unit operations such as reactors, distillation columns, heat exchangers, and separators.
- Perform steady-state and dynamic simulations of complete process flow-sheets.
- Analyze mass and energy balances, thermodynamic properties, and process efficiencies.

LIST OF EXPRIMENTS:

1. Solving a linear system using Gaussian elimination method
2. Finding Eigen vectors, Eigen values for a linear system, Curve fitting tool box
3. Solving an ordinary differential equation, PDE etc
4. Three CSTR's in series – open loop & closed loop
5. Non isothermal CSTR
6. Isothermal batch reactor – open loop
7. Non-isothermal Batch reactor
8. Plug flow reactor
9. Heat Exchanger
10. Gravity Flow tank.
11. Bubble point & Dew point calculations
12. Binary Distillation column

COURSE OUTCOME:

Upon completion of this course, the students will be able to:

1. Identify and analyze the relevance of modelling of processes
2. Analyze physical and chemical phenomena involved in various process.
3. Develop mathematical models for various chemical processes.
4. Inspect various simulation approaches.
5. Simulate a process using process simulators.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3	2	2	3	3	3	3	3	3	2
CO2	3	3	3	3	3	2	2	3	3	3	3	3	3	1
CO3	3	3	3	3	3	2	2	3	3	3	3	3	2	1
CO4	3	3	3	3	3	2	2	3	3	3	3	3	2	1
CO5	3	3	3	3	3	2	2	3	3	3	3	3	2	1

25CHCP708	**CHEMICAL PLANT DESIGN & DRAWING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

COURSE OBJECTIVES:

To equip students with the foundational skills required for the design and layout of chemical process plants through manual and computer-aided drafting. The laboratory aims to:

- Understand the principles of process plant design, layout, and equipment arrangement.
- Learn the design criteria for process equipment such as reactors, heat exchangers, distillation columns, and storage tanks.
- Foster an understanding of safety, operability, and economic considerations in plant layout and design.

LIST OF EXPERIMENTS

1. Design of Filter Press
2. Design of Barometric Condenser
3. Design of Agitated Vessel
4. Design of Basket Centrifuge
5. Design of Distillation Column
6. Design of Heat Exchanger
7. Design of Absorption column
8. Design of Multiple Effect Evaporator
9. Design of Rotary Dryer

DESIGN - CASE STUDIES

1. Design of Cooling tower
2. Design of Crystallizer
3. Design of Venturi Meter
4. Design of Cyclone Separator
5. Design of Steam Ejector

COURSE OUTCOMES:

On completion of the course, students will be able to:

1. Determine the basics of process equipment design and important parameters of equipment design
2. Formulate the equipment fabrication and materials used
3. Design of reactors for non-catalytic and catalytic reactions.
4. Create a design for various process equipments.
5. Estimation of capital investment, total product costs, and profitability.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	3	-	1	-	1	-	-	-	-	1	-	-
CO2	2	-	3	1	-	-	-	-	-	-	-	1	2	-
CO3	-	-	3	-	1	-	1	-	-	-	-	1	-	2
CO4	-	-	3	-	-	-	-	-	-	-	-	1	-	-
CO5	-	-	3	-	1	-	1	-	-	-	-	1	-	-

EIGTH SEMESTER

25CHPV803	PROJECT WORK AND VIVA-VOCE	L	PR	S	C
		0	10	2	6

COURSE OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification, literature review till the successful solution of the same
- To train the students in preparing projects based on the knowledge

METHOD OF EVALUATION

1. The project work could be done in the industry or R&D Institute or an experimental project in the university. Participation in any technical event/competition to design, fabricate and demonstrate an innovative equipments or product could be encouraged under this course
2. The students in a group of 2 or alone works on a topic approved by the Head of the Department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor
3. The progress of the project is evaluated based on a minimum of three reviews. The review committee will be considered by the Head of the Department
4. A project report is submitted at the end of the semester
5. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

COURSE OUTCOME:

1. Formulate and solve chemical engineering and its allied field problems
2. Relate the concepts of science, engineering and technology for innovation
3. Perform experiments individually, handle sophisticated instruments and write technical documents for their work
4. Built team spirit and healthy relationship among team members
5. Know the professional ethics, responsibilities and project management

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	3	-	1	-	1	-	-	-	-	1	-	-
CO2	2	-	3	1	-	-	-	-	-	-	-	1	2	-
CO3	-	-	3	-	1	-	1	-	-	-	-	1	-	2
CO4	-	-	3	-	-	-	-	-	-	-	-	1	-	-
CO5	-	-	3	-	1	-	1	-	-	-	-	1	-	-

PROFESSIONAL ELECTIVES

25CHPESCN	PETROLEUM REFINERY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide the student knowledge about origin, formation and exploration of crude oil
- To teach the students about the petroleum refining processes and its products
- To illustrate the concepts of various cracking and reforming operations
- To illustrate the various petroleum products purification processes
- Develop problem-solving skills relevant to real-world refinery engineering challenges.

UNIT I

Origin, Exploration, exploitation, Production of petroleum, Composition of petroleum, Major challenges and future strategies in petroleum refining industry, Refinery economics, petroleum and petrochemical integration for value addition.

UNIT II

Crude heating, Desalting, Primary distillation, Atmospheric distillation, Vacuum distillation, Evaluation of petroleum products and their physical properties.

UNIT III

Cracking, Mechanism of cracking, Thermal cracking processes, Catalytic cracking, Catalyst used in cracking, Fluid catalytic Cracking and catalyst regeneration, Hydro cracking, Catalyst deactivation and regeneration, Recent advances in industrial catalysis.

UNIT IV

Reforming, Thermal and Catalytic reforming processes, Alkylation, Isomerization and Polymerizations processes.

UNIT V

Desulphurization processes, Solvent extraction processes, De-waxing processes, De-asphalt processes. Purification of the products, Air blowing of bitumen, recent trends lube base stock refining.

TEXT BOOKS:

1. W L Nelson Petroleum Refinery Engineering by Published by Mcgraw Hill Book Company Inc, 4th edition (1 January 1958)
2. B.K. Bhaskara Rao “Modern Petroleum Refining Processes”, 2008.

REFERENCES:

1. Dawe R.A.,”Modern Petroleum Technology part-I”, by Institute of petroleum(IP), John wiley

2. Lueas.A.G.,"Modern Petroleum Technology part-II" by Institute of petroleum(IP), John wiley.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand the origin, formation and exploration of crude oil
2. Gain knowledge on crude distillation processes
3. Develop suitable cracking process to convert heavy to lighter distillate
4. Understand the importance of various reforming operations
5. Gain knowledge on petroleum products purification processes

Mapping with POs & PSOs													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO 1**	**PSO2**	**PSO3**
CO1	3	3	2	-	-	2	3	2	-	-	2	3	2	3
CO2	3	3	2	-	-	2	3	2	-	-	2	3	2	3
CO3	3	3	2	2	-	2	3	2	-	-	2	3	2	3
CO4	3	3	2	2	-	2	3	2	-	-	2	3	2	3
CO5	3	3	2	2	-	2	3	2	-	-	2	3	2	3

25CHPESCN	**BIOCHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the concepts of microbial world and its application in biochemical industries.
- To insight the significance of microbes in fermentation and its enzymatic kinetics.
- To realize the operation of large scale bioprocess and its control.
- To provide a thorough understanding of the principles and applications of biochemical processes, focusing on the design, analysis, and optimization of systems involving biological organisms or molecules for the production of valuable products in industries such as pharmaceuticals, food, and biofuels.

UNIT I

Introduction and characteristics of biological materials - Evaluation of modern fermentation processes - Development of Biochemical Engineering - Fermentation products future trends - Types of microorganism - Chemical composition - Requirements for growth and media fermentation Reproductive cycle variation in micro organism - strain breeding, maintenance and stock culture.

UNIT II

Fermentation - Types - Kinetics of fermentation processes – Enzyme – Kinetics - Enzyme inhibition

UNIT III

Sterilization – Liquid / Air / Surface - Media sterilization – Microbial Death Kinetics – Batch and Continuous Sterilization of media – Media for Industrial Fermentation.

UNIT - IV

Design of fermenters, Aeration and agitation -Scale up criteria - Cell separation. Downstream process, Product Recovery and Purification

UNIT - V

Equipments - operations, Measurement and Control in fermentation - Mechanical separation and Disintegration of cells for product recovery. Enzyme engineering, enzyme immobilization techniques, Immobilized enzyme columns - Effect of pH, temperature, space velocity and pressure drop on performance.

TEXT BOOKS:

1. Biochemical Engineering, Shuichi Aiba, Arthur E. Humphery & Nancy F. Millis 1965, Academic Press, Newyork.
2. Biochemical Engineering Fundamentals, James E. Bailey, David F. Ollis, 2nd Edition, 2010, Tata McGraw - Hill, New Delhi.

REFERENCES:

1. Karl Schugerl, Bioreaction Engineering (Volume 1), 1987, John Wiley.
2. T.K.Ghose (Ed)., Process Computations in Biotechnology, 1994, Tata-McGraw Hill,
3. Atkinson, B. & Mavituna. F., Biochemical Engineering and Biotechnology Handbook, 1993, McGraw Hill (2nd Edition).

COURSE OUTCOMES:

1. Gaining the interaction of microorganism and its application to mankind.
2. Explore the mechanism of fermentation process and inhibition kinetics.
3. Assess the sterilization, its application in industrial process.
4. Explore the fundamentals for bioprocess.
5. Understanding the operation and control in bioprocess engineering.

Mapping with POs & PSOs														
COs	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	-	-	1	1	-	-	-	1	1	3	-
CO2	2	1	1	3	2	-	-	-	-	-	1	3	1	1
CO3	3	1	3	3	2	1	1	-	-	-	1	3	2	-
CO4	3	3	3	1	2	1	1	-	-	-	2	3	3	1
CO5	3	2	2	2	1	1	1	-	-	-	1	2	3	-

25CHPESCN	**ENVIRONMENTAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To familiarize the students about pollution laws.
- To provide basic knowledge about the biosphere
- To make the students to understand about the equipment and working principles of different air pollution control methods and also about wastewater treatment technologies
- To illustrate the concepts of various methods of solid waste management.

UNIT I

The biosphere; The hydrologic cycle; The nutrient cycles – Carbon, Nitrogen, Phosphorus, Sulphur; Pollution of air, water and soil; Air pollution laws and standards; Water pollution laws and standards; Water quality standards; Effects and control of noise, thermal and radioactive pollution.

UNIT II

Origin of wastewater; Types of water pollutants and their effects; Wastewater sampling and analysis; Determination of organic and inorganic matters - physical, chemical characteristics, bacteriological measurements.

UNIT III

Basic process of wastewater treatment – Primary - screening, comminution, grit removal, and sedimentation; Secondary - Trickling filter, Activated sludge process, Oxidation pond. Rotating biological contacter; Tertiary treatments – advanced wastewater treatments; recovery of materials from process effluents.

UNIT IV

Air pollution control methods: particulate emission control - gravitational settling chambers - cyclone separators, fabric filters, electrostatic precipitators, wet scrubbers, adsorbers. Control of sulfur dioxide, oxides of nitrogen, carbon monoxide and hydrocarbons. Types of air pollutant sampling and measurement, ambient air sampling, stack sampling, analysis of air pollutants. effect of air pollutants, factors affecting dispersion of air pollutants, dispersion modeling.

UNIT V

Characterization, classification of solid wastes, problems of collection and handling, solid disposal waste management such as compaction, incineration, composting, landfills and biological processing, solid waste as resource material.

TEXT BOOKS:

1. Rao, C.S. Environmental Pollution Control Engineering, 2007, New Age International, pp. 442.
2. George Tchobanoglous, Franklin L. Burton , H. David Stensel, Wastewater Engineering: Treatment and Reuse, 2002, Metcalf & Eddy, Inc., McGraw-Hill Education, pp 1848.

REFERENCES:

1. Mahajan.S.P, Pollution control in process industries, 1995, Tata-McGraw Hill, pp 273.
2. Noel de Nevers . Air Pollution and Control Engineering, 2002, McGraw Hill, pp 586.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, 2nd Edition, 2004, Prentice Hall of India, pp 778.
4. Rao M.N. and Rao H.V.N. Air Pollution, 1993, Tata – McGraw Hill Publishing Ltd.
5. De A.K - Environmental Chemistry, 1999, Tata – McGraw Hill Publishing Ltd.
6. Sawyer, C.N., McCarty, P.L., Parkin, G.F., Chemistry for Environmental Engineering, 2000, Tata McGraw-Hill.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand the terminologies of biosphere, various standards and laws that forms the basis for mitigating pollution
2. Evaluate the various types of pollution abatement techniques
3. Indicate the quality and characteristics of wastewater
4. Determine various water/air quality parameters
5. Explain the solid wastes collection, handling, waste management and Disposal

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	1	1	3	3	2	-	1	3	3	3	3
CO2	3	3	3	1	1	3	3	2	-	1	3	3	3	3
CO3	**3**	3	3	1	1	3	3	2	-	1	3	3	3	3
CO4	3	3	3	1	1	3	3	2	-	1	3	3	3	3
CO5	3	3	3	1	1	3	3	2	-	1	3	3	3	3

		L	T	P	C
25CHPESCN	**ELECTROCHEMICAL ENGINEERING**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the basic principles of electrochemical science and engineering
- To understand the mechanism involved in electrochemical systems.
- To familiarize the mass transfer and mechanism of corrosion.
- To aquire knowledge on concepts of electro process and design of batteries and fuel cell
- To understand the fundamental concepts of electrochemical reactor system

UNIT I

Basics of Electrochemistry-Faraday's law -Nernst potential –Galvanic cells – Polarography Electrical double layer and It's role in electrochemical processes – Electro capillary curve – Helmholtz layer –Guoy –Steven's layer –Fields at the interface.

UNIT II

Mass Transfer in Electrochemical Systems-Diffusion Controlled Electrochemical Reaction Importance of Convention and Concept of Limiting Current- Over Potential, Primary-Secondary Current Distribution – Rotating Disc Electrode

UNIT III

Introduction to Corrosion - Corrosion Theories -Derivation of Potential-Current relations of activities Controlled and Diffusion- Controlled Corrosion Process-Potential-pH Diagram-Forms of Corrosion- Definition, Factors and Control Methods of Various Forms of Corrosion-Corrosion Control Measures- Industrial Boiler Water Corrosion Control – Protective Coatings –Vapor Phase Inhibitors – Cathodic Protection, Sacrificial Anodes – Paint Removers.

UNIT IV

Electro Deposition –Electro Refining –Electroforming –Electro Polishing –Anodizing – Selective Solar Coatings, Primary and Secondary Batteries –Types of Batteries- Fuel Cells.

UNIT V

Electrodes used in different Electrochemical Industries-Metals-Graphite –Lead Dioxide Titanium Substrate Insoluble Electrodes –Iron Oxide –Semi Conducting type - Metal Finishing-Cell Design-Types of Electrochemical Reactors, Batch Cell, Fluidized Bed Electrochemical Reactor, Filter Press Cell, Swiss Roll Cell, Plug Flow Cell, Design Equation, Figures - Merits of different type of Electrochemical Reactors- Current Electrochemical practices in industries.

TEXT BOOKS

1. Picket, "Electrochemical Engineering ", Prentice Hall. 1977.
2. Newman, J. S., "Electrochemical systems ", Prentice Hall, 1973.

REFERENCES

1. Barak, M. and Stevenge, U. K., "Electrochemical Power Sources - Primary and Secondary Batteries" 1980
2. Mantell, C.," Electrochemical Engineering ", McGraw Hill, 1972.R.Subramanian, "Professional
Ethics ", Oxford University Press, Reprint, 2015.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand the concept of electrochemistry and electrochemical process.
2. Knowledge on mass transfer and limiting current in electrochemical engineering.
3. Evaluate the corrosion rate and control methods.
4. Understand the industrial applications of electro processing.
5. Explains the cell, Batteries and electrochemical reactions.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3		3	3	2	2	2	2	-	2	-	2	3	3
CO2	3		3	3	2	2	2	2	-	2	-	2	3	3
CO3	3		3	3	2	2	2	2	-	2	-	2	3	3
CO4	3		3	3	2	2	2	2	-	2	-	2	3	2
CO5	3		3	3	2	2	2	2	-	2	-	2	3	2

25CHPESCN	**NUCLEAR ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To develop a strong foundation in the principles of nuclear reactions, radiation physics, and reactor design
- To develop skills to safely and efficiently apply nuclear technology in energy production, medicine, and industry.
- To provide in-depth knowledge of the fundamental principles, methodologies, and safety considerations involved in the design, analysis, and optimization of nuclear reactors for efficient and reliable energy production.
- To gain fundamental knowledge on nuclear physics, nuclear reactor, nuclear fuels, and safe disposal of nuclear wastes.
- To understand the fundamental mechanisms of nuclear fission and fusion, including the physical principles, energy release, reaction conditions, and their applications in power generation and other nuclear technologies.

UNIT I

Nuclear physics: Nuclear model of an atom-Equivalence of mass and energy-binding- radio activity-half life-neutron interactions-cross sections.

UNIT II

Nuclear reactor : Nuclear reactors: types of fast breeding reactors. Design and construction of fast breeding reactors-heat transfer techniques in nuclear reactors- reactor shielding. Fusion reactors.

UNIT III

Nuclear reactions and reaction materials :Mechanism of nuclear fission and fusion- radio activity- chain reactions-critical mass and composition-nuclear fuel cycles and its characteristics-uranium production and purification. Zirconium, thorium, beryllium.

UNIT IV

Properties of irradiated fuel - separation of reactor products:Uses of stable isotopes and methods of isotope separation principles of isotope separation - Separation of isotopes of light elements - separation of isotopes of heavy elements.

UNIT V

Safety and disposal: Nuclear plant safety-safety systems-changes and consequences of accident-criteria for safety- nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation.

TEXT BOOKS:

1. Thomas J.Cannoly, “Fundamentals of Nuclear Engineering” 1978, John Wiley.
2. Collier J.G., and Hewitt G.F, “Introduction to Nuclear power”, 1987, Hemisphere publishing, New York.

REFERENCES:

1. Wakil M.M.El., “Power Plant Technology” 1984, Mc Graw-Hill International.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Explain the fundamentals of nuclear science.
2. List out nuclear reaction process and nuclear reactors.
3. Discover knowledge in nuclear fuel cycles and its characteristics.
4. Classification of nuclear reactor products.
5. Extend knowledge in safety and disposal of nuclear fuels.

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3				2	2				2	-	3	2	2
CO2	3				2	2				2	-	3	3	2
CO3	3				2	2				-	-	3	3	2
CO4	3				2	2				-	-	3	3	2
CO5	3				3	3				2	2	3	3	2

25CHPESCN	POLYMER ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the characterization, structure, mechanism, various techniques of polymerization.
- To familiarize the methods of preparation, properties and applications of thermoplastic materials covering commodity, engineering and high-performance plastics.
- To understand mechanical behavior of polymeric materials under applied load for short term and long-term properties.
- To explain the flow and rheological behavior of polymer and processing operations of polymer

UNIT-I

Classification, structure and characterization of polymers - Thermal analysis, Morphological characterization, Physical testing.

UNIT-II

Kinetics of polymerization - Condensation, free radical, cationic, anionic, stereo regular polymerization - polymerization reaction engineering, Emulsion polymerization - Smith

and Ewart model. Dispersion polymerization - Fitch model. Pearl and bead polymerization, Solution polymerization.

UNIT-III

Introduction to reactor design, Interpretation of batch reactor data; Rate equations, Recycle reactor, auto catalytic reactions, Design for multiple reactions: Parallel and series reactions, quantitative and qualitative treatment of product distribution and of reactor size for different types of ideal reactors.

UNIT-IV

Rheology Definitions, Simple shear flow, measurement of viscosity with various flow geometries like capillary viscometer, cone and plate viscometer, cup and bob viscometer. Viscoelasticity Mechanical models, Maxwell model, Voight model, response of models in creep, Stress, Stress relaxation dynamic experiments. Temperature dependency of viscosity. William Landel Ferry equation.

UNIT-V

Processing operations - Description of various process operations such as extrusion calendaring, moulding, block moulding, thermoforming, compounding and mixing of polymers.

TEXT BOOKS:

1. F.W.Billmeyer, Text Book of Polymer Science, 3rd Edn., 1985, Wiley - Inter Science.
2. Anil Kumar and S.K.Gupta, Fundamentals of polymer Science and Engineering, 2003, Tata McGraw Hill Publications.

REFERENCES:

1. Ferdinand Rodriguez, Principles of Polymer Systems, Tata McGraw Hill Publication
2. Crawford,R.J., Plastic Engineering, 2nd Edn, 1989, Pergamon Press
3. McCrum,N.G., Buckley,C.P. and C.B.Bucknall, Principles of Polymer Engineering, 1988, Oxford Science Publications, Oxford University Press.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Acquire knowledge on the estimation of weight average molecular masses, degree of polymerization and mass fraction of chains present in the polymer samples.
2. Understand the role of reaction engineering in improving the chemical properties of polymers.

3. Understand the key design features of a product which relate directly to the materials used in its construction
4. Understand the role of rheological properties in improving the strength of polymers
5. Able to know the process operation of various polymeric products developed

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	2	3	3	-	2	-	2	-	3	3	2	3
CO2	3	3	3	2	2	-	2	2	-	2	3	3	2	3
CO3	3	3	3	2	2	-	2	3	-	-	3	3	2	3
CO4	3	3	2	2	-	-	2	-	-	-	3	3	2	3
CO5	3	-	2	2	-	-	2	-	-	-	3	3	2	3

25CHPESCN	**AIR POLLUTION & CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To study about the effects of air pollutants on human beings and environment, what their sources are, and their physical and chemical behavior in the atmosphere.
- To get exposed to a wide range of control technologies and future trends towards preventing air pollution.

UNIT - I : Air pollution

Air Pollution-Sources and Effects Definitions, Scope, Air Pollutants – Classifications – Natural and Artificial – Primary and Secondary, Sources of air pollution- stationary and mobile sources. Effects of Air pollutants on humans, materials and vegetation. Global effects of air pollution – Green House effect, Heat Islands, Acid Rains, Ozone Holes etc.

UNIT – II: Air quality monitoring management

Ambient Air Sampling- sampling procedures for collection of gases and particulates, High Volume Sampler. Stack monitoring- Sampling Techniques for Stack gases. Analysis of Air Pollutants: SOx, NOx, CO, Hydrocarbons and Particulate matter. Air quality standards and Emission standards

UNIT – III:Meteorology and plume dispersion

Properties of atmosphere - Temperature, Pressure and Wind forces. Influence of Meteorological phenomena on Air Quality. Temperature lapse rates and Atmospheric Stability.

Wind velocity and turbulence. Plume behaviour. Wind rose diagrams. Dispersion theories and models- stack height, plume rise.

UNIT – IV: Air pollution control methods

Source correction methods – Raw material changes, Process Changes and Equipment modifications, Particulate control equipments – Settling Chambers, Centrifugal separators, Fabric filters Wet scrubbers and Electrostatic precipitators. Collection efficiency and design problems. General Methods of Control of Gaseous emissions- Absorption, Adsorption and Combustion. Control of NOx and SOx emissions.

UNIT – V: Air pollution in industries and automobiles

Air pollution from major industrial operations: Mining and mineral processing, Cement manufacturing, Petroleum refinery, Metallurgical operations Thermal power plants. Air Pollution due to Automobiles: Emissions from automobiles, formation of photochemical smog, Combustion, Air-Fuel ratio, Control of Exhaust emissions, biological reactors for Air pollution control.

TEXT BOOKS:

1. M.N Rao and H.V.N Rao, Air Pollution, , 2007, Tata McGraw- Hill Publishing Company Limited, New Delhi.
2. R.K Trivedy and P.K Goel, An Introduction to Air Pollution, 2009, BS Publications, Hyderabad.

REFERENCES:

1. Richard W. Boubel. Fundamentals of Air Pollution, Academic Press, (Elsevier), New York
2. Noel De Nevers, Air Pollution control, McGraw – Hill publishing Co. Ltd., New York.
3. Peavy H.S, Rowe D.R. and Tchobanoglous, Environmental Engineering, Tata McGraw Hills, New Delhi
4. KVSG Murali Krishna, Air Pollution and Control, Kushal &Co, Kakinada
5. C.S Rao, Environmental Pollution Control Engineering, New Age International Publishers, New Delhi

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Identify the sources of air pollutants and analyse its effects on human and environment
2. Understand air sampling techniques and analysis of air pollutant concentration.
3. Know the meteorological properties and dispersion mechanism of pollutants in air.
4. Analyse control methods and use of industrial equipment to remove pollutants from air.
5. Apply methods of pollution control in process industries and automobiles.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	-	3	**2**	-	-	-	-	**3**	**2**	**2**
CO2	3	3	3	2	-	2	**2**	-	-	-	-	**3**	**2**	**2**
CO3	**3**	2	3	2	2	2	**2**	-	-	-	-	**3**	**2**	**2**
CO4	**3**	2	3	2	2	2	**2**	-	-	-	-	**3**	**3**	**2**
CO5	**3**	3	3	2	2	2	**2**	-	-	-	-	**3**	**2**	**3**

25CHPEXXX	**CHEMICAL PLANT UTILITIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

This course will enable the students to understand the knowledge about the types and functioning of various mechanical devices used in process industries such as boilers, steam engines, turbines compressors, pumps, boiler water preparation, steam generation, refrigeration and cryogenic systems.

UNIT-I

Boilers-Classification: Boilers-Fittings and Accessories.

Unit-II

Steam engines and Turbines - Properties of steam, tables and charts- gas turbines.

Unit-III

Compressed air and Vaccum-Compressors and Vaccum pumps and their performance characteristics. Boosters, Use of air in process industries for conveying, drying and instrumentation, air receivers, Design of pipelines and piping networks for water, steam, condensate and air, piping systems, air leaks, lubrication oil removal.

Unit-IV

Treatment of water, cooling water, boiler water, cooling tower operation, desalination process, co-generation, steam generation for power and processes.

Unit-V

Refrigeration, cryogenic systems, Principle, types, selection and operations of pump, fans and compressor selection.

Reference Books

1. Mujawar, B.A. Plant Utilities, III edn, Nirali Prakashan Publication, 2007.
2. Dhona, D.B., Plant Utilities, I Edn, Nirali Prakashan Publication, 2018.
3. Khurmi, R.S., Thermal Engineering, S.Chand& Co., 1993
4. Ballaney, Heat Engines, Khanna Publishers

5. Ballaney, Thermal Engineering, Khanna Publishers
6. Rase, H. F., Barrow, M. H., Project Engineering for Process Plants, John Wiley & Sons, 1957.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Know about boiler types and its accessories.
2. Understand the functioning of steam engines and turbines.
3. Describe the compressor and vacuum pump and their characteristics.
4. Gain knowledge about water treatment plants.
5. Understand the principles of refrigeration and cryogenic systems used in process industries.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	1	-	-	-	-	-	-	-	2	-	-
CO2	3	3	-	1	-	-	-	-	-	-	-	3	-	-
CO3	3	3	-	1	-	-	-	-	-	-	-	3	-	-
CO4	3	3	-	1	-	-	-	-	-	-	-	3	-	-
CO5	3	3	-	2	2	-	-	-	-	-	-	3	-	

25CHPESCN	**PETROCHEMICAL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To teach the students about the history, evolution and feature of petrochemical Industries and its economics.
- To teach the students the technological principles of organic synthesis of petrochemicals
- To teach the students about the production of polymers and petrochemicals from the petroleum products

UNIT I

Introduction – History, economics and future of petrochemicals, energy crisis and petrochemical industry, sources and classification of petrochemicals.

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

UNIT III

Second generation petrochemicals synthesis gas, methanol, formaldehyde chloromethanes, ethanol, acetaldehyde, acetic acid, acetic anhydride, isopropyl alcohol, ethylene oxide, propylene oxide, acetone, vinyl chloride, phenol, aniline and styrene.

UNIT IV

Third generation petrochemicals – plastics, rubbers and fibres, olefinic polymers, polyethylene, polypropylene, polyisobutylene, diene polymers – polybutadiene, neoprene, polyisopropene, SBR, synthetic fibres.

UNIT V

Production of Petrochemicals: Dimethyl Terephathalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Pentaerythritol and Production of Carbon Black. Acrylic Acid, Oxo Alcohols, Acrylates, Polyols, Propylene Glycol, Ethylene Oxide/Mono Ethylene Glycol.

TEXT BOOKS:

1. S.Maiti, Introduction to petrochemical industry, 1961, Pergamon.
2. Bhaskara Rao, B. K. "A Text on Petrochemicals", 1st Edn., 1987, Khanna Publishers, New Delhi

REFERENCES:

1. G. D. Hobson and W. Pohl., "Modern Petroleum Technology", 1990, Gulf Publishers, 2nd Edn.,
2. R. A. Meyers, "Hand book of Petroleum Refining Processes", 1980, McGraw Hill, 1st Edn.,
3. B. K. Bhaskara Rao, "Modern Petroleum Refining Processes", 2nd Edn., 1990, Oxford and IBH Publishing Company, New Delhi
4. G.T.Austin, Shreves chemical process industries, 5th edn., 1986, Mcgraw Hill.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Understand a detailed insight of petrochemical Industries
2. Gain knowledge on the production of first generation petrochemicals.
3. Gain knowledge on the production of second generation petrochemicals.
4. Understand the production methods of rubber, plastics, fibres and their applications
5. Understand the production methods of specialty petrochemicals

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	-	-	2	2	-	-	2	2	3	2	2
CO2	3	2	2	-	-	2	2	-	-	2	2	3	2	2
CO3	3	2	2	-	-	2	2	-	-	2	2	3	2	2
CO4	3	2	2	-	-	2	2	-	-	2	2	3	2	2
CO5	3	2	2	-	-	2	2	-	-	2	2	3	2	2

25CHPESCN	PULP & PAPER TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Gaining Knowledge of pulp & paper industry, mill Operations, products, process variables, equipment, and terminology.
- Increasing knowledge of how the Pulp &Paper processes affect product properties, in order to improve product quality and troubleshoot variations in quality.
- To illustrate the concepts of various unit operations steps appropriately in manufacturing of paper.

UNIT I

Introduction to pulp and paper technology –Wood as a raw material – different types of wood and their uses.

UNIT II

Woodyard operation Woodyard operation - Mechanical pulping – Chemical pulping – Secondary fibre pulp processing.

UNIT III

Paper machine Paper Machine wet and addition paper machine dry and operation – Paper machine - Wet and operation.

UNIT IV

Paper and paperboard Paper and paperboard frames and products – Surface treatments – Finishing operation– End uses.

UNIT V

Properties and testing of pulp and paper Properties and Testing of pulp and paper Process control – Quality assurance – Water and air pollution control.

TEXTBOOKS:

1. Monica ER Monica, Goran Gellerstcdt Gunnar Hennksson De Gneyter, Pulp and paper chemistry and Technology, 2009.

2. Rao, M.Gopal, Sitting, Marshall, Dryden's outlines of Chemical Technology, 3rd Edition, Affilated East- West Press Pvt. Ltd.

REFERENCES:

1. Biermann, Christopher J Handbook of Pulping and Papermaking.

2. Metcalf & Eddy, Wastewater Engineering, Treatment, Dispose and Reuse, Inc. IV EDN, 2002.

3. Austin, George T., Shreves' Chemical Process Industries, 5th Edition, McGraw-Hill Education India Pvt. Ltd - New Delhi

4. Bhatia, S.C. Environmental Pollution and Control in Chemical Process Industries Second Edition 2011.

5. Trivedi, R.K., Pollution Management in Industries, Environmental Publication, Karad, India

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Describe the basic concepts of pulp and paper technology and the raw material for paper making.

2. Analyze various unit operations and reactions involved in pulp making process.

3. Explain about paper machine and its distinct operational sections.

4. Summarize various paper products and surface treatments.

5. Analyze the properties, testing of paper and the waste disposal techniques in pulp and paper industry

Mapping Cos with POs & PSOs														
Cos	**PO 1**	**PO 2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	-	-	2	-	-	-	-	2	3	2	2
CO2	3	3	2	2	-	2	-	-	-	-	2	3	2	3
CO3	3	3	3	2	2	2	-	-	-	-	2	3	3	3
CO4	3	3	3	2	2	2	-	-	-	-	2	3	3	3
CO5	3	3	3	2	2	2	-	-	-	-	2	3	3	3

25CHPESCN	**INDUSTRIAL BIO-TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To motivate students to excel in research and to practice the technologies in the field of Industrial biotechnology.

- To provide students with a solid understanding of Biotechnology fundamentals and applications required to solve real life problems.
- To provide students with an academic environment that is aware of professional excellence and leadership through interaction with professional bodies

UNIT-I

Overview of the cell: Cell, structure and properties, prokaryotic and eukaryotic cells, structural organization and function of intracellular organelles; Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes and Chloroplast.

UNIT-II

Microbial growth: pure culture techniques: Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. The definition of growth, mathematical expression of growth, Growth curve, availability of oxygen, culture collection and maintenance of cultures.

Media formulation: principles of microbial nutrition, formulation of culture medium, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors and antifoam agents. Importance of pH.

UNIT-III

Management of waste: Management of Contaminated land**,** lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting

UNIT-IV

Bioremediation: Definition, constraints and priorities of Bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons. Lignocellulosic Compounds.

UNIT-V

Bioenergy & Biomining: Bio energy: Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass. **Biomining:** Bioleaching, monitoring of pollutants, microbially enhanced oil recovery, microbial fuel cells.

TEXT BOOKS:

1. Molecular Biology of cell, Alberts. B et al.Developmental Biology, SF Gilbert, Sinauer Associates Inc.
2. AVN Swamy, Industrial Pollution Control Engineering, 2006, Galgotia Publication,

REFERENCES:

1. Environmental Biotechnology - Allan Stagg.

COURSE OUTCOMES:

On completion of the course, students would be able to biology.

1. Master about the material in cell
2. Familiar about the microbial growth techniques and cultural media.
3. Know about the strategy on industrial waste management
4. Analyzing a solution for emerging contaminant problems via Bioremediation.
5. Observe the application of living biological materials for energy and extraction of metals.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	-	-	-	-	-	-	1	-	-	2	-	1	-
CO2	3	2	2	2	-	2	1	-	-	-	3	3	3	2
CO3	3	2	2	2	-	2	3	3	-	2	3	3	3	2
CO4	2	2	2	2	-	2	3	3	-	2	3	3	3	2
CO5	3	2	2	2	-	2	3	3	-	2	3	3	3	2

25 CHPESCN	**WASTEWATER TREATMENT TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the fundamental concepts and scope of wastewater engineering, including the sources, characteristics, treatment methods, and disposal of wastewater, with an emphasis on protecting public health and the environment.
- To provide comprehensive knowledge of the principles, processes, and technologies used in the treatment of wastewater,
- To understand the emphasis on environmental sustainability, regulatory compliance, and the design and operation of treatment systems for safe water discharge or reuse.
- To focus on the wastewater transport system and the theoretical techniques for the wastewater treatment process.
- To understand the principles and applications of biological processes in wastewater treatment, focusing on the role of microorganisms in the removal of organic and inorganic pollutants, and the design and operation of biological treatment systems such as activated sludge, biofilms, and lagoons.

UNIT – I

Overview of waste water Engineering
Terminolgy, Wastewater characteristics, Physical characteristics, Inorganic Constituents, Organic constituents, Biological characteristics.

UNIT – II
Physical unit operations
Screening, Coarse Solids reduction, Flow equalization, Mixing and flocculation, Gravity separation, Grit removal, Sedimentation, Clarification and flotation.
Chemical unit process
Chemical coagulation, Chemical precipitation, Chemical oxidation, Chemical neutralization, Scale control and Stabilization.

UNIT – III
Biological treatment
Overview, classification, Basics and Mechanism of Aerobic and anaerobic process. Activated sludge process, Aerated lagoons, Trickling filter, Rotary biological reactor, Oxidation ponds.

UNIT – IV
Reactors in wastewater treatment
Principle, working, advantages and limitations of- Packed bed reactor, fluidized bed reactor, Inverse fluidized bed reactor, Air lift reactor, Anaerobic digestor, Sequential batch reactor, UASB reactor, Membrane reactor.

UNIT –V
Advanced wastewater treatment
Need and Techniques used for Advanced treatment, Depth Filters, Surface filtration, Membrane filtration process, Adsorption, Gas stripping, Ion exchange, Advanced oxidation process, Distillation.

TEXT BOOKS:
1. Metcalf & Eddy, Wastewater Engineering Treatment & Reuse, Tata McGraw –Hill, IV Edn, 2003.
2. Arun Kr. Jain, Ashok Kumar Jain, and B.C. Punmia, Wastewater Engineering, Laxmi Publications, New Delhi, 1998

REFERENCES:
1. George Tchobanoglous, Franklin L. Burton , H. David Stensel, Wastewater Engineering: Treatment and Reuse, 2002, Metcalf & Eddy, Inc., McGraw-Hill Education.

COURSE OUTCOMES:
On completion of the course, students would be able to
1. Characterize the various industrial effluents.
2. Perform the treatment of wastewater by physical removal and chemical degradation.
3. Articulate various aerobic and anaerobic processes for the waste water treatment and

to select suitable treatment process for given situation.

4. Select and Employ different types of reactors in the waste water treatment
5. Device the adaptable treatment technology to meet out pollution control norms.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	2	2	3	2	-	-	-	3	3	2	3
CO2	3	3	-	2	2	3	2	-	-	-	3	3	2	3
CO3	3	3	2	2	2	3	2	-	-	-	3	3	2	3
CO4	3	3	2	2	2	3	2	-	-	-	3	3	2	3
CO5	3	3	2	2	2	3	2	-	-	-	3	3	2	3

25CHPESCN	**GREEN CHEMISTRY AND TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To promote an understanding of environmentally benign chemical practices and technologies by emphasizing the principles of green chemistry, with the aim of minimizing waste, reducing the use of hazardous substances, and developing sustainable processes for chemical manufacturing and industrial applications.
- To explore and develop eco-friendly reagents using the principles of green chemistry, aiming to minimize environmental impact, enhance atom economy, and replace hazardous substances with safer, sustainable alternatives in chemical synthesis.
- To study environmentally sustainable oxidation and photochemical reaction processes that utilize green reagents, catalysts, and energy sources, with the aim of reducing hazardous byproducts and improving the efficiency and safety of chemical transformations.

Unit – I: Green Chemistry

Twelve principles of green chemistry, Green technology-definition, importance, factors affecting green technology. Introduction to Life Cycle Assessment. Role of industry, government and institutions; industrial ecology, role of industrial ecology in green technology.

Unit - II

Synthesis of Green Reagents, Green Solvents and Volatile Organic Compounds, Solvent-free Systems, Super critical fluids - extraction, process and applications. Supercritical Carbon Dioxide, Supercritical Water, Water as a Reaction Solvent, Water-based Coatings, Ionic Liquids, Ionic Liquids as Catalysts, Ionic Liquids as Solvents, Fluorous Biphase Solvents.

Unit III:

Green oxidation and photochemical reactions, Microwave and Ultrasound assisted reactions, Photochemical Reactions, Advantages of and Challenges Faced by Photochemical, Processes, Examples of Photochemical Reactions, Chemistry Using Microwaves, Microwave Heating, Microwave-assisted Reactions, Sonochemistry, Sonochemistry and Green Chemistry, Electrochemical Synthesis, Examples of Electrochemical Synthesis.

Unit-IV

Renewable energy technologies like solar, wind, hydropower, geothermal and biomass energy, phytoremediation, eco-restoration, issues and challenges.

Unit V

Green materials, -biomaterials, biopolymers, bioplastics, composites, Sensors, Biomimetic Sensors.

Green nanotechnology - Nanomaterials for fuel cells and hydrogen generation and storage. Nanostructures for efficient solar hydrogen production, solar thermal Energy and Photovoltaic. Smart nanomaterials, Nano Catalysts, Nano-sensors.

By the end of the course, student will be able to:

1 Understand the basic and needs of green chemistry and technology

2. Realise the importance of green technologies in sustainable growth of Industry and society.

3. Adopt alternative methods and solvents for green synthesis.

4. Know and apply various renewable technologies for green technology

5. Understand and develop green materials for various applications

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	2	-	-	-	-	-	3	1	-
CO2	3	3	-	-	-	3	-	-	-	-	-	3	2	-
CO3	3	3	2	-	-	2	-	-	-	-	-	3		-
CO4	3	3	2	-	-	2	-	-	-	-	-	3		-
CO5	3	3	2	-	-	2	-	-	-	-	-	3		-

25 CHPESCN	MODERN SEPARATION PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The course is aimed at developing the skills of engineering students in novel separation processes. The learners will be enabled to appreciate the important role of modern separation processes concepts in engineering application as well as industries.

UNIT I

Thermal Diffusion: Basic Rate Law, Theory of Thermal Diffusion Phenomena for gas and liquid mixtures, Equipments design and Applications. Zone Melting: Equilibrium diagrams, Controlling factors, Apparatus and Applications.

UNIT II

Sorption Techniques - Types and choice of adsorbents, Normal Adsorption techniques, chromatographic techniques, Equipment and commercial processes, Recent advances and economics, Molecular Sieves.

.

UNIT III

Membrane Separation Processes - Types and choice of membranes, their merits, commercial, pilot plant and laboratory membrane permeators, Dialysis, Reverse Osmosis, Ultrafiltration, Membrane bioreactor, Membrane Distillation, Economics of Membrane operations.

UNIT IV

Ionic Separation - Controlling factors, Applications, Equipments for Electrophoresis, Dielectrophoresis, Electro Dialysis and Ion -Exchange, Commercial processes.

Other Techniques: Adductive Crystallization: Molecular addition compounds, Clathrate compounds and Adducts, Equipments, Applications, Economics and Commercial processes..

UNIT V

Foam Separation - Surface Adsorption, Nature of foams, Apparatus, Applications, and Controlling factors.

TEXT BOOKS:

1. Schoen H. M., "New Chemical Engineering Separation Techniques", 2nd Edition, 1972, Inter Science Publications, New York.
2. Loeb .C and Lacey R. E., "Industrial Processing with Membranes", 2nd Edition, 1972, Wiley Inter Science.

REFERENCES:

1. Perry R.H. and. Green D.W, “Perry’s Chemical Engineers Hand book”, 6th Edition., 1990, McGraw Hill, New York.
2. Coulson J. M. and Richardson J. F., "Chemical Engineering", Vol. II, 4th Edition, 1991, Butterworth, Heinemann, London.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Describe the design principle and application of thermal diffusion.
2. Explain adsorption techniques and its commercial equipments.
3. Select suitable membrane separation processes and explain applications of membrane.
4. Articulate about ionic, crystallization and its applications
5. Illustrate surface adsorption , foam separation apparatus and its application

Mapping with POs & PSOs															
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2		-	2	2	2	-	-	-	2	3	2	2
CO2	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2
CO3	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2
CO4	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2
CO5	3	3	2	-	-	2	2	2	-	-	-	2	3	2	2

25CHPESCN	**MEMBRANE SCIENCE AND ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To make students understand the various types of Membrane compositions.
- To familiarize the students various Membrane configuration Units about.
- To provide knowledge about the various Membrane separations techniques.
- To illustrate the various membrane synthesis techniques and its applications

UNIT I

Synthetic Membranes - configuration, morphology, principles of permeation and separation, membrane materials.

UNIT II

Processing: Phase-inversion process, anisotropic membranes, isotropic porous membranes. Polymer blends and alloys, dynamic membranes, liquid membranes, biomimetic membranes ion exchange membranes, electro dialysis, bipolar membranes, mosaic membranes.

UNIT III

Separation processes: Electro dialysis, micro filtration, ultra filtration, reverse osmosis, hemodialysis, hem filtration.

UNIT IV

Membrane systems: Plate and frame, spiral-wound Unit, hollow fiber Units.

UNIT V

Membrane Applications: Wastewater treatment, bioseparation, biomedical.

TEXT BOOKS:

1. R.B. Kesting., Synthetic Polymeric Membranes, Second Edn., 1985, Wiley- Interscience, New York.
2. Enrico Drioli, Lidietta Giorno, Enrica Fontananova Comprehensive Membrane Science and Engineering, 2013, Elsevier, II Edn.

REFERENCES:

1. Mulder, J Basic Principles of Membrane Technology, 1996, Springer.
2. Richard W. Baker, Membrane technology and applications, II Edn., 2004 Wiley Publication.

COURSE OUTCOMES:

On completion of the course, students would be able to

1. Explain principles of permeation and separation
2. Describe Synthesis of membranes
3. Classify Membrane Separation Process
4. Differentiate membranes based on their configuration modules.
5. Discuss application of membrane

Mapping with POs & PSOs														
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	2	2	2	2	-	2	2	3	3	2	3
CO2	3	3	3	3		2	2	-	-	3	2	3	2	2
CO3	3	3	2	-	-	2	2	-	-	-	2	3	2	2
CO4	3	3	3	-	-	2	2	-	-	-	2	3	2	2
CO5	3	3	3	-	-	3	3	3	3	3	3	3	2	3

25CHPESCN	**FOOD PROCESSING TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To familiarize the basic sciences in the fundamentals of physical, chemical and biochemical nature of food.
- To provide basic knowledge about the principles of different food preservation techniques and the simultaneous extension of shelf life of food materials.
- To demonstrate about various dairy products and beverages like carbonated and noncarbonated beverages.
- To illustrate the concepts of the processing of fruits and vegetables, meat, poultry and fishery products.

- To characterize different types and importance of packaging materials for food

UNIT I

Introduction to food processing – nutritive values of food; types of microorganisms associated with food, its sources and behavior in food.

UNIT II

Food deterioration and its control – shelf life and dating of food – principles of food preservation – heat preservation and processing sterilization, pasteurization and blanching – cold preservation and processing freezing, refrigeration and cold storage – food irradiation, microwave heating and ohmic heating.

UNIT III

Dairy chemistry – milk as a food and its composition – quantitative analysis of milk – milk processing – pasteurization of milk – milk products – manufacturing process of milk cream, butter, evaporated milk, condensed milk, concentrated milk, ice cream, skim milk, fermented milk, butter milk, whey, dried milk products – beverages– carbonated and non carbonated beverages.

UNIT IV

Canning process of fruits and vegetables, grading, washing, peeling, coring and pitting – blanching – can filling – processing of meat and poultry – Canning of fish – preparation of raw material, salting, blanching process – filling, exhausting, sealing, can washing, thermal processing, cooling, drying and packing.

UNIT V

Principles of food packaging – introduction, types of containers, food packaging materials and forms, package testing, package with special features, safety of food packaging – method of food packaging.

TEXT BOOKS:

1 Norman N. Potter and Joseph H. Hotchkins, Food Science, V Edition, 1998, CBS Publishers & Distributors, New Delhi.
2 W.C. Frazier & D.C. Westhoff, Food Microbiology, 1986, Tata McGraw Hill.

REFERENCES:

1. Arthur W. Farrall, Engineering for Dairy and Food Products, 1967.Wiley Eastern Private Ltd,
2. G.S.Siddappa, Preservation of Fruits and Vegetables, 1986, ICAR, New Delhi.

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COURSE OUTCOMES:

Upon the completion of the course, the students will be able to:

1. Familiar about simple scientific information on food components and their interactions with microorganism.
2. Know about enhancing the shelf life of food by heat and cold processing technologies.
3. Understand the chemistry of milk and technology of various dairy products.
4. Observe the preservation by canning process of fruits, vegetables, meat, poultry and fish.
5. Gain knowledge on food packaging materials and application of packaging materials.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	2	-		2	1	1	1	-	1	2	1	1
CO2	2	1	2	1	1	1	1	1	1	-	1	1	2	1
CO3	3	1	2	1	1	2	1	1	-	-	1	1	2	1
CO4	1	1	2	1	1	3	1	2	-	-	1	2	3	1
CO5	2	1	1	1-	1	3	2	1	-	-	1	2	3	1

25CHPESCN	**FERTILIZER TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.

UNIT I

Nitrogenous fertilizer's

Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

UNIT II Phosphatic fertilizer's

Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers – ground rock phosphate; bone meal-single

superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

UNIT III Potassic fertilizer's

Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.

UNIT IV Mixed fertilizers

Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitrophosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

UNIT V Miscellaneous fertilizers

Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.

TEXT BOOKS:

1. "Handbook of fertilizer technology", Association of India, 1997, New Delhi.
2. Menno, M.G.; "Fertilizer Industry - An Introductory Survey", 1973, Higginbothams Pvt. Ltd.,

REFERENCES:

1. Sauchelli, V.; "The Chemistry and Technology of Fertilizers", ACS MONOGRAPH No. 148, 1980, Reinhold Publishing Cor. New York.
2. Fertilizer Manual, "United Nations Industrial Development Organization", United Nations, New York, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilizers, 1966, Interscience, New York,

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Describe about various Nitrogen fertilizer production and its characteristics
2. Explain about Phosphatic fertilizer with flow diagram
3. Develop the knowledge of Potassic fertilizer with their specifications
4. Explain about mixed fertilizer and NPK fertilizer in our country
5. Justify the different types of fertilizer applied to agriculture production of various crops

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO3	**3**	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	2	-	3	-	-	-	-	-	-	-	-	3	-	-
CO5	-	3	3	2	-	-	-	-	-	-	-	-	3	2

25CHPESCN	FLUIDIZATION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the students to learn the design aspects of fluidized beds.

UNIT-I : Basics of fluidization

Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozneykarman – On set of fluidization – Properties of fluidized beds –Development of fluidization from fixed bed.

UNIT-II: Fluidized bed types

Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT-III: Design aspects

Channeling – Bed expansion in liquid – Solid and gas – Solid fluidizations. Design aspects of fluidized bed systems.

UNIT-IV: Heat and mass transfer in fluidized beds

Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT-V: Other types of fluidization

Single stage and multistage fluidization – Collection of fines – Use of cyclones.

TEXT BOOKS:

1. Daizo Kunii, Octave Levenspiel," Fluidization Engineering" 2nd Edition, 1991, Butterworth –Heinmann.
2. Leva, M., "Fluidization", 1959, McGraw Hill Book Co

REFERENCES:

1. Rowe and Davidson, "Fluidization", 1971, Academic Press
2. Wen-Ching Yang., "Handbook of Fluidization and Fluid-Particle Systems", 20013, Marcel Dekker Inc.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Explain the fundamentals of fluidization phenomena, correlations of Ergan and Kozney-karman equations.
2. Identify the fluidization bed types and describe minimum fluidization condition, bed expansion, elutriation and spouted bed.
3. Compare solid-liquid and solid-gas fluidizations and analyze the design aspects of fluidized bed systems
4. Describe the heat and mass transfer in fluidized beds and the industrial applications of

fluidized bed reactors

5. Analyze single and multistage and the use of cyclones for the collection of fines.

Mapping with POs & PSOs														
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	2	3	2	-	-	2	-	-	-	2	3	-	-
CO 2	2	3	3	2	-	-	2	-	-	-	2	3	-	-
CO 3	2	2	3	2	-	-	2	-	-	-	2	3	-	-
CO 4	2	2	3	3	-	-	2	-	-	-	2	3	-	-
CO 5	2	2	3	2	-	-	2	-	-	-	2	3	-	-

25CHPESCN	**DISTILLATION**	**L**	**P**	**T**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To impart the fundamentals of phase diagrams and equilibria
- To understand the principles of vapor-liquid equilibrium and apply them to simple distillation processes for the effective separation of binary mixtures, focusing on phase behavior, operating conditions, and process efficiency.
- To make the students evaluate the concepts of equilibrium and simple distillation, multi component distillation ternary distillation and azeotropic distillation.
- To understand the behavior, phase relationships, and separation techniques of ternary and multi-component systems, with emphasis on their applications in chemical process design, distillation, and extraction operations.
- To make the students assess the design principles of distillation process and its industrial application

UNIT I

Gibbs phase rule, phase equilibrium, ideal and non-ideal gas mixtures, Raoult's law, nonideal liquid - liquid mixtures; phase diagrams, effect of pressure on phase equilibria; Vapor Liquid Equilibria: Ideal and non-ideal binary and multi-component systems - Correlation and prediction –consistency tests; VLE of complex system-true boiling point curves-ASTM distillation, equilibrium flash vaporization curves.

UNIT II

Equilibrium and simple distillation: flash vaporization of binary and multi-component systems, differential vaporization and condensation; steam distillation; fractionation of binary systems-analytical and graphical methods of determination of number of equilibrium stages.

UNIT III

Ternary systems and multi-component systems- Sorel method, Lewis-Matheson method, Thiele-Geddes method, short cut methods, graphical evaluation of number of stages for ternary systems.

UNIT IV

Azeotropic distillation and extractive distillation: separation of homogeneous azeotropes, separation of heterogeneous azeotropes, selection of addition agents-design of azeotropic distillation process, design of extractive distillation process; Reactive Distillation and Case studies.

UNIT V

Design methods: fractionation devices, bubble cap, sieve and other types of trays-plate and column hydraulics and efficiency- plate fractionation column design methods, packed column design

TEXT BOOKS:

1. Van Winkle, M., Distillation, 2nd ed. 1967, McGraw Hill publications.
2. Doherty, M.F and Malone, M.F., Conceptual Design of Distillation systems, 2006, McGraw Hill International Edn

REFERENCES:

1. Holland, Multi-component Distillation. First Edn., 1963
2. Treybal,R.E.,Mass Transfer Operation, 3rd Edn., 1981, 3rd Edn., 1981, McGraw Hill
3. McCabe, W.L., Smith, J.C. and P. Harriot, Unit Operations in Chemical Engineering, VII Edn., 2005, McGraw Hill.
4. Sherwood,T.K.,Pigford,R.L and Cr.Wilke., Mass Transfer, McGraw Hill

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the basic concept of thermodynamics and phase equilibria.
2. Acquire knowledge on distillation processes and determine the number of equilibrium stages.
3. Acquire knowledge on principles of ternary and multi component distillation.
4. Understand the concepts and principles of azeotropic and extractive distillation.
5. Acquire knowledge on design and develop the distillation process.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3		3	2	2	2		3		2	2	3	2	2
CO2	3		3	2	2	2		2		2	2	3	2	2
CO3	3		3	2	2	2		2		2	2	3	2	2
CO4	3		3	2	2	2		2		2	2	3	2	2
CO5	3		3	2	2	2		2		2	2	3	2	2

25CHPESCN	MIXING THEORY & PRACTICE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To teach the students about the importance of mixing in chemical process industries. To teach the students about the heat and mass transfer impacts in mixing.
- To enlighten the knowledge about behavior of the Newtonian and Non Newtonian Liquids.

UNIT - I

Mixing in chemical processes

Examples of processes signifying importance of mixing - Goodness of mixing: Qualification - Significance of dimensionless groups - dimensional analysis - power number correlation - Expressions for NRe, NFr, NWe, NPr from their definitions as ratios applied to resisting forces - analogy between drag coefficient and power number. Power curves with and without baffles - power reduction - Power measurement techniques - Scale - up - principle of similarity - scale-up criteria - Operating characteristics of small blade and large blade agitators

UNIT – II

Mixing operations

Mixing of solids, liquids, immiscible liquids and semisolids. Industrial mixing – Batch – Continuous. Purging of stirred tanks in series - Effect of mixing on chemical reactions - introduction -batch reactor and CSTR comparison - Residence time distribution - mixing concepts and models - RTD functions J(8) and J'(8). Imperfect mixing in Stirred tanks. Challenges in industrial mixing – lumping – clogging – air intrusions – foaming.

UNIT - III

Heat transfer and mass transfer in Mixing

Heat transfer promotion by mixing - mixing and overall heat transfer coefficient - Heat transfer correlation for helical coils and jacketed vessels - transient analysis of heat transfer - Design calculation for heat transfer in mixing vessels - Mixing and mass transfer - introduction - Interfacial phenomena - drop size distribution -coalescence - breakage - emulsion - surfactant - Mass transfer coefficient - two film concept - mass transfer modeling - Correlation for mass transfer coefficient - stage efficiency.

UNIT - IV

Fluid Behaviour in Mixing

Non-Newtonian liquids mixing - introduction, pseudoplastic, dilatant, Bingham plastic liquid, - thixotropic and rheopectic liquids - shear rate - shear stress behaviour - apparent viscosity - Power curve for non-Newtonian liquids - Viscometry - shear in stirred tanks - Shear in stirred tanks related to shear in pipes, apparent viscosity in pipe-line flow and stirred tanks - discussion of experimental work literature - Reynolds number modification - Practical application of Non-Newtonian mixing.

UNIT – V

Industrial Mixing Equipments

Different agitator types - appearance, characteristic features viscosity ranges, advantages, flow patterns they create and mounting specialties if any of turbines, propellers, paddles, anchors, gates, helical screws, helical ribbons. Industrial Mixers.

TEXT BOOKS:

1. Holland and Chapman, Liquid Mixing and processing in Stirred Tanks, Reinhold Publishing Co-operation, 1966, New York and London.
2. Uhl and Gray, Mixing theory and practice, Vol.1 and II, 1967, Academic Press, NewYork and London.

REFERENCES:

1. Shinji Nagata, Mixing Principles and Applications, 1975, HoltedPress , Tokyo

COURSE OUTCOMES:

After the completion of the course, the student should be able to

1. Understand the Basics of mixing in Chemical Processes.

2. Able to gain knowledge on mixing operations in the mixing equipments.
3. Understand the impact of heat transfer and mass transfer in mixing.
4. Understand the behavior of fluids in mixing.
5. Gain knowledge on the industrial mixing process and equipments.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	2	2	-	-	-	2	3	2	2
CO2	2	2	2	2	-	2	2	-	-	-	2	2	2	2
CO3	3	2	2	2	-	2	2	-	-	-	2	3	2	2
CO4	3	2	2	2	-	2	2	-	-	-	2	2	2	2
CO5	3	2	2	2	3	3	2	-	-	-	2	2	2	2

25CHPESCN	**TECHNOLOGY OF FINE AND SPECIALTY CHEMICALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the Fine chemical production methods in Global level and basic need of fine chemical industries
- Study of Chemical technology of selected Fine chemicals and Specialty chemicals
- Role of Catalysis and catalytic processes in fine chemical production
- Fine chemical manufacturing methods and scale up procedure
- To analyze the design, cost and operation for fine chemical process

UNIT I

Introduction. Characteristic features of fine and specialty chemicals manufacture. Types of Catalysts in Fine Chemicals Synthesis**.** Role of Heterogeneous Catalyst in Improving Selectivity**.** Aspects of Process Development of Fine Chemicals**.** Relevant Separation Methods**.** Different Types of Manufacturing Facilities of Fine Chemicals.

UNIT II

Chemistry of Fine and Specialty Chemicals Synthesis. Fine and specialty chemicals introduction, Historical development of organic synthesis. Fine and specialty chemicals vs. bulk chemicals manufacture. Process selection: process profile analysis. Factors influencing process choice: cleaner and safer technologies. E factors and atom utilization. The role of catalysis in waste minimization. Fine chemicals and specialty chemicals and catalysis: examples.

UNIT III

Types of Catalysts in Fine Chemicals and specialty Synthesis. Introduction. Mechanism of catalysis. Heterogeneous catalysts - types and preparation. Catalyst performance: activity, selectivity, and stability. Catalyst selection. Catalyst characterization. Homogeneous catalysis. Phase-transfer catalysis. Biocatalysis.

Role of Heterogeneous Catalyst in Improving Selectivity. Heterogenization of homogeneous catalysis. Additional liquid phase. Rate and selectivity improvement via manipulation of 'microenvironment'. Rate and selectivity improvement via manipulation of 'macro environment'. Unconventional techniques. Continuous processes.

UNIT IV

Brief overview of Relevant Separation Methods. Application of Distillation. Extraction. Crystallization. Adsorption. Membrane separations for fine and specialty chemicals Processing.

Aspects of Process Development of Fine and specialty Chemicals. Introduction. Steps in process development. Scale-up procedures. Chemical reactor scale-up, design, and Operation. Acronyms and symbols.

UNIT V

Brief overview of Different Types of Manufacturing Facilities of Fine and specialty Chemicals. Types of production plants for Fine Chemicals. Typical equipment in a multi-product plant. Production costs. Design and scheduling of batch plants. Principles of good Manufacturing practice.

TEXTBOOKS:

1. Fine Chemicals Manufacture: Technology and Engineering, A. Cybulski M.M. Sharma R.A. Sheldon J.A. Moulijn, Elsevier Science 2001.
2. Sustainable Value Creation in the Fine and Specialty Chemicals Industry – R Rajagopal Wiley

publications, 2014.

3. Specialty Chemicals Innovations in industrial synthesis and applications - B Perason, Springer Netherlands, 1991.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand and analyze the characteristic features of fine and specialty chemicals.
2. Know and the development of the cleaner and safer technologies for the synthesis of fine and specialty chemicals.
3. Understand the mechanism and design of catalysts used in the fine and specialty chemicals production.
4. Assess, design and apply various separation methods for the development of fine and specialty chemicals
5. Apply the principles of costing, management, and good manufacturing practice for the production of fine and specialty chemicals.

Mapping with POs & PSOs														
COS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	2	2	1	-	-	2	2	2	1
CO2	3	3	3	3	-	2	2	1	-	-	2	2	2	1
CO3	3	3	3	3	-	2	2	1	-	2	2	2	2	1
CO4	3	3	3	3	-	2	2	2	-	2	2	2	2	1
CO5	3	3	3	3	-	2	2	2	-	2	2	2	2	1

25CHPESCN	**COMPUTATIONAL FLUID DYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the fundamental concepts, governing equations, and basic numerical techniques of Computational Fluid Dynamics (CFD), enabling learners to understand and simulate simple fluid flow and heat transfer problems.

- To provide brief introduction of Computational Fluid Dynamics along with chemical engineering application specifically, analysis of fluid mechanics and heat transfer related problems.
- o understand the mathematical representation and physical significance of the pressure gradient term and the continuity equation in fluid dynamics, and to apply these principles in the formulation and analysis of fluid flow problems.
- To analyze and understand the behavior of steady one-dimensional convection and diffusion processes, and to apply governing equations for modeling mass, momentum, and heat transfer in fluid systems.

UNIT I

Basics of computational fluid dynamics-Governing equations of fluid dynamics- Continuity,

Momentum and Energy equations-Chemical species transport-Physical boundary conditions-Time-averaged equations for turbulent flow-Turbulent-Kinetic Energy Equations-Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II

Derivation of finite difference equations-Simple Methods-General Methods for first and second order accuracy-solution methods for finite difference equations-Elliptic equations-Iterative solution Methods-Parabolic equations-Explicit and Implicit schemes- Example problems on elliptic and parabolic equations.

UNIT III

Finite volume formulation for steady state One, Two and Three-dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank - Nicolson and fully implicit schemes.

UNIT IV

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT V

Representation of the pressure gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and Velocity corrections -Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models.

TEXT BOOKS:

1. T.J. Chung, Computational Fluid Dynamics, Cambridge University, Press, 2002. 85
2. Versteeg, H.K., and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The finite volume Method, Longman, 1998.
3. Ghoshdastidar , P.S., computer Simulation of flow and heat transfer, Tata McGraw Hill Publishing Company Ltd., 1998.
4. Anderson Jr J. D., “Computational Fluid Dynamics: The Basics with Applications”, 1995, McGraw Hill.

REFERENCES:

1. Muralidhar K. and Sundararajan T., “Computational Fluid Flow and Heat Transfer”, 2003, Narosa Publishing House.
2. Vivek V. Ranade, Computational flow modeling for chemical reactor engineering 2002, Academic Press, San Diego.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Assess the governing equations involving continuity, momentum and energy. Analyze the

effect of PDEs on CFD.

2. Investigate the use of Finite Difference equations involving simple and iterative methods.
3. Assess Finite volume formulation for steady state One, Two and Three-dimensional diffusion problems and fully implicit schemes.
4. Generate and optimize the numerical mesh for steady one-dimensional convection and diffusion
5. Justify representation of the pressure gradient term and continuity equation in context to conservativeness, boundedness, trasnportiveness, hybrid, power-law, QUICK Schemes.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	3	2	3	2	3	-	3	3	-	-
CO2	3	3	3	3	3	2	3	2	3	-	3	3	3	2
CO3	3	3	3	3	3	2	3	3	3	-	3	3	3	2
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	2
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

25CHPESCN	**OPTIMIZATION OF CHEMICAL PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- The course is aimed at developing the skills of engineering students in Optimization of chemical processes.
- The learners will be enabled to appreciate the important role of Optimization of chemical processes concepts in engineering application.

UNIT I :Objective and formulation of optimization

Objective and Introduction, Objective Function and Decision variables, Inequality and Equality Constrains in Models Formulation of the Objective Function, Lower and Upper Bounds, Selecting Functions to Fit Empirical Data, Factorial Experimental Designs, Degrees of Freedom, Economic Objective Functions, Measures of Profitability

UNIT II: Basic concepts of optimization

Continuity of Function, NLP Problem Statement, Convexity and Its Applications, Interpretation of the Objective Function in Terms of its Quadratic Approximation, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function.

UNIT III: Optimization of unconstrained functions

One-Dimensional Search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Unidimensional Search.

UNIT IV: Unconstrained multivariable optimization

Linear Programming (LP) and Applications Geometry of Linear Programs, Basic Linear Programming Definitions and Results, Simplex Algorithm, Barrier Methods, Sensitivity Analysis, Linear Mixed Integer Programs, Application of the EXCEL Solver Spreadsheet for Optimization, Formulation. Introduction to Non-linear Programming with Constraints and Mixed-Integer Programming.

UNIT V: Application of optimization in chemical engineering

Examples of Optimization in Chemical Processes like optimizing recovery of waste heat, Optimal Shell and Tube Heat Exchanger Design, Optimal Design and Operation of binary Distillation Column, Optimal pipe diameter etc. Flow sheet Optimization - Case studies.

TEXT BOOKS:

1. Edger T.F., Himmelblau D.M. and Lasdon L.S., "Optimization of Chemical Processes", 2nd Edition, 2001, McGraw- Hill.
2. Seider W.D., Seader J.D. and Lewin D.R., "Product and Process Design Principles- Synthesis, Analysis, and Evaluation", 2nd Edition, 2008, John Wiley and Sons Inc

REFERENCES:

1. Kalyan Moy Deb "Optimization for Engineering Design", 2nd Edition, 2009, Prentice Hall of India.
2. Gupta P.K, Hira D.S, Problems in Operations Research – First Edition 1991, S.Chand& Company Ltd. New Delhi.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Identify and formulate optimization problems in chemical engineering
2. Compare the constrained and unconstrained situations in the chemical reactions
3. Apply the optimization software tools in chemical engineering processes
4. Solve the various multivariable optimization problems
5. Apply the optimization concepts in chemical process equipment's.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	-	-	2	-	-	-	3	3	-	3
CO2	3	3	3	2	-	-	2	-	-	-	3	3	-	3
CO3	3	3	3	2	-	-	2	-	-	-	3	3	-	3
CO4	3	3	3	2	-	-	2	-	-	-	3	3	-	3
CO5	3	3	2	2	-	-	2	-	-	-	3	3	-	3

25CHPESCN	**OPERATIONS RESEARCH**	**L**	**P**	**T**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To teach the basic principles on operations research and optimization problem.
- To teach the basic knowledge on principles of linear programming.
- To familiarize the functioning of nonlinear programming
- To illustrate the concepts of decision making and game theory
- To teach the design of optimization by PERT and CPM

UNIT-I

Basics of operations research - Linear programming- mathematical formulation- graphical methods, theory and applications of simplex method, duality theory, revised simplex methods.

UNIT-II

Transportation models- formulation as LP problem, methods of obtaining initial solution, setting up of transportation table- performing optimality test- test for optimality

UNIT-III

Dynamic programming; Non linear programming

UNIT-IV

Decision theory and games: decision making under conditions of certainty- decision making under conditions of uncertainty- optimistic criterion- pessimistic criterion; decision making under conditions of risk. The theory of games- maximin and minimax criteria-mixed strategies for games with saddle points

UNIT-V

Programming Evaluation and Review Technique (PERT) and Critical path method (CPM)

TEXT BOOKS:

1. Gupta P.K, Hira D.S, Problems in Operations Research – First Edition 1991, S.Chand & Company Ltd. new Delhi.
2. Rudd, F., C. Watson, Strategy of Process Engineering, 19686, John Wiley.

REFERENCES:

1. Taha H.A "Operation Research" IX Edn, 2010, Prentice Hall of India, New Delhi.
2. Sharma S.K."Mathematical models in Operation Research," Tata McGraw Hill Publishing Company Ltd ,New Delhi.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the different methods of solving problem.
2. Acquire knowledge on linear programming with limitations.
3. Acquire knowledge on principles of nonlinear programming.
4. Understand the concepts, principles of game theory and decision making.
5. Acquire knowledge on design and develope optimization using PERT and CPM.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	2	2	2	2	2	2	3	3	2
CO2	3	3	3	3	2	3	2	2	2	2	2	3	3	2
CO3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
CO4	3	3	2	3	2	2	2	2	2	2	2	3	3	2
CO5	3	3	3	3	3	2	2	2	2	2	2	3	3	2

25CHPESCN	**PROCESS MODELING & SIMULATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

Course Objective:

- To understand knowledge of fundamental principles and basic laws of modeling.
- Formulation of a mathematical model for various chemical Engineering processes.

- To apply the mathematical model inChemical Reaction Engineering.
- To apply the mathematical model to simulate mass and heat transfer processes.

Unit-I: Introduction, uses of mathematical models, Scope of coverage, Principles of formulations, Fundamental Laws, Continuity equations, Energy equations, Equation of motions, Transport equation, Equation of State, Equilibrium and Chemical Kinetics, Simple Examples. Introduction of Matlab.

Unit-II: Mathematical Modeling in Fluid Mechanics - Simple hydraulic Tank, Variable flow, Hydraulic Tank, Enclosed Tank, Adiabatic compression in Gas space, Gas flow system, Example, Three volume gas flow system, pipeline Gas flow, Hydraulic transient between two reservoirs, Pumping system

UNIT – III Mathematical Modeling in Chemical Reaction Engineering: Basic Modeling, Mixing Vessel, Mixing with reaction, Reaction kinetics- Reversible reaction CSTR, PFR, Batch reactor, Series of isothermal CSTR, CSTR's with variable hold ups, non-isothermal CSTR, Radical kinetics, Elementary radical of mechanics, Rate limits steps, Heterogeneous kinetics, Example Auto Clave.

Unit-IV: Mathematical Modeling in Heat transfer: Steam jacketed vessel, Two heated tanks, single component vaporizer, continuous flow boiling system double pipe heat exchanger, shell and tube heat exchanger, multicomponent flash drum, cooling towers. forward and backward feed triple effect evaporator

Unit-V: Mathematical Modeling in Mass Transfer: Batch liquid- liquid extraction, continuous extraction, multistage countercurrent extraction, Ideal binary distillation column, multicomponent non ideal distillation column, pipe line flash process,. Absorption, Adsorption.

TEXT BOOKS:

1. Lubyen W. L., Process Modeling, Simulation and Control for Chemical Engineers, McGraw- Hill, New York, 1989.
2. Franks RGE, Modeling and Simulation in Chemical Engineering, 1971, Wiley Inter - Science, New York.
3. Elements of Chemical Reaction Engineering by Fogler, Prentice Hall of India.
4. Mickley H. S., Sherwood T. S., Reed C. E., Application of Mathematical Modeling in Chemical Engineering, Tata-McGraw-Hill, New Delhi, 2002.
5. A. Kayode Coker, Modelling of Chemical Kinetics and Reactor Design, Gulf professional publication

COURSE OUTCOMES:

After the completion of this course, the students will be able to

1. Understand the principles of fundamental laws, reaction kinetics and uses of models.
2. Develop models for chemical processes used in industries.
3. Develop mathematical models fordistillation, extraction and absorption process.
4. Develop models for heat exchanger and pipe flow process.
5. Apply mathematical modelling in Chemical Processes.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	2	-	-	-	-	3	3	2	-	3
CO2	3	3	3	3	1	2	2	-	2	3	3	1	2	3
CO3	3	2	3	3	1	2	2	-	2	3	3	2	1	3
CO4	3	2	3	3	1	2	2	-	2	3	3	2	1	3
CO5	3	3	3	3	1	2	2	-	2	3	3	2	1	3

25CHPEXXX	**HAZARDOUS CHEMICAL STORAGE AND HANDLING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- Identify and classify hazardous chemicals
- Assess and manage the hazards associated with chemicals.
- Handle chemicals and operate chemical plant safely
- Implement proper procedures for storage and transportation of hazardous chemicals
- Identify potential emergency incidents of toxic and hazardous materials

UNIT - I

Introduction to Toxic and Hazardous Materials (HAZMAT) - Classification of toxic and hazardous substances - Types of hazard - Material safety data sheets - Toxicity and health effects - Control of sources of exposure - Environmental effects on health- Safety and health Standards - Indian Standards & Codes for safety & health - International standard: OHSAS 18001

UNIT - II

Chemical hazards - Classification of Chemical Hazards and their control - Occupational diseases and Poisoning - Prevention of diseases due to chemical effect - Safety aspects in plant layout – Ventilation and Lighting - Color codes and symbols for Safety in chemical plants - Classification of Color codes and Symbols - Color codes for gas cylinders and pipelines - Personal Protective Devices (PPDs) - Non Respiratory – Respiratory

UNIT - III

Safe Handling of Hazardous Chemicals - Safe Handling of Toxic and Hazardous Materials - Safe Work Systems and Essential practices for handling hazardous chemicals - Personal protection clothing and equipment (selection and use) - Provision of training and information on chemical risks - General and local exhaust ventilation methods - Maintenance of engineering control measures - Monitoring and Measuring methods and record-keeping - Laboratory waste management - Transportation of hazardous chemicals

UNIT - IV

Operational Control Measures - Risk assessment techniques for identifying chemical hazards - Analyzing risk assessment findings and evaluating risk levels - Control measures for chemicals hazardous to health - Control measures of flammable, dangerously reactive or explosive chemicals - Control measures for the storage of hazardous chemicals - Hazardous waste audit and disposal and treatment of waste chemicals - Fire Hazards and their Prevention

UNIT - V

Emergency Management and Response Plans - Identifying potential emergency incidents of toxic and hazardous materials - Emergency response procedures - On-site and Off-site Emergency plans - Emergency training, exercises and drills- Medical first aid, health surveillance and medical records - Investigation of incidents and lessons learned

COURSE OUTCOMES:

After learning the course, the students will be able to

1. Understand the toxicity and health effects of hazardous chemicals
2. Know about the chemical hazards and their control.
3. Understand the safe handling of hazardous chemicals
4. Knowledge in operational control measures of hazardous chemicals
5. Clear about the emergency response procedures and emergency training of workers in industries.

TEXT BOOKS

1. Manual of Chemical Technology, Chemtech-I D.Venkateswarlu, K.R.Upadrashta, K.D. Chandrasekaran Chemical Engineering Education Development Centre, IIT, Madras, 1975

2. Fundamentals of Industrial Safety & Health Dr. K. U. Mistry Siddharth Prakashan, Ahmadabad

3. Chemical Process Safety: Fundamentals with Application Daniel A. Crowl, Joshef F. Louvar, 3rd Edition, 2011, Prentice Hall, USA,

4. Industrial Safety Management N. K. Tarafdar, K. J. Tarafdar Dhanpatrai and Co.Ltd, New-Delhi, 1st Edition, 2012

5. Industrial Safety Management L M Deshmukh Tata McGraw Hill, New Delhi, 2006

6. Industrial Safety, Health & Environment Management Sunil S. Rao, R.K.Jain Khanna Publishers, New Delhi, 2006

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2									3		
CO2	1	2	2									3		
CO3	1	2	2									3		
CO4	1	3	3									3		
CO5	1	3	3									3		

25CHPESCN	**TOTAL QUALITY MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To have a comprehensive knowledge on the evolution, principles, practices, tools and techniques of Total quality management.
- To understand the quality statements, customer focus and elements of continuous quality improvement.
- To comprehend the traditional and contemporary tools of quality control and bench marking.
- To understand the working of the quality circle and strategies for improvement and enhance performance.
- To learn the importance of ISO audits and management strategies for improved qualities.

UNIT I: Introduction

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality - Basic concepts of TQM – TQM Framework - Contributions of Quality Gurus – Barriers to TQM – Cost of Quality.

UNIT II: TQM Principles

Quality statements - Customer focus –Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Continuous process improvement – PDCA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating

UNIT III: TQM Tools & Techniques I

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV: TQM Tools & Techniques II

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures - BPR.

UNIT V: Quality systems

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing QS 9000 – ISO 14000 – Concepts, Requirements and Benefits –Quality Council – Leadership, Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

TEXT BOOKS:

1. Dale H.Besterfiled, Carol Besterfield-Michna,Glen Besterfield,Mary Besterfield-Sacre, "Total Quality Management", Third Edition , 2006, Pearson Education Asia, , Indian Reprint
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Ed., 2005, South-Western (Thomson Learning).

REFERENCES:

1. Oakland, J.S. "TQM – Text with Cases", Third Edition , 2003, Butterworth – Heinemann Ltd., Oxford.
2. Suganthi,L and Anand Samuel, "Total Quality Management", 2006, Prentice Hall (India) Pvt. Ltd.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Know prerequisites of evolution of total quality management and significant contributions of quality gurus' to the management of modern organizations.
2. Evaluate the principles of quality management and to administer how these principles can be applied within quality management systems.
3. Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
4. Identify and prioritize customers' expectations quickly and effectively and to enlist the factors for improving the "Overall Equipment Effectiveness"
5. Describe the various elements of quality systems and critically appraise the teamwork requirements for effective quality management.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	2	2	3	2	1	2	3	2	3	2
CO2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

25CHPESCN	CHEMICAL WORKS ORGANIZATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To Provide foundational knowledge of organizational structures, roles, and functions within chemical industries to understand how engineering and management intersect in real-world operations.
2. To equip students with the ability to plan projects effectively, including site selection, plant layout, equipment arrangement, and workflow optimization specific to chemical process industries.
3. To familiarize students with essential concepts of production planning, process scheduling, materials management, and quality control to improve operational efficiency in chemical plants.
4. To impart knowledge on the importance of industrial safety standards, environmental regulations, and risk management practices to ensure sustainable and compliant chemical plant operations.
5. To provide students with skills to conduct cost estimation, budgeting, and economic evaluation of chemical engineering projects for informed decision-making and resource optimization.

UNIT - I

Industrial Relations – Introduction. Significance & conditions for good industrial relations- Causes of poor industrial relations & suggestions to improve it. Labour disputes in India. Industrial disputes act-1947 (only Salient Points). Types of industrial disputes – strikes – lockouts. Regulation of strikes & Lockouts.

UNIT - II

Business organization - Various forms of private, ownerships, comparison and choice. Industrial Organizations - Plant location - Factors influencing plant location - split and coupled locations- size of industrial units. Plant layout - Choice of equipment various types of layout - guarding of machineries - illumination, heating and ventilation.

UNIT - III

Material management - Organization - Production Planning, purchase, store - inventory control, sales and marketing. Scientific management - Rationalization - time and motion study analysis. Time management.

UNIT IV

Personality predispositions – personality and personality types, Maddi's models of personality. Perpectual process – development of perpectual skills. Motivation and work performance. Reinforcement theory – Relationship between motivation and performance.

UNIT V

Dynamics of communication – The communication process, structure of communication, Transactional Analysis, The five common communication networks in an organization. Group Dynamics – Synergy through groups, Group behaviour, group effectiveness, stages of group development. Properties and Characteristics of Highly effective groups

TEXT BOOKS:

1.Sukla,M.C., Business Organization and Management, 2010.

2.Uma sekaran – "Organisational Behaviour – Text and Cases" 2004, Tata McGraw Hill New Delhi.

REFERENCES:

1.Tripathi – "Personnel Management & Industrial Relations" 2013, Sultan Chand and Sons New Delhi.
2.K.Aswathappa, Organization behavior - Texts and Cases, 1997Himalaya Publishing House.
Industrial disputes act-1947
3.Chakraborty S K- Managerial Development & Appraisal –Macmillan India
4.Strauss & Sayles – Personnel Management

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understanding the salient features of good relations and industrial disputes
2. Gaining knowledge about types of ownerships, plant layout and plant location
3. Developing skills in management of material, marketing, and time
4. Attaining skills to develop personality in motivating performance
5. Improving knowledge on dynamics, structure of communication, and group behavior

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	3	2	3	3	3	3	3	3	2	3	3
CO2	2	2	3	3	3	3	3	2	2	3	3	2	3	3
CO3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
CO4	2	2	3	3	3	2	3	3	3	3	3	3	3	3
CO5	2	2	2	3	2	2	3	3	3	3	3	2	2	3

25CHPESCN	**ENTREPRENEURSHIP & INNOVATION: BUILDING THE FUTURE**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To provide students with a clear understanding of the entrepreneurial mindset, types of entrepreneurs, and the role of innovation in identifying and developing business opportunities.
2. To equip students with the ability to prepare business plans, conduct market research, evaluate feasibility, and structure new ventures relevant to the chemical and allied industries.
3. To familiarize students with the legal structures for startups, intellectual property rights, licenses, and environmental regulations specific to chemical-based enterprises.
4. To teach students key concepts of funding, budgeting, cost analysis, and resource optimization essential for launching and sustaining a chemical-based business.
5. To inspire students to apply chemical engineering knowledge to develop innovative, sustainable, and socially responsible solutions through entrepreneurship.

UNIT – I

Meaning – Characteristics of management – Nature of management – Process of management – Functional areas of management – Management and administration – Role of management – Level of management – Evolution of management.

UNIT – II

Meaning - Nature of planning – Importance of planning – Types of planning – Steps in planning – Decision making – Meaning and definition of organizing – Steps in organizing – Nature of organization – Organization structure – Purpose of organization – Principles of organization – Delegation of authority – Nature and importance of staffing.

UNIT – III

Meaning and nature of direction – Principles of directing – Leadership and leadership style – Motivation – Communication – Need and feedback in communication – Importance of communication – Channels of communication – Types of communication – Forms of communication.

UNIT – IV

Evolution of concept of entrepreneur – Concept of entrepreneur – Characteristics of entrepreneur – Distinction between entrepreneur and manager – Technical entrepreneur – Charms of being an entrepreneur – Types of entrepreneur – Role of entrepreneurship in economic development – Barriers in entrepreneurship.

UNIT – V

Meaning of project – Project classification – Project identification – Meaning and significance of project report – Contents of a project report – Formulation of project report – Planning commission guidelines – Identification of opportunity – Project feasibility study.

TEXT BOOKS:

1. Veerabhadrappahavinal, Management and entrepreneurship, New age International, New Delhi, 2008. 2. Peter F. Drucker; Innovation and entrepreneurship, Butterworth – Heinemann, London, 1985.

REFERENCES:

1 "Creativity, innovation, entrepreneurship and enterprise in construction and development", University of Reading, Alan Barrell – Entrepreneur in Residence Entrepreneur in Residence, University of Xiamen, Xiamen 2012.

2 "Entrepreneurship Studies", National University Commission (Nigerian University System), 2010.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Identify the concept of management, nature, process, functional areas, roles and levels of management.
2. Assess the importance of planning, decision making, organization structure and delegation of authority
3. Examine the principles of direction, leadership styles, importance of communication, types of communications and forms of communication.
4. Assess the concept of entrepreneurship, charms, types and role of entrepreneur, role and barriers
5. Evaluate the meaning of project, identification, classification and feasibility of projects

Mapping with POs & PSOs													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	2	1	2	3	3	3	3	3	1	2	3
CO2	1	1	3	3	2	3	3	3	3	3	3	2	3	3
CO3	1	1	3	3	2	3	3	3	3	3	3	2	3	3
CO4	1	1	1	3	2	3	3	3	3	3	3	3	3	3
CO5	2	3	3	3	3	3	3	3	3	3	3	3	3	3

25CHPESCN	**INDUSTRIAL RELATIONS & ORGANIZATIONAL DEVELOPMENT**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

1. To provide students with a foundational understanding of employer-employee relationships, labor laws, trade unions, and dispute resolution mechanisms in industrial settings.

2. To enable students to understand individual and group behavior in organizations, including motivation, communication, leadership, and conflict management.

3. To introduce the concepts, models, and interventions used in organizational development to improve effectiveness, adaptability, and employee engagement.

4. To prepare students to manage and adapt to organizational change, especially in the context of technological advancements and global competition in chemical industries.

5. To provide insights into recruitment, training, performance appraisal, and employee welfare with a focus on enhancing productivity and maintaining positive industrial relations.

UNIT I

Impact of Industrial Revolution – Industrial Relations: Concept – Importance of Industrial Relations – Scope and Aspects of Industrial Relations –Factors Affecting Industrial Relations – Perspectives/Approaches to Industrial Relations – Organisation of Industrial Relations – Dimensions of Industrial Relations Work – Prerequisite Successful Industrial Relations Programme.

UNIT II

Evolution of Industrial System – Anatomy of industrial conflicts - Genesis of Industrial Conflicts – Industrial Conflicts/Disputes – Concept and Essential of a Dispute – Classification of Industrial Disputes – Impact of Industrial Disputes – Cause of Industrial Conflicts –Strikes – Typology of Strikes — Lockouts. The state and industrial relations policy - Evolution of Industrial relations policies – Industrial Relations Policy During the plan Period – The Plan Period – Recognition of Unions Machinery for solving the Dispute - Standing Orders –Grievances – Procedure for Settlement – Essence of Model Grievance Procedure.

UNIT III

The Industrial Disputes Act, 1947 - Wage Legislations - The Payment of Bonus Act, 1965 - The Factories Act, 1948. Recent Amendments.

UNIT IV Group

Behaviour: Group Dynamics, Cohesiveness and Productivity; Management of Dysfunctional groups; Group Decision Making; Organisational Politics. Leadership - Concept and Styles; Fielder's Contingency Model; House's Path - Goal Theory; Leadership Effectiveness; Sources, patterns, levels, and types of conflict; Traditional and modern approaches to conflict; Functional and dysfunctional conflicts; Resolution of conflict.

UNIT V

Organization structure – Formation – Groups in organizations – Influence – Group dynamics – Emergence of informal leaders and working norms – Group decision making techniques – Team building - Interpersonal relations – Communication – Control. Meaning – Importance – Leadership styles – Theories – Leaders Vs Managers – Sources of power – Power centers – Power and Politics. Organizational culture and climate – Factors affecting organizational climate – Importance. Job satisfaction – Determinants – Measurements – Influence on behavior. Organizational change – Importance – Stability Vs Change – Proactive Vs Reactive change – the change process – Resistance to change – Managing change. Stress – Work Stressors – Prevention and Management of stress – Balancing work and Life. Organizational development – Characteristics – Objectives – Organizational effectiveness Developing Gender sensitive workplace.

TEXT BOOKS:

1. Mamoria, Mamoria and Gankar, "Dynamics of Industrial Relations", Himalaya Publishing House, Sixteenth Edition, 2008.
2. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008. 11 2. Fred Luthans, Organisational Behavior, McGraw Hill, 11th Edition, 2001.

REFERENCES BOOKS:

1. Mc Shane & Von Glinov, Organisational Behaviour, 4th Edition, Tata Mc Graw Hill, 2007.
2. Nelson, Quick, Khandelwal. ORGB – An innovative approach to learning and teaching. Cengage learning. 2nd edition. 2012
3. Ivancevich, Konopaske & Maheson, Oranisational Behaviour & Management, 7th edition, Tata McGraw Hill, 2008.
4. Udai Pareek, Understanding Organisational Behaviour, 3rd Edition, Oxford Higher Education, 2011.
5. Jerald Greenberg, Behaviour in Organization, PHI Learning. 10th edition. 2011

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to:

1. Assess the industrial revolution, its effect on industrial relations, scope and aspect of industrial relations and factors affecting industrial relations
2. Identify the concept of dispute / conflict, strikes, industry relation plan, grievances and grievances models
3. Investigate the legislative aspects including the Industrial Disputes Act 1947, The Payment of Bonus Act 1965 and The Factories Act
4. Identify the nuances of Group Behaviour, Types of Leadership and dealing with conflicts.
5. Assess the organization structure, leadership styles, organizational climate, managing stress, organizational development and effectiveness.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	3	2	1	3	2	1	2	3	1	2	2
CO2	1	2	2	3	1	1	3	2	2	3	3	1	3	2
CO3	1	2	2	2	1	1	3	1	2	3	3	1	2	2
CO4	1	3	3	3	2	2	3	3	3	3	3	1	3	3
CO5	1	3	3	3	2	2	3	3	3	3	3	1	3	3

25CHPEXXX	AI AND ML IN CHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

- Understand foundational AI and ML concepts relevant to chemical engineering.
- Apply machine learning tools to solve problems in process systems, molecular design, and optimization.
- Interpret and validate data-driven models used in chemical processes.
- Use AI techniques in control, fault detection, and predictive maintenance.
- Analyze real-world case studies where AI and ML have been successfully applied in chemical engineering, fostering critical thinking and innovation in solving engineering problems.

Unit I: Introduction and Foundations

Overview of AI/ML in chemical engineering. Types of ML: Supervised, Unsupervised, Reinforcement Learning. Tools & Libraries: Python, Scikit-learn, TensorFlow/PyTorch, Pandas. Data preprocessing and feature engineering

Unit 2: Supervised Learning

Regression: Linear, Ridge, Lasso, SVR. Classification: Decision Trees, Random Forests, SVM, k-NN. Model performance metrics: RMSE, R^2, Confusion Matrix, ROC-AUC. Case Study: Predicting reaction yields or product quality

Unit III: Unsupervised Learning and Dimensionality Reduction

Clustering: k-Means, Hierarchical, DBSCAN. Dimensionality Reduction: PCA, t-SNE, Autoencoders. Application: Process monitoring, anomaly detection

Unit IV: Deep Learning

Neural Networks: Architecture, activation functions, back-propagation. Convolutional Neural Networks (CNNs): For image-based reactor monitoring. Recurrent Neural Networks (RNNs), LSTM: For time-series data in process control. Application: Fault detection, predictive maintenance

Module V: Process Systems Engineering Applications

Soft sensors and virtual metrology. Surrogate modeling for process simulation. Optimization with ML-based models. Hybrid modeling: Combining first-principles with ML.

Molecular and Materials Design

ML in computational chemistry and materials discovery. Property prediction (e.g., solubility, boiling point). Generative models for molecular design (VAEs, GANs)

Textbooks:
1. Machine Learning: A Probabilistic Perspective by Kevin P. Murphy
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

COURSE OUTCOMES:
Upon the completion of the course, the students will be able to:

1. Explain key concepts, algorithms, and workflows in artificial intelligence and machine learning relevant to engineering problems.
2. Recognize processes and operations within chemical engineering that can benefit from AI/ML-based solutions.
3. Prepare chemical process data for ML modeling, including handling missing data, scaling, and feature selection.
4. Implement supervised and unsupervised learning models using tools like Python, Scikit-learn, Tensor Flow, etc., and evaluate their performance using appropriate metrics.
5. Critically evaluate real-world examples where AI/ML has been applied in areas like reaction engineering, materials discovery, and process monitoring.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	3	2						3	1	1	
CO2	3	2	2	3	1						3	1	1	
CO3	3	2	2	2	1						3	1	1	
CO4	3	3	3	3	2						3	1	1	
CO5	3	3	3	3	2						3	1	1	

25CHPEXXX	**PILOT PLANT AND SCALE UP METHODS IN CHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Unit – I
Scale up: Description and evolution of a process system, Introduction to Scale up procedures, Dimensional analysis, Similitude.

Unit – II
Reactors for Fluid Phase Processes Catalyzed by Solids: Pseudo-homogeneous and heterogeneous models, Two-dimensional models, Scale up considerations.

Unit – III
Fluid-fluid Reactors: Scale-up considerations in packed bed absorbers and bubble columns, Applicability of models to scale-up.

Unit – IV

Mixing Processes: Scale-up relationships, Scale-up of polymerization units, Continuous stages gas liquid slurry processes, Liquid-liquid emulsions.

Fluidized Beds: Major scale-up issues, Prediction of performance in large equipment, Practical commercial experience, Problem areas.

Unit – V

Solid-Liquid Separation Processes: Fundamental considerations, Small scale studies for equipment design and selection, Scale-up techniques, Uncertainties.

Continuous Mass Transfer Process: Fundamental considerations scale-up procedure for distillation, Absorption, Stripping and extraction units.

Text Books:

1. Marko Zlokarnik, Scale-up in chemical engineering, Wiley-VCH (2006).
2. R.E. Johnstone and M.W. Thring, Pilot Plants, Models and Scale-up Methods in Chemical Engineering, McGraw-Hill (1957).

Reference Books:

1. Colin Divall, Sean Johnston, Scaling up: the Institution of Chemical Engineers and the rise of a new profession, Springer (2000).
2. Bisio, A. and Kabel, R.L., Scale-up of Chemical Processes, John Wiley (1985).

COURSE OUTCOMES:

Upon the completion of the course, the students will be able to:

1. Explain the significance of pilot plants in chemical process development and scale-up strategies.
2. Apply dimensional analysis and similarity criteria for effective scale-up of chemical processes
3. Analyze the key differences between laboratory-scale, pilot-scale, and industrial-scale processes.
4. Evaluate scale-up challenges in mixing, heat transfer, mass transfer, and reaction kinetics.
5. Use empirical and theoretical models to predict performance of full-scale equipment based on pilot plant data.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	-									3		
CO2	3	2	2	2								3		
CO3	3	2	2									3		

CO4	3	3	3									3		
CO5	3	3	3		2							3		

OPEN ELECTIVES

25CHOESCN	SOLID WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Provide students with an understanding of technical issues and the management of resources and solid waste.
- Examine appropriate methods of storage, collection, transfer, treatment and disposal appropriate for industrialized and developing countries.

UNIT-I

Sources and types of municipal solid wastes-waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes-Public health and environmental effects. Elements of solid waste management –Social and Financial aspects – Municipal solid waste (M&H) rules – integrated management-Public awareness; Role of NGO‟s.

UNIT-II

On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – waste segregation and storage – case studies under Indian conditions – source reduction of waste – Reduction, Reuse and Recycling.

UNIT-III

Methods of Residential and commercial waste collection – Collection vehicles – Manpower– Collection routes – Analysis of collection systems; Transfer stations – Selection of location, operation & maintenance; options under Indian conditions – Field problems- solving.

UNIT-IV

Objectives of waste processing – Physical Processing techniques and Equipments; Resource recovery from solid waste composting and biomethanation; Thermal processing options – case studies under Indian conditions.

UNIT-V

Land disposal of solid waste; Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor– Dumpsite Rehabilitation. Incineration, composting methods.

TEXT BOOKS:

1. Tchobanoglous, G., Theisen, H. M., and Eliassen, R. "Solid. Wastes: Engineering Principles and Management Issues". 1993, McGraw Hill, New York,
2. Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", 198, Prentice Hall, Inc.

REFERENCES:

1. Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.
2. Bhide A.D. and Sundaresan, B.B. "Solid Waste Management Collection", Processing and Disposal, 2001
3. Manser A.G.R. and Keeling A.A.," Practical Handbook of Processing and Recycling of Municipal solid Wastes", 1996, Lewis Publishers, CRC Press,
4. George Tchobanoglous and Frank Kreith"Handbook of Solid waste Management", 2002, McGraw Hill, New York.
5. Paul T Willams, "Waste Treatment and Disposal", 2000, John Wiley and Sons.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the nature and characteristics of municipal solid wastes
2. Understand the regulatory requirements regarding municipal solid waste management
3. Plan waste minimization and design storage, collection, transport, processing and disposal of municipal solid waste
4. Describe about treatment of solid wastes.
5. Explain about the landfill in solid waste management.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	-	-	2	3	2	-	2	-	3	2	3
CO2	3	2	2	3	-	3	3	2	-	2	-	3	2	3
CO3	3	2	3	-	3	2	3	2	-	2	-	3	2	2
CO4	3	2	2	-	-	2	2	2	-	2	-	3	2	3
CO5	3	3	2	-	-	2	2	2	-	2	-	3	2	3

25CHOESCN	MATERIALS OF CONSTRUCTION IN THE PROCESS INDUSTRIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop the skills of engineering students in Materials of constructions
- To appreciate the important role of materials concepts in engineering application.

UNIT I

Materials Classification: Engineering materials and their classification - Properties: Intrinsic and extrinsic, Structure sensitive ad Structure insensitive properties- Mechanical, Electrical, Thermal, magnetic and optical properties of materials - Deformation of materials- Heat Treatment techniques – Failure of Materials : Brittle and ductile fracture, Creep failure, Fatigue, Development of creep and fatigue resistant materials- Corrosion Of Material – corrosion - theories of corrosion - control and prevention of corrosion.

UNIT II

Metals: Fundamentals of metal forming: Classification of forming process, mechanisms of metal forming Rolling of metals; Rolling Process - Forging: Classification of forging process - Engineering materials - ferrous metals - Iron and their alloys Iron and steel Iron carbon equilibrium diagram. Non ferrous metals and alloys.

UNIT III

Aluminium, copper, Zinc, lead, Nickel and their alloys with reference to the application in chemical industries.

UNIT IV.

Non Metals: Inorganic materials: Ceramics, Glass and refractories

UNIT V

Organic materials: wood, plastics, and rubber and wood with special reference to the applications in chemical Industries.

TEXT BOOKS:

1. Lawrence H. Van Vlack, "Elements of Material Science and Engineering", VI Edn. 1989, Addison Wesley Publishing
2. S. K. Hajra Choudhury, "Material Science and processes", 1st Edn. , 1977. Indian Book Distribution Co., Calcutta.

REFERENCES:

1. V. Raghavan, Materials Science and Engineering, 2004, Prentice Hall of India..
2. Fundamentals of Metal forming Processes – B.L.Juneja.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the classification, properties, deformation and corrosion of materials.
2. Explain describe forming, classification, rolling and forging of metals.
3. Ferrous and Non-Ferrous metals and their alloys with reference to chemical industries.
4. Describe the properties and applications of Non Metals; Inorganic materials; Ceramics, Glass and refractories.
5. Describe the properties and applications of organic materials.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	-	2	2	-	-	-	3	2	3
CO2	3	2	2	2	-	-	2	2	-	-	-	3	2	3
CO3	3	-	3	-	-	-	2	2	-	-	-	3	2	3
CO4	3	-	2	-	-	-	2	2	-	-	-	3	2	3
CO5	3	-		3	-	-	2	2	-	-	-	3	2	3

25CHOESCN	**PROJECT ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To familiarize the students on project engineering, operations and contracts.
- To provide knowledge about the selection of heat exchangers, pumps, compressors turbines etc.
- To illustrate the concepts of pipe design and thermal insulation.
- To impart knowledge on fire, explosion and other industrial hazards and to provide basic knowledge on personal protective equipments and their applications.
- To gain knowledge on hazard analysis, its types, hazard evaluation, health, safety and ergonomics.

UNIT - I

Preliminary data for construction projects- process Engineering - process flow and PI diagrams, scheduling the project; procurement operations - contracts.

UNIT - II

Selection of heat exchangers, pumps, compressors, vacuum pumps, motors turbines and other process equipment.

UNIT - III

Piping design - pipes and fittings, pipe supports, selection of valves - piping layout and arrangement. **Thermal insulation**: types and characteristics, Selection and erection of insulation.

UNIT - IV

Fire Types of fire- fire hazards-hazards of flammable liquids and gases-ignition hazards-fire extinguishers-fire exits. **Explosion** Fire and explosion index-dust explosion and prevention. **Toxic releases-** Toxicity and its measurements- release control- reduction and removal methods maintenance- emergency management plans.

Personal protective equipment - Types-helmets-respirators-air purification-chemical protective clothing-gloves-eye glasses- foot and knee protection-skin care.

UNIT - V

Hazard analysis- Types of hazard analysis-hazard identification-hazard survey-hazard and operability studies-fault tree analysis -event tree analysis-technique of operation review- safety audit-hazard evaluation. Health and safety-ergonomics.

TEXT BOOKS:

1. Rase,H.F.,and M.H.Barrow, Project Engineering of process plants, 1987, John Wiley & Sons.
2. Dan Patterson, Techniques of Safety Management, 2nd edition, 1996, Mc Graw Hill, Kogakusha,

REFERENCES:

1. Anilkumar, Chemical Process Synthesis and Engg. Design, 1997, Tata McGraw Hill Pub. Co. New Delhi.

2. R.V.Betrabeta and TPS.Rajan, Safety in Chemical Industry in Chemical Technology - I, Chemical Engg. Division center IIT, Chennai.

3. K.V.Ragavan and A.A.Khan, Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI - 1990.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Create data for construction projects and process equipment.
2. Select various process equipment based on process conditions.
3. Apply the concepts of pipe design and to eruct thermal insulation.
4. Express knowledge on fire, explosion, industrial hazards and personal protective equipment.
5. lentify hazard and to conduct hazard analysis, safety audit, hazard survey & hazard evaluation.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	3	2	2
CO2	3	3	3	2	2	-	-	-	2	-	2	3	2	2
CO3	3	2	3	-	-	2	2	-	3	-	-	3	2	2
CO4	3	2	-	-	-	2	2	3	3	-	-	3	2	2
CO5	3	2	-	3	3	2	2	3	3	-	2	3	2	3

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25CHOESCN	FUEL TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand about the Fuels and its Types and properties.
- To impart knowledge on Distillation Techniques
- To familiarize Combustion Technology and calculations of calorific values

UNIT I

Introduction -History of Fuels - Solid fuels, Liquid fuels and Gaseous fuels - Production- Present scenario - Consumption pattern of fuels - Fundamental definitions, properties and various measurements- Definitions and Properties of Solid fuels, Liquid fuels and Gaseous fuels - Various measurement techniques

UNIT II

Solid Fossil Fuel - Coal classification - Composition and basis - Coal mining - Coal preparation and washing- Combustion of coal and coke making- Action of heat on different coal samples-Different types of coal combustion techniques- Coal tar distillation- Coal liquefaction- Direct liquefaction- Indirect liquefaction - Coal gasification

UNIT III

Liquid Fossil Fuel - Exploration of crude petroleum - Evaluation of crude - Distillation - Atmospheric distillation - Vacuum distillation - Secondary processing - Cracking - Thermal cracking-Visbreaking - Coking- Catalytic cracking - Reforming of Naphtha -Hydro treatment - Dewaxing -Deasphalting - Refinery equipments

UNIT IV

Gaseous Fuels- Natural gas and LPG - Producer gas - Water gas- Hydrogen - Acetylene- Other fuel gases

UNIT V

Combustion Technology - Fundamentals of Thermo chemistry - Combustion air calculation - Calculation of calorific value of fuels - Adiabatic flame temperature calculation - Mechanism

and kinetics of combustion - Flame properties - Combustion burners - Combustion furnaces - Internal combustion engines

TEXT BOOKS:

1. Glassman, Yetter and Glumac, Combustion, V edn., 2014, Academic Press.
2. John Griswold, Fuels Combustion and Furnaces, 1946, Mc-Graw Hill Book Company Inc.
3. Samir Sarkar, Fuels and Combustion, 3rd. ed 2010, Universities Press.
4. W.L. Nelson, Petroleum Refinery Engineering, 4th ed. 1958., Mc-Graw Hill Book Company.

REFERENCES:

1. B.K. Bhaskar Rao, Modern Petroleum Refining Processes, 4th ed., , 2008, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Richard A. Dave, IP, Modern Petroleum Technology, Vol 1, Upstream, 6th ed., 2000, John Wiley & Sons. Ltd.
3. Alan G. Lucas, IP, Modern Petroleum Technology, Vol 2, Downstream, 6th ed., 2002, John Wiley & Sons. Ltd.
4. Report on the project "Coal Combustion Study", sponsored by Tata Tron and Steel Company Ltd., Jamshedpur.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Illustrate about fuels, characteristics and classification.
2. Describe solid fuels; their combustion technologies, efficiency and applications.
3. Describe liquid fuels; their characterization, processing and equipment.
4. Describe gaseous fuels and applications.
5. Discuss thermo chemistry and combustion properties.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	-	2	2	3	3	3	2	3	2	3
CO2	3	2	3	2	-	2	2	3	3	3	2	3	2	3
CO3	**3**	2	2	2	3	3	2	3	3	3	2	3	2	3
CO4	3	2	3	2	-	2	3	3	3	3	2	3	2	3
CO5	3	2	3	2	-	3	3	3	3	3	2	3	2	3

25CHOESCN	**RENEWABLE ENERGY TECHNOLOGY**	**L**	**P**	**T**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the various methods of conventional and renewable energy resources and present scenario with energy conservation and regulations.
- To illustrate the aspects in utilization of solar energy storage technologies.

- To understand the description, selection, sizing and performance of wind energy system.
- To explain the basic principles and operations analysis of bio-energy systems.
- To understand the aspects of ocean, geothermal, hydrogen production and fuel cell.

UNIT I

Introduction to energy

Indian Energy Scenario – Types & Forms of Energy - Primary / Secondary Energy Sources – Energy Conservation – Need – EC Act 2003 : Salient Features – Energy Intensive Industries – Barriers -Roles & Responsibility of Energy Managers – Energy Auditing : Preliminary & Detailed - Benchmarking .

UNIT II

Solar energy

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

UNIT III

Wind energy

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy – Hybrid systems - safety and environmental aspects – wind energy potential and installation in India-Repowering concept.

UNIT IV

Bio-energy

Biomass resources and their classification - Biomass conversion processes - Thermochemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction – biochemical conversion - anaerobic digestion - types of biogas Plants - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

UNIT V

Other types of energy

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plants - ocean wave energy conversion - tidal energy conversion – small hydro – geothermal energy - geothermal power plants – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.– Energy scenario in India – Growth of energy sector and its planning in India.

TEXT BOOKS:

1. Chetan sing solanki, Renewable Energy Technologies, PHI Learning pvt Ltd, 2009

2. D.P.Kothari, K.C.Singal, Rakesh ranjan, II edn,Renewable Energy Sources and Emerging Technology,PHI Learning pvt Ltd, 2019

3. Sukhatme, S.P., J.K.Nayak, Solar Energy, III Edn. 2008,Tata McGraw Hill,.
4. Twidell, J.W. and Weir, A., Renewable Energy Sources,1986, EFN Spon Ltd..

REFERENCES:

1. Kishore VVN, Renewable Energy Engineering and Technology, 2012, Teri Press, New Delhi
2. Peter Gevorkian, Sustainable Energy Systems Engineering, 2007, McGraw Hill
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, 1996, Oxford University Press, U.K,
3. Yogi Goswami, Kreith, F and Kreider, J. F., Principles of Solar Engineering, 2000, McGraw-Hill, II Edn.
4. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, 1990, McGraw-Hill
5. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, 2012, Academic Press

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Acquire knowledge on environmental aspects and impacts of non-renewable and renewable energy resources.
2. Understand the solar energy technology for domestic and commercial applications.
3. Analyze the functionality of components of the wind energy systems and their behavior in operation.
4. Understand the bio-energy system to pre-feasibility study and perform an initial design.
5. Acquire knowledge on present technologies to connect renewable energy such as geothermal, hydrogen production and fuel cell.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	2	3	2	3	2	2	2	3	3
CO2	3	3	3	3	-	2	3	2	3	2	2	2	3	3
CO3	3	3	3	3	-	2	3	2	3	2	2	2	3	3
CO4	3	3	3	3	-	2	3	2	3	2	2	2	3	3
CO5	3	3	3	3	-	2	3	2	3	2	2	2	3	3

25CHOESCN	**HAZARDOUS WASTE MANAGEMENT**	**L**	**P**	**0**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To define and identify the characteristics of hazardous wastes.
- To identify the environmental concerns for hazardous waste on water, land and air
- To impart knowledge and skills in the collection, storage, transport, treatment, disposal and recycling options for hazardous wastes.
- To familiarize students with laws and regulations governing hazardous wastes.

UNIT I

Introduction

Definition – Introduction – Sources of hazardous wastes – Effects on community – terminology and classification – Need for hazardous waste management — Problems in developing countries – Protection of public health and the environment.

UNIT II

Nuclear wastes and e-waste

Characteristics – Types – Nuclear waste – Uranium mining and processing – Power reactors– Refinery and fuel fabrication wastes – spent fuel – Management of nuclear wastes – Decommissioning of Nuclear power reactors – Health and environmental effects of Nuclear waste - E-waste – sources and management.

UNIT III

Biomedical and chemical wastes

Biomedical wastes – Sources - Types – Collection- Segregation and Labelling – Treatment – Autoclaving, Incineration, Chemical Disinfection – Disposal, Infection control practices - Chemical wastes – Sources – Domestic and Industrial - Inorganic pollutants – Environmental effects – Need for control – Treatment and disposal techniques – Physical, chemical and biological processes – Health and environmental effects.

UNIT IV

Hazardous wastes management

Handling, collection, Segregation, storage and transport, TSDF concept. Hazardous waste treatment technologies - Physical, chemical and thermal treatment, solidification, chemical fixation, encapsulation, pyrolysis and incineration of Hazardous wastes.

UNIT V

Waste disposal

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps – landfill remediation – Hazardous waste management Rules 2016.

TEXT BOOKS:

1. Hazardous waste management by Charles A. Wentz. Second edition 1995, McGraw Hill International.
2. Harry M. Freeman, Standard handbook of Hazardous waste treatment and disposal, 1996, McGraw Hill.

REFERENCES:

1. Criteria for hazardous waste landfills – CPCB guidelines 2000.
2. Daniel B. Botkin and Edward A. Keller Environmental Sciences, Wiley student, 6th Edn 2009.
3. Biomedical waste (Management and Handling) Rules, 1998.
4. Paul T Williams, Waste Treatment and Disposal, 2005, Wiley.
5. J. Glynn Henry and Gary. W. Heinke Environmental Science and Engineering, , 2004, Prentice Hall of India.
6. Anjaneyulu, Hazardous waste management

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Identify the sources, characteristics of hazardous wastes and its effects on community.

2. Understand the characteristics, effects and management of Nuclear wastes and e-waste.

3. Evaluate different treatment technologies used for Biomedical and Chemical wastes.

4. Discuss the facilities for the Handling, collection, Segregation, storage and transport, TSDF concept. Hazardous waste treatment technologies.

5. Understand and an insight into the Secure land filling and the national legal frame work of hazardous waste management.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	3	-	2
CO2	3	2	3	-	2	-	2	2	2	2	-	3	3	2
CO3	3	2	3	-	3	3	2	2	3	2	2	3	3	2
CO4	3	2	3	-	3	2	2	2	3	2	-	2	3	2
CO5	3	2	3	-	2	2	2	2	3	2	-	2	3	2

		L	P	0	C
25CHOESCN	**DISASTER MANAGEMENT**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To summarize the basics of disasters and management
- To explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- To illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

- To describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- To develop the strengths and weaknesses of disaster management approaches

UNIT – I

Introduction – Disaster- Characteristics and types of Disasters- Causes and effects of Disaster - Risk- Vulnerability – Preparedness- Disaster mitigation and disaster management- Classification of mitigation measures-Vulnerability Analysis- Observation and Perception of Vulnerability- Socio- Economic Factors of Vulnerability- Vulnerability in India- Disaster related policy goals of UNDP UNDRO and Govt. of India- Appraising disaster needs - Needs for technical expertise- Role of various Agencies in Disaster Management and Development - Disaster risk reduction planning- Role of Developmental Planning for disaster Management.

UNIT - II

Earthquake - Cause of Earthquake- General characteristics- Measuring Earthquakes- Distribution
pattern of Earthquakes in India- Earthquake prone areas- case studies of important Indian earthquakes - Forecasting techniques and risk analysis- Possible risk reduction measures- earthquake resistance buildings and re-engineering techniques in India.

UNIT - III

Tsunamis- Causes of a Tsunami- General Characteristics- Tsunami warning system- Distribution pattern of Tsunami in India- Possible risk reduction measures- Integrated coastal zone management- Avalanches- Mud flows and glaciers- Landslides and rock falls- landslide hazard zonation- Instrumentation and monitoring- Techniques for reducing landslide hazards.

UNIT - IV

Tropical cyclones- Structure of tropical cyclones- Nature of tropical cyclones- Cyclone experience n India and Tamilnadu- Preparedness- Tropical cyclones and their warning systems- Tropical cyclone warning strategy in India special nature of the problem in the region Classification- Protection of buildings from cyclones of India- Precautions during and before cyclones.

UNIT- V

Coastal floods - Intensification of hazards due to human interference- Management - River and coastal floods - Temperature extremes and wild fires - Physiological hazards- Flood forecasting - mitigation - planning-management - flood prone areas the Indian scenario - Flood experience in India and Tamilnadu. Environmental hazards- Typology- Assessment and response- Strategies -The scale of disaster-Vulnerability- Disaster trends- Paradigms towards a balanced view- Chemical hazards and toxicology-Biological hazards- Risk analysis- Other technological disasters.

TEXT BOOKS:

1. David R. Godschalk (Editor), Timothy Beatiey, Philip Berke,.David J. Browt:r, Edward J. Kaiser Charles C. Boh, R. Matthew Goebel, Natural Hazard Mitigation: Recasting Disaster Policy and Planning Island Press; (January 1999), ISBN) 559636025
2. Sinha, P.C. Wind & Water Driven Disasters, 1998, 250pp, Anmol Publications

REFERENCES:

1. Davide Wikersheimer Windstorm Mitigation Manual for Light Frame Construction, 1997, DIANE Publishing Company
2. Brown D Redevelopment After the Storm: Hazard Mitigation Opportunities in the Post Disaster Setting, 1985,John Wiley & Sons.
3. Sinha, P.C. Technological Disasters, 1997, 516 pp Anmol Publications Trivedi,

COURSE OUTCOMES

On completion of the course, the students would be able to

1: Summarize the basics of disaster management problems and solutions

2: Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

3: Explain and illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

4: Described the standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

5: Explain the strengths and weaknesses of disaster management approaches.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	1	3	3	3	3	3	2	2	3	3
CO2	3	3	3	3	2	3	3	3	3	3	3	2	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	2	3	3

25CHOESCN	**Human Factors Engineering, BBS& Occupational Health**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

By the end of the course, students should be able to:

- Understand the fundamentals of human factors contributing to accidents
- Know the importance of ergonomics
- Implement programmes on BBS

- Understand the notifiable diseases
- Understand the physiological requirements in work place

UNIT- I

Concept of Man-Machine System – Applications of human factors engineering – Man as a Sensor – Man as an Information Processor – Man as a Controller
Human factors contributing to accidents-Unsafe action factors – Psychological Factors – Psychosocial Factors - Theories of Motivation and their application to Safety

UNIT II
Ergonomics – Principles – Approach Solutions – Ergonomic Programme – Principles of Motion Economy – Anthropometry – Biomechanics Lighting, noise, and thermal comfort
Shift work and circadian rhythms

UNIT III
Behaviour based safety –The ABC Model: Antecedent-Behavior-Consequence- Behaviour observation and data collection - Implementing Behavior-Based Safety Programs - Feedback and Positive Reinforcement - Measuring and Sustaining BBS Performance - Case Studies and Industrial Applications

UNIT IV
Occupational health - Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations – occupational related diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax, lead nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

UNIT V
Occupational physiology - allocation of functions– efficiency –work capacity aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements – categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

TEXT BOOKS:
1. McCornick, E.J. and Sanders, M.S., Human Factorsin Engineering and Design, 1992, Tata McGraw-Hill.
2. Geller, E. S. – Behavior-Based Safety: A Guide to Achieving Safe Behavior in the Workplace

3. Krause, T. R. – The Behavior-Based Safety Process: Managing Involvement for an Injury-Free Culture

4. Handbook of Occupational Health and Safety, NSC Chicago, 1982

5. Encyclopedia of Occupational Health and Safety, Vol. I & II, International Labour Organisation, Geneva, 1985

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the concept of Man-Machine System
2. Recognize the causes of occupational injuries due to ergonomical factors
3. Reinforce to overcome risk behavior through BBS implementation
4. Understand the effect of various occupational diseases and its prevention

Mapping with POs & PSOs														
COS	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	1	-	3	2	2	-	1	1	3	-	2
CO2	3	1	-	2	-	3	2	-	-	-	-	3	3	2
CO3	3	2	1	3	2	3	3	1	2	1	3	3	2	3
CO4	1	1	1	1	-	3	2	-	-	3	1	2	-	3
CO5	2	2	1	-	-	3	2	1	1	2	1	2	1	2

25CHOESCN	**BIOCONVERSION AND PROCESSING OF WASTE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To give an idea about different biomass and other solid waste materials as energy source and their processing and utilization for recovery of energy and other valuable products.
- A comprehensive knowledge of how wastes are utilized for recovery of value would be immensely useful for the students from all fields.

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UNIT-I

Biomass definition - resources - properties – classification – availability –estimation of availability, consumption and surplus biomass –energy plantations. Proximate analysis, Ultimate analysis, thermo gravimetric analysis and summative analysis of biomass briquetting

UNIT-II

Biomass pyrolysis – pyrolysis – types, slow fast – manufacture of charcoal, methods, yields and application – manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III

Biomass gasification – gasifiers – fixed bed system – downdraft and updraft gasifiers – fluidized bed gasifiers – design, construction and operation – gasifier burner arrangement for thermal heating – gasifier engine arrangement and electrical power – equilibrium and kinetic consideration in gasifier operation.

UNIT-IV

Biomass combustion – biomass stoves – improved chullahs, types, some exotic designs – fixed bed combustors – types, inclined grate combustors – fluidized bed combustors – design, construction and operation and operation of all the above biomass combustors.

UNIT-V

Introduction to Energy from waste -classification of waste as fuel – agro based, forest residue, industrial waste, MSW – conversion devices – incinerators, gasifiers, digestors. Separation of components of solid wastes and processing techniques, Bioconversion into biogas, mechanism, Composting technique, Bioconversion of substrates into alcohols, Bioconversion into hydrogen, Solvent extraction of hydrocarbons, Fuel combustion into electricity, case studies

TEXT BOOKS:

1. Desai, Ashok V., Non Conventional Energy, 1990, Wiley Eastern Ltd.
2. H.D.Joseph, P.Joseph, H.John, Solid Waste Management, 1993, New York, Van Nostrand,

REFERENCES

1. Khandelwal, K. C. and Mahdi, S. S., Biogas Technology -A Practical Hand Book -Vol. I & II, 1983, Tata McGraw Hill Publishing Co. Ltd.
2. Challal, D. S., Food, Feed and Fuel from Biomass, 1981, IBH Publishing Co. Pvt. Ltd.,
3. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, 1996, John Wiley & Sons.
4. G.Tchobanoglous, H.Theisen, S.V.Tchobanoglous, G.Theisen, H.V.Samuel, Integrated Solid Waste management: Engineering Principles and Management issues, 1993, McGraw Hill.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Know about the renewable organic materials and its availability.
2. Understand the principle of thermochemical treatment of biomass and its application in industry.
3. Know about the gasification process, types of gasifiers and its design considerations.
4. Familiar with the process of biomass combustion, efficiency and applications.
5. Observe the Conversion of biomass through different technologies and its mechanism.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	2	1	1	1	1	-	-	-	1	2	1	-
CO2	1	1	2	1	-	1	1	-	-	-	1	1	1	-
CO3	2	2	2	1	1	2	1	-	-	-	2	2	1	1
CO4	1	1	2	1	2	1	1	-	-	-	1	2	1	-
CO5	2	2	3	2	2	2	2	-	-	-	2	2	2	-

25CHOESCN	BIOLOGY FOR ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The course acts as a bridge between engineering and biology to provide basic understanding of biological mechanisms of living systems from engineering perspective.
- It will illustrate the many possible means to utilize living things' relevance to engineering principles.
- With substantial knowledge and continuing interest will make a student into a specialist in the technical diversity.

UNIT I

Requirements of biological systems: Biological Units Need Water; Biological Units Need the Right Amount of Oxygen; Biological Units Need Food and Nutrients; Biological Units Become Ill in the Presence of Wastes; Biological Units Need Heat Sources and Sinks.

UNIT II

Behavior of biological systems: Biological Units Adapt to Their Environments; Biological Units Modify Their Environments; Adaptations Require Extra Energy and Resources; Biological Units, If Possible, Move to Friendlier Environments; Biological Units Evolve under Environmental Pressures.

UNIT III

Response to stress by biological systems: Crowding of Biological Units Produces Stress; Biological Units Are Affected by Chemical Stresses; Biological Units Respond to Mechanical Stresses; Optimization Is Used to Save Energy and Nutrient Resources; Biological Units Alter Themselves to Protect against Harsh Environments.

UNIT IV

Existence of biological systems: Biological Units Cooperate with Other Biological Units; Biological Units Compete with Other Biological Units; Biological Units Reproduce; Biological Units Coordinate Activities through Communication; Biological Units Maintain Stability with Exquisite Control; Biological Units Go through Natural Cycles; Biological Units Need Emotional Satisfaction and Intellectual Stimulation; Biological Units Die.

UNIT V

Scaling factors and biological engineering solutions: Allometric Relationships from Evolutionary Pressure; Dimensional Analysis; Golden Ratio; Fractal Scaling within an Organism; Self-Similarity for Tissues and Organs; Self-Similarity in Populations; Systems Approach; Relationships between Engineering and Biology; The Completed Design.

TEXT BOOKS:

1. Arthur T. Johnson, "Biology for Engineers", 2000, CRC Press.

2. S. Thyaga Rajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," 2012, Tata McGraw-Hill, New Delhi.

REFERENCES:

1. Aydin Tözeren, Stephen W. Byers, New Biology for Engineers and Computer Scientists, 2004, Pearson/Prentice Hall.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Understand the information about requirements of living systems.
2. Anticipate the properties of an unfamiliar group of living things from knowledge about a familiar group.
3. Observe the relevance of engineering to biological systems.
4. Exhibit knowledge about biological responses and it is scaling with respect to scientific principles that cannot be related back.
5. Demonstrate biological principles and generalizations that can lead to useful products and processes.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	-	1	-	-	1	2	2	-	-	-	2	2	-
CO2	1	1	2	1	-	1	2	1	-	-	-	2	2	-
CO3	2	2	2	1	-	2	2	2	-	-	-	2	2	-
CO4	1	-	1	1	2	3	2	1	1	-	-	2	2	1
CO5	2	1	2	1	2	2	1	1	1	-	-	2	2	-

25CHOESCN	**INTELLECTUAL PROPERTY RIGHTS**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**

COURSE OBJECTIVES:

- To understand the concepts IPR
- To understand Trademarks, Trade Secretes and GI of goods.
- To understand Copyrights, Patents and Industrial Designs.
- To learn about how to manage IP rights and legal aspects.
- To understand the concepts of Cyber laws in IPR.

UNIT - I

Introduction to Intellectual Property: IPR - Definition - Types of IPR: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional

Knowledge, Geographical Indications, IP as a factor in R&D; Few Case Studies WTO - Definition - Functions - Forms of IPR Protection.

UNIT–II

Trade Marks: Purpose and function of trademarks, Acquisition of trade mark rights, transfer of rights, Selecting and evaluating trademark, registration of trademarks, claims.

Trade Secrets: Trade secret law, determination of trade secret status, liability for misappropriation of trade secrets, trade secret litigation. Geographical Indication of Goods: Basic aspects and need for the registration

UNIT–III

Copyrights: Fundamentals of copyright law, originality of material, right of reproduction, right to perform the work publicly, copyright ownership issues, notice of copyright.

Patents: Foundation of patent law, patent searching process, Basic Criteria of Patentability **Industrial Designs:** Kind of protection provided in Industrial design

UNIT–IV

Managing IP Rights: Acquiring IP Rights: letters of instruction, joint collaboration agreement.

Protecting IP Rights: nondisclosure agreement, cease and desist letter, settlement memorandum.

Transferring IP Rights: Assignment contract, license agreement, deed of assignment

UNIT-V

Introduction to Cyber law: Information Technology Act, cybercrime and e-commerce, data security, confidentiality, privacy, international aspects of computer and online crime.

Reference Books

1. Bare Act, The Indian Patent Act 1970 and the Patent Rules, Universal Law Publishing Co.
Pvt. Ltd., 2007.
2. Mittal D.P., Indian Patents Law. Taxmann Allied Services (p) Ltd., 1999.
3. Deborah E Bouchoux, Intellectual Property: Right: The Law of Trademarks, Copyrights, Patents and Trade Secrets, 2012.

4. Gerald R. Ferrera,Cyber law: Text and Cases, South-Western Cengage Learning, 2012.
5. N.K Acharya, Intellectual property rights, Scandinavian Languages Edition, 2021.
6. Kompal Bansal, Fundamentals of Intellectual Property for Engineers, BS Publications 2013.
7. P. Radhakrishna, Intellectual Property Rights: Text and Cases, Excel Books, 2008.

COURSE OUTCOMES

On completion of the course, the students will be able to

1. Demonstrate understanding of basic concepts of IPR.
2. Differentiate between Trademarks, Trade secrets and GI of goods.
3. Understand Copyrights, Patents and Industrial Designs and analyze various forms of IPR protections.
4. Evaluate collaborative agreements and legal contacts in managing IP rights effectively.
5. Evaluate the international legal aspects and implications of computer and online crimes.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2					2	2						2	
CO2	2					3	3	3	3	3			2	
CO3	2					3	3	3	3	3			2	
CO4	2					3	3	3	3	3			2	
CO5	2					3	3	3	3	3			2	

25CHOESCN	**NCC Studies (Army Wing) – I (Offered by Faculty of Engineering and Technology)**	**L**	**T**	**P**	**C**
		2	**0**	2	**3**

Course Objective

- This course is designed especially for NCC Cadets. This course will help develop character, camaraderie, discipline, secular outlook, the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working in teams, learning military subjects including weapon training.

Unit – I (Lecture)

NCC Organisation and National Integration

NCC Organisation – History of NCC- NCC Organization - NCC Training- Promotion of NCC cadets – Aim and advantages of NCC Training- NCC badges of Rank- Honours and Awards – Incentives for NCC cadets by central and state govt. National Integration- Unity in diversity- contribution of youth in nation building- national integration council- Factors affecting national integration.

Unit – II (Lecture)

Personality Development and Leadership

Introduction - Factors influencing / shaping Personality - Self-Awareness – Know yourself/ Insight - Communication Skills - Leadership Traits – Types – Attitude - Time Management - Effects of Leadership - Stress Management Skills - Interview Skills - Conflict Motives - Resolution - Importance of Group / Team Work - Influencing Skills - Body Language - Sociability: Social Skills

Unit – III (Lecture)

Social Awareness and Community Development

Aims of Social service-Various Means and ways of social services- family planning – HIV and AIDS- Cancer its causes and preventive measures- NGO and their activities- Drug trafficking- Rural development programmes - MGNREGA-SGSY-JGSY-NSAP-PMGSY-Terrorism and counter terrorism- Corruption – female foeticide -dowry –child abuse-RTI Act- RTE Act- Protection of children from sexual offences act- civic sense and responsibility

Unit – IV (Lecture)

Specialized Subject (Army Wing)

Basic structure of Armed Forces- Military History – War heroes- battles of Indo-Pak war- Param Vir Chakra- Career in the Defence forces- Service tests and interviews-Fieldcraft and Battlecraft-Basics of Map reading.

Unit – V (Practical)

Basic Physical Training and Weapon Training

Basic physical Training – various exercises for fitness (with Demonstration) - Food – Hygiene and Cleanliness. Drill- Words of commands- position and commands- sizing and forming- saluting- marching (WITH DEMONSTRATION)

Main Parts of a Rifle- Characteristics of .22 rifle- Characteristics of 7.62mm SLR- Characteristics of 5.56mm INSAS rifle - stripping and assembling – position and holding- safety precautions – range procedure- firing simulation.

TEXT BOOK:

1. “National Cadet Corps- A Concise handbook of NCC Cadets”, Ramesh Publishing House, New Delhi, 2014.

REFERENCES:

1. “Cadets Handbook – Common Subjects SD/SW”, published by DG NCC, New Delhi.
2. “Cadets Handbook- Specialized Subjects SD/SW”, published by DG NCC, New Delhi.
3. “NCC OTA Precise”, published by DG NCC, New Delhi.

COURSE OUTCOMES:

On completion of the course, the students will be able to

1. Display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion
2. Acquaint and provide knowledge on personality development, self awareness, communication skills with leadership traits to work as a team and sociability values
3. Understanding about social evils and shall inculcate sense of whistle blowing against such evils and ways to eradicate such evils
4. Acquaint, expose & provide knowledge about Army/Navy/ Air force and to acquire information about expansion of Armed Forces, service subjects and important battles.
5. Demonstrate health exercises, the sense of discipline, improve bearing, smartness, turnout, develop the quality of immediate and implicit obedience of orders and basic knowledge of weapons and their use and handling.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	3	2	3	1	1	1	3	3	1
CO2	3	-	-	-	-	3	3	3	2	1	-	3	3	1
CO3	3	-	-	-	-	3	3	3	-	-	-	3	3	2
CO4	3	-	-	-	-	2	2	3	3	2	3	3	3	3
CO5	3	-	-	-	-	3	2	3	2	1	2	3	3	3

EXTRA ONE CREDIT COURSES

25CHOCSCN	**HEALTH, SAFETY AND ENVIRONMENT**	**L**	**C**
		2	**1**

COURSE OBJECTIVES:

- Understanding of the fundamental principles of health, safety, and environmental management in the workplace.
- Relevant legal frameworks, regulations, and standards governing workplace health, safety, and environmental management.
- Skills and knowledge necessary to identify, assess, and control workplace hazards and risks related to health, safety, and environmental issues.

Unit – I

Occupational health and safety management:

1. General definitions: Health, safety, environment protection, occupational accident, hazard, risk, near misses, health and safety culture. 2. Key elements for health and safety system 3. Importance of health and safety policy, aim and objective of health and safety policy 4. Health and safety culture, factors influencing health and safety culture 5. Influencing factors for health and safety management.

Unit – II

Safety elements:

1. Philosophy of safety a. Need of safety philosophy b. Nature and subjects of safety philosophy 2. Safety psychology a. Need of safety psychology b. Meaning and aim of safety psychology c. Factors affecting safety at work: attitude, aptitude, frustration, morale, motivation, individual differences.

Unit - III

Environment:

1. Introduction and 5 elements 2. Environmental issues in fire protection, a. Halon and the ozone layer, b. Other special extinguishing agent, c. Water based fire protections, d. Fire protection measures.

Unit – IV

Environmental Audit

Environmental audit a. Need b. procedure c. Benefit 4. Solid waste management a. Definition b. Classification c. Characteristics of solid wasted. Environment impact e. Role of citizen

Unit – V

Various Pollution & its effects on Environment

1. Noise Pollution a) Introduction b) Fundamentals of noise c) Transmission of sound d) The ear and the measurement of hearing e) Noise control 2. Radiation a)Introduction b)The concept

of injury by radiation c) Infra red radiation d)Corpuscular radiation e) Poisoning from radio isotopes 3.Water Pollution a) Introduction b) Sources of water pollution c)Water pollution monitoring d)Control of water pollution Treatment of domestic waste water f)Treatment of industrial waste water.

TEXT BOOKS:

1. Safety, health and working condition in the transfer of technology - International Labor Office, 1988
2. Industrial Safety, Health and environment Management system - RK Jain and Sunil S Rao, 2000

REFERENCES:

1. Publications from Inter National Standard Organizations like ISO, OSHA, IOSH, NEBOSH etc.
2. Encyclopedia of occupational health and safety- International Labor Office, 2012

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. identify and assess workplace hazards related to health, safety, and environmental issues.
2. design and implement effective workplace health, safety, and environmental programs.
3. evaluate and manage risks associated with health, safety, and environmental issues in the workplace.
4. demonstrate an understanding of the relevant legal frameworks, regulations, and standards governing workplace health, safety, and environmental management.
5. foster a culture of safety and environmental responsibility in the workplace through effective communication, leadership, and collaboration.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	-	-	-	-	-	3	-	-
CO2	3	3	3	3	-	-	-	-	-	-	-	3	-	-
CO3	3	3	2	2	3	-	-	-	-	-	-	3	-	-
CO4	3	3	2	2	-	-	3	3	3	3	3	3	-	-
CO5	3	3	2	2	-	-	3	-	3	3	-	3	-	-

25CHOCSCN	EXPLOSIONS AND INDUSTRIAL FIRE SAFETY	L	C
		2	1

COURSE OBJECTIVES:

- Basic principles of fire safety, the science of fire, the elements that contribute to its occurrence and the different types of fires that can happen in an industrial setting.
- Identify potential fire hazards in an industrial setting, including combustible materials, ignition sources, and other factors that can contribute to fire risk.
- Analyze and evaluate real-world fire incidents in industrial settings, including the causes of the fire, the effectiveness of the response, and strategies for preventing similar incidents in the future.

Unit – I

Introduction to Explosion Characteristics:

Background – Burchfield explosion case study. Other similar explosion incidents; Explosion hazards; Stoichiometry for gases- Introduction, Calculation for air, Calculation for O2; Stoichiometry for general hydrocarbons and wood (Air to fuel ratio); Application of stoichiometry- Naphtha storage tank example, Burner startup ;Boiler firebox explosion.

Unit – II

Flammability limits and Theories:

1. Lean limit and Rich limit, 2. LEL &UEL measurement techniques and equipment, 3. Minimum ignition energy, 4. Relation between auto-ignition temperature and flash point, 5. Effect of temperature and pressure on flash point, 6. Classification of flammable materials, 7. Vapour tank explosion, a. TWA flight 800 Disaster.

Unit - III

Explosion Prevention and Protection

1. Explosion prevention techniques-a. Ventilation. Separation. Physical barriers. Alternative techniques,2.Preventing the formation of explosive atmosphere,3.Explosion protection systems - a. Protection techniques- Containment, Isolation, Suppression, Venting, ventilation for explosion protection system, c. Explosion protection using inert gases,4.Flame arrest or sand quenching distance.

Unit – IV

Safety Management

Concept of Safety, Industrial Accidents, Reasons for Accident Prevention, Function of Safety Management, Safety Organizations, Objectives of Safety Organizations, Role of Industrial Organization (Safety),Essential Requirements of Safety Programs, Plant Safety Rules and Procedures, Formulation of Rules, Types of Rules, Violation of Rules, Reduction of Hazards.

Unit – V

Safety in Miscellaneous Industries

Hazards and Safety Measures for Welding Process, Types of Welding Processes, Precaution and Safety, Fertilizer Industry, Pesticides Industry, Lethal Dosages, Manipulation Process and Their Hazards and Controls, Textile Industry, Steel Industry, Chemical Hazards.

TEXT BOOKS:

1. Handbook of fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical and Related Facilities-Dennis. P. Nolan Fourth Edition, 2019
2. National Fire Protection Association Handbook, 20th Edition

REFERENCES:

1. Hazards in Process Industries – Hidup Suatu Pendakian
2. Industrial Safety Management -N.K.Tarafdar, K.J Tarafdar
3. Industrial Safety-National Safety Council of India

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. develop comprehensive fire safety plans for industrial settings that include procedures for fire prevention, detection, and suppression, as well as emergency response and evacuation plans.
2. identify potential fire hazards in industrial settings and implement measures to mitigate them, such as installing fire detection and suppression systems, controlling fuel sources, and ensuring proper storage of hazardous materials.
3. demonstrate an understanding of relevant fire safety regulations, such as OSHA standards, and implement measures to ensure compliance.
4. conduct fire safety inspections in industrial settings, identifying potential hazards and ensuring that fire safety systems and equipment are functioning properly.
5. analyze and evaluate real-world fire incidents in industrial settings, identifying root causes and developing recommendations for prevention and response in the future.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	-	-	-	-	3	-	-	3	-	-
CO2	3	3	2	2	-	-	3	-	3	-	-	3	-	-
CO3	**3**	**3**	2	2	-	-	-	-	3	-	-	3	-	-
CO4	3	3	2	2	-	3	-	-	3	3	-	3	-	-
CO5	3	3	2	2	3	3	3	-	3	3	3	3	-	-

HONOUR ELECTIVE COURSES

25CHHE601	ADVANCED HEAT TRANSFER	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

- To apply scientific and engineering principles to analyze thermofluid aspects of engineering systems
- To use appropriate analytical and computational tools to investigate the steady state and unsteady state heat transfer phenomena
- To understand the heat transfer mechanisms in fluids and their applications in various heat transfer equipment in process industries.
- To recognize the broad technological context of heat transfer, especially related to energy technology

Unit - I

Transient heat conduction. Extended surfaces and fins. Numerical solutions for one-dimensional and two-dimensional steady state heat conduction problems. Unsteady state conduction: unidimensional and multidimensional systems-Use of transient heat conduction charts.

Unit - II

Convective heat transfer: theories and practice-energy equation for thermal boundary layer over a flat plate. Momentum and heat exchange in turbulent fluid flow- empirical equations for forced and free convection based on experimental results.

Unit - III

Heat transfer with change of phase: Phenomena of boiling and condensation- Regimes of pool boiling-heat transfer during boiling-dropwise and filmwise condensation-effects of turbulence and high vapour velocity on filmwise condensation.

Unit - IV

Compact heat exchangers: plate and spiral type heat exchangers-finned tube heat exchangers- heat pipes-regenerators and recuperators.

Unit - V

Special topics in heat transfer: Heat transfer in magneto fluidynamic systems-transpiration cooling-ablation-heat transfer in liquid metals-heat transfer in fluidized beds- heat transfer processes in nuclear reactors

TEXT BOOKS:

1. Knudsen.J.G., D.L.Katz, Fluid Dynamics and Heat Transfer, 1958, McGraw-Hill, New York.
2. Jacob.M., Heat Transfer, 1962, John Wiley, New York.

REFERENCES:

1. Mc Adams, Heat transmission, 1954, McGraw Hill, New York.
2. Holman.J.P., Heat Transfer, 8th edition , 1997, McGraw Hill, New York

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand and use appropriate analytical and computational tools to investigate the steady state and unsteady state heat transfer phenomena.
2. Acquire knowledge on heat transfer mechanisms in fluids and their applications.
3. Understand the various conditions of boiling and condensation
4. Acquire knowledge and design compact heat exchangers for industrial applications
5. Understand heat transfer phenomena in special conditions like electronic cooling and energy technology.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	2	2	2	2	-	2	3	2	2
CO2	3	3	3	2	2	2	2	2	2	-	2	3	2	2
CO3	3	3	3	2	2	2	2	2	2	-	2	3	2	2
CO4	3	3	3	2	2	2	2	2	2	-	2	3	2	2
CO5	3	3	3	2	2	2	2	2	2	-	2	3	2	2

25CHHE602	**ADVANCED THERMODYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- This course will help to interpret, correlate, and predict thermodynamic properties used in mixture-related phase-equilibrium calculations.
- Basic statistical mechanical principles and intermolecular forces will be discussed, and applied to the correlation and prediction of thermodynamic properties and phase equilibria.
- Concepts of statistical thermodynamics along with classical thermodynamics, molecular physics, and physical chemistry will be applied to solve real-world problems.

Unit - I

Thermodynamic properties with independent variables P & T, fugacity of a component in a mixture at moderate pressures, thermodynamic properties with independent variables V and T, fugacity of component in a mixture according to Vander Waals equation.

Unit - II

Lewis fugacity rule, Virial equations of state, Extension to mixtures, fugacities from virial equation, calculation of virial coefficients from potential functions, third Virial coefficients, Virial coefficients from corresponding states correlation, fugacities from generalized charts for pure components, fugacities from an empirical equation of state.

Unit - III

Ideal solution, fundamental relations of Excess function, Activity and activity coefficients, Normalization of activity coefficients, activity coefficients from excess functions in binary mixtures application of Gibbs Duhum equation - Thermodynamic consistency tests, Whol's expansion for Excess gibbs energy, Wilson, NRTL and UNIQUAC equation, multi component mixtures Excess functions using Whols, Wilson, NRTL and UNIQUAC.

Unit - IV

Theory of Van laar, Scat chard - Hildelrand theory, Lattice theory Wilson's empirical extension of the Flory - Huggin's equation, two liquid theory, chemical theory - Ideal gas solubility, Henry's law and its thermodynamic significance, effect of pressure and temperature on gas solubility. Estimation of gas solubility, Ideal solubility, Non ideal solutions, solubility of solid in a mixed solvent, solid solutes.

Unit - V

Chemical Reaction equilibria - Homogenous simple reactions, Heterogenous reactions, High pressure vapour liquid equilibria studies.

TEXT BOOKS:

1. John M. Prausnitz, Lichten Thaler R.N. & de Azeredo E.G Molecular thermodynamics of fluid phase equilibria, 2nd edn;, prentice Hall Inc., Engle wood cliffs NJ, 1986.
2. Hougen O.A., Watson K.M., Ragatz, R.A., Chemical process principles part II, Asia publishing house, Madras 1969.
3. J.M. Smith, H.C. Vannes, M.M. Abbotta, Introduction to chemical engineering thermodynamics, 5l Edn;, McGrawHill International edn., 1996

REFERENCES:

1. J.M. Smith. H.C.Van Ness and M.M.Abott. "Introduction to Chemical Engineering Thermodynamics, 5th ed. 1996 McGraw Hill International edition

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Formulate solutions to phase equilibrium problems
2. Knowledge on principles and methods to apply various models / equations for VLE computations for non ideal systems
3. Application of various activity coefficient models
4. Understand the behaviour of solutions for industrial applications

5. Insight on chemical reaction equilibria concepts and high pressure VLE computations

Mapping with POs & PSOs														
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	3	-	-	-	-	-	-	-	3	2	2
CO2	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO4	3	-	2	2	3	-	-	-	-	-	-	3	2	2
CO5	3	-	2	3	-	-	-	-	-	-	-	3	2	3

25CHHE701	**ADVANCED PROCESS CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

COURSE OBJECTIVES:

- To impart advanced knowledge on the concepts of chemical process control
- To give an idea on in-depth analysis of various processes and to get the input/output data
- To study the effect of time domain analysis and frequency domain analysis of a process
- To study about multivariable processes, Z-transform and stability analysis and an in-depth idea of identification of processes

Unit - I

Introduction: Some important Simulation results, General Concepts and terminology, Laws, Languages and Levels of process control. Time Domain Dynamics: Classification and definition, linearization and perturbation variables, responses to simple linear systems, solutions using MATLAB.

Unit - II

Laplace - Domain Dynamics, Laplace- Domain Analysis of conventional feedback control systems Laplace-Domain analysis of advanced control systems. Frequency-domain Dynamics and Control: Frequency-Domain Dynamics, Frequency-Domain analysis of closed loop systems.

Unit - III

Conventional control systems and Hardware: Control Instrumentation performance of feedback controllers,Controller tuning.Advanced control systems: Ratio control, cascade control, override control, computed variable control, nonlinear and adaptive control, valve position control, feed forward control aspects, control design concepts.

Unit - IV

Interaction between steady state design and dynamic control lability qualitative examples, simple quantitative example, impact of controllability on capital investment

and yield, general trade-off between controllability and thermodynamic reversibility, dynamic controllability, plant wide control.

Unit - V

Multivariable processes: Matrix representation and analysis, Design of Controllers for multivariable processes, sampling, Z_Transform and stability, stability analysis. Process identification: Fundamental concepts, direct methods, pulse testing, relay feedback identification, Least-square methods, use of MATLAB identification Toolbox.

TEXT BOOK:

1. Luyben.M.L, W. L.Luyben, Essentials of Process Control, 1997, McGraw Hill International

REFERENCES:

1. B. Wayne Bequette, Process Control: Modeling, Design, and Simulation, 2003, Prentice Hall Professional.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Impart advanced knowledge on the concepts of chemical process control.
2. Analyse various processes to get the input/output data.
3. Study the effect of time domain analysis and frequency domain analysis of a process.
4. Apply various computer architecture for the study of inputs to various complex systems and to get their output.
5. Understand multivariable processes, Z-transform and its application in multivariable processes and in-depth idea of identification of processes.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	-	2	-	-	-	-	3	2	3
CO2	3	3	2	2	-	-	2	-	-	-	-	3	2	3
CO3	3	3	2	2	-	-	2	-	-	-	-	3	2	3
CO4	3	3	2	2	-	-	2	-	-	-	-	3	2	3
CO5	3	3	2	2	2	-	2	-	-	-	-	3	2	3

25CHHE702	**ADVANCED FLUIDIZATION ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To learn the fluidization phenomena, industrial applications of fluidized beds and
- To acquire knowledge on their operational and design aspects.
- To know the mathematical models of Fluidized Bed

Unit - I

The phenomenon of Fluidization - Liquid like behavior of a Fluidized Bed – Comparison with Other contacting Methods – Advantages and Disadvantages of Fluidization - Types of Fluidization Operations. Applications of fluidized bed: Physical Operations – Synthesis Reactions – Cracking and Reforming of Hydrocarbons – Carbonization and Gasification – Calcining and Clinkering – Gas Solid Reactions

Unit - II

Minimum Fluidizing Velocity, Terminal Velocity and Pressure Drop in Fluidized Beds – Types of Fluidization, bubble formation and importance of the distributors – Voidage in Fluidized Beds – Transport Disengaging Height, TDH – Variation in Size Distribution with height – Viscosity and Fluidity of Fluidized Beds – Power Consumption

Unit - III

Single Rising Bubbles – Stream of Bubbles from a Single Source – Bubbles in Ordinary Bubbling Beds – The Bubbling Bed Model for the Bubble Phase Movement of Individual Particles – Turnover of Individual Particles – Residence Time Distribution of solids – The Diffusion Model for Movement of Solids – The Bubbling model for the Emulsion Phase – Interpretation of Solids Mixing Data in terms of the Bubbling Bed Model

Unit - IV

The Bubbling Bed Model for Gas Interchange – Interpretation of Gas Mixing Data in Terms of the Bubbling Bed Model. Experimental Findings of Mass Transfer – Mass Transfer Rate from the Bubbling Bed model – Experimental Findings on Heat Transfer – Heat Transfer Rate from the Bubbling Bed Model - Two Region Models – K-L Model

Unit - V

Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds – Channeling – Design aspects of fluidized bed systems – Collection of fines

TEXT BOOKS:

1. Daizo Kunii, Octave Levenspiel, Fluidization Engineering, 1985, John Wiley & Sons, inc., New York
2. Davidson.J.F., Cliff.R., Harrison.D., Fluidization, II Edition, 1985, Academic press, London,

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Explain the concepts of fluidization phenomena and operational regimes
2. Understand the behavior of fluidized beds with respect to the gas velocity
3. Estimate pressure drop, bubble size, voidage, heat and mass transfer rates of the fluidized beds
4. Develop various mathematical models of the fluidized bed
5. Analyze the design aspects of fluidization systems

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	2	2	-	-	-	-	2	-	3	2	3
CO2	2	3	2	-	-	-	2	-	-	2	2	3	3	3
CO3	3	3	3	2	-	-	-	-	-	-	2	3	3	3
CO4	3	2	-	3	-	-	-	-	2	-	-	3	2	3
CO5	3	-	2	3	3	2	2	2	2	-	3	3	2	3

25CHHE801	**APPLICATION OF NANOTECHNOLOGY IN CHEMICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the fundamentals of the preparation and properties of nanomaterials from a chemical engineering perspective.
- To gain knowledge of structure, properties, manufacturing, and applications of various nanomaterials and characterization methods in nanotechnology
- To give a survey of the key processes, principles, and techniques used to build novel nanomaterials and assemblies of nanomaterials

Unit – I: Introduction

Introduction to nanotechnology, Feynman's Vision-There's Plenty of Room at the Bottom, Classification of nanostructures, Nanoscale architecture, Chemical interactions at nanoscale, Types of carbon based nanomaterials, Synthesis of fullerenes, Graphene, Carbon nanotubes, Functionalization of carbon nanotubes, One, two and multidimensional structures, Crystallography.

Unit – II: Approaches to Synthesis of Nanoscale Materials

Top down approach, Bottom up approach Bottom-up vs. top-down fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self-assembly; Ultrasound assisted, microwave assisted, Mini, micro and nanoemulsion. Wet grinding method, Spray pyrolysis, Ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures, Types of molecular modeling methods.

Unit – III: Characterization of Nanoscale Structures and Surfaces

Size, shape, crystallinity, topology, chemistry analysis using X-ray imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.

Unit – IV: Semiconductors and Quantum dots

Intrinsic semiconductors, Extrinsic semiconductors, Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle Pauli exclusion principle Schrödinger's equation Properties of the wave function, Applications: quantum well, wire, dot, Quantum cryptography

Unit – V: Polymer-based and Polymer-filled Nanocomposites

Nanoscale Fillers, Nanofiber or Nanotube Fillers, Plate-like Nanofillers, Equi-axed Nanoparticle Fillers, Inorganic Filler Polymer Interfaces, Processing of Polymer Nanocomposites, Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing, Nanoparticle/Polymer Composite Processing: Direct Mixing, Solution Mixing, In-Situ Polymerization, In-Situ Particle Processing, In-Situ Particle Processing Metal/Polymer Nanocomposites, Properties of nanocomposites.

TEXT BOOKS:

1. Louis Hornyak G., Dutta Joydeep, Tibbals Harry F. and Rao Anil K., "Introduction to Nanoscience", 2008, Taylor and Francis.
2. Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science and Technology", 2003, Wiley.

REFERENCES:

1. Kelsall Robert W., Hamley Ian W., Geoghegan Mark, "Nanoscale Science and Technology", 2006, John Wiley & Sons, Ltd
2. Kal Ranganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering", 2010, McGraw-Hill Companies, Inc.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Illustrate the basics of nano science.
2. Synthesize nano materials through various methods.
3. Characterize nano materials.
4. Explain about Semiconductors and Quantum dots.
5. Distinguish polymer based nano materials.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	-	2	2	2	2	2	2	3	2	3
CO2	2	2	3	3	3	2	2	2	-	1	2	2	3	2

CO3	2	3	2	2	-	2	2	2	-	2	-	3	3	2
CO4	3	2	2	2	2	2	2	2	2	-	2	3	2	3
CO5	2	3	2	2	-	2	2	2	2	2	2	2	2	3

25CHHE802	HETEROGENEOUS REACTOR DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on catalytic reactions and catalyst preparation
- To develop the knowledge of the impact of mass and heat transfer effects on heterogeneous reactions.
- To understand multiphase reactors (gas-liquid and fluid-solid reactions) concept in heterogeneous reactor
- To analyse and design of different heterogeneous reactor

Unit - I

Catalyst and characterization: Introduction catalysts and reactions – catalyst preparation – characterization of catalyst – characterization of support, catalyst deactivation: deactivation by sintering – coking or fouling – poisoning – moving bed reactor.

Unit - II

Catalytic reactions, rate controlling steps, Langmuir-Hinshelwood model, Rideal-Eiley mechanism.

Unit - III

External diffusion effects in heterogeneous reactions- mass and heat transfer coefficients in packed beds, quantitative treatment of external transport effects, modeling diffusion with and without reaction-Internal transport process-porous catalyst- Intrapellet mass and heat transfer, evaluation of effectiveness factor, mass and heat transfer with reaction.

Unit - IV

Fluid-Fluid reactors- Rate equations – Kinetic regimes

Unit - V

Analysis and design of heterogeneous reactors- packed bed reactors - two-phase fluidized bed model- slurry reactor model- trickle bed reactor model-experimental determination and evaluation of reaction kinetics for heterogeneous systems-application to design reactors with particles of single size - mixture of particles of different sizes under plug flow and mixed flow conditions

TEXT BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd Edition, 1997, John Wiley & Sons.
2. J.M. Smith, Chemical Kinetics, 3rd Edition,1984, McGraw Hill.

REFERENCES:

1. Froment, G. F. and Bischoff, K. B., "Chemical Reactor Design and Analysis", 2nd Edition, 1997, John Wiley & Sons, New York.
2. Sharma, M.M. and Doraiswamy, L.K., "Heterogeneous reactions: Analysis, Examples and Reactor Design". Vols. I & II, 1984, John Wiley and Sons, NY,

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Acquire knowledge about catalysts.
2. Understand about heterogeneous catalytic reaction mechanisms.
3. Analyse about heat and mass transfer in heterogeneous reactions.
4. Gain knowledge on fluid-fluid reaction kinetics.
5. Design and analyze industrial heterogeneous reactors.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	2	2	-	-	-	-	3	2	3
CO2	3	3	2	-	-	2	2	-	-	-	-	3	2	3
CO3	3	3	3	3	-	2	2	-	-	-	-	3	2	3
CO4	3	3	3	3	-	2	2	-	-	-	-	3	2	3
CO5	3	3	3	3	3	2	2	-	-	-	-	3	2	3

MINOR ENGINEERING COURSES

25CHMI601	BASIC PRINCIPLES OF CHEMICAL ENGINEERING	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

- The course will serve as a basis for all further engineering courses that are part of the curriculum

UNIT –I: Introduction

Stoichiometric and composition relations, Excess and limiting reactants, Degree of completion.

Ideal Gas: Ideal gas law and its applications. Dissociating gases, gas mixture & Vapour pressure -Effect o temperature Vapour pressure plots. Vapour pressure of immiscible Liquids. Raoult's law, relative vapor pressure.

UNIT – II: Humidity and saturation

Humidity chart. Relative & percent saturation evaporation and condensation processes. Solubility and crystallization: Mass balance and yield calculations in dissolution and crystallization processes. Solubility of gases (Henry's law)

UNIT – III: Material Balance

Calculation for Batch and Continuous Processes, Recycling Process, by pass and purging operation.

UNIT – IV: Fuel and Combustion

Fuels and Combustion: Problems on combustion of solids, liquids and Gaseous fuels and pyrites. Two stage conversion of SO_2 to SO_3.

UNIT – V: Thermo Physics and Thermo Chemistry

Mean specific heat. Heat of fusion & vaporization. Heat of formation, combustion and reaction. Degree of conversion based on inlet and outlet temperature. Enthalpy - Hess law. Theoretical flame temperature.

TEXT BOOKS:

Hougen,O.A.,Watsen,K.M., and R.A.Ragartz, Chemical Process Principles, part -I, 1975, John Wiley and Asia Publishing Co.

REFERENCES :

1. Bhatt,B.L, and S.M.Vohra, Stoichiometry, Tata McGraw Hill. 3rd ed

2. Himmelblau,D.M.,Basic Principles and Calculations in chemical Engineering. 2nd ed. 1967
3. Mayers and seider, Introduction to chemical Engineering and computer calculations, 3rd ed. 1982, Prentice Hall.
4. Asokan, K., Chemical Process Calculations, First Edn., 2007, Universities Press, Hyderabad.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Understand the concepts of stoichiometry and explain the gas laws and equations.
2. Interpret humidity chart.
3. Discuss the basics of material balance.
4. Calculate combustion efficiency for different fuels.
5. Explain the concepts of thermo physics and thermo chemistry.

Mapping with POs & PSOs														
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	-	-	1	-	-	-	-	-	3	2	-
CO2	3	2	1	-	-	1	-	-	-	-	-	3	2	-
CO3	3	2	1	-	-	1	-	-	-	-	-	3	2	-
CO4	3	2	1	-	-	1	-	-	-	-	-	3	2	-
CO5	3	2	1	-	-	1	-	-	-	-	-	3	2	-

25CHMI602	**ORGANIC & INORGANIC CHEMICAL TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Impart clear description of one latest process along with its Chemistry, Process parameters, Engineering Problems and Optimum Conditions.
- To improve knowledge of the chemical processes along with emphasis on recent technological development
- To understand unit operations involved in the physical separation of the products obtained during various unit processes.
- To study process technologies of various organic and inorganic process industries
- Appreciate the usage of other engineering principles such as Thermodynamics, Heat, mass and momentum transfer in operation and maintain the productivity.

UNIT -I

Industrial gases: Carbon dioxide, Hydrogen, Oxygen, Nitrogen and synthesis gas. Sulfur, Sulfuric Acid, Hydrochloric acid, Chlor-Alkali Industry: Sodium chloride, Soda ash, Sodium Bi-Carbonate, Chlorine, Caustic soda.

UNIT -II

Nitrogen Industry: Ammonia, Ammonium sulfate, Ammonium Nitrate, Ammonium Phosphate, Ammoniumchloride, urea, Nitric acid, Nitro Phosphate, cyanamide. Phosphorous

Industry- Phosphorus, phosphoric acid Calcium phosphate, Sodium phosphate, Di and Triammonium phosphate, Mixed Fertilizers and compound super phosphates.

UNIT-III

Silicate industry : Ceramics, Glass and Cement, paint, Varnish, Enamel and Lacquer, White lead, Zinc oxide, Lithophone, Titanium di oxide. Fermentation products, absolute alcohol, penicillin.

UNIT - IV

Sugar, starch, glucose, pulp, paper, leather, glue and gelatin.Petroleum refining Processes, Oils, fats, soaps, glycerin, synthetic detergents

UNIT - V

Plastics - Phenol, vinyl, and urea formaldehydes; polypropylene and silicone. Elastomers, Natural and Synthetic fibers, Cellulose acetate, viscose rayon, Nylon, polyester.

TEXT BOOKS:

1. Austin.G.T., Shreve's Chemical Process Industries, Fifth Edn., 1984, McGraw Hill.
2. Gopal Rao,M., and M. Sittig., Dryden's Outlines of Chemical Technology, 2nd edition, 1979 Affiliated East West Press.

REFERENCES:

1. Kirk and Othmer, Encyclopedia of Chemical Technology, 5th edition, 2005, John Wiley.
2. Pandey,GN., A Text Book of Chemical Technology, 1997, Vikas Publishing Company, Vol. II,

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Understand the processes involved in manufacturing of various inorganic and organic chemicals
2. Read and interpret basic process industry drawings
3. understand the process flow diagrams.
4. Analyze important process parameters and engineering problems during production.
5. Suggest manufacturing process for a chemical.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	3	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	3	-	-

25CHMI701	CHEMICAL ENGINEERING OPERATIONS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

The principles learnt in this course are required in almost all the courses and throughout the professional career of Chemical Engineer

UNIT-I

Introduction to Unit Operations and Chemical Engineering Processes. Single Equilibrium Stage, Binary vapor–liquid systems, bubble-point, and dew-point calculations. Absorption and Stripping of dilute mixtures: Fundamentals of absorption, equilibrium curves, Operating lines from material balances, Number of equilibrium stages.

UNIT-II

Distillation of binary mixtures: Differential distillation, Flash or equilibrium distillation, Fractionating column and multistage column, design and analysis factors, degrees of freedom, specifications, reflux, reflux ratio, need for reflux,

UNIT-III

Particulate solids: Particle characterization Shape, size, particle size measurement, Particle size analysis in process equipment. Particle Size Reduction: Necessity for size reduction of solids, Mechanism for size reduction, Energy requirements for size reduction and scale-up considerations, Operational considerations, Crushing and grinding equipment: impact and roller mills, fluid energy mills, wet/dry media mills

UNIT-IV

Liquid Filtration: Filtration theory: constant pressure, constant rate, and variable pressure-variable rate filtration, Incompressible and compressible cake filtration, Continuous filtration, filter aids, Filtration equipment. Sedimentation, Classification and Centrifugal Separations: Design and scale up equations, Performance evaluation, Sedimentation equipment, classifiers, centrifugal equipment, Sieving operations, types of sieving (dry, wet, vibro), magnetic separators, and froth flotation.

UNIT-V

Drying of solids: Mechanism of drying, drying rate curves, Estimation of drying time , Drying Equipment, operation.

TEXT BOOKS:

1. Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., Chemical engineering: Particle technology and separation processes. 2002, Butterworth-Heinemann, Woburn, MA.
2. McCabe, W., Smith, J., Harriott, P., Unit Operations of Chemical Engineering, 7 ed. 2004, McGraw- Hill Science/Engineering/Math, Boston.

REFERENCES:

1. Green, D., Perry, R., Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. 2007, McGraw-Hill
2. Dutta, B.K., Principles of Mass Transfer and Separation Process.2007, Prentice-Hall of India Pvt. Ltd, New Delhi.

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Estimate thermodynamic properties of substances in gaseous ,liquid states and determination of thermodynamic efficiency in various energy related processes
2. Understand the separation of binary mixtures using distillation column.
3. Select suitable size reduction equipment, solid-solid separation method and conveying system
4. Evaluate the parameters of various filtration equipment and sedimentation
5. Understand the drying characteristics and mechanism of different types of dryers

Mapping with POs & PSOs													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	2	2	2	2	2	-	-	-	3	2	3
CO2	3	3	3	2	2	2	2	2	-	-	-	3	2	3
CO3	3	3	3	2	2	2	2	2	-	-	-	3	3	3
CO4	3	3	3	2	2	2	2	2	-	-	-	3	3	2
CO5	3	3	3	2	2	2	2	2	-	-	-	3	3	2

25CHMI702	**BASICS OF FLUID MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To develop an understanding of fluid statics and dynamics in chemical engineering
- To understand and use differential equations to determine pressure and velocity variation in fluid flows.
- To understand the concept of viscosity
- To use dimensional analysis to design physical or numerical experiments

UNIT I: Fluid statics and its applications

Unit systems-conversion of units- Dimensional analysis-Basic concepts; fluid mechanics

Hydrostatic equilibrium-application of fluid statics-manometers, continuous gravity decanter and centrifugal decanter

UNIT II: Fluid flow phenomena

Rheological properties of fluids-laminar and turbulent flow-boundary layers

Basic equations of flow- continuity equation, mechanical energy equation. Bernoulli equation and correction factors, pump work in Bernoulli equation.

UNIT III: Flow of incompressible fluids

Incompressible flow in pipes-shear stress and skin friction in pipes, friction factor, flow in noncircular channels, laminar and turbulent flow in pipes and channels, friction factor chart, friction loss from sudden contraction and expansion

UNIT IV: Flow past immersed bodies

Drag and drag coefficients, flow through beds of solids-Ergun's equation. Motion of particles through fluids-terminal velocity, Stoke's law and Newton's law. Hindered settling.

UNIT V: Transportation and metering of fluids

Pipes, fittings and valves. Pumps - power requirement, suction lift and cavitation. Classification of pumps - positive displacement and centrifugal pumps. Introduction to fans, blowers and compressors, selection criteria of pumps.

Measurement of flowing fluids-venturi meter, orifice meter, rotameter, pitot tube, magnetic flow meter.

TEXT BOOKS:

1. McCabe,W.L, Smith,J.C and P.Harriot., Unit Operations of Chemical Engineering, Seventh Edn., 2005, McGraw Hill
2. Noel De Nevers, Fluid Mechanics for Chemical Engineers, Third Edn.,2005, McGraw Hill.

REFERENCES:

1. J.M.Coulson, J.F. Richardson's, Chemical Engineering, Vol.1., VI Edition, 1999.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Perform dimensional analysis and explain basic concepts of fluid flow.
2. Apply Bernouli principle and compute pressure drop in flow systems of different configurations
3. Explain flow characteristics of incompressible fluids.
4. Compute power requirement in fixed bed system and determine minimum fluidization velocity in fluidized bed
5. Determine and analyze the performance aspects of fluid machinery.

Mapping with POs & PSOs

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	-	1	-	-	2	-	2	3	2	-
CO2	3	3	3	3	3	2	3	2	2	2	2	3	3	2
CO3	3	3	3	3	3	2	2	2	2	2	2	3	3	2
CO4	3	3	3	3	3	2	2	2	2	2	2	3	3	2
CO5	3	3	2	2	3	2	3	2	2	2	2	3	2	3

25CHMI 801	BASIC PRINCIPLES OF CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide basic knowledge on the selection of right type of reactor for the required reaction.
- To familiarize the students' knowledge on reaction kinetic principles and different type of reactors.
- To gain knowledge on ideal and non-ideal flow conditions.
- To gain knowledge on adiabatic and non-adiabatic conditions
- To familiarize the students' knowledge on non-ideal parameters.

UNIT I

Thermodynamic Restrictions, chemical Kinetics, types of complex reactions, rate equation-Temperature dependency of rate equation.

UNIT II

Interpretation of rate data in variable and constant volume systems, concentration dependency.

UNIT III

Ideal reactors: Concepts of Ideality, development of design expressions for Batch, Tubular, Stirred tank, Semi batch and Recycle reactors, Combined reactor system, comparison, advantages and limitations in application-Isothermal reactors design.

UNIT IV

Thermal characteristics of reactors, adiabatic and non-adiabatic conditions, principles of reactor stability and optimization.

UNIT V

Residence time distribution: Residence time functions and relation among them, Application to non ideal reactors-modeling of real systems. Non-ideality parameters, prediction of reactor performances, concept of macro mixing.

TEXT BOOKS:

1. Octave Levenspiel, Chemical Reaction Engineering, 3rd edition, 2006, Wiley Eastern,
2. K.A. Gavhane, Chemical Reaction Engineering -I, 10th edition, 2008, Nirali Prakashan,

REFERENCE BOOKS:

1. Fogler .S "Fundamental Chemical Reaction Engg", Prentice Hall of India, 2nd edition, 1992.
2. Smith,J.M., Chemical Engineering Kinetics, 3rd edition, McGraw Hill, 1981.

COURSE OUTCOMES

On completion of the course, the students would be able to

1. Select right type of reactor for specific type of process.
2. Interpret rate data.
3. Develop design expressions for different reactors.
4. Understand thermal characteristics of reactors.
5. Predict reactor performances and non-ideality.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	2	-	-	-	-	-	3	3	3
CO2	3	3	3	3	-	-	2	-	-	-	-	3	3	3
CO3	3	3	3	3	3	-	3	-	-	2	-	3	2	3
CO4	3	3	3	3	-	2	-	-	-	-	-	3	2	3
CO5	3	3	3	3	-	3	2	-	-	-	-	3	2	3

25**CHMI802**	**PROCESS ENGINEERING & ECONOMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- Explain the principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.
- Describe the role of economic evaluation in decision making and design of processes with standard methodology.
- Estimate the value of money, worth of equipment & processes with period with different methods.
- Analyze and compare alternatives for equipment, processes and economic evaluation.
- Identify, justify and design process plants and evaluate existing facilities with budgeting and benchmarking.

UNIT - I

Value of money and equivalence - Amortization - Depreciation

UNIT - II

Capital requirements for process plants - Balance sheet chart - earnings, profits and returns - Economic production, Break even Analysis Charts

UNIT- III

Cost accounting -Pre construction cost estimation - allocation of cost.

UNIT - IV

Economics of selecting alternatives

Annual cost methods, Present worth method. Replacement, rate of return method and payout time method.

UNIT - V

Economic balance

General principles and method economic balance in single variable operation and in two variable operation.

TEXT BOOKS:

1. Schweyer, Process Engineering Economics, 1955, Me Graw Hill.
2. Peter and Timmerhaus, Plant Design and Economics for Chemical Engineers 3rd ed. 1984.

REFERENCES:

1. S.N.Maheshwari, Principles of management Accounting, 2000, sultan Chand and sons , New Delhi
2. Dhanasekaran. S, Muralikandan. K, Mukundhan .K.S., "Engineering Economics", Saitech Publication Pvt Ltd., Chennai, Tamil Nadu, India

COURSE OUTCOMES:

On completion of the course, the students would be able to

1. Calculate cost and asset accounting, time value of money, profitability, alternative investments, minimum attractive rate of return, sensitivity and risk.
2. Examine the production using economic concepts to predict and analyze the production.
3. Recommend most economical solution among alternatives in engineering problems.
4. Plan for an economical investment in process plants with fundamental knowledge encouraging them to be successful entrepreneurs.
5. Design and develop new process plant with economic evaluation.

Mapping with POs & PSOs														
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	3	-	-	-	3	3	3	3	-	3
CO2	2	3	3	3		-	-	-	-	-	-	3	2	2
CO3	-	3	2	3	2	-	-	-	-	-	-	3	3	3
CO4	-	3	-	3	2	-	-	-	-	-	-	3	2	-
CO5	2	2	-	2	2	-	-	-	-	-	-	3	2	3

VALUE ADDED COURSES

25ECHEVAC01	FOOD PRESERVATION TECHNOLOGY	L/P
		3

LEARNING OBJECTIVES:

- To study the importance of microorganisms in food preservation
- To introduce the basics of various food processing and preservation technologies.
- To train the student to analyze food components.
- To make the students aware of the standards of food quality

Unit - I

Principle of food preservation--Removal of Microorganism-Maintenance of anaerobic conditions-General principles underlying spoilage-Chemical changes caused by microorganisms - Spoilage of different kinds of foods-Intrinsic and Extrinsic Parameters that affect microbial growth.

Unit - II

Heat preservation and Processing-Degrees of preservation-Selecting heat treatments-Heat resistance of Microorganisms-Heat transfer-Protective effects of food contamination-Cold Preservation and processing Distinction between Refrigeration and Freezing-Refrigeration and cold storage-Freezing and frozen stage- Different methods of drying process-Food dehydration-Food concentration-Food irradiation-Microwave heating and ohmic heating

Unit - III

Milk and milk products-Meat and meat products-Cereals and cereal products- Sugar and sugar products-Canned foods and Bottled beverage-Fruit and Vegetable Products-Fruit juices-Jams-Marmalades-Squashes-Cordials-Ketchup/Sauces-Soup Powder.

Unit – IV (Practical)

1. Estimation of gluten content in wheat flour
2. Determination of TSS in different fruit juices
3. Determination of Moisture content of given sample
4. Estimation of Ash
5. Adulteration a) pepper b) chili powder c) Milk (Iodine) D) Coffee powder E) Honey F) Turmeric
6. Determination of milk (Water, MBRT, Coagulation).
7. Drying characteristics in vegetables.
8. Determination of titratable acidity in given sample.

Unit – V (Practical)

1. Determination of pH in different food using pH meter.
2. Extention of shelf life /preservation of food by use of low temperature.
3. Osmotic concentration / dehydration of certain fruits and vegetables using concentrated sugar and salt solution.

4. Pasteurization of milk (Low Temperature Less Time).
5. Blanching of tomato.
6. Preparation of sugar boiled Candy

TEXT BOOKS:

1. B. Srilakshmi, Food science, New Age Publishers, 2002
2. Meyer, Food Chemistry, New Age, 2004
3. Bawa. A.S, O.P Chauhan etal. Food Science. New India Publishing agency, 2013
4. Frazier WC and Westhoff DC, Food Microbiology, TMH Publication, New Delhi, 2004.
5. Desrosier NW and Desrosier JN, The Technology of Food Preservation, CBSPublication, New Delhi, 1998.

REFERENCES:

1. Paine FA and Paine HY, Handbook of Food Packaging, Thomson Press India Pvt Ltd, New Delhi- 1992
2. Potter NH, Food Science, CBS Publication, New Delhi, 1998
3. Ramaswamy H and Marcott M, Food Processing Principles and Applications CRC Press, 2006
4. Rao PG, Fundamentals of Food Engineering, PHI Learning Pvt Ltd, New Delhi, 2010
5. Toledo Romeo T, Fundamentals of Food Process Engineering, Aspen Publishers, 1999

25ECHEVAC02	PERSONAL PROTECTIVE EQUIPMENT (PPE) & FIRST AID	L/P
		3

LEARNING OBJECTIVES:

- To understand the importance of PPE and safeguard the life of workers.
- To know the different types of PPE and its applications.
- To understand the necessity of First aid in emergencies and in life saving.
- To provide appropriate First-Aid for the victim of different injuries.

Unit - I

NEED FOR PERSONAL PROTECTIVE EQUIPMENT:

Need for personal protective equipment – selection - Applicable standards, supply, use, care & maintenance.

Unit - II

RESPIRATORY & NON RESPIRATORY PERSONAL PROTECTIVE DEVICES:

Respiratory personal Protective equipment - Classification of respiratory personal protective equipment - Selection of respiratory personal protective equipment - Non-respiratory personal protective devices, Head protection, Ear protection. Face and Eye protection, Hand protection, Foot protection and Body protection.

Unit - III

FIRST AID:

Body structure and Functions, Position of causality, he unconscious casualty, fracture and dislocation, Injuries in muscles and joints, Bleeding, Burns, Scalds and accidents caused by electricity, Respiratory problems, Rescue and Transport of Casualty. Cardiac massage, poisoning, wounds.

Unit – IV (Practical)
PRACTICAL ON PERSONAL PROTECTIVE EQUIPMENT
Personal protective equipment: Respiratory and non-respiratory-demonstration-self contained breathing apparatus. Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, anti static and conducting plastics/rubber materials, apron and leg guard.

Unit – V (Practical)
PRACTICAL ON FIRST AID
Classroom based power-point presentation with practical components; (i.e. Dealing with Emergencies)

REFERENCES:

1. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2, Butterworth Heinemann Ltd., London (1991).
2. Industrial Safety - National Safety Council of India.
3. R. K. Jain and Sunil S. Rao, Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

25ECHEVAC03	FIRE ENGINEERING AND EXPLOSION CONTROL	L/P
		3

LEARNING OBJECTIVES:
- To provide knowledge about the science of fire
- To evaluate methods to prevent fire in industries.
- To know the various fire prevention systems.
- To inculcate the concept of explosion and its prevention..

Unit - I
PHYSICS AND CHEMISTRY OF FIRE

Sources of fire-Types & Classification-Fire triangle-fire properties of solid, liquid &gases-Fire spread-Toxicity of products of combustion - Theory of combustion and explosion – vapour clouds – Flash fire – Jet fires – Pool fires – Unconfined vapour cloud explosion, shock waves - Auto-ignition – Boiling liquid expanding vapour explosion.

Unit - II
FIRE PREVENTION AND PROTECTION

Sources of ignition – Principles of fire extinguishing –Active and passive fire protection systems – Types of fire extinguishers – Fire stoppers – Hydrant pipes – Hoses – Monitors –

Fire watchers – Layout of stand pipes – Fire station-fire alarms and sirens – Maintenance of fire trucks – Foam generators – Escape from fire rescue operations – Fire drills.

Unit - III
INDUSTRIAL FIRE PROTECTION SYSTEMS

Sprinkler-hydrants-stand pipes – Special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO_2 system, foam system, dry chemical powder (DCP) system, halon system.

Unit – IV (Practical)
FIRE EXTINGUISHERS AND ITS OPERATIONS (Practical's)

Water, Foam, Carbon dioxide (CO_2), Dry chemical powder extinguisher.

Unit – V (Practical)
FIRE ALARM/SMOKE DETECTOR

Application of Fire alarm/Smoke detector – Case study

REFERENCES:

1. "Accident Prevention manual for industrial operations" N.S.C., Chicago, 1982.
2. R.S. Gupta, "Hand Book of fire technology", 1976, Orient Longman Limited
3. "Fire Prevention and fire fighting", Loss prevention Association, India.
4. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.
5. Dinko Tuhtar,, Fire and explosion protection: A System Approach. E. Horwood publishers, 1989

25ECHEVAC04	DAIRY TECHNOLOGY	L/P
		3

LEARNING OBJECTIVES:

- Milk and its composition, properties and uses of milk constituents.
- Qualitative and Quantitative analysis of milk.
- Manufacturing process of milk products.

Unit - I

Composition and nutritive value of milk- composition of milk from different species-Properties of Milk components-Collection, Transportation, Reception & Treatment of Milk at the Dairy Plant-Chilling-Clarification and Storage–Materials and sanitary features of the diary Equipments.

Unit - II

Pasteurization-Batch, flash and continuous (HTST) pasteurizers-Sterilization-Different type of sterilizers in bottle sterilizers, autoclaves, continuous sterilization plant-UHT Sterilization. Homogenization-Effect of Homogenization, single stage and two stage homogenizer-Drying and Different methods of drying process-Evaporation and concentration of Milk. Creams–Types of cream separators-Ice cream freezers-Classification of freezers.

Unit - III

Diary products-Pasteurized milk, Sterilized milk, Condensed milk, Reconstituted milk, Flavored Milk. Cream, Butter, Ice cream, Milk powder, casein, Khoa, Whey, Yohurt, Fermented milk and Cheese. Food hygiene, Personal hygiene, Plant hygiene-Cleaning and Sanitation-Different types of cleaning and sanitizing agents

Unit – IV (Practical)

1. Detection of Adulterants in Milk.
2. Test for Presence of Hydrogen Peroxide in Milk.
3. Preparation of Sample of Icecream.
4. Determination of Total Ash.
5. Determination of Moisture in Butter.
6. Preparation of Sample of Yoghurt.

Unit – V (Practical)

1. Preparation of Sample of Casien.
2. Determination of pH in different Milk.
3. Determination of Fat in Milk.
4. Pasteuration of Milk (Low Temperature Less Time)
5. Detection of calcium in Milk.

REFERENCES:

1. De Sukumar, 1999. "*Outlines of Dairy Technology*", Oxford University Press, New, Delhi.
2. Edgar R.Ling, 1956. "*A Text book of dairy chemistry*", Chapman And Hall Ltd.
3. Robinson, R.K.1996. "*Advances in Milk Processing*", Elsevier Applied Science Publishers, Ltd., London, UK.
4. Tufail Ahmed, 2001. Diary plant Engineering and Management, CBS Publishers and distributors, New Delhi.
5. Norman N.Potter, Joseph H.Hotchkiss, Food science, CBS Publishers and distributors, 1995.