KLE Technological University | Creating Value, Leveraging Knowledge

Curriculum Structure and Curriculum Content for the Academic Batch 2022-26

Department of Chemical Engineering

Program: Bachelor of Engineering

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Vision and Mission of KLE Technological University

Vision

KLE Technological University will be a national leader in Higher Education–recognised globally for innovative culture, outstanding student experience, research excellence and social impact.

Mission

KLE Technological University is dedicated to teaching that meets highest standards of excellence, generation and application of new knowledge throughresearch and creative endeavors.

The three-fold mission of the University is:

- To offer undergraduate and post-graduate programs with engaged and experiential learning environment enriched by high quality instruction that prepares students to succeed in their lives and professional careers.

- To enable and grow disciplinary and inter-disciplinary areas of research that build on present strengths and future opportunities aligning with areas of national strategic importance and priority.

- To actively engage in the Socio-economic development of the region by contributing our expertise, experience and leadership, to enhance competitiveness and quality of life.

As a unified community of faculty, staff and students, we work together with the spirit of collaboration and partnership to accomplish our mission.

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Vision and Mission Statements of the Chemical Engineering Department

Vision

To be a department of excellence in education and research, meeting the requirements of industry and society.

Mission

- To create graduates with sound knowledge in the theoretical and applied aspects of Chemical Engineering.
- To prepare graduates for professional practice and higher studies in core and multidisciplinary areas through seminars and projects.
- To achieve excellence in academics and research through quality education and student support systems.
- Foster an industry-institute relationship to bridge the gap between theory and practice.
- To facilitate employability and entrepreneurship through holistic education and an alumni network.

Program Educational Objectives/Program Outcomes and Program-Specific Objectives

Program Educational Objectives -PEOs
Department of Chemical Engineering accomplishments that graduates are expected to attain after 3 to 5 years of graduation
PEO1: Integrate science and engineering with interdisciplinary areas to formulate, analyze, and solve chemical and allied engineering problems.
PEO2: Pursue careers in chemical engineering and allied areas to achieve professional growth in industry and academia.
PEO3: Exhibit professional ethics and address issues of environment and sustainability.
Program Outcomes-POs
PO1: **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialisation as specified in WK1 to WK4, respectively, to develop solutions to complex engineering problems.
PO2: **Problem Analysis**: Identify, formulate, review research literature and analyse 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, recognising their limitations to solve complex engineering problems. (WK2 and WK6)
PO6: **The Engineer and The World**: Analyse 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 multidisciplinary environments.
PO11: **Life-Long Learning**: Recognise 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)

Program Specific Objectives - PSOs
PSO 1 - Expertise in core chemical Courses: Exhibit basic understanding of process calculations, reaction engineering and process equipment design.
PSO 2 - Flair to industry: Acquire practical knowledge of unit operations and unit processes through industry visits, internships and projects.
PSO 3 - Expertise in allied areas: Apply principles of chemical engineering to bio-energy, petroleum, biochemical and environmental engineering.

Knowledge and Attitude Profile (WK)

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WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

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Curriculum Structure - Overall

Semester: 1 to 8 (2022- Batch)							Total Program Credits:178	
Course with course code	I	II	III	IV	V	VI	VII	VIII
	Single Variable Calculus (18EMAB101)	Multivariable Calculus (18EMAB102)	Calculus & Integral Transforms (Diploma Students) (15EMAB231)	Vector Calculus & Differential Equations (Diploma Students) (15EMAB241)	Numerical Methods and Statistics (Diploma Students) (24EMAB301)	Professional Aptitude & Logical Reasoning (16EHSC301)	Process Equipment Design and Drawing (22ECEC401)	Program Elective - 6 (22ECEE4XX)
	Engineering Chemistry (15ECHB101)	Engineering Physics (15EPHB102)	Statistics and Integral Transforms (15EMAB201)	Numerical Methods and Partial Differential Equations (19EMAB206)	Process Engineering Economics & Plant Design (22ECEC301)	Chemical Reaction Engineering - II (22ECEC306)	Process Control & IIOT (22ECEC402)	Open Elective (22ECEO45X)
	C Programming for Problem solving (18ECSP101)	Engineering Mechanics (15ECVF102)	Momentum Transfer (22ECEC201)	Industrial Pollution Control (22ECEC205)	Computer Applications, Modelling and Simulation (22ECEC302)	Mass transfer-II (22ECEC307)	Program Elective– 03 (22ECEE4XX)	Internship – Training (Optional In place of 1 & 2) (22ECEI493)
	Engineering Exploration (15ECRP101)	Computer Aided Engineering Drawing (15EMEP101)	Particulate Technology (22ECEC202)	Process Heat Transfer (22ECEC206)	Bioprocess Engineering (22ECEC303)	Program Elective – 1 (22ECEE3XX)	Program Elective – 4 (22ECEE4XX)	Capstone Project / Internship – Project (22ECEW402/ 22ECEW494)
	Basic Electronics (18EECF102)	Basic Electrical Engineering (18EEEF102)	Material & Energy Balance Calculations (22ECEC203)	Chemical Engineering Thermodynamics (22ECEC207)	Mass Transfer I (22ECEC304)	Program Elective – 2 (22ECEE3XX)	Program Elective – 5 (22ECEE4XX)	
	Basic Mechanical Engg. (15EMEF101)	Design Thinking for Social Innovation (20EHSP101)	Chemical Process Industries (22ECEC204)	Material Science & Engineering (22ECEC208)	Chemical Reaction Engineering - I (22ECEC305)	Chemical Reaction Engineering Lab (22ECEP303)	Process Control Lab (19EMEP401)	
	Professional Communication (15EHSH101)	Engineering Physics Lab (16EPHP102)	Momentum Transfer Lab (22ECEP201)	Computer-Based Chemical Calculations Lab (22ECEP204)	Computer Applications & Simulation Lab (22ECEP301)	Mass Transfer Lab (22ECEP304)	Senior Design Project (22ECEW40)	
			Particulate Technology Lab (22ECEP202)	Process Heat Transfer Lab (22ECEP205)	Pollution Control Lab (22ECEP302)	Minor Project (22ECEW302)	CIPE/EVS (15EHSA401)	
			Computer aided Drawing Lab (22ECEP203)	Technical Chemistry Lab (22ECEP206)	Mini Project (22ECEW301)	Industry Readiness & Leadership Skills (22EHSH302)	REU (22ECEE490)	
			Corporate Communication	Problem Solving & Analysis (19EMEP202)	Arithmetical Thinking & Analytical Reasoning (22EHSH301)			
Credits	**23**	**21**	**22**	**24**	**24.5**	**23.5**	**22**	**17**

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Curriculum Structure-Semester wise

Semester – I

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EMAB101	Single Variable Calculus	BS	4-1-0	5	6	50	50	100	3 hours
2	15ECHB101	Engineering Chemistry	BS	3-0-0	3	3	50	50	100	3 hours
3	18ECSP101	C Programming for Problem solving	ES	0-0-3	3	6	80	20	100	3 hours
4	15ECRP101	Engineering Exploration	ES	0-0-3	3	6	80	20	100	3 hours
5	18EECF102	Basic Electronics	ES	4-0-0	4	4	50	50	100	3 hours
6	15EMEF101	Basic Mechanical Engg.	ES	2-1-0	3	4	50	50	100	3 hours
7	15EHSH101	Professional Communication	HSS	1-1-0	2	3	50	50	100	3 hours
TOTAL				**14-3-6**	**23**	**32**				

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Semester – II

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	18EMAB102	Multivariable Calculus	BS	4-1-0	5	6	50	50	100	3 hours
2	15EPHB102	Engineering Physics	BS	3-0-0	3	3	50	50	100	3 hours
3	15ECVF102	Engineering Mechanics	ES	4-0-0	4	4	50	50	100	3 hours
4	15EMEP101	Computer-Aided Engineering Drawing	ES	0-0-3	3	6	80	20	100	3 hours
5	18EEEF102	Basic Electrical Engineering	ES	3-0-0	3	3	50	50	100	3 hours
6	20EHSP101	Design Thinking for Social Innovation	HSS	0-1-1	2	3	80	20	100	3 hours
7	16EPHP102	Engineering Physics Lab	BS	0-0-1	1	2	80	20	100	3 hours
TOTAL				**14-2-5**	**21**	**27**				

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Semester – III

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	15EMAB231	Calculus & Integral Transforms **(Diploma Students)**	BS	4-0-0	4	4	50	50	100	3 hours
2	15EMAB201	Statistics and Integral Transforms	BS	4-0-0	4	4	50	50	100	3 hours
3	22ECEC201	Momentum Transfer	PSC	4-0-0	4	5	50	50	100	3 hours
4	22ECEC202	Particulate Technology	PSC	4-0-0	4	5	50	50	100	3 hours
5	22ECEC203	Material & Energy Balance Calculations	PSC	4-0-0	4	5	50	50	100	3 hours
6	22ECEC204	Chemical Process Industries	PSC	3-0-0	3	3	50	50	100	3 hours
7	22ECEP201	Momentum Transfer Lab.	PSC	0-0-1	1	2	80	20	100	3 hours
8	22ECEP202	Particulate Technology Lab.	PSC	0-0-1	1	2	80	20	100	3 hours
9	22ECEP203	Computer-Aided Drawing Lab.	PSC	0-0-1	1	2	80	20	100	3 hours
10	22EHSH201	Corporate Communication	ESH		0.5	2	100	-	-	
TOTAL				**19-0-3**	**22.5**	**30**				

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Semester – IV

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	15EMAB241	Vector Calculus & Differential Equations (**Diploma Students**)	BS	4-0-0	4	4	50	50	100	3 hours
2	19EMAB206	Numerical Methods and Partial Differential Equations	BS	3-1-0	4	5	50	50	100	3 hours
3	22ECEC205	Industrial Pollution Control	PSC	3-0-0	3	3	50	50	100	3 hours
4	22ECEC206	Process Heat Transfer	PSC	4-0-0	4	4	50	50	100	3 hours
5	22ECEC207	Chemical Engineering Thermodynamics	PSC	4-0-0	4	4	50	50	100	3 hours
6	22ECEC208	Material Science & Engineering	PSC	3-0-0	3	3	50	50	100	3 hours
7	22ECEP204	Computer-based Chemical Calculations Lab.	PSC	0-0-1	1	2	80	20	100	3 hours
8	22ECEP205	Process Heat Transfer Lab.	PSC	0-0-1	1	2	80	20	100	3 hours
9	22ECEP206	Technical Chemistry Lab.	BS	0-0-1	1	2	80	20	100	3 hours
10	22ESHH202	Problem Solving and Analysis	H&SS		0.5	2	100	--		
TOTAL				**17-1-3**	**21.5**	**31**				

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Semester – V

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	24EMAB301	Numerical Methods and Statistics **(Diploma Students)**	BS	3-0-1	4	4	50	50	100	3 Hours
2	22ECEC301	Process Engineering Economics & Plant Design	PSC	3-0-0	3	3	50	50	100	3 Hours
3	22ECEC302	Computer Applications, Modelling & Simulation	PSC	4-0-0	4	5	50	50	100	3 Hours
4	22ECEC303	Bioprocess Engineering	PSC	3-0-0	3	3	50	50	100	3 Hours
5	22ECEC304	Mass Transfer - I	PSC	4-0-0	4	5	50	50	100	3 Hours
6	22ECEC305	Chemical Reaction Engineering - I	PSC	4-0-0	4	5	50	50	100	3 Hours
7	22ECEW301	Mini Project	PRJ	0-0-3	3	9	50	50	100	3 Hours
8	22ECEP301	Computer Applications & Simulation Lab.	PSC	0-0-1	1	2	80	20	100	3 Hours
9	22ECEP302	Pollution Control Lab.	PSC	0-0-1	1	2	80	20	100	3 Hours
10	22EHSH301	Arithmetical Thinking & Analytical Reasoning	ESH		0.5	2	100	-	100	
TOTAL				**18-0-5**	**23.5**	**40**				

Semester – VI

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	16EHSC301	Professional Aptitude & Logical Reasoning	PSC	3-0-0	3	3	50	50	100	3 Hours
2	22ECEC306	Chemical Reaction Engineering - II	PSC	4-0-0	4	5	50	50	100	3 Hours
3	22ECEC307	Mass Transfer - II	PSC	4-0-0	4	5	50	50	100	3 Hours
4	22ECEE3XX	Program Elective - 01	PE	3-0-0	3	3	50	50	100	3 Hours
5	22ECEE3XX	Program Elective - 02	PE	3-0-0	3	3	50	50	100	3 Hours
6	22ECEW302	Minor Project	PRJ	0-0-6	6	18	50	50	100	3 Hours
7	22ECEP303	Chemical Reaction Engineering Lab	PSC	0-0-1	1.5	3	80	20	100	3 Hours
8	22ECEP304	Mass Transfer Lab	PSC	0-0-1	1.5	3	80	20	100	3 Hours
9	22EHSH302	Industry Readiness & Leadership Skills	HS		0.5					
TOTAL				**16-0-8**	**26.5**	**30**				

Program Electives		
Vertical-I (Energy, Environment, and Sustainability)	**Vertical-II (EET) (Advanced Process Technology)**	**Vertical-III (Process Monitoring, Control, and Optimization)**
22ECEE301 Renewable Energy	22ECEE302 Fermentation & Downstream Processing	22ECEE306 Instrumentation Engineering
22ECEE304 Industrial Safety & Health	22ECEE305 Transport Phenomena	22ECEE311 Instrumental Methods of Analysis
22ECEE307 Chemical Plant Utilities	22ECEE308 Oils & Fats	

Semester – VII

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	22ECEC401	Process Equipment Design & Drawing	PSC	4-0-0	4	4	50	50	100	3 Hours
2	22ECEC402	Process Control & IIOT	PSC	3-0-0	3	3	50	50	100	3 Hours
3	22ECEE4XX	Program Elective - 03	PE	3-0-0	3	3	50	50	100	3 Hours
4	22ECEE4XX	Program Elective - 04	PE	3-0-0	3	3	50	50	100	2 Hours
5	22ECEE4XX	Program Elective - 05	PE	3-0-0	3	3	50	50	100	3 Hours
6	15EHSA401	Humanities – 02 (CIPE & EVS)	HSA	-	Audit	3	50	50	100	3 Hours
7	22ECEW401	Senior Design Project	PRJ	0-0-6	6	18	50	50	100	3 Hours
8	22ECEP401	Process Control Lab	PSC	0-0-1	1	2	80	20	100	3 Hours
9	22ECEE490	REU	PRJ	0-0-6	6	6	50	50	100	3 Hours
TOTAL				**16-0-7**	23	39				

Program Electives		
Vertical-I (Energy, Environment, and Sustainability)	**Vertical-II (EET) (Advanced Process Technology)**	**Vertical-III (Process Monitoring, Control, and Optimization)**
22ECEE401 Sustainable Technologies	22ECEE402 Food Technology	22ECEE406 Process Modeling and Simulation
22ECEE404 Waste Management	22ECEE405 Petroleum and Petrochemicals Engineering	22ECEE409 Data Analytics and Applications in Chemical Engineering
22ECEE407 Pollution Control Technologies	22ECEE408 Pulp and Paper Technology	2ECEE412 Machine Learning for Process Optimization in Chemical Engineering
22ECEE410 Unit Operations in Environmental Engineering	22ECEE411 Polymer Science and Technology	22ECEE413 Advanced Process Control

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Semester – VIII

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration (in hrs)
1	22ECEE4XX	Program Elective - 6	PE	3-0-0	3	3	50	50	100	3 Hours
2	22ECEO45X	Open Elective	OE	3-0-0	3	3	50	50	100	3 Hours
3	22ECEI401	Internship – Training (Optional In place of 1 & 2)		0-0-6	6	----	80	20	100	3 Hours
4	22ECEW402 / 22ECEW403	Capstone Project / Internship - Project	PW	0-0-11	11	22	50	50	100	3 Hours
TOTAL				**6-0-17**	**17**	**28**				

Program Electives		
Vertical-I (Energy, Environment, and Sustainability)	**Vertical-II (EET) (Advanced Process Technology)**	**Vertical-III (Process Monitoring, Control, and Optimization)**
22ECEE401 Fuels Furnaces & Refractories	22ECEE402 Nano Materials & Applications	22ECEE403 AI & ML for Chemical Engineers
22ECEE404 Environmental Impact Assessment	22ECEE405 Corrosion Engineering	

Open Elective			
22ECEO401	Green Technology	22ECEO402	Process Air Pollution & Control
22ECEO403	Environmental Protection and Management	22ECEO404	Solid Waste Management
22ECEO405	Occupational Safety and Health Administration	22ECEO406	Nano Science & Technology

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Credits	**23**	**21**	**22.5**	**21.5**	**23.5**	**26.5**	**23**	**17**	**178**

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List of Open Electives

Sr. No.	Name of the Course	Course Code
1	Green Technology	22ECE0401
2	Process Air Pollution & Control	22ECE0402
3	Environmental Protection and Management	22ECE0403
4	Solid Waste Management	22ECE0404
5	Occupational Safety and Health Administration	22ECE0405
6	Nano Science & Technology	22ECEO406

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List of Program Electives

Sr.No	Name of the Course	Course Code
1	Renewable Energy	22ECEE301
2	Fermentation and Downstream Processing	22ECEE302
3	Industrial Safety and Health	22ECEE304
4	Transport Phenomena	22ECEE305
5	Instrumentation Engineering	22ECEE306
6	Chemical Plant Utilities	22ECEE307
7	Oils and Fats	22ECEE308
8	Instrumental Methods of Analysis	22ECEE311
9	Sustainable Technologies	22ECEE401
10	Food Technology	22ECEE402
11	Waste Management	22ECEE404
12	Petroleum and Petrochemicals Engineering	22ECEE405
13	Process Modelling and Simulation	22ECEE406
14	Pollution Control Technologies	22ECEE407
15	Pulp and Paper Technology	22ECEE408
16	Data Analytics and Applications in Chemical Engineering	22ECEE409
17	Unit Operations in Environmental Engineering	22ECEE410
18	Polymer Science and Technology	22ECEE411
19	Machine Learning for Process Optimisation in Chemical Engineering	22ECEE412
20	Advanced Process Control	22ECEE413

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Curriculum Content - Course wise (Semester – 1)

Program: UG		Semester: I
Course Title: Single Variable Calculus		Course Code: 18EMAB101
L-T-P: 4-1-0	Credits: 05	Contact Hours: 6 hrs/week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 50	Examination Duration: 3hrs	

Unit I

Chapter 1. Functions, Graphs and Models

Functions, types of functions, transformations and models (Linear, exponential, trigonometric).MATLAB: Graphing functions, Domain-Range and Interpreting the models

07 Hrs

Chapter 2. Calculus of functions and models

Limit of a function, Infinite limits- graph, Continuity and discontinuity, Intermediate value theorem statement, Roots of the equation using Bisection Method and Newton-Raphson Method
Interpretation of derivative as a rate of change, all the rules of derivatives (List only), Maxima, Minima and optimisation problems. Curvature and Radius of Curvature, Indeterminate forms, L- Hospital's rule- Examples
MATLAB: optimisation problems. Curvature problems

13 Hrs

Unit II

Chapter 3. Infinite Series

Definition, Convergence of series, Tests of convergence – p-series, Alternating series. Power series, radius of convergence, Taylor's and Maclaurin's series, Applications of Taylor's and Maclaurin's series,
MATLAB: Convergence of series

06 Hrs

Chapter 4. Integral calculus

Tracing of standard curves in Cartesian form, Parametric form and Polar form; Beta and gamma function, relation between them, evaluation of integrals using Beta and gamma functions; Applications to find arc length, Area, Volume and surface area (Cartesian, parametric and polar curves). Approximateintegration- Trapezoidal rule, Simpson's 1/3 rule
MATLAB: problems on arc length, area, volume and surface area

14 Hrs

Unit III

Chapter 5. Ordinary differential equations of first order

a. Introduction to Initial Value Problems. Linear and Bernoulli's equations, Exact equations and reducible to exact form, Numerical solution to Initial Value problems-Euler's method, Modified Euler's method and Runge-Kutta method
b. Applications of first-order differential equations: Orthogonal trajectories, growth and decay problems, mixture problems, Electrical circuits, and falling bodies.
MATLAB: Solve differential equations

10 Hrs

Text Books:

1. Early Transcendentals Calculus- James Stewart, Thomson Books, 7th ed., 2010.

Reference Books:

1. Calculus Single and Multivariable, Hughes-Hallett, Gleason, Wiley India Ed, 4th ed, 2009.
2. Thomas Calculus, George B Thomas, Pearson India, 12th ed., 2010

Back to Semester - 1

Program: UG		Semester: I
Course Title: Engineering Chemistry		Course Code: 15ECHB101
L-T-P: 3-0-0	Credits: 03	Contact Hours: 3 hrs/week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3hrs	

Unit-I

Chapter 1. Pure substances

Properties of pure substance (Steam), two property rule, T-H diagram, formation of steam at constant pressure. Different states of steam: Wet steam-dryness fraction, determination by separating-throttling calorimeter, Dry saturated steam, Superheated steam, thermodynamic parameters of steam, steam table, numerical problems. T-V, P-V & P-T diagrams of a pure substance, taking water as an example. Triple point & critical point. Sub-cooled liquid, saturated liquid, mixture of saturated liquid & vapour, Saturated vapour & superheated vapour states.

08 Hrs

Chapter 2. Real and ideal gases

Properties of Real and Ideal Gases. Vander Waal's equation, Vander Waal's constant in terms of critical properties –numerical problems. Compressibility factor, compressibility chart, and the Law of Corresponding States. Ideal Gas: Equation of State, Internal Energy, and Enthalpy as Functions of Temperature. Ideal gas mixture: Dalton's law of additive pressures and Amagat's law of additive volumes. Terms used in the analysis of a mixture of gases - numerical problems.

05 Hrs

Chapter 3. Engineering Materials

Ferrous metals – properties and applications of Iron and Steel. Ferrous metals – properties andApplications of copper and aluminium.

Cement- properties, mechanism of setting & hardening of cement and applications.

Lubricants- Properties –viscosity, flash point, fire point, cloud point and pour point, mechanism- hydrodynamic and boundary lubrication and applications.

03 Hrs

Unit – II

Chapter 4. Fuel Chemistry

Fuels, classification, determination of calorific value of a fuel (solid/liquid fuel by Bomb calorimeter), coal analysis- Numerical problems. Petroleum - cracking, Octane number, Cetane number, reforming, and the mechanism of knocking in Petrol and Diesel engines. Renewable energy sources – power alcohol and biodiesel.

06 Hrs

Chapter 5. Energy Storage and Conversion Systems

Electrode potential, Nernst equation, Formation of a cell; Reference electrodes – Calomel electrode and Determination of electrode potential using calomel electrode, numerical problems on E, E_{cell}, E^{o}_{cell}. Batteries: Classification, characteristics, Lead-acid and Li ion batteries. Fuel cells: Methanol-O_2 fuel cell.

06 Hrs

Chapter 6. Surface Chemistry

Corrosion: Electrochemical theory of corrosion taking iron as an example; corrosion control – galvanisation and tinning. Metal Finishing: Technological importance of metal finishing, Electroplating, factors affecting the nature of electrodeposit- Throwing power of plating bath solution- numerical problems. Electroless plating – advantages over electroplating, electroless plating of copper and its applications in the manufacture of printed circuit boards.

04 Hrs

Unit – III

Chapter 7. Polymers

Introduction, free radical mechanism of addition polymerisation taking Ethylene as an example; commercial polymers - Plexiglass, polyurethane and polystyrene. Adhesives – synthesis, properties and applications of Epoxy resins; Polymer Composites - structure, properties and applications of Kevlar and carbon fibre.

04 Hrs

Chapter 8. Environmental Chemistry:

Water: Sources and ill effects of water pollutants- fluoride and nitrate; Determination of total hardness of water by EDTS method – numerical problems. Sewage: Determination of biological oxygen demand by Winkler's method – numerical problems and determination of chemical oxygen demand - numerical problems.

04 Hrs

Text Books:

1. A Text book of Engineering Chemistry, 1st edition, Dara. S. S, S. Chand & Co. Ltd., 2009, NewDelhi.
2. A Text Book of Engineering Chemistry, 16th edition, Jain P.C. and Jain M, Dhanpat RaiPublications, 2006, New Delhi.

Reference Books:

1. An Introduction to Thermodynamics, Y V C Rao, Revised Edition, University Press, 2009 Hyderabad.
2. Hand book of batteries, David Linden, Thomas B Reddy, 3rd edition, McGraw-Hill Publications,2001.
3. Puri B. R., Sharma L.R. and Pathania M. S., Principles of Physical Chemistry, 33rd Edition, SNagin Chand & Co., 1992.
4. Fontana M G, Corrosion Engineering, 3rd Edition, McGraw-Hill Publications, 1986.
5. Billmeyer F W, Textbook of Polymer Science, John Wiley & Sons, 1994.
6. Principles of Polymer Chemistry- A. Ravve, Pleum Press, New York and London.
7. Callister William D, Materials Science and Engineering: An Introduction, John Wiley and Sons 2007: 721 pages.

Program: UG		**Semester: I**
Course Title: C Programming for Problem Solving		**Course Code: 18ECSP101**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hrs: 6 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hrs: 78	**Exam Duration: 3 hrs**	

1	**Introduction to Problem-Solving** Introduction to algorithms/flowcharts and their notations, top-down design, elementary problems.	3 hrs
2	**Basics of C programming language** Characteristics and uses of C, Structure of C program, C Tokens: Keywords, Identifiers, Variables, Constants, Operators, Data-types, Input and Output statements.	15 hrs
3	**Decision control statements** Conditional branching statements: if statement, if else statement, else if ladder, switchstatement, unconditional branching statements: break, continue. Introduction to Debugging Skills Introduction to Test Driven Programming.	12 hrs
4	**Iterative statements** while, do while, for, nested statements	10 hrs
5	**Functions** Introduction, Function declaration, definition, call, return statement, passingparameters to functions, introduction to macros. Introduction to Coding Standards	10 hrs
6	**Arrays and Strings** Introduction, Declaration, Accessing elements, Storing values in arrays, Operations onone dimensional arrays, Operations on two dimensional arrays, Introduction to Code Optimization and refactoring	15 hrs
7	**Pointers** Introduction, declaring pointers, pointer variables, pointer expressions and arithmetic, passing arguments to functions using pointers, pointers and arrays, passing an array toa function.	08 hrs
8	**Structures and Unions** Introduction, passing structures to functions, Array of structures, Unions	05 hrs

Text Books:

1. R.G.Dromey, How to Solve it by Computer, 1st ed., PHI, 2008.
2. Yashvant Kanetkar, Let us C,15th ed, BPS Publication, 2016.

Reference Books:

3. B W Kernighan, D M Ritchie, The Programming Language C, 2nd ed., PHI, 2004.
4. B S Gottfried, Programming with C, 2nd ed., TMH, 2006.
5. B.A. Forouzan, R.F. Gilberg, A Structured Program Approach Using C, 3rd, CENGAGE Learning,2008.

Back to Semester - 1

Program: UG		**Semester: I**
Course Title: Engineering Exploration		**Course Code: 15ECRP101**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hrs: 6 hrs/week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hrs: 78	**Exam Duration: 3 hrs**	

No	Content	Sessions
1	Introduction to Engineering and Engineering Study	1
2	Role of Analysis in Engineering, Analysis Methodology	2
3	Data Analysis Graphing	2
4	Basics of Engineering Design, Multidisciplinary Nature of Engineering Design	5
5	Project Management	1
6	Sustainability in Engineering	2
7	Ethics	1
8	Modelling, Simulation and Data Acquisition using Software Tool	1
9	Platform-based development: Arduino	3
9	Course Project	3

Reference Books:

1. Engineering Fundamentals & Problem Solving by Arvid Eide, Roland Jenison, Larry Northup, Steven, McGraw-Hill Higher Education, 6th Edition (2011)
2. Engineering Exploration (Edited Book, 2008) by Pearson Publication

Evaluation Scheme

Chapter No	Name	Weightage in percentage
1	Introduction to Engineering and Engineering Study	-
2	Role of Analysis in Engineering	10
3	Analysis Methodology	
4	Data Analysis Graphing	10
5	Basics of Engineering Design	20
	Multidisciplinary Nature of Engineering Design	
6	Project Management	5
7	Sustainability in Engineering	10
8	Ethics	5
9	Modelling, Simulation and Data Acquisition using Software Tool	-
10	Platform Based Development: Arduino	-
10	Course Project	40

Back to Semester - 1

Program: UG		Semester: I	
Course Title: Basic Electronics		Course Code: 18EECF102	Teaching Hours
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4Hrs/week	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100	
Teaching Hours: 50 Hrs.	Examination Duration: 3 Hrs.		
Unit I **Chapter 1: Overview of Electronics in Mechanical Engineering** Definition & overview of Mechatronics, Mechatronics and Design Innovation, Mechatronics and Manufacturing, Mechatronics and Education; Typical Mechatronics Components; Sensors and Transducers.			03
Chapter 2: Semiconductor Devices and Applications: PN junction diode, characteristics and parameters, diode approximations, half wave rectifier, full wave bridge rectifier, full wave bridge rectifier capacitor filter, Zener diode, Voltage regulator design, BJT, Darlington Pair, JFET, MOSFET, UJT, SCR.			10
Chapter 3: Operational Amplifiers: Ideal op-amp characteristics, op-amp applications: Comparator, Inverting amplifier, Non-inverting amplifier, Voltage follower, Integration, Differentiation, Adder, Subtractor and numerical as applicable.			08
Unit II **Chapter 4: Digital Logic:** Digital Number system: Binary & Hexadecimal number systems, Conversion, BCD Number system, Gray code, Data word representation, Binary Arithmetic, Boolean Algebra, Logic gates, Combinational & Sequential circuits, Adders, Flip-Flops, Registers, Counters, Multiplexer. **Introduction to Digital Electronics (Text-2):** Introduction, Switching and Logic Levels using circuits, Digital Waveform (Sections 9.1to 9.3).Number system: Binary, Octal, Decimal and Hexadecimal, Inter Conversion, BCD Number system, Grey code, Data word representation, Binary Arithmetic, Boolean Algebra: Laws, rules & theorems of Boolean algebra, Sum of products form (SOP), products of sum form (POS) of Boolean functions. Study of Karnaugh Maps (K-maps) for 2, 3 & 4 variables only. Logic gates, Adders, Encoder, Decoder, Multiplexer and De- multiplexer. Combinational & Sequential circuits, Latches and Flip-Flops(SR, JK, D, T),			13
Chapter 5: Sensors and Transducers : Introduction, Classification of sensors and transducers, Contact type – Mechanical switches, Non-contact type - proximity sensors & Hall sensors, principle of working of light sensors, Future Challenges			06
Unit – III **Chapter 6: Signal Conditioning:** Analog & Digital signals, Digital to Analog Conversion, R-2R DAC, Analog to Digital Conversion, SAR ADC, Data Acquisition.			06
Chapter 7: Case Studies of Mechatronic Systems: Automatic Camera, Drilling Machine, Bar code reader.			04

Text Books

1. David A Bell, “Electronic devices and Circuits” , PHI New Delhi, 2004.
2. Morris Mano, “Digital logic and Computer design” 21st Indian print Prentice Hall India, 2000.
3. W.Bolton, "Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering", 3rd edition Pearson Education, 2005.
4. David Bradley and David W., “Mechatronics in Action”, 2nd edition, Springer, 2010

References

1. David G Alciatore, Michael B Histand, “Introduction to Mechatronics and Measurement Systems”, TMH 3rd edition, 2007.
2. K.A Krishnamurthy and M.R.Raghuveer, “Electrical, Electronics and Computer Engineering for Scientists and Engineers”, Second Edition, New Age International Publishers, Wiley Eastern, 2001.
3. P. Malvino, “Electronic Principles”, Sixth edition, Tata McGraw Hill, 1999.
4. Floyd, “Digital fundamentals”, Third Edition, Prentice Hall India, 2001
5. Boylestead Nashelsky, “Electronic devices & Circuit theory” Sixth Edition, Prentice Hall India,2000.
6. Ramakant Gayekawad, “Operational Amplifiers & applications” 3rd Edition, PHI, 2000.

Back to Semester - 1

Program: UG		**Semester: I**
Course Title: Basic Mechanical Engineering		**Course code: 15EMEF101**
L-T-P: 2-1-0	**Credits: 3**	**Contact Hrs.: 4 hrs/week**
CIE Marks: 50	**SEE Marks: 50**	**Total Marks: 100**
Teaching Hrs: 50		**Exam Duration: 3 hrs**

Chapter	Contents	Hours	Tutorial	Sessions
	Unit I			
1	Introduction to Mechanical Engineering: Definition of engineering, Mechanical Engineering, Branchesof Mechanical Engineering, Who are Mechanical Engineers?, Mechanical Engineers' top ten achievements.	2	Visit to Workshop and Machine Shop, Tools, Safety Precautions Video presentations	1
2	Manufacturing Engineering: Basicsof Manufacturing What is manufacturing?, The main manufacturing sectors, The importance of the main manufacturing sectors to the Indianeconomy, Scales of production, Classification of manufacturing Processes. Advances in Manufacturing: CNC machines, Mechatronics and applications	8	Demonstration on the working of Lathe, milling, drilling, grinding machines. Demonstration on Welding (Electric Arc Welding, Gas Welding, Soldering). Demonstration and Exerciseson Sheet metal work. Visit to Learning Factory	5
	Unit II			
3	Design Engineering: Power Transmission Elements Overview Design Application: • Belt Drives. Types, Length of Belt. Velocity Ratio, Initial Tension. Ratio of Tensions. Power Transmitted, Numerical Problems. • Gears. Spur Gear, Rack and Pinion, Worm Gear, Bevel Gear, Helical Gears. Speed, Torque, and Power in Gear pair. Simpleand Compound Gear trains. Numerical Problems. • Ball and Roller Bearings, Types, Applications.	6	Design Problems like a moving experience, aluminium can crusher Video presentations	5

4	Thermal Engineering 1: Prime Movers. Internal Combustion Engines: Classification, IC engine parts, 2 stroke SI and CI engine, 4 Stroke SI and CI Engine, PV diagrams of Ottoand Diesel cycles, Comparison of 2stroke and 4 stroke engine, comparison of CI and SI engine, Problems on Engine Performance, Future trends in IC engines.	4	Case study on power requirement of a bike, car or any machine Video presentations	1
	UNIT III			
5	Thermal Engineering 2: Thermal Systems' Applications Refrigeration system, Air conditioning system, Pumps, Blowers and Compressors, Turbines, and their working principle and specifications.	5	Case study on selection of various thermal systems Video presentations	1

Text Books:

1. Jonathan Wickert and Kemper Lewis, An Introduction to Mechanical Engineering, ThirdEdition, 2013- Cengage Learning
2. K.R. Gopalkrishna, Sudhir Gopalkrishna, S.C. Sharma. A Text Book of Elements of Mechanical Engineering, 30th Edition, Oct 2010,–Subhash Publishers, Bangalore.

Reference Books:

1. Course Material developed by the Department of Mechanical Engineering.
2. SKH Chowdhary, AKH Chowdhary, Nirjhar Roy, The Elements of Workshop Technology - Vol I& II , 11th edition 2001, Media Promoters and Publishers.
3. Basic Manufacturing, Roger Timings, Third edition, Newnes, An imprint of Elsevier

Back to Semester - 1

Program: UG		Semester: I
Course Title: Professional Communication		Course Code: 15EHSH101
L-T-P: 1-1-0	Credits: 2	Contact Hrs: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 42	Exam Duration: 3 hrs	

Content	Hrs
Chapter 1. Basics- English Communication Course Introduction, Explanation of template mix-ups with correct usages & necessity of grammar in error detection, Usage of tenses	9 hrs
Chapter 2. Vocabulary and grammar Vocabulary, Word Formation and Active and Passive Voice	6 hrs
Chapter 3. Bouncing Practice Definition and types of bouncing and its practice with examples, reading skills, free style speech. Individual presentation.	6 hrs
Chapter 4. Rephrasing and Structures Comprehension and Rephrasing, PNQ Paradigm and Structural practice	8 hrs
Chapter 5. Dialogues Introduction of dialogues, Situational Role plays,	3 hrs
Chapter 6. Business Communication Covering letter, formal letters, and Construction of paragraphs on any given general topic.	9 hrs
Text Book: **References:** 1. Collins Cobuild Advanced Learner's English Dictionary 2. Raymond Murphy - Intermediate English Grammar, Cambridge University Press 3. Martin Hewings- Advanced English Grammar, Cambridge University Press.	

Curriculum Content - Course wise (Semester – 2)

Program: UG		**Semester: II**
Course Title: Multivariable calculus		**Course Code: 18EMAB102**
L-T-P: 4-1-0	**Credits: 05**	**Contact Hours: 6 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3hrs.**	

Unit I

Chapter 1. Partial differentiation

Function of several variables, Partial derivatives, Level curves, Chain rule, Errors and Approximations. Extreme value problems. Lagrange's multipliers.

12 Hrs

Chapter 2. Double integrals

Double integrals- Rectangular and polar coordinates, Change the order of integration. Changeof variables, Jacobian. Application of double integrals

MATLAB: optimization problems, application of double integrals.

8 Hrs

Unit II

Chapter 3. Triple integrals

Triple integrals, Cartesian, change to Cylindrical and Spherical coordinates Application of Triple integrals.

7 Hrs

Chapter 4. Calculus of Vector Fields

Vector fields, Gradient and directional derivatives. Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem.

MATLAB: application of Triple integrals, Vector calculus problems

13 Hrs

Unit III

Chapter 5. Differential equations of higher orders

Linear differential equations of second and higher order with constant coeffiISAnts The method of Variation of parameters. Initial and boundary value problems.

Applications of second order differential equations-Newton's 2^{nd} law, electrical circuits, Simple Harmonic motion. Series solution of differential equations. Validity of Series solution of Differential equations.

MATLAB: application of differential equations

(5+5) Hrs

Text Books:

1. Early Transcendental Calculus- James Stewart, Thomson Books, 7ed 2010

Reference Books:

1. Calculus Single and Multivariable, Hughues-Hallett Gleason, Wiley India Ed, 4ed, 2009.
2. Thomas Calculus, George B Thomas, Pearson India, 12ed, 2010

Back to Semester –II

Program: UG		Semester: II
Course Title: Engineering Physics		Course Code: 15EPHB102
L-T-P: 3-0-0	Credits: 3	Contact Hours: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs.	

	Unit I	
Chapter 1	**Concept of Motion - Kinematics in One Dimension** Introduction, Motion Diagrams, The Particle Model, Position Model, LinearVelocity and Acceleration, Uniform Motion, Instantaneous Velocity, Finding Position from Velocity, Motion with Constant Acceleration, Free Fall Motion onan Inclined Plan, Instantaneous Acceleration, Numericals.	6 Hrs
Chapter 2	**Kinematics in Two Dimensions** Introduction to Vectors, Properties of vectors, Coordinate Systems and Vector Components, Vector Algebra. Position, velocity and Acceleration vectors, Projectile Motion, Relative Motion, Uniform Circular Motion, Velocity and Acceleration in Uniform Circular Motion, Nonuniform Circular Motion and Angular Acceleration, Numericals.	6 Hrs
Chapter 3	**Force and Motion** Concept of Force, Identifying Forces, A Virtual Experiment, Newton's First Law, Newton's Second Law, Free-Body Diagrams, Applications.	4 Hrs
	Unit II	
Chapter 4	**Dynamics I** Equilibrium using Newton's second Law, Friction, Drag, Newton's Third Law, Analyzing Interacting Objects, Newton's Third Law,Applications.	5 Hrs
Chapter 5	**Dynamics II** Motion in a plane, Dynamics in Two Dimension, Velocity and Acceleration in Uniform Circular Motion, Dynamics of Uniform Circular Motion, Fictitious Forces, Non-uniform Circular Motion, Numerical.	6 Hrs
Chapter 6	**Impulse and Momentum** Momentum and Impulse, Problems, Conservation of Momentum, Inelastic Collisions, Explosion, Momentum in Two Dimension, Numericals.	5 Hrs
	UNIT III	
Chapter 7	**Energy and Work** Energy: Kinetic Energy and Gravitational Potential Energy, Restoring Forces,Hooke's Law, Elastic Potential Energy, Elastic Collisions, Energy Diagrams, Work: Work and Kinetic Energy, Force, Work and Potential energy,Conservation of Energy, Power, Numericals.	8 Hrs

Text Book:

1. John W Jewett and Raymond A Serway, Physics for Scientists and Engineers with Modern Physics, Cengage publication, India Edition, 8th Edition.

Reference:

1. Randall D Knight, Physics for SISAntists and Engineers, Pearson publication, 2nd Edition.
2. Hans C Ohanian and John T Markert, Physics for Engineers and Scientists, W W Norton and Company, Volume 1, 3rd Edition

Back to Semester –II

Program: UG		**Semester: II**
Course Title: Engineering Mechanics		**Course Code: 15ECVF102**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 3 hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs.**	

Unit I

No	Content	Hrs.
1	**Chapter 1: Overview of Civil Engineering** Evolution of Civil Engineering Specialisation, scope and role. Impact of Civil Engineering on National economy, environment and social & cultural fabric. Challenges and Opportunities for Civil Engineers Civil Engineering Marvels, Future challenges, Higher education and Research.	04
2	**Chapter 2: Coplanar concurrent force system** Introduction to Engineering Mechanics: Basic idealizations – Particle, Continuum, Body, Rigid body, Deformable body, Definition of force and its elements; Laws of Mechanics – Parallelogram law of forces, Principle of transmissibility, Law of Superposition, Newton's laws of motion. Classification of force systems 3 hrs. Resultant of coplanar concurrent force system: Definitions – Resultant, composition & Resolution of a force, Equilibrium, Equilibrant, Formulae for resultant of forces and resolution of a force. Numerical problems on resultant of forces. 4 hrs. Equilibrium of coplanar concurrent force system: Conditions of equilibrium, Action & Reaction, Free body diagram, Lamis' theorem. Numerical problems on equilibrium of forces. 5 hrs.	12
3	**Chapter 3: Coplanar non-concurrent force system** Resultant of a force system: Moment, moment of a force, couple, moment of a couple, Characteristics of couple, Equivalent force-couple system, Numerical problems on moment of forces and couples, on equivalent force-couple system. Varignons principle of moments, Resultant of coplanar-non-concurrent force systems and numerical problems. 5 hrs.	05
	Unit II	
4	**Chapter 4:Equilibrium of a force system** Conditions of equilibrium, types of support and loading for a statically determinate beam, Reactions at support connections, Numerical problems on equilibrium of force systems and support reactions for a statically determinate beam. 5 hrs.	18

5	**Chapter 5:Static Friction** Introduction, types of friction, definition, limiting friction, coefficient of friction, laws ofCoulomb friction, angle of friction, angle of repose, and cone of friction. Wedge and beltfriction theory. Derivation of the belt friction formula. Numerical problems on impending motion on horizontal and inclined planes (including connected bodies); wedge friction; Ladder friction, and Belt friction. 8 hrs.	
6	**Chapter 6: Centroid of Plane Figures** Introduction, Definition, Methods of determining the centroid, axis of reference, axis of symmetry, Locating the centroid of simple plane figures (triangle, semicircle, quarter of a circle and sector of a circle etc,.) using the method of integration, Numerical problems on Centroid of simple built up sections. 5 hrs.	
	Unit – III	
7	**Chapter 7: Second moment of area (Plane figures)** Introduction, Definition, Method of determining the second moment of area, Section Modulus, Radius of gyration, perpendicular and Parallel axis theorems, Polar second moment of area, second moment of area of simple plane figures (triangle, rectangle, semicircle, circle etc,.) using method of integration, Numerical problems on MI ofsimple built up sections. 5 hrs.	11
8	**Chapter 8: Kinetics of a particle- Work, Power, Energy** Introduction – Kinematics and Kinetics, Definitions – work, power and energy. Work done by a force (constant, gravitational and spring forces) in rectilinear motion. Numerical problems, Kinetic energy of a particle, principle of work and energy. 6 hrs.	

Text Book:

1. Beer, F.P. and Johnston, R., Mechanics for Engineers: Statics, MGH, New York, 1988.
2. Bhavikatti, S.S., and Rajashekarappa K.G., Engineering Mechanics, 3rd Ed., New Age InternationalPub. Pvt. Ltd., New Delhi, 2008.
3. Kumar, K.L., Engineering Mechanics, 3rd. Ed., Tata McGraw Hill Publishing Company, New Delhi,2003.
4. Punmia, B.C., Jain, A. and Jain, A., Mechanics of Materials, Lakshmi Publications, New Delhi,2006

References:

1. Jagadeesh, T.R. and Jayaram, *Elements of Civil Engineering*, Sapna Book House, Bangalore,2006.
1. Ramamrutham, S., *Engineering Mechanics*, Dhanpat Rai Publishing Co., New Delhi, 1998.
2. Singer, F.L., *Engineering Mechanics*, 3rd edition Harper Collins, 1994.
3. Timoshenko, S.P. and Young, D.H., Engineering Mechanics, 4th edition, McGraw Hill Publishing Company, New Delhi, 1956.
4. Irving H Shames, Engineering Mechanics, 3rd edition, Prentice-Hall of India Pvt. Ltd, New Delhi-110 001, 1995.

Back to Semester –II

Program: UG		Semester: II
Course Title: Computer-Aided Engineering Drawing		Course Code: 15EMEP101
L-T-P-SS: 0-0-3	Credits:3	Contact Hours: 6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 50	Examination Duration: 3 Hrs.	

Sl. No	Content	No. of Sessions
01	**Chapter 1: Introduction to engineering drawing and orthographic projections.(Manual Drafting)** i) Introduction to engineering drawing – BIS conventions. ii) Orthographic projections: first angle projection and third angle projection – symbolic representation. iii) Projections of points. iv) Projections of lines inclined to both the planes and determination of true length by rotating the view method (Problems on traces of a line and mid-point problems are not included). However application problems are included. v) Projection of planes: Planes parallel to one plane and perpendicular to other plane or perpendicular to one plane and inclined to other plane (Two stage problems). vi) Projection of simple solids such as prisms, pyramids, cylinders, cones and sphere and their frustums in simple positions (Base parallel to or in one of the three planes).	08
02	**Chapter 2: Development of lateral surfaces of solids. (MANUAL)** i) Development of lateral surface of prisms and cylinders (Either full or truncatedusing parallel line development method) ii) Development of lateral surface of pyramids and cones (Either full or truncatedor of their frustums using radial line development method) iii) Development of lateral surfaces of spheres using both methods anddevelopment of transition pieces.	07
03	**Chapter 3: Conversion of pictorial views into orthographic projections using CADsoftware.** Drawing orthographic projections of objects shown in pictorial views by the first anglemethod of projection using CAD software. (2D drafting only)	06
04	**Chapter 4: Isometric projection or view using CAD software.** Drawing isometric projections or views of objects shown in orthographic projections using CAD software.	04

Text Books:

1. Text Book of Engineering Drawing by K R Gopalakrishna
2. Text Book of Engineering Drawing by N D Bhatt and V M Panchal

Back to Semester –II

Program: UG			Semester: II
Course Code: 18EEEF102		Course Title: Basic Electrical Engineering	
L-T-P: 3-0-0		Credits: 3	Contact Hrs.: 3 hrs/week
CIA Marks: 50		ESA Marks: 50	Total Marks: 100
Teaching:40 Hrs..		Exam Duration: 3 Hrs..	

Chapter No.	Unit-I	Hrs..
1	**Overview of Electrical Engineering** Specialisation, scope & role, impact of Electrical Engineering on national economy, environment, Sources of generation, sustainability, challenges and opportunities for electrical engineers, electrical engineering marvels, future challenges.	02
2	**DC Circuits** Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with DC excitation. Time-domain analysis of first-order RLand RC circuits.	05
3	**AC Circuits** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysisof single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. power measurement using two-watt meters	08
	Unit-II	
4	**Electrical Actuators** Electromagnetic principles, Solenoid, Relays, classification of Electric motors, DC motors-shunt, series, compound, separately excited, PMDC motors – Speed Control, Stepper Motors, BLDC motors, three phase induction motor, Characteristics and applications, selection of motors for various applications.	9
5	**Power Electronics (Text1, chapter 45)** Introductory, Thyristor, Some thyristor circuits, Limitations to thyristor operation, The thyristor in practice, The fully controlled AC/DC converter, AC/DC inversion, Switching devices in inverters, Three-phase rectifier networks, The three-phase fully controlled converter, Inverter-fed induction motors, Soft-starting induction motors, DC to DC conversion switched-mode power	6
	Unit-III	
6	**Electrical Wiring, Safety and protection(ref :Text3-page 1 to 10)** Types of wires and cables for internal wiring, Types of switches and Circuits, Types of wiring, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Importance of grounding and earthing, Methods for earthing, Fuses, MCB, ELCB and Relays, Lockout and Tag out, Electrical Codes and Standards.	05
7	**Batteries:** Basics of lead acid batteries, Lithium Ion Battery, Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing. Numericals..	05

Text Books:

1	Hughes, Electrical & Electronic Technology, 8th, Pearson Education, 2001
2	P C Sen, Principles of Electrical Machines and Power Electronics, 2nd, Wiley Publications

3	Gilbert M Masters, Renewable and Efficient Electrical Power systems, John Wiley & Sons, 2004
4	Frank D. Petruzella, Electric Motors and Control Systems, MGH Education, 2009 Edition
Reference Books:	
1	D C Kulshreshtha, Basic Electrical Engineering, McGraw-Hill Publications
2	David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw-Hill Education Private Limited, New Delhi., 2005
3	Vincent Del Toro, Electrical Engineering Fundamentals, 2nd edition, Prentice Hall India

Back to Semester –II

Program: UG				Semester: II
Course Code: 20EHSP101			Course Title: Design Thinking for Social Innovation	
L-T-P: 0-1-1			Credits: 2	Contact Hrs.:4 hrs/ week
ESA Marks: 80			ISA Marks: 20	Total Marks: 100
Teaching Hrs.: 28				Exam Duration: 3 hrs.
Module		Topics	Assignments	Support activities / Tools
KNOWLEDGE, TOOLS & DEVELOPMENT	Course sensitization	1. Introduction to Social Innovation: • Awakening social consciousness (www.yourstory.com) • Social Innovation and Leadership • Engineering& Social innovation (EPICS) (Connecting SI Course to MiniProject, Capstone Project, Campus Placements) • Course Overview • Students' Self Introduction Activity • Group formation Activity	Reading assignments • Read the handout on "The Process of Social Innovation" by Geoff Mulgan • Design Thinking for Social Innovation Written Assignments • Writing about Akshaya Patra in class. (Background information about Akshaya patra and the Social Cuase it is addressing) • Brainstorming Session on Social Innovators in Class	• Class activity on Behavioural Blocks to Innovation: Discussion on the behavioural blocks. • Introducing oneself with three Adjectives- Appreciating diversity and discovering self • Group Formation Activity (Forming square) (Making four equilateraltriangles out of popsiclesticks to enhance group cohesiveness amongst the group mates)
	Create Mindsets	Seven Mindsets: 1. Empathy (Example of The Boy and the Puppies) 2. Optimism (Person Paralysed waist down / Glass Halh full Half Empty) 3. Iteration (Thomas Alva Edison) 4. Creative Confidence (Origamy – Josef Albers) 5. Making it 6. Embracing Ambiguity (Confusion is the Welcome doormat at the door of Creativity) 7. Learning from Failure (Designing Website first and then	Reading assignments • Handout on " Create Mindsets"	• (How to train the Dragon? Common Video for all the mindsets) • Watching in Class TED Talk on "How to build youir Creative Confidence by David Kelley – IDEO Founder)

		asking the stakeholders about the website) (Spending one lakh for the business which is never launched)		
	Process of Social Innovation	Engage Community study and Issue Identification	Reading assignments • Handout on Community Study and Issue Identification • Case Study on "EGramSeva" • Case Study on "Janani Agri Serve" Class Presentations • Initial observations being made by the group (Literature Survey of Placesof Hubli- Dharwad) www.readwhere.com • Detailed interaction / engagements with the society and finalising the social issue for intervention Use template 1: Frame your Design Challenge	• Activity on Observation skills To know how to use one's observation skillsin understanding the social conditions • Experience sharing by senior students • Brainstorming Deliberations on the initial observations and arrive at the "Social Issue" • Familiarisation of the respective templates with the help of sample case study
		PEER REVIEW		
		2. Inspiration • Plan for the Research • Development of Interview guide • Capture your Learnings	Reading assignments • Handout on Overview of Inspiration Class Presentations • Entirety of the Social Issue • Identification of the Stake Holders (Examples on Fluoroscent Curtain and Students' Punctuality for Class) • Interview Questions (Role Play on Interview with Stakeholders) • Category wise Learnings capture Use template 2: Plan your Research Template 3. Development of Interview Guide Template 4. Capture your Learning	• Familiarisation of the respective templates with the help of sample case study
		3. Ideation	Reading assignments	• Familiarisation of the

		3.1 Synthesis • Search for meaning • Create "How might we" question	• Handout on Overview of Ideation-Synthesis Class Presentations • Create insights • "How might we" questions Use template 5: Create Insights Template 6: Create "How Might We' Questions	respective templates with the help of sample case study
		3.0 Ideation 3.2 Prototyping • Generate Ideas • Select Promising Ideas • Determine what to prototype • Make your prototype • Test and get feedback	Reading assignments • Handout on Overview of Ideation-Prototyping Class Presentations • Story board-demonstrating the possible solutions Use template 7: Select your best ideas Template 8 : Determine what to prototype	• Brain storming • Familiarisation of the respective templates with the help of sample case study • Activity on Risk management • Activity on Resource management Structure building games
		PEER REVIEW		
		4.0 Implementation • Create an action plan • Community Partners(if any) • Budgeting & Fundraising 1. Peer to Peer 2. Crowd Funding 3. Giving Kiosks 4. Donation 5. Envelop Funding 6. Marathons/ Walkathons 7. Conducting Yoga Classes (www.causevox.com / www.blog.fundly.com) • Duration • Ethical concerns • Launch your solution • Feedback (Impact)	Reading assignments • Handout on Overview of Implementation Class Presentations • Pilot implementation plan with required resources and Budget indicating stake holders & their enagement	• Familiarisation of the respective templates with the help of sample case study

		5.0 Reflect Reflection of the overall learning by the students	<u>Reading assignments</u> • Handout on Overview of students Reflection Use template 9: Reflection on the Process <u>Class Presentations</u> Final Presentation- After Implementation	• Familiarization of the respective templates with the help of sample case study

Back to Semester –II

Program: UG		Semester: II
Course Code: 16EPHP102	Course Title: Engineering Physics Lab.	
L-T-P-SS:0-0-1	Credits : 1	Contact Hrs.: 02 Hrs./Week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs.: 24 Hrs.		Examination Duration: 3 Hrs.

Experiments	
1.	Experimental Data Error Analysis
2.	Coefficient of Friction
3.	Centripetal Force
4.	Young's Modulus by Searle's method
5.	The Law of Forces by three wire suspension table
6.	Force Table and Vector addition of forces
7.	Momentofinertiaandrotationalmotion
8.	Projectile motion
9.	Variable g pendulum
10.	Study of one dimension motion by linear air track

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Curriculum Content - Course wise (Semester – 3)

Program: Bachelor of Engineering		Semester: III
Course Title: Calculus and Integral Transforms		Course Code:15EMAB231
L-T-P: 4-0-0	Credits:04	Contact Hours: 4 hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 3hrs	

Unit I

1. Differential Calculus

Differentiation of standard functions of first and higher orders, Taylor's and Maclaurin's seriesexpansion of simple functions for a single variable.

2. Integral Calculus

Evaluation of integrals, properties, Beta and Gamma functions, relation between Beta and Gammafunctions simple problems, Approximate integration- Trapezoidal rule, Simpson's 1/3 rule

3. Fourier Series

Fourier series, Evaluation of Fourier coefficients, Waveform symmetries as related to Fourier coefficient, Exponential form of the Fourier series, half range Fourier series. Practical Harmonic Analysis.

Unit II

4. Fourier Transform

Exponential Representation of non-periodic signals, Existence of Fourier transforms, properties of Fourier Transform: symmetry, scaling, shifting, Fourier transform of Sine and Cosine, Convolution theorem.

5. Laplace Transforms

Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions. Inverse Transforms- properties- Initial and final value theorems and examples; Convolution Theorem. Applications to differential equations.

Unit III

6. Ordinary differential equations of first order

Introduction, order and degree of equation, Solution of first order first-degree differential equations –variable separable methods, Linear differential equations, Bernoulli's equations, Initial value problems.

7. Complex analysis

Function of complex variables. Limits, continuity and differentiability. Analytic functions, C-R equations in Cartesian and polar forms, construction of Analytic functions (Cartesian and polar forms).

Text Books

1. Grewal B S, Higher Engineering Mathematics, 38th ed., Khanna Publication, New Delhi, 2001
2. Bali and Iyengar, A text book of Engineering Mathematics, 6th ed., Laxmi Publications(p) Ltd, New Delhi,2003

Reference Books:

1. Calculus- James Stewart, Early Transcendentals Thomson Books, 5e, 2007

Back to Semester –III

Program: Bachelor of Engineering		Semester: III
Course Title: Statistics and Integral Transforms		Course Code:15EMAB201
L-T-P:4-0-0	Credits:04	Contact Hours: 4 hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration:3hrs	

Unit I

1. Curve fitting and regression

Introduction to the method of least squares, fitting of curves $y = a + bx$, $y = ab^x$, $y=a + bx +cx^2$, correlation and regression. Applications to civil Engineering problems.

2. Probability

Definition of probability, addition rule, conditional probability, multiplication rule, Bayes' rule. (no proof) Discrete and continuous random variables- PDF-CDF- Binomial, Poisson and Normal distributions (Problems only).

3. Tests of hypothesis 1

Sampling, Sampling distribution, Standard error, Null and alternate hypotheses, Type I and Type II errors, Level of significance. Confidence limits, testing of hypotheses for single mean and difference of means (large samples). Applications to civil Engineering problems

Unit II

4. Tests of hypothesis-2

T-test (test for single mean, paired t-test), Chi Squared distribution, analysis of variance (one-way and two-way classifications). Case studies of designs of experiments (CRD, RBD). Applications to civil Engineering problems.

5. Laplace Transforms

Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions.

Inverse Transforms- properties- Initial and Final value theorems, examples, Convolution Theorem. Applications to differential equations.

Unit III

6. Fourier Series

Fourier series representation of a function, even and odd functions, half-range series, and Practical Harmonic Analysis.

7. Fourier Transform

Exponential Representation of non-periodic functions, Existence of Fourier transforms, properties of Fourier Transform: Fourier Sine and Cosine transforms.

Text Books

1. Gupta S C and Kapoor V K, Fundamentals of Mathematical Statistics, 9th ed., Sultan Chand & Sons, New Delhi, 2002

2. J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 4th Ed, TATA McGraw-Hill Edition 2007.

3. Kreyszig, E, Advanced Engineering Mathematics, 8th ed., John Wiley & sons, 2003.

Reference Books:

1. Kishor S Trivedi, probability and statistics with reliability queuing and computer science applications, PHI, 2000.
2. Miller, Freud and Johnson, Probability and Statistics for Engineering, 5th ed., PHI publications, 2000
3. Potter M C, Jack Goldberg and Aboufadel E F, Advanced Engineering Mathematics, 3rd ed. Oxford Indian.

Back to Semester –III

Program: Bachelor of Engineering		Semester: III
Course Title: Momentum Transfer		Course Code: 22ECEC201
L-T-P:4-0-0	Credits:4	Contact Hours:4 hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration:3 hrs	

Unit - 1

Chapter 1.Fluid Statics, Its Applications

Fluid Flow Phenomena Concept of unit operations, Concept of momentum transfer, Nature of fluids and pressure concept, variation of pressure with height – hydrostatic equilibrium, Barometric equation, Measurement of fluid pressure – manometers, Continuous gravity decanter, Centrifugal decanter. Type of fluids – shear stress and velocity gradient relation, Newtonian and non-Newtonian fluids, Viscosity of gases and liquids. Types of flow – laminar and turbulent flow, Flow in boundary layers, Reynolds number, and Boundary layer separation and wake formation.

10 Hours

Chapter 2. Basic Equations of Fluid Flow and Dimensional Analysis

Average velocity, Mass velocity, Continuity equation, Euler and Bernoulli equations Modified equations for real fluids with correction factors, Pump work in Bernoulli equation, Angular momentum equation. Dimensional homogeneity, Rayleigh's, and Buckingham Π - methods, Significance of different dimensionless numbers, Elementary treatment of similitude between model and prototype.

10 Hours

Unit - 2

Chapter 3. Flow of Incompressible Fluids in Conduits

Laminar flow through circular and non-circular conduits, Hagen Poiseuille equation. Friction factor chart, friction from changes in velocity or direction, Form friction losses in Bernoulli equation.

8 Hours

Chapter 4. Flow of Compressible Fluids

Continuity equation, Concept of Mach number, Total energy balance, Velocity of sound, Ideal gas equations, Flow through variable-area conduits, Adiabatic frictional flow, Isothermal frictional flow (elementary treatment only).

12 Hours

Unit - 3

Chapter 5. Transportation and Metering of Fluids

Pipes, Fittings and valves, Measurement of fluid and gas flow rates by venturi meter, orifice meter, rotameter and pitot tube, Elementary concept of target meter, vortex-shedding meters, turbine meters, positive displacement meters, magnetic meters, Coriolis meters and thermal meters, Flow through open channel-weirs and notches.

6 Hours

Chapter 6. Pumps

Performance and Characteristics of pumps positive displacement and centrifugal pumps, Fans, compressors, and blowers.

4 Hours

Textbooks

1. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill Education, 2017.
2. Kumar K.L. Engineering Fluid Mechanics, S Chand & Co Ltd., 2008
3. Bansal R.K. A Textbook of Fluid Mechanics, Laxmi Publications Pvt Limited, 2005

References

1. Coulson J.M. and Richardson J.F. with Backhurst J.R. and Marker J.H., Chemical Engineering, Vol. 1, 6th Edition, B utter worth - Heinemann New Delhi, 1999
2. Walter L. Badger, Julius T. Banchero, Julius T. Bancheo, Introduction to Chemical Engineering, Tata McGraw Hill, New York, 1997

Program: Bachelor of Engineering		Semester: III
Course Title: Particulate Technology		Course Code: 22ECEC202
L-T-P:4-0-0	Credits:4	Contact Hours:4 hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration:3 hrs	

Unit - 1

Chapter 1. Particle Size Analysis

Particle shape, particle size, different ways of expression of particle size, shape factor, sphericity, particle size analysis, screens – ideal and actual screens, Differential and cumulative size analysis, the effectiveness of screen, Specific surface of a mixture of particles, number of particles in a mixture, standard screens, Sub - Sieve analysis: BET analysis, Acoustic spectroscopy and Flow cytometry. Industrial screening equipment, motion of screen, Grizzly, Vibrating screen, Trommels.

10 Hours

Chapter 2. Size Reduction

Introduction – types of forces used for comminution, Criteria for comminution, Characteristics of comminated products, Laws of size reduction, Work Index, Energy utilization, methods of operating crushers – Free crushing, choke feeding, open circuit grinding, Closed circuit grinding, wet and dry grinding, equipment for size reduction – Classification of size reduction equipment, equipment – jaw crusher, impactor, Ball mill, Critical speed of ball mill, Knife cutter. Simulation of communition processes. Selection of construction materials for face plates of jaw crushers and grinding media.

10 Hours

Unit - 2

Chapter 3. The flow of fluid past immersed bodies

Drag, Drag coefficient, Pressure drop – Kozeny-Carman equation, Blake-Plummer, Ergun equation, Fluidisation, conditions for fluidisation, Minimum fluidisation velocity, Pneumatic conveying. Case study: Fluidised bed combustor in cogeneration unit.

5 Hours

Chapter 4. Motion of particles through fluids

Mechanics of particle motion, an equation for one-dimensional motion of particles through a fluid in the gravitational and centrifugal field, Terminal velocity, drag coefficient, the motion of spherical particles in Stoke's region, Newton's region, and Intermediate region, criterion for settling regime, Hindered settling, modification of equation for hindered settling, Centrifugal separators, Cyclones and Hydro cyclones. Case Studies: Motion of coal particles in a fluidised bed combustor, Calculation of the efficiency of a cyclone separator.

5 Hours

Chapter 5. Sedimentation

Batch settling test, Coe and Clevenger theory, Kynch theory, design of a continuous thickener.

5 Hours

Chapter 6. Filtration

Introduction, Classification of filtration, Cake filtration, Clarification, batch and continuous filtration, Pressure and vacuum filtration, Constant rate filtration and cake filtration, Characteristics of filter media, Filter aids, Application of filter aids, Industrial filters, Plate and frame filter press, Leaf filter, Rotary drum filter, Suspended batch centrifuge, Principles of cake filtration.

5 Hours

Unit - 3

Chapter 7. Agitation and Mixing

Application of agitation, Agitation equipment, Types of impellers – Propellers, Paddles and Turbines, Flow patterns in agitated vessels, Prevention of swirling, Standard turbine design, Power correlation and power calculation, Mixing of solids, Types of mixers – Muller mixers, Mixing index, Ribbon blender, Internal screw mixer. Case Study: Dispersing of paints and mixing of powders in pharmaceutical industries.

5 Hours

Chapter 8. Sampling, Storage & Conveying of Solids and Miscellaneous Separation

Sampling of solids, Storage of solids, Open and closed storage, Bulk and bin storage, Conveyors – Belt, conveyors, Bucket conveyor, and Screw conveyor.

Magnetic separation, Electrostatic separation, Jigging, Heavy media separation, Froth flotation process.

5 Hours

Textbooks

1. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition Paperback – 1 July 2017
2. Anup Swain, Hemlata Patra, G K Roy, Mechanical Operations, July 2017, McGraw-Hill Education
3. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 3rd Edition Tata McGraw Hill International Edition, Singapore, 1999
4. J H Harker, J R Backhurst, J.F. Richardson, Chemical Engineering Volume 2, July 2002

References

1. Foust, Alan S., Leonard A. Wenzel, Curtis W. Clump, Louis Maus, and L. Bryce Andersen. Principles of unit operations. John Wiley & Sons, 2015.

Back to Semester –III

Program: Bachelor of Engineering		Semester: III
Course Title: Material and Energy Balance Calculations		Course Code: 22ECEC203
L-T-P:4-0-0	Credits:4	Contact Hours:4 hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration:3 hrs	

Unit - 1

Chapter 1. Basic Chemical Calculations:

Fundamental and derived units, Conversion, Dimensional consistency of equations, Dimensionless groups and constants, conversions of equations. Mole, Mole fraction, Weight fraction, Volume fraction, Molarity, Molality, ppm, Ideal gas law calculations, Partial pressure, Concept of vapour pressure.

10 Hours

Chapter 2. Material Balance Without Reaction:

General material balance equation for steady and unsteady state, Steady and unsteady process, Tie element, batch and continuous operation, Typical steady-state material balances in distillation, absorption, Liquid-liquid extraction, Leaching.

10 Hours

Unit - 2

Chapter 3. Multistream Material Balance (Bypass, Purge, and Recycle):

Drying, mixing, evaporation, and Elementary treatment of material balances involving bypass, recycling and purging. Problems.

10 Hours

Chapter 4. Steady State Material Balance with Reaction:

Principles of Stoichiometry, Stoichiometry coefficient, Concept of limiting, excess reactants, fractional and percentage conversion, fractional yield and percentage yield, selectivity, related problems, Calculations involving burning of solid, liquid and gaseous fuels, excess air, air-fuel ratio calculations.

10 Hours

Unit - 3

Chapter No.5. Energy Balance:

General steady-state energy balance equation, Concept of enthalpy, Heat capacity, Heat of formation, Heat of reaction, Heat of combustion and Calorific values. Heat of solution, Heat of mixing, Heat of crystallisation, determination of $\Delta H°R$ at standard and elevated temperatures, Theoretical flame temperature, and adiabatic flame temperature.

10 Hours

Textbooks

1. Bhatt B.I. and Vora S.M., "Stoichiometry (SI units)", 3rd edition, 1996, Tata McGraw-Hill Publishing Ltd., New Delhi,1996
2. Hougen O.A., Watson K.M. and Ragatz R.A., "Chemical Process Principles - Part I", "Material and Energy balances", 2nd edition, CBS publishers and distributors, New Delhi 2004

References

1. Himmelblau D.M., "Basic principles and Calculations in Chemical Engineering", 6th edition, Prentice Hall of India, New Delhi,1997

Back to Semester –III

Program: Bachelor of Engineering		Semester: III
Course Title: Chemical Process Industries		Course Code: 22ECEC204
L-T-P:3-0-0	Credits:4	Contact Hours:4 hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration:3 hrs	

Unit - 1

Chapter 1 Industrial gases

Basics of unit operations and unit processes in chemical process industries.
Production CO_2, H_2, O_2, N_2, Water gas and Synthesis gas.

5 Hours

Chapter 2: Acids

Production of Sulfuric acid, Nitric acid, Hydrochloric acid, and phosphoric acid.

5 Hours

Chapter 3 Chlor-Alkali Industries

Production of Sodium chloride, Soda ash, Caustic soda, Chlorine, Bleaching powder

5 Hours

Unit - 2

Chapter 4 Fertiliser

Production of Ammonia, Urea, Ammonium nitrate, Ammonium phosphate, MAP and DAP, Super phosphate and Triple Super Phosphate Bio-fertiliser.

5 Hours

Chapter 5 Petroleum industries and petrochemicals

Origin and classification. Petroleum refining and processing. LPG, CNG, LNG technologies, Methane, Benzene.

5 Hours

Chapter 6 Polymers

Polymerisation, PVC, LDPE, Polyproylene, Cross-linked polymers, Natural rubber, Synthetic rubber and Rubber compounding.

5 Hours

Unit - 3

Chapter 7 Natural products:

Vegetable oil extraction, Hydrogenation of oil, Sugar production from cane, Ethyl alcohol by fermentation.

5 Hours

Chapter 8: Miscellaneous Industries

Production of Paints, Pigments, Varnishes, Hydrogen peroxide (H_2O_2), Portland cement, and Silicon carbide.

5 Hours

Textbooks

1. Shreve's Chemical Process Industries, 4th edn, McGraw-Hill.
2. Dryden – Outlines of Chemical Technology for the 21st Century, Gopal Rao & Marshall Sittig, 3rd edition, EWP.
3. A Textbook of Chemical Technology Volume-1 and 2, S Chand publisher; Second edition

References

1. Encyclopedia of Chemical Technology, Kirk-Othmer, 27th volume, 5th ed., Wiley, 2004.
2. Unit Processes in Organic Chemical Industries, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.
3. Bose P.K., Chemical Engineering Technology, Vol -1,2, Books and Allied Pvt. Ltd

Back to Semester –III

Program: UG		Semester: III
Course Title: Momentum Transfer Lab.		Course Code: 22ECEP201
L-T-P:0-0-1	Credits:1	Contact Hours: 2hrs/week
ISA Marks:80	ESA Marks: 20	TotalMarks:100
Teaching Hours: 24	Examination Duration:3hrs	

Demonstration

1. Reynolds apparatus
2. Bernoulli's Experiment

Exercise

1. Venturimeter
2. Orificemeter
3. Rectangular Notch
4. Triangular Notch
5. Centrifugal pump
6. Open Orifice
7. Study of various pipe fittings
8. Spiral Coil

Structured Enquiry

1. Friction in circular pipes

Text Books

1. Kumar K.L., Engineering Fluid Mechanics, S Chand & Co Ltd., 2008
2. Bansal R.K. A Textbook of Fluid Mechanics, Laxmi Publications Pvt Limited, 2005

Back to Semester –III

Program: UG		Semester: III
Course Title: Particulate Technology Lab.		Course Code: 22ECEP202
L-T-P:0-0-1	Credits:1	Contact Hours: 2hrs/week
ISA Marks:80	ESA Marks: 20	TotalMarks:100
Teaching Hours: 24	Examination Duration:3hrs	

Demonstration

1. Blaines Permeability
2. Beaker Decantation

Exercise

1. Screen Analysis
2. Screen Effectiveness
3. Jaw Crusher
4. Drop weight crusher
5. Ball Mill
6. Cyclone Separator
7. Air Elutriation

Structured Enquiry

1. Differential and Cumulative Analysis

Text Books

1. Unit operations of chemical engineering by McCabe W. L. and Smith J. C, McGraw-Hill.
2. Coulson and Richardson's Chemical Engineering - Particle Technology And Separation Processes (Volume - 2) Richardson J. F.

Back to Semester –III

Program: UG		Semester: III
Course Code: 22ECEP203	Course Title: Computer-Aided Drawing Lab.	
L-T-P-SS:0-0-1	Credits: 1	Contact Hrs.: 02 Hrs./Week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs.: 24 Hrs.		Examination Duration: 3 Hrs.

Experiments

1.	**Sectional views**: Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.
2.	**Proportionate Drawings** Equipment and piping symbols, Vessel components: Vessel openings, Manholes, Vessel enclosures, Vessel support, Jackets, Shell and tube heat exchanger, Reaction vessel and different types of Evaporators. P & I Diagrams
3.	**Assembly drawings**: Joints: Cotter joint with sleeve, Socket and Spigot joint, Flanged pipe joint, Union joint, Stuffing box and Expansion joint (Screw type or flanged type)

Textbooks

1. Gopal Krishna K.R., "Machine Drawing", 2nd revised edn., Subhas Stores, Bangalore, 1998
2. Bhat N.D., "Machine Drawing", 22ndedn., Charoter Publishing House, Anand, 1987
3. Joshi M.V., "Process Equipment Design", 3rd edn., Macmillan India publication, New Delhi, 1999

Reference Books:

1. Walas S.M., "Chemical Process Equipment", Butterworth Heinemann Pub., 1999
2. Ludwig E.E., "Applied Process Design", 3rd edn., Gulf Professional Publishing, New Delhi, 1994

Back to Semester –III

Program: UG		Semester: III
Course Code: 22EHSC201	Course Title: Corporate Communication	
L-T-P-SS:0-0-0.5	Credits : 0.5	Contact Hrs.: 02 Hrs./Week
ISA Marks: 100	ESA Marks: --	Total Marks: 100
Teaching Hrs.: 16 Hrs.		Examination Duration:

Contents

1.	**Chapter 1. Communication Skills** Tools of Communication, Listening, Body Language, Common Postures and Gestures, Open and Closed Body Language, Body Language to be used in Corporate Scenarios, Voice: Pitch, Pace, and Pause, Verbal Language: Positive & Negative Vocabulary, Corporate Conversations.
2.	**Chapter 2. Presentation Skills** Zero Presentation, Individual Presentations, and feedback, Making Presentations Interactive, Types of Questions, Taking off and Signing off differently, Captivating your Audience, Corporate Presentations.
3.	**Chapter 3. Spoken English** Phonetic and Non-Phonetic Languages, Introduction to IPA, Sounds in English, Syllables, Word Stress, Rhythm, Pausing, and Intonation.
4.	**Chapter 4. Written English** Vocabulary Enhancement Strategies, Root Words in English, Grammar Improvement Techniques, Dictionary Usage, Similar and Contradictory Words.

References:

1. Diana Booher - Communicate With Confidence, McGraw-Hill Publishers
2. Norman Lewis – Word Power Made Easy, Goyal Publishers
3. Cambridge Advanced Learner's Dictionary, Cambridge University Press.

Curriculum Content - Course wise (Semester – 4)

Program: Bachelor of Engineering		**Semester: IV**
Course Title: Vector Calculus and Differential Equations		**Course Code:15EMAB241**
L-T-P:4-0-0	**Credits:4**	**Contact Hours:4 hrs/week**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:50	**Examination Duration:3hrs**	

Unit I

Chapter 1. Vector Algebra

Vectors, Vector addition, multiplication (Dot and Cross products), Triple products, Vector functions, Vector differentiation, Velocity and Acceleration of a vector point function.

Chapter 2. Partial differentiation

Function of several variables, Partial derivatives, Chain rule, Errors and approximations.

Chapter 3. Multiple integrals

Double integral, Evaluation by change of order, change of variables, simple problems, Triple integrals, simple problems.

Unit II

Chapter 4. Vector Calculus

Vector fields, Gradient and directional derivatives, Line and Surface integrals. Independence of path andpotential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem.

Chapter 5. Differential equations of the second order

Differential equations of second and higher orders with constant coefficients, the method of variation of parameters.

Unit III

Chapter 6. Partial differential equations

a. Introduction, classification of PDE, Formation of PDE, Solution of equations of the type Pp + Qq = R, Solution of partial differential equations by direct integration methods, method of separation of variables.
b. Modelling: Vibration of one-dimensional string-wave equation and heat equation. Laplace equation. Solution by the separation of variables method

Text Books

1. Grewal B S, Higher Engineering Mathematics, 38th ed, Khanna Publication, New Delhi, 2001
2. Bali and Iyengar, A text book of Engineering Mathematics, 6th ed, Laxmi Publications (P) Ltd, New Delhi, 2003

Reference Books:

1. Early Transcendental Calculus- James Stewart, Thomson Books, 5th ed, 2007

Back to Semester –IV

Program: UG		Semester: IV
Course Title: Numerical methods, Linear Algebra and Partial differential equations		Course Code: 22EMAB206
L-T-P:3-1-0	Credits:4	Contact Hours: 4hrs/week
ISAMarks:50	ESAMarks:50	TotalMarks:100
TeachingHours:50	ExaminationDuration:3hrs	

Unit I

Chapter 1 Interpolation techniques

Finite differences, Forward, Backward and central difference operators. Newton Gregory forward and backward interpolation formulae. Sterling's and Bessel's formulae for central difference, Lagranges and Newton's divided difference formula for un equal intervals. Gas law problem-using interpolation.

8 Hours

Chapter 2 Matrices and System of linear equations

Introduction to system of linear equations, Rank of a matrix by elementary row transformations. Consistency of system of linear equations, solution of system by Direct methods-Gauss elimination, Gauss Jordon method . Eigenvalues and Eigenvectors of a matrix. Diagonalization of a matrix.

12 Hours

Unit II

Chapter 3 Numerical solution of linear equations

Solution of system of equations by Iterative methods- Gauss-Seidal method. Eigenvalue and the corresponding Eigenvector by power method. Spring mass system Falling parachutist using system of equations**.**

8 Hours

Chapter 4 Partial differential equations

Introduction, classification of PDE, Formation of PDE, Solution of equation of the type Pp+Qq=R, Solution of partial differential equation by direct integration methods, method of separation of variables. Modeling: Vibration of one-dimensional string-wave equation and heat equation. Laplace equation. Solution by method of separation of variables.

12 Hours

Unit III

Chapter 5 Finite difference method.

(a) Finite difference approximations to derivatives, finite difference solution of parabolic PDE explicit and Crank-Nicholson implicit methods. Engineering Problems: Temperature distribution in a heated plate.

(b) Hyperbolic PDE-explicit method, Elliptic PDE-initial-boundary value problems. Vibration of a stretched string, steady-state heat flow.

10 Hours

Text Books

1. Kreyszig, E. (2003). Advanced Engineering Mathematics (8th ed.). John Wiley & Sons.
2. Potter M C, Jack Goldberg and Aboufadel E F, Advanced Engineering Mathematics, 3rd ed., Oxford Indian Edition, 2005.
3. Grewal B S, Higher Engineering Mathematics, 38th ed., TATA McGraw-Hill, 2001
4. Chapra S C and Canale R P, Numerical Methods for Engineers, 5th ed., TATA McGraw-Hill, 2007.

Reference Books:

1. Burden R L and Douglas Faires J, Numerical Analysis, 7th ed., Thomson publishers, 2006.
2. Simmons G F and Krantz S G, Differential Equations, TATA McGraw-Hill, 2007.
3. Sastry S S, Introductory method for numerical analysis, 3rd ed., PHI, 2003

Back to Semester –IV

Program: UG		Semester: IV
Course Title: Industrial Pollution and Control		Course Code: 22ECEC205
L-T-P:3-0-0	Credits:3	Contact Hours: 3 hrs/week
ISAMarks:50	ESAMarks:50	TotalMarks:100
Teaching Hours: 40	Examination Duration: 3hrs	

Unit I

Chapter 1. Introduction

Importance of the environment for mankind. Biosphere and layers of the atmosphere. Hydrological cycle and nutrient cycles. Types of pollution. Damages from environmental pollution. The Need for Environmental Legislation and Environmental Acts in India. Functions of the central and state pollution control boards

7 Hours

Chapter 2. Sources, Sampling and Analysis of Wastewater

Sources, Sampling and Analysis of Wastewater: Water Resources. Origin of wastewater. Evaluation, classification and characterisation of wastewater. Physical and chemical characteristics. BOD, COD and their importance. Types of water pollutants and their effects.

8 Hours

Unit II

Chapter 3. Wastewater Treatment

Preliminary, primary, secondary and tertiary treatments of wastewater. Sludge
Treatment and disposal. Advanced wastewater treatment. Recovery of materials from process effluents

8 Hours

Chapter 4. Applications to Industries

Norms and standards of treated water. Origin, characteristics, and treatment methods in typical industries – petroleum refinery, pulp and paper, distillery, and textile processing.

7 Hours

Unit III

Chapter 5 Air Pollution Control

Sampling of pollutants. Methods of estimation of air pollutants. Automobile
Pollution. Control methods for particulates and gaseous pollutants. Origin, control methods, and equipment used in typical industries, including metallurgical industries, cement industries, and Nuclear Industries (Radioactive Pollution).

10 Hours

Text Books

1. Environmental Pollution Control Engg, C.S. Rao, 2nd edn, New Age International Reprint, 2002.
2. Pollution Control in Process Industries, S.P. Mahajan, Tata McGraw-Hill, 22nd Reprint, 1999

Reference Books:

1. Principles and Practices of Air Pollution Control and Analysis, J.R. Mudakvi, I.K. International Publishing, Home Pvt. Ltd., New Delhi, 2010.
2. Air Pollution, H.C. Perkins, McGraw-Hill, 1974.
3. Industrial Pollution Control Handbook, Lund, H.F., 6th edn, Vol.1, McGraw-Hill, 1971

Program: UG		Semester: IV
Course Title: Process Heat Transfer		Course Code: 22ECEC206
L-T-P:4-0-0	Credits:3	Contact Hours: 5hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration: 03	

Unit I

Chapter 1. Conduction & Extended Surfaces

Modes of heat transfer, Fourier's law, Steady state unidirectional heat flow through single and multiphase layers slabs, cylinders, and spheres for constant and variable thermal conductivity—properties of insulation materials, Types of insulation, Critical and Optimum thickness.

Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness, and Elementary treatment of unsteady state heat conduction.

10 Hours

Chapter 2. Convection & Heat Transfer with Phase Change

Individual and overall heat transfer coefficient, LMTD, LMTD correction factor, Dimensionless numbers, and Dimensional analysis, Empirical correlation for forced and natural convection. The analogy between momentum and heat transfer- Reynolds, Colburn and Prandtl analogies.

Boiling phenomena: Nucleate and Film boiling, Condensation - Film and Dropwise condensation.

10 Hours

Unit II

Chapter 3. Heat Transfer Equipment

Double pipe heat exchangers, Shell & tube heat exchangers – Types of shell & tube heat exchangers, Construction details, Condenser, types of condensers.

8 Hours

Chapter 4. Design of Heat Transfer Equipment

Elementary design of double pipe heat exchangers, shell and tube heat exchangers, and condensers. Numerical Problems.

12 Hours

Unit III

Chapter 5. Evaporators & Radiation

Types of evaporators, the performance of tubular evaporators – Evaporator capacity, Evaporator economy, Multiple effect evaporators – Methods of feeding, the effect of liquid head and boiling point elevation.

Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation, gray body radiation, Stefan–Boltzmann law, Wein's displacement law, Kirchhoff's law.

10 Hours

Text Books

1. Kern D.Q., "Process Heat Transfer", McGraw-Hill., New York, 2001
2. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill Education, 2017.
3. Dutta, Binay K., "Heat Transfer: Principles and Applications", PHI Learning. 2000
4. Rao Y.V.C., "Heat Transfer", 1st ed. Universities Press (India) Ltd., New Delhi, 2001

Reference Books:

Coulson J.M. and Richardson J.F. with Backhurst J.R. and Marker J.H., Coulson J.M. Chemical Engineering, Vol. 1, 6th Edition, Butterworth-Heinemann New Delhi, 1999

Program: UG		Semester: IV
Course Title: Chemical Engineering Thermodynamics		Course Code: 22ECEC207
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4hrs/week
ISA Marks: 50	ESA Marks:50	TotalMarks:100
Teaching Hours:50	Examination Duration:3hrs.	

Unit I

Chapter 1. Basic Concepts

Scope of thermodynamics, System, Surroundings and processes, Closed and Open systems, state and Properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase rule, Zeroth law of thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes.

First Law of Thermodynamics: Internal energy, General statement of First law of thermodynamics, First law of thermodynamics for cyclic process, non-flow processes and steady state flow process, Heat capacity. **10 Hours**

Chapter 2. PVT Behaviour

P-V-T behaviour of pure fluids, Equations of state and ideal gas law, Processes involving ideal gas law, constant volume, constant pressure, constant temperature, adiabatic and polytropic processes, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equation of state for real gases, van der Waals equation, Redlich–Kwong equation, Peng–Robinson equation, Virial equation. Numerical. Compressibility charts: Principles of corresponding states. **10 Hours**

Unit II

Chapter 3. Second Law of Thermodynamics

General statements of the Second Law. Concept of Entropy and numerical analysis of Entropy. The Carnot Principle: Calculation of Entropy Changes and Clausius Inequality.

06 Hours

Chapter 4. Thermodynamic Properties of Pure Fluids

Properties, Energy Properties, Derived Properties, Work function, Gibbs free energy, Fundamental property relations, Maxwell's equations, Clapeyron equations, Numerical based on Clapeyron equation, Entropy heat capacity relations, Relationships between CP&Cv, Gibbs Helmholtz equation, Fugacity, Fugacity coefficient, Effect of temperature and pressure on Fugacity, Activity, Effect of temperature and pressure on activity.

08 Hours

Chapter 5 Properties of Solutions

Partial molar properties, Chemical potential, Effect of temperature and pressure on chemical potential, Fugacity in solutions, Henry's law and dilute solutions, Lewis Randall rule, Raoult's law, Activity in solutions, Activity coefficients, Gibbs–Duhem's equation.

06 Hours

Unit III

Chapter 6 Phase equilibria

Criteria of phase equilibria, Criterion of stability, Vapour–Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, Boiling point diagram.

04 Hours

Chapter 7 Chemical Reaction Equilibrium

Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, Pressure on equilibrium constants and other factors affecting equilibrium conversion.

06 Hours

Text Books

1. Smith J.M. and Vanness H. C., "Introduction to Chemical Engineering Thermodynamics", 8th ed., McGraw-Hill, New York.
2. Narayanan K.V., "Textbook of Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2013

Program: U G		Semester: IV
Course Title: Material Science and Engineering		Course Code: 22ECEC208
L-T-P:3-0-0	Credits: 3	Contact Hours: 3hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours:40	Examination Duration:3hrs	

Unit I

Chapter 1 Introduction

Introduction to material science, Classification of engineering materials, Properties of materials and Level of structure. Atomic structure and atomic bonding.

5 Hours

Chapter 2: Crystal geometry and structure determination

The geometry of crystals – the Bravais lattices, Crystal directions and planes – the Miller indices, Structure determination by X–Ray diffraction – Bragg law and Powder method.

5 Hours

Chapter 3 Crystal imperfections

Point Imperfections, Line imperfections – edge and screw dislocations, the Burgers vector, Surface imperfections and Volume imperfections

5 Hours

Unit II

Chapter 4 Phase diagram and phase transformations

Phase rule, Single component systems, Binary phase diagrams, Lever rule, Typical phase diagrams for Magnesia-Alumina, Copper–Zinc, iron–carbon systems, Nucleation and growth, Solidification, and Allotropic transformation.

6 Hours

Chapter 5 Deformation of materials and fracture

Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, and Different types of fracture.

4 Hours

Chapter 6 Heat treatments

Annealing, normalising, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering

5 Hours

Unit III

Chapter 7 Corrosion and Its Prevention

Direct corrosion, Electrochemical corrosion, Galvanic cells, High-temperature corrosion, Passivity factors influencing corrosion rate, Corrosion Control and prevention, Inhibitors, Protective coatings

5 Hours.

Chapter 8: Typical engineering materials

Ferrous metals, Non-ferrous metals and alloys – Aluminium and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high-temperature service, Ceramic materials, Refractories, Glasses, abrasives, Plastics, fibres and elastomers, Organic protective coatings.

5 Hours.

Text Books

1. Raghavan V., "Materials Science and Engineering – A First Course", 6th Edition. Prentice Hall of India Pvt. Ltd., New Delhi, 2021
2. Hajra Choudhury S.K., "Materials Science and Processes", Indian Book Distributing Co., 1982

Reference Books:

1. Elements of Materials Science and Engineering (Addison-Wesley Series in Metallurgy & Materials Engineering) by L. H. Van Vlack – 1 January 1989

Back to Semester –IV

Program: UG		Semester: IV
Course Title: Computer-based Chemical Calculations Lab.		Course Code: 22ECEP204
L-T-P:2-0-0	Credits:2	Contact Hours: 2hrs/week
ISA Marks:80	ESA Marks: 20	TotalMarks:100
Teaching Hours: 24	Examination Duration:3hrs	

Demonstration

1. Unit Conversions and determination of thermodynamic properties using a spreadsheet
2. Solution of simultaneous linear equations using a spreadsheet

Exercise

1. Estimation of loss of pressure in a piping system
2. Estimation of annual operating cost and Power requirements for a pumping system
3. Determination of average specific heat and heat load
4. Determination of liquid level in a tank
5. Determination of the volume of gas/gas mixture in a pressurised tank
6. Adiabatic flame temperature calculations
7. Standard turbine design and mixing calculations

Structured Enquiry

1. Heat exchanger

Text Books

1. Felder, Richard M., Ronald W. Rousseau, and Lisa G. Bullard. Elementary principles of chemical processes. John Wiley & Sons, 2020
2. Binay K. Dutta, Heat Transfer: Principles and Applications, 2nd ed., PHI Learning Pvt. Ltd., 2023
3. Rao Y.V.C., “Heat Transfer”, 1st ed. Universities Press (India) Ltd., New Delhi, 2001
4. Ahuja, Pradeep. Introduction to Numerical Methods in Chemical Engineering. Prentice Hall India Learning Private Limited, 2010

Back to Semester –IV

Program: UG		Semester: IV
Course Title: Process Heat Transfer Lab.		Course Code: 22ECEP205
L-T-P:0-0-1	Credits:1	Contact Hours: 2hrs/week
ISA Marks:80	ESA Marks: 20	Total Marks:100
Teaching Hours: 24	Examination Duration:3hrs	

Demonstration

1. Dropwise & Film-wise condensation
2. Fluidized bed

Exercise

1. Lagged pipe
2. Natural Convection in Bare Tube
3. Natural Convection in Finned Tube
4. Cross-flow Heat Exchanger
5. Composite Wall
6. Jacketed Vessel
7. Emissivity

Structured Enquiry

1. Heat exchanger (Double Pipe & Shell & Tube)

Text Books

1. Kern D.Q., "Process Heat Transfer", McGraw-Hill., New York, 2001
2. Warren McCabe, Julian Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill Education, 2017.
5. Binay K. Dutta, Heat Transfer: Principles and Applications, 2nd ed., PHI Learning Pvt. Ltd., 2023
3. Rao Y.V.C., "Heat Transfer", 1st ed. Universities Press (India) Ltd., New Delhi, 2001

Reference Books:

1. Coulson J.M. and Richardson J.F. with Backhurst J.R. and Marker J.H., Coulson J.M. Chemical Engineering, Vol. 1, 6th Edition, Butterworth-Heinemann New Delhi, 1999

Back to Semester –IV

Program: UG		Semester: IV
Course Title: Technical Chemistry Lab.		Course Code: 22ECEP206
L-T-P:2-0-0	Credits:2	Contact Hours: 2hrs/week
ISA Marks:80	ESA Marks: 20	TotalMarks:100
Teaching Hours: 24	Examination Duration:3hrs	

Demonstration

1. Colorimetric estimation of copper
2. Estimation of dissolved oxygen in a given water sample by Winkler's method

Exercise

1. To determine the rate of constant and order of the reaction of the hydrolysis of an ester (methyl acetate) catalysed by an acid (dilute HCl)
2. Determination of rate constant for the reaction between potassium persulphate and potassium iodide (Second Order Kinetics)
3. Estimation of phenol by the iodometric method
4. Preparation of p-bromo acetanilide by bromination of acetanilide
5. Determination of total hardness of water using the disodium salt of EDTA
6. Determination of calcium oxide in cement solution by the rapid EDTA method
7. Conductometric estimation of strong and weak acids from a given mixture using a standard NaOH solution
8. Determination of the viscosity coefficient of a given liquid using Ostwald's viscometer
9. Potentiometric estimation of FAS using standard K2Cr2O7 solution
10. Estimation of the percentage of available chlorine in the given sample of bleaching powder (Iodometric method)

Text Books

1. Arun Bahl and Bahl B.S., "A textbook of Organic Chemistry", 15th edn., Chand S. and Company, New Delhi, 1998
2. Morrison B.R. and Boyd L.L., "Organic Chemistry", 6th edn, ELBS, New Delhi, 1998
3. Tiwari, Melhotra, and Vishnoi, "Organic Chemistry", 7th ed., Chand S. and Company, New Delhi, 1996
4. Puri L.R. and Sharma B.R., "Physical Chemistry", 14th ed., Chand S. and Company, New Delhi, 1998
5. James Huheey, "Inorganic Chemistry," 19th ed. Wiley Publishers, New Delhi, 19

Back to Semester –IV

Program: UG		Semester: IV
Course Title: Problem Solving & Analysis		Course Code: 22EHSH202
L-T-P:2-0-0	Credits:2	Contact Hours: 2hrs/week
ISAMarks:100	ESA Marks: 0	TotalMarks:100
Teaching Hours: 16	Examination Duration:	

Content

Chapter 1. Analytical Thinking

Analysis of Problems, Puzzles for practice, Human Relations, Direction Tests; Looking for Patterns: Number and Alphabet Series, Coding Decoding; Diagrammatic Solving: Sets and Venn diagram-based puzzles; Visual Reasoning, Clocks and Calendars.

4 Hours

Chapter 2. Mathematical Thinking

Number System, Factors and Multiples, Using Simple Equations for Problem Solving, Ratio, Proportion, and Variation.

4 Hours

Chapter 3. Verbal Ability

Problem Solving using Analogies, Sentence Completion.

4 Hours

Chapter 4. Discussions & Debates

Team efforts in Problem Solving: A Zero Group Discussion, Mock Group Discussions, and Feedback; Discussion v/s Debate; Starting a Group Discussion: Recruitment and other Corporate Scenarios; Evaluation Parameters in a Recruitment Group Discussion, Types of Initiators: Verbal and Thought, Conclusion of a Discussion.

4 Hours

Reference Books:

1. R. S. Aggarwal, “A Modern Approach to Verbal and Non–Verbal Reasoning”, Sultan Chand and Sons, New Delhi, 2018
2. R. S. Aggarwal, “Quantitative Aptitude”, Sultan Chand and Sons, New Delhi, 2018
3. Chopra, “Verbal and Non–Verbal Reasoning”, Macmillan India
4. M Tyra, “Magical Book on Quicker Maths”, BSC Publications, 2018
5. Diana Booher - Communicate With Confidence, McGraw-Hill Publishers
6. Norman Lewis – Word Power Made Easy, Goyal Publishers
7. Cambridge Advanced Learner’s Dictionary, Cambridge University Press.
8. Kaplan’s GRE guide

Curriculum Content - Course wise (Semester – 5)

Program: Bachelor of Engineering		**Semester: V**
Course Title: Numerical Methods and Statistics		**Course Code:24EMAB301**
L-T-P:3-0-1	**Credits:4**	**Contact Hours:6Hrs/week**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:40	**Examination Duration:3 Hrs**	

Unit I

Chapter 1. Numerical Methods:

Introduction to numerical methods. Roots of equations using Bisection Method, Newton- Raphson Method, Finite differences, Forward, Backward Operators. Newton Gregory forward and backward interpolation formulae. Newton's divided difference formula for unequal intervals. Numerical solution of first order ODE, Euler's and Modified Euler's method, Runge-Kutta 4^{th} order method. Implementation using Python programming.

8 Hours

Chapter 2. Matrices and Systems of Linear Equations:

Introduction to the system of linear equations, Rank of a matrix by elementary row transformations. Consistency of the system of linear equations, solution of the system by (i) Direct methods: Gauss elimination, Gauss-Jordan method (ii) Iterative methods: Gauss-Seidel method. Eigen values and Eigenvectors of a matrix. Largest Eigen value and the corresponding Eigenvector by the power method. Implementation using Python programming.

8 Hours

Unit II

Chapter 3. Curve fitting and regression:

Introduction to method of least squares, fitting of curves $y = a + bx$, $y = ab^x$, $y=a + bx +cx^2$, correlation and regression.

5 Hours

Chapter 4. Probability:

Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule. (no proof) Discrete and continuous random variables- PDF-CDF- Binomial, Poisson and Normal distributions (Problems only).

9 Hours

Unit III

Chapter 5. Sampling distributions:

(a) Sampling, Sampling distribution, Standard error, Null and alternate hypotheses, Type-I and Type- IIerrors, Level of significance. Confidence limits for means (large sample).

(b) Testing of the hypothesis for means. Large and small samples and Student's t- t-distributionand Confidence limits for means (small sample).

10 Hours

Text Books

1. Bali and Iyengar, A textbook of Engineering Mathematics, 6^{th} ed., Laxmi Publications(p) Ltd, New Delhi,2003
2. Chapra S C and Canale R P, Numerical Methods for Engineers, 5^{th} ed., TATA McGraw-Hill, 2007
3. Gupta S C and Kapoor V K, Fundamentals of Mathematical Statistics, 9^{th} ed., Sultan Chand & Sons, New Delhi, 2002

Reference Books:

1. Sastry S S, Introductory method for numerical analysis, 3^{rd} Ed, PHI, 2003.
2. J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 4^{th} Ed, TATA McGraw-Hill Edition 2007.

Program: Bachelor of Engineering		Semester: V
Course Title: Process Engineering Economics & Plant Design		Course Code:22ECEC301
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Process Design Development:

Overall planning of a plant, Feasibility studies and Material and energy balance, Equipment sizing and selection, Process flow sheet, P & I diagram, Plant layout and location.

08 hours

Chapter 2: Cost Analysis:

Factors affecting investment and production cost, Estimation of capital investment, Factors in capital investment, Estimation of working capital, cost index. Time value of money: Types of interests: Effective and nominal interest rates, present worth and discount.

07 hours

Unit II

Chapter 3: Depreciation, Taxes, and Profitability:

Types of Depreciation and calculation methods Theory of profitability and its evaluation methods.

07 hours

Chapter 4: Replacements & Alternatives Investments:

Theory of replacements, causes for replacements, types of replacements, Theory of alternative investments, and causes for the same.

08 hours

Unit III

Chapter 5: Financial Statements and Design Report:

Introduction to financial statements, Cash flow diagrams, balance sheet, and Break-even analysis.

Design report: Introduction to design of reports. Types of reports, Organization of Report and purpose of Report.

10 hours

Text Books

1. Chemical Process Engineering Design And Economics by Silla, Harry, CRC Press, 2017
2. Plant Design and Economics for Chemical Engineers by Max Peters, Klaus Timmerhaus, Ronald West, 5th Edn., McGraw Hill Education, 2017
3. Process Engineering Economics (Chemical Industries) by James Riley Couper, CRC Press, 2003

Reference Books:

1. Chemical Engineering Process Design and Economics, a Practical Guide by Gael D. Ulrich, 2016

Back to Semester – V

Program: Bachelor of Engineering		Semester: V
Course Title: Computer Applications, Modeling & Simulation		Course Code: 22ECEC302
L-T-P:3-1-0	Credits:4	Contact Hours:4 Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Review of Computational Methods:

Non-linear Algebraic equation- Newton Raphson. Ordinary Differential Equation - R-K Method. Numerical Integration Simpson's 1/3 Rule. Curve Fitting-Least Squares, Specific volume by Redlich Kwong equation, Batch Reactor, Liquid level in a tank, Nre Vs FF, and Arrhenius equation.

10 hours

Chapter 2: Applications of Vapour: Liquid Equilibrium

Vapour: Liquid equilibrium for binary mixtures. Calculation of Bubble Pressure and Bubble Point. Dew Pressure and Dew point for Ideal Binary and multi-component system. Flash Vaporization for multi-component system.

10 hours

Unit II

Chapter 3: Design of Process Equipment

Design of Reactors: Adiabatic Batch Reactor, Adiabatic P.F.R., Adiabatic CSTR and Combinations. Design of Heat Exchangers: Double Pipe Heat Exchanger (Area, Length and Pressure Drop). Shell & Tube Heat Exchanger (Area, Number of tubes, Pressure drop). Design of Distillation column (Number of trays and height of column).

10 hours

Chapter 4: Modeling:

Models and model building, principles of model formulations, precautions in model building, Fundamental laws: Review of shell balance approach, continuity equation, energy equation, equation of motion, transport equation of state equilibrium and Kinetics, classification of mathematical models.

10 hours

Unit III

Chapter 5: Mathematical Modeling of Process Equipment:

Basic tank model – Level V/s time, Heat exchanger, Batch Distillation – Vapour composition with CSTRs in series. Data-Driven Soft Sensors in the Process Industry.

10 hours

Text Books

1. Process Modeling Simulation and Control for Chemical Engineering, William. L Luyben, 2nd edition, McGraw Hill, 1990.
2. Elements of Chemical Reaction Engineering, H. Scott Fogler, 2nd edition, Prentice Hall, 2001.
3. Introduction to Chemical Engineering Thermodynamics, Smith J. M. and H. C. Vanness, 5th edition, McGraw Hill, 1996.
4. Introduction to Chemical Engineering and Computer Calculations, Myers, A.L and Seider W.D, Prentice Hall, 1976.
5. Felder and Rousseau, Elementary Principles of Chemical Processes, 3rd edition, John Wiley and Sons, Inc., 2005.

Reference Books:

1. Coulson J.M. and Richardson J.F. with Backhurst J.R. and Marker J.H., Coulson J.M. Chemical Engineering, Vol. 1, 6th edition, Butter worth-Heinemann New Delhi, 1999

Back to Semester – V

Program: Bachelor of Engineering		Semester: V
Course Title: Bioprocess Engineering		Course Code: 22ECEC303
L-T-P:3-1-0	Credits:4	Contact Hours:4Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction:

Bioprocess engineering and technology. Role of a Chemical engineer in bioprocess industry. Microbiology: Structure of cells: Prokaryotes and Eukaryotes. Classification of micro-organisms. Taxonomy, control of microorganisms – physical and chemical methods. Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids. Vitamins, Biopolymers, Nucleic Acids: RNA, DNA, and their derivatives (Structure, Biological function and Importance for life only to be studied).

7 hours

Chapter 2: Kinetics of Enzyme action:

Detailed structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes. Kinetics and mechanism of Enzyme action: Michaelis–Menten, Briggs-Haldane approach. Derivation. Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Line weaver–Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods).

8 hours

Unit II

Chapter 3: Enzyme Inhibition:

Effect of Inhibitors (Competitive, noncompetitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalyzed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses.

7 hours

Chapter 4: Fermentation Technology:

Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: Sources of nutrients. Introduction to sterilization of bioprocess equipment, Fed-batch reactors.

Growth Kinetics of Microorganisms: Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Continuous culture: Optimum Dilution rate and washout condition in Ideal Chemostat.

8 hours

Unit III

Chapter 5: Downstream Processing:

Strategies and steps involved in product purification. Methods of cell disruption, Filtration, Centrifugation, Sedimentation, Chromatography, Freeze drying / lyophilization. Membrane separation Technology: Reverse Osmosis, Ultra filtration, Micro filtration, Dialysis.

10 hours

Text Books

1. Biochemical Engineering Fundamentals, Bailey and Ollis, 2nd Edition, McGraw Hill, 2017.
2. Bioprocess Engineering, Shuler M. L. and Kargi F., 2nd Edition, Prentice Hall, 2015

Reference Books:

3. Principles of Fermentation Technology, Peter Stanbury, Allan Whitaker, Stephen J. Hall, 3rd Edition, Butterworth-Heinemann an Imprint of Elsevier, 2016

Back to Semester – V

Program: Bachelor of Engineering		Semester: V
Course Title: Mass Transfer		Course Code: 22ECEC304
L-T-P:3-1-0	Credits:4	Contact Hours:4Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1. Introduction

Diffusion, types of diffusion, Diffusion in liquids, gas, and solids, Mass transfer coefficients. Theories of mass transfer, Interphase mass transfer, stages, cascades, stage efficiency, Material Balance for co-current, cross-current, and counter-current operations, Concept of stages, cascade operation.

10 hours

Chapter 2 Gas Liquid Operations

The objective of gas-liquid operations, Factors affecting effectiveness, Types of gas-liquid contact, Tray column, Operational difficulties in tray column, types of trays, packed column, types of packing materials, entrainment, channeling, Comparison between the plate and packed column, Liquid hold up- static, total and operating hold up: Venturi scrubber, HTU, NTU, and HETP.

10 hours

Unit II

Chapter 3 Humidification

Concepts in humidification – absolute humidity, molal humidity, saturation and unsaturation humidity, dew point, WBT, DBT. Theory of wet bulb temperature and wet bulb equation (Lewis relation), Adiabatic saturation temperature, Humidity chart, Cooling towers.

10 hours

Chapter 4 Adsorption

Theories of adsorption, Isotherms. Types of operations – single stage operation, multistage cross current operation, multistage counter current operation, problems on adsorption operation, Industrial adsorbents. Adsorption Equipment.

10 hours

Unit III

Chapter 5 Crystallization

Factors governing nucleation and crystal growth rates. Controlled growth of crystals. Incorporation of principles into the design of equipment. Different types of crystallizer equipment.

7 hours

Chapter 6 Drying

Introduction, Moisture content on dry and wet basis, Equilibrium moisture content, Free moisture content, Constant and falling rate period, Drying rate curve, Batch drying, Selection of dryers, Drying equipment.

8 hours

Text Books

1. Mass Transfer Operations by Robert Treybal, 3rd Edn 2017
2. Unit Operations in Chemical Engineering - McCabe & Smith, 7th Edn McGraw Hill, 2017
3. Chemical Engineering Vol I, II, IV and V - Coulson and Richardson, 4th Edn Pergamon Press, 1998.
4. Introduction to Chemical Engineering - Badger & Banchero, TMH 6th Reprint 1998

Reference Books:

1. Principles of Unit Operation - Foust et.al., 2nd Edn John Wiley, 2015

Back to Semester – V

Program: Bachelor of Engineering		Semester: V
Course Title: Chemical Reaction Engineering - I		Course Code: 22ECEC305
L-T-P:3-1-0	Credits:4	Contact Hours:4Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1 Introduction

Classification of reactions, Variables affecting rate, Definition of rate equation. Series and parallel reactions, elementary and non elementary reactions, Chemical kinetics and thermodynamics equilibrium. Temperature dependent term of rate equations from Arrhenius theory and comparison with collision and transition state theory. Non - Elementary Reactions: Difference between elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions.

8 hours

Chapter 2 Homogeneous Reactions

Interpretation of batch reactor data in constant & variable volume batch reactor. Integral and Differential method of analysis of kinetic data, For irreversible and reversible first, and second order reactions. Zero order, catalytic and auto catalytic, series and parallel reactions.

12 hours

Unit II

Chapter 3 Design of Ideal Reactors

Introduction to mass and energy balance equations for the reactor. Definition and concepts of ideal reactors. Development of performance equations for batch, mixed and tubular reactors for both constant and variable volume reactions. Space time, space velocity, and holding time for flow reactors. Numerical problems.

13 hours

Chapter 4 Multiple Reactors

Plug flow and/or mixed flow reactors in series and parallel. Reactors of different types and sizes in series. General graphical size comparison of single and multiple reactor systems.

8 hours

Unit III

Chapter 5 Design of multiple reactions

Parallel reaction - Qualitative and quantitative treatment of product distribution. Series reaction – Qualitative treatment of product distribution.

5 hours

Chapter 6 Non-Isothermal reactors

Introduction, effect of temperature on equilibrium constant and heat of reaction, Material and Energy balances, general design procedure, optimum temperature progression. Adiabatic and non-adiabatic operations.

5 hours

Text Books

1. Chemical Reaction Engineering, Octave Levenspiel, 3rd edition, John Wiley & Sons, 2001.
2. Elements of Chemical Reaction Engineering, H. Scott Fogler, 3rd edition, Prentice Hall 2001
3. Chemical Engineering Kinetics, J.M. Smith, 3rd edition, McGraw Hill, 1984

Reference Books:

1. Encyclopedia of Chemical Technology, Kirk and Othmer, 27th volume, 5th edition, Wiley, 2004.
2. The Engineering of Chemical Reactions, Lanny D. Schmidt, 2nd edition, Oxford University Press

Program: Bachelor of Engineering		Semester: V
Course Title: Mini Project		Course Code:15EMEW301
L-T-P:0-0-3	Credits:3	Contact Hours:3 Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:36	Examination Duration:3 Hrs	

Mini-project work in chemical engineering for waste recycling is an essential part of a chemical engineering education. It allows students to apply their knowledge and skills to solve a real-world problem and develop their professional skills. Waste recycling is the process of converting waste materials into new materials and objects. It is an alternative to conventional waste disposal that can save material and help lower greenhouse gas emissions. Mini-projects in chemical engineering for waste recycling can address a variety of topics, including waste reduction, reuse, reclamation, and recycling. Mini-project work in chemical engineering for waste recycling provides students with the following benefits:

- The opportunity to apply their knowledge and skills to solve a real-world problem
- Experience working effectively in a team
- The ability to communicate their ideas clearly and concisely
- The ability to manage a project effectively

The opportunity to develop their professional skills, such as problem-solving, critical thinking, communication, teamwork, and time management.

References:

1. Waste Management in the Chemical and Petroleum Industries, by Alireza Bahadori, Wiley; 2nd edition (15 November 2019)

Back to Semester – V

Program: Bachelor of Engineering		Semester: V
Course Title: Computer Applications & Simulation Lab.		Course Code: 22ECEP301
L-T-P:0-0-1	Credits:4	Contact Hours:4Hrs/week
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration:3 Hrs	

List of Experiments

1. Determination of thermodynamic properties using spread sheet
2. Thermodynamic Calculations & basic design of equipment using programming languages
3. Mixing of ideal liquid streams
4. Determination of thermo physical properties of pure components
5. Generation of V.L.E. data of binary component systems
6. Determination of equilibrium conversion of reversible reactions
7. A material balance on the reactor based on yield/conversion data.
8. Simulation of a CSTR for liquid phase reaction
9. Simulation of a flash column
10. Simulation of a distillation column
11. Determination of heat duty
12. Shortcut simulation of heat exchanger to determine outlet stream temperature
13. Detailed simulation of heat exchanger
14. Simulation of Process flow sheet
15. Adiabatic Flame Temperature Calculations

Text Books

1. Amiya K. Jana, Process Simulation and control using ASPEN, 2nd edition, Prentice Hall India Learning Pvt. Ltd., 2012
2. Amiya K. Jana, Chemical Process Modelling and Computer Simulation, 3rd edition, Prentice Hall India Learning Pvt. Ltd., 2018,
3. Sandler Stanley, Using Aspen Plus in Thermodynamics Instruction: A Step-by-Step Guide, John Wiley & Sons, 2015,
4. DWSIM - Process Simulation, Modeling and Optimization, Technical Manual, Version 4.0, Revision 0, August 2016
5. Warren D. Seider, Daniel R. Lewin, J. D. Seader, Soemantri Widagdo, Rafiqul Gani, Ka Ming Ng, Product and Process Design Principles: Synthesis, Analysis and Evaluation, 4th edition, John Wiley & Sons, 2016

Back to Semester – V

Program: Bachelor of Engineering		Semester: V
Course Title: Pollution Control Lab.		Course Code: 22ECEP302
L-T-P:0-0-1	Credits:4	Contact Hours:4Hrs/week
ISA Marks:80	ESA Marks:20	Total Marks:100
Teaching Hours:24	Examination Duration:3 Hrs	

List of Experiments

1. Analysis of flue gases by Gas chromatograph
2. Bomb calorimeter
3. Analysis of effluents by pH meter
4. Determination of Alkalinity by titrometric method
5. UV Spectrophotometer
6. KF Auto titrator
7. Determination of Turbidity by Nephelometric turbidity meter
8. Determination of Biological Oxygen Demand
9. Dissolved Oxygen measurement
10. Red Wood Viscometer
11. Analysis of liquid effluents by pH meter in terms of alkalinity and acidity

Text Books

1. Air Pollution Engineering Manual, Wayne T. Davis, John Wiley & Sons, Inc., 2000.
2. Practical Waste Treatment and Disposal, Dickinson, Applied Science publication, London.
3. Pollution control in Process industries, Mahajan, McGraw Hill Education, 2017

Back to Semester – V

Program: Bachelor of Engineering		Semester: V
Course Title: Arithmetical Thinking and Analytical Reasoning		Course Code: 22EHSH301
L-T-P:0-0-1	Credits:4	Contact Hours:4Hrs/week
ISA Marks:100	ESA Marks: - NA -	Total Marks:100
Teaching Hours:16	Examination Duration: - NA -	

Chapter 1. Analytical Thinking

Importance of Sense of Analysis for Engineers, Corporate Methodology of Testing Sense of Analysis, Puzzles for practice: Analytical, Mathematical, Classification Puzzles, Teamwork in Problem Solving.

4 hours

Chapter 2. Mathematical Thinking I

Problems on Finance: Percentages, Gain and Loss, Interest; Distribution and Efficiency Problems: Averages, Time Work, Permutations Combinations.

4 hours

Chapter 3. Mathematical Thinking II

Distribution Problems: Permutations Combinations.

2 hours

Chapter 4. Verbal Ability

Comprehension of Passages, Error Detection and Correction Exercises, Common Verbal Ability questions from Corporate Recruitment Tests.

6 hours

References:

1. George J Summers, “The Great Book of Puzzles & Teasers”, Jaico Publishing House, 1989
2. Shakuntala Devi , “Puzzles to Puzzle You”, Orient Paper Backs, New Delhi, 1976
3. R. S. Aggarwal, “A Modern Approach to Logical Reasoning”, Sultan Chand and Sons, New Delhi, 2018
4. M Tyra, “Magical Book on Quicker Maths”, BSC Publications, 2018
5. Cambridge Advanced Learner’s Dictionary, Cambridge University Press.
6. Kaplan’s GRE guide

Curriculum Content - Course wise (Semester – 6)

Program: Bachelor of Engineering		**Semester: VI**
Course Title: Professional Aptitude & Logical Reasoning		**Course Code:16EHSC301**
L-T-P:3-0-0	**Credits:3**	**Contact Hours:3Hrs/week**
ISA Marks:50	**ESA Marks:50**	**Total Marks:100**
Teaching Hours:40	**Examination Duration:3 Hrs**	

Unit – I - Arithmetical Reasoning and Analytical Thinking

Chapter 1. – Arithmetical Reasoning	10 Hrs
Chapter 2. – Analytical Thinking	4 Hrs
Chapter 3. – Syllogistic Logic	3 Hrs

Unit – II – Verbal and Non – Verbal Logic

Chapter 1. – Verbal Logic	9 Hrs
Chapter 2. – Non-Verbal Logic	6 Hrs

Unit – III - Lateral Thinking

Chapter 1. - Lateral Thinking	8 Hrs

Text Books

1. A Modern Approach to Verbal and Non – Verbal Reasoning – R. S. Aggarwal, Sultan Chand and Sons, New Delhi
2. Quantitative Aptitude – R. S. Aggarwal, Sultan Chand and Sons, New Delhi

Reference Books

1. Verbal and Non – Verbal Reasoning – Dr. Ravi Chopra, MacMillan India
2. Lateral Thinking – Dr. Edward De Bono, Penguin Books, New Delhi

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Chemical Reaction Engineering - II		Course Code:25ECEC306
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Non Ideal flow

Causes of non ideal conditions in reactor. Importance and Interpretation of RTD, Stimulus response technique, C, E &F curves, Conversion using tracer information (first order reaction). Models for non ideal flow – dispersion model and tanks in series Model. Numerical problems.

8 hours

Chapter 2: Introduction to heterogeneous reacting systems

Introduction to Heterogeneous Systems: Rate equations, contacting patterns. Fluid-particle non catalytic reactions: unreacted core model, particles of unchanging size, shrinking spherical particles. Fluid-Fluid Non Catalytic Reactions: Kinetic regimes for mass transfer and reaction and their rate equations.

7 hours

Unit II

Chapter 3: Catalysis

Introduction to Catalysis - General properties of catalyst, promoters, inhibitors, mechanism of catalysis. Estimation methods for catalytic properties, methods for estimation for catalytic Properties. Deactivation of Catalyst and mechanism of deactivation.

8 hours

Chapter 4: Solid Catalyzed Reactions

Heterogeneous reactions- Introduction, Kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Thiele modulus and enhancement factor, Porous catalyst particles. Heat effects during reaction.

7 hours

Unit III

Chapter 5: Catalytic Reactors

Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates. Packed bed catalytic reactor & reactors with suspended solid catalyst. Fluidized reactors of various types. Gas-Liquid Reactors: Trickle bed, slurry reactors. 3-phase fluidized bed.

10 hours

Text Books

1. Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, John Wiley & Sons, 2001.
2. Elements of Chemical Reaction Engineering by H. Scott Fogler, 3rd Edition, Prentice Hall, 2001.
3. Chemical Engineering Kinetics by J. M. Smith, 3rd Edition, McGraw-Hill, 1984.

Reference Books

1. Chemical Reactor Analysis and Design by Gilbert F. Froment and Kenneth B. Bischoff, 2nd Edition, Wiley, 1990.
2. Reaction Engineering Principles by Himadri B. Gupta, CRC Press, 2014

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Mass Transfer - II		Course Code: 25ECEC307
L-T-P:3-1-0	Credits:4	Contact Hours:4 Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:50	Examination Duration:3 Hrs	

Unit I

Chapter 1: Absorption:

Absorption: Introduction, Solvent selection for absorption, Material balance and concept of driving force, Multistage absorption columns, minimum solvent rates, Design of Plate columns, Absorption and desorption factors, Liquid phase hold up and pressure drop in absorption towers. Design of packed towers (process design-height and diameter). Multi-component absorption. Absorption with chemical reaction.

14 hours

Chapter 2: Distillation:

Introduction: Relative volatility, Prediction of and using relative volatility, types of distillation- Simple and flash distillation.

06 hours

Unit II

Chapter 3: Continuous Distillation

Multi-stage rectification column, Reflux ratio- maximum, minimum and optimum reflux ratio, reboiler arrangement, Design using McCabe Thiele method – Feed condition, feed plate location and construction of operating lines, Heating and cooling requirements.Ponchon-Savarit method, Introduction to Multi-component distillation, Extractive and Reactive distillation, Azeotropic distillation and Steam distillation.

14 hours

Chapter 5: Leaching:

Introduction, Phase and equilibrium diagram, factors affecting the rate of leaching, Leaching operation- single stage operation, multistage cross current operation, multistage counter current operation, Equipment for leaching operation.

06 hours

Unit III

Chapter 5: Extraction:

Introduction, selection of solvent for extraction, phase diagram, Extraction operation- single stage operation, multistage cross current operation, multistage counter current operation, Extraction equipment.

05 hours

Chapter 5: Introduction to Novel Separations:

Membrane processes- Reverse Osmosis, Dialysis, Ultra and Micro-filtrations, Super- critical fluid extraction.

05 hour

Text Books

1. Edward L. Cussler, Diffusion: Mass Transfer in Fluid Systems, Cambridge Series in Chemical Engineering, 3rd Edition, Cambridge University Press, 2009.
2. Robert E. Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, 2017.
3. W.L. McCabe, J.C. Smith, and P. Harriott, Unit Operations in Chemical Engineering, 7th Edition, McGraw Hill, 2017.
4. J.M. Coulson and J.F. Richardson, Chemical Engineering Vol. I, II, IV, and V, 4th Edition, Pergamon Press, 1998.

Reference Books

1. W.L. Badger and J.T. Banchero, Introduction to Chemical Engineering, Tata McGraw-Hill, 6th Reprint, 1998.
2. A.S. Foust et al., Principles of Unit Operations, 2nd Edition, John Wiley & Sons, 2015.

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Minor Project		Course Code: 22ECEW302
L-T-P : 0-0-6	Credits: 4	Contact Hours: 16 Hrs/week
ISA Marks : 50	ESA Marks:50	Total Marks:100
Examination Duration:3 Hrs		

Minor project work in chemical engineering for waste recycling is essential to a chemical engineering education. It allows students to apply their knowledge and skills to solve real-world problems and develop their professional skills. Waste recycling is converting waste materials into new materials and objects. It is an alternative to conventional waste disposal that can save material and help lower greenhouse gas emissions. Mini-projects in chemical engineering for waste recycling can address various topics, including waste reduction, reuse, reclamation, and recycling. Mini-project work in chemical engineering for waste recycling provides students with the following benefits:

- The opportunity to apply their knowledge and skills to solve a real-world problem
- Experience working effectively in a team
- The ability to communicate their ideas clearly and concisely
- The ability to manage a project effectively
- The opportunity to develop their professional skills, such as problem-solving, critical thinking, communication, teamwork, and time management

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Chemical Reaction Engineering Lab.		Course Code: 22ECEP303
L-T-P : 0-0-1.5	Credits: 1.5	Contact Hours: 3 Hrs/week
ISA Marks : 80	ESA Marks:20	Total Marks:100
Examination Duration:3 Hrs		

Experiments

1. Batch reactor
2. Isothermal plug flow reactor
3. Mixed flow reactor
4. Adiabatic reactor
5. Packed bed reactor
6. RTD Studies in tubular reactor
7. Effect of temperature on rate of reaction
8. RTD Studies in mixed flow reactor
9. RTD studies in series reactor
10. Photochemical reactor

Text Books:

1. Chemical Reaction Engineering, Octave Levenspiel, 3rd Edn, John Wiley & Sons, 2001.
2. Elements of Chemical Reaction Engineering, H. Scott Fogler, 3rd Edn, Prentice Hall 2001
3. Chemical Engineering Kinetics, J.M. Smith, 3rd Edn, McGraw Hill, 1984.

Reference Books

Chemical & Catalytic Reaction Engineering, James J. Carberry, McGraw Hill, 1976.

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Mass Transfer Lab.		Course Code: 22ECEP303
L-T-P : 0-0-1.5	Credits: 1.5	Contact Hours: 3 Hrs/week
ISA Marks : 80	ESA Marks:20	Total Marks:100
Examination Duration:3 Hrs		

Experiments

1. Diffusion of organic vapours in air
2. Simple Distillation
3. Packed column/ plate column distillation
4. Steam distillation
5. Solid - liquid leaching
6. Tray dryer
7. Adsorption studies
8. Liquid-liquid/Vapour -liquid equilibrium
9. Liquid extraction
10. Absorption studies

Text Books:

1. Mass Transfer Operations by Robert Treybal, 3rd Edn., McGraw Hill, 2017.
2. Unit Operations in Chemical Engineering - McCabe & Smith, 7th Edn McGraw Hill, 2017
3. Chemical Engineering Vol I, II, IV and V - Coulson and Richardson, 4th Edn, Pergamon Press, 1998.
4. Principles of Unit Operation - Foust et.al., 2nd Edn, John Wiley, 2015**Reference Books**

Back to Semester – VI

Program: Bachelor of Engineering		**Semester: VI**
Course Title: Industry Readiness & Leadership Skills		**Course Code: 22EHSH302**
L-T-P: 0.5-0-0	**Credits: 0.5**	**Contact Hours: 1Hr/week**
ISA Marks: 100	**ESA Marks: Nil**	**Total Marks: 100**
Teaching Hours: 16	**Examination Duration: NA**	

Chapter No. 1. Written Communication

Successful Job Applications, Résumé Writing, Emails, Letters, Business Communication, Essay, and Paragraph Writing for Recruitment Tests

Chapter No. 2. Interview Handling Skills

Understanding Interviewer Psychology, Common Questions in HR Interviews, Grooming, Interview Etiquette

Chapter No. 3. Lateral & Creative Thinking

Lateral Thinking by Edward de Bono, Fractionation and Brain Storming, Mind Maps, Creativity Enhancement through Activities

Chapter No. 4. Team Building & Leadership Skills

Communication in a Team, Leadership Styles, Playing a Team member, Belbin's team roles, Ethics, Effective Leadership Strategies

References:

1. Diana Booher – E Writing, Laxmi Publications
2. Edward de Bono – Lateral Thinking – A Textbook of Creativity, Penguin UK
3. William Strunk, E B White – The Elements of Style, Pearson
4. John Maxwell – The 17 Essential Qualities of a Team Player, HarperCollins Leadership
5. Robin Ryan – 60 Seconds and You're Hired! – Penguin Books

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Renewable Energy		Course Code: 22ECEE301
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Energy Sources:

World energy use, reserves of energy resources, energy cycle of the earth, environmental aspects of energy utilization, renewable energy resources and their importance. Solar Energy: Solar radiation and its measurement – solar constant, solar radiation at earth's surface, solar radiation geometry, solar radiation measurement. Introduction to solar energy. Applications – solar water heating, space heating, space cooling, solar thermal electric conversion. Agriculture and industrial process heating, solar distillation, solar pumping, solar cooking.

07 hours

Chapter 2: Energy from Biomass (Bio Gas):

Introduction. Biomass conversion Technologies. Wet processes. Dry processes. Biogas generation. Factors affecting bio digestion or generation of gas. Classification of biogas plants. Advantages and disadvantages of floating drum plant. Advantages and disadvantages of fixed dome type plant. Types of biogas plants (KVIC model &Janata model). Selection of site for biogas plant.

08 hours

Unit II

Chapter 3: Bio-Energy (Thermal Conversion):

Methods of obtaining energy from biomass. Biodiesel, Thermal gasification of biomass. Classification of biomass gasifiers. Chemistry of gasification process. Applications of the gasifiers.

Wind Energy: Introduction. Basic components of WECS (wind energy conversion system). Classification of WECS. Types of wind machines-horizontal axis machines, vertical axis machines. Applications of wind energy.

07 hours

Chapter 4: Energy from the Oceans:

Introduction. Ocean thermal electric conversion (OTEC). Methods of ocean thermal electric power generation. Open cycle OTEC system. Closed or Anderson OTEC cycle, hybrid cycle. Application of energy from oceans. Basic principles of tidal power. Components of tidal power plants. Operation methods of utilization of tidal energy. Advantages and limitations of tidal power generation. Applications of tidal energy..

08 hours

Unit III

Chapter 5: Energy Economy & Legislations:

Final energy consumption, Energy needs of growing economy, Long term energy scenario, Energy pricing, energy sector reforms, energy security, energy strategy for future.

Energy conservation act, its features and related policies: features of the energy conservation act 2001 and the energy conservation (amendment) act, 2010, schemes under ect-2001, integrated energy policy, NAPCC.

05 hours

Text Books

1. Solar Energy Utilization by G.D. Rai, 4th Edition, Khanna Publications, 2006.
2. Non-Conventional Energy Sources by G.D. Rai, 4th Edition, 2nd Reprint, Khanna Publications, 1997.
3. Engineering Chemistry by P.C. Jain and M. Jain, 10th Edition, 3rd Reprint, Dhanpat Rai & Sons, 1995.

Reference Book

1. Solar Energy by S.P. Sukhatme, 2nd Edition, 3rd Reprint, Tata McGraw Hill, New Delhi, 1998.

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Fermentation & Downstream Processing		Course Code: 22ECEE302
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction to fermentation & Microbial Growth Kinetics:
History and development of fermentation, general requirements of the fermentation, range of fermentation processes, parts of a fermentation process-upstream and down stream processing, aerobic and anaerobic fermentation, solid state and submerged fermentation. Batch culture (Quantifying cell concentration, Growth patterns and Kinetics), Continuous culture, Comparison of batch and continuous cultures in industrial processes, Fed batch culture, Examples of use of fed batch cultures.

08 hours

Chapter 2: Isolation, preservation Pathways and improvement of industrial Microbes:
Isolation, preservation Improvement of industrially important micro organisms, DNA techniques Induction, carbon catabolite repression, crab tree effect, feedback Inhibition and repression.

07 hours

Unit II

Chapter 3: Media, Sterilization inoculum for industrial fermentations:
Introduction, Typical media, Energy sources, Carbon sources, Nitrogen sources, Buffers, Oxygen requirements, Antifoams, Medium optimization, Medium sterilization: The design of batch sterilization processes. The design of continuous sterilization processes, Sterilization of the fermenter, feeds and air, Filter sterilization. The development of inocula for yeast, bacterial and fungal processes, The aseptic inoculation of plant fermenters.

08 hours

Chapter 4: Aeration agitation & Design of fermenter:
The oxygen requirements and supply of industrial fermentations, Determination of K_{La}, Factors affecting K_{La} values, balance between oxygen supply and demand, Basic function of a fermenter for microbial or animal cell culture, body construction, and various parts of a fermenter.

07 hours

Unit III

Chapter 5: Important products through Fermentation:
Organicacids: citric and aceticacid; enzymes: amylase, protease, lipase; antibiotics: penicillin; vitamins: vitB12; amino acids: lysine, Glutamic acid; organic solvents: ethanol, acetone, butanol, alcoholic beverages: wine, beer; biomass: baker's yeast; bio fertilizers; bio pesticides; biosurfactant; steroid transformation; bio polymers.

10 hours

Text Books

1. Biochemical Engineering Fundamentals by James Bailey and David Ollis, 2nd Edition, McGraw-Hill Education, 2016.
2. Bioprocess Engineering: Basic Concepts by Michael L. Shuler and Fikret Kargi, 2nd Edition, Pearson Education India, 2015.
3. Principles of Fermentation Technology by Peter F. Stanbury, Allan Whitaker, and Stephen J. Hall, 3rd Edition, Butterworth-Heinemann, 2016.

Reference Books

1. Biochemical Engineering and Biotechnology by Ghasem Najafpour, 2nd Edition, Elsevier, 2015.
2. Biotechnology: A Textbook of Industrial Microbiology by Wulf Crueger and Anneliese Crueger, 2nd Edition, Sinauer Associates, 1990.

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Industrial Safety and Health		Course Code: 22ECEE304
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction and Scope:

Definition of Occupational Health as per WHO/ILO. Occupational Health and Environmental Safety Management – Principles practices. Common Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.

08 hours

Chapter 2: Monitoring for Safety, and Health:

Occupational Health and Environment Safety Management System, ILO and EPA Standards. Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.

07 hours

Unit II

Chapter 3: Monitoring for Environment:

Chemical Hazard: Introduction to chemical hazards, dangerous properties of chemical, dust, gases, fumes, mist, Vapours, Smoke and aerosols. Route of entry to human system, recognition, evaluation and control of basic hazards, concepts of dose response relationship, bio-chemical action of toxic substances. Concept of threshold, limit values.

08 hours

Chapter 4: Occupational Health and Environmental Safety Education:

Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit Ergonomics-Introduction, Definition, Objectives, Advantages. Ergonomics Hazards. Musculoskeletal Disorders and Cumulative Trauma Disorders. Physiology of respiration, cardiac cycle, muscle contraction, nerve conduction system etc. Assessment of Workload based on Human physiological reactions. Permissible limits of load for manual Lifting and carrying. Criteria or fixation limits.

07 hours

Unit III

Chapter 5: Occupational Safety, Health and Environment Management

Safety of handling of nanomaterials, Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department, Safety committee and function, Role and responsibilities of safety officer

10 hours

Text Books

1. Ray Sinnott, Chemical Engineering Vol. 6: Design (Coulson & Richardson's Chemical Engineering), Pergamon Press, 1996.
2. R.K. Jain and Sunil S. Rao, Industrial Safety, Health and Environment Management Systems, Khanna Publishers, New Delhi, 2006.
3. L. Slote, Handbook of Occupational Safety and Health, John Wiley and Sons, New York, 1987.
4. Jeanne Mager Stellman, Encyclopaedia of Occupational Health and Safety, International Labour Office (ILO), 4th Edition, 1998.

Reference Books

1. Safety and Health for Engineers by Roger L. Brauer, 3rd Edition, Wiley, 2016.
2. Fundamentals of Occupational Safety and Health by Mark A. Friend and James P. Kohn, 6th Edition, Bernan Press, 2018.

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Transport Phenomena		Course Code: 22ECEE305
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction:

Momentum Energy and Mass Transport Newton's law of viscosity (NLV). Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction (FLHC), Fick's law of diffusion (FLD), Effect of temperature and pressure on transport properties of fluids.

07 hours

Chapter 2: Velocity Distribution in Laminar Flow:

Different Flow situations, Steady state Shell momentum balances, Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flow through Annulus.

Steady State Shell Energy Balances:

General Boundary conditions applicable to energy transport problems of chemical engineering. Heat conduction through compound walls. Overall heat transfer coefficient.

08 hours

Unit II

Chapter 3: Temperature Distribution in Solids and in Laminar Flow:

Different situations of heat transfer: Heat conduction with internal generation by electrical and nuclear energy sources, Heat conduction in a cooling fin: Forced and free convection heat transfer.

Concentration Distributions in Laminar Flow:

Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Equimolar counter diffusion. Numerical problems.

08 hours

Chapter 4: Concentration Distributions in Laminar Flow:

Diffusion through stagnant gas and liquid films, Diffusion with homogeneous reaction, Diffusion with heterogeneous reaction Diffusion into falling film – Forced convection mass transfer.

07 hours

Unit III

Chapter 5: Analogies between Momentum, Heat and Mass Transport:

Reynold's, Prandtl's and Chilton & Colburn analogies.

Equations of Change:

Equation of continuity, Equation of motion; Navier – Stokes equation.

10 hours

Text Books

1. Transport Phenomena, Bird, Stewart and Lightfoot, Academic Press, 1994.
2. Momentum Heat and Mass Transport, Welty, Wikes and Watson, 4th edn., John Wiley, 2000.
3. Principles of Unit Operations in Chemical engineering, Foust et al., 2nd edn, John Wiley, 1990.
4. Transport Phenomena - A Unified Approach, Robert S. BrodKey and Henry C. Hershley, Vol.2, Brodkey Publishing, 2003

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Instrumentation Engineering		Course Code: 22ECEE306
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Basics of Instrumentation

Introduction, Instrument symbols & Tag numbering system, Organization of instrumentation dept. Electric Power Systems, Instrument Power Requirements, Instrument. Power Distribution, Control Room Lighting, Communication Systems, Electrical Classifications, Control Panel Types, Flat face Panels, Breakfront Panels, Consoles, Comparison Of Panel Types, Panel Layout, Face Layout, Rear Layout, Auxiliary Racks & Cabinets, Panel Piping & Tubing, - Air Headers, Tubing Runs, Panel Wiring, Nameplates & Tags, Painting, Graphic Displays - Control Room Layout Panel, Human engineering, Panel enclosure standard - Bid Specifications, Panel Inspections, Control center inspection.

07 hours

Chapter 2: Instrument Air System & Control Valves:

Sizing criteria, pressure level, air supply source, Compressor systems, positive displacement compressors, dynamic compressors, non lubricated compressor, compressor cooling, compressor Control Oil removal, general considerations, refrigeration type, necessity for dryers, desiccant type, Design guideline criteria, distribution systems, general layout, Header & branch sizing, materials, take off & valving, control room air supply, case purging for electrical area classification Valve Terminology, Valve Capacity, Valve rangeability, Valve type based on body Design: Globe Bodies, Angle, Needle, Ball, Eccentric Rotating, Plug, Butterfly, Diaphragm, Pinch, Drag Flow Characteristic, Trim Design, Mechanical Feature Actuator, Pneumatic Types, Electric Types, Electro Hydraulic Types Positioner- Pneumatic, Electro Pneumatic, Positioner Features & accessories, Control Valve Accessories. Testing procedure of control valve CV and Rangeability (Valve sizing-initial level), Relief valve, Safety valves and Rupture discs.

08 hours

Unit II

Chapter 3: Signal Converting Elements :

Pneumatic to electrical convertors, Electric to Pneumatic convertors, Voltage to Current convertor, Current to Voltage convertor, Frequency to voltage & Voltage to Frequency convertor.s

08 hours

Chapter 4: Indicator recorders and Actuators:

Indicators: Types of Indicators for various applications, Recorders: Types of recorders and its merits and demerits, Annunciators: Function, sequences displays, types, - Microprocessor for recording, announcing and indicating purpose.

07 hours

Unit III

Chapter 5: Transmitters:

Pneumatic Transmitter- Force balance & Motion Balance, Electronic Transmitter- 2- wire & 4-wire system, Smart Transmitter.

10 hours

ext Books

1. William Andrews, Applied Instrumentation in the Process Industry Vol. I & II, Gulf Publishing Co., 1994.
2. B.G. Liptak, Process Control: Instrument Engineers' Handbook, 3rd dition, Chilton Book Company, 1995.
3. Curtis Johnson, Process Control and Instrumentation Technology, 4th Edition, Prentice-Hall of India, 1997.
4. E.O. Doebelin, Measurement Systems, 4th Edition, McGraw Hill, 1990.

Reference Book

1. Modern Control Engineering by Katsuhiko Ogata, 5th Edition, Prentice Hall, 2010.
2. Principles of Measurement Systems by John P. Bentley, 4th Edition, Pearson Education, 2005.

Back to Semester – VI

Course Title: Chemical Plant Utilities		Course Code: 22ECEE307
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1 Introduction

Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities.

Water: Water resources. Quality Standards for Process water, cooling water, drinking water and boiler feed water. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Water pre-treatment for cooling tower, boilers and chillers.

08 ours

Chapter 2 Air

Compressed air, blower air, fan air. Types of compressors and vacuum pumps and selection. Power requirements, performance, and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system- piping and accessories. Air-water vapour system: humidification/ dehumidification and evaporative cooling-related calculations. Insulation: Insulation Materials & Selection- Economics of insulation. Insulating factors. Properties & Classification.

07 hours

Unit II

Chapter 3 Steam and Power

Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Cogeneration power plants. CHPs and Boiler performance. Related calculations. Economy of steam generation with different fuels. Steam storage and handling-piping and accessories. Boiler performance. Economy of steam generation with different fuels. Steam storage and handling-piping and accessories.

08 hours

Chapter 4 Refrigeration

Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect- related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants. Cold insulation and cryogenic insulation.

07 hours

Unit III

Chapter 5 Energy Safety Devices

Pressure relief valves. Rupture discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices. Process Safety Analysis: HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis. Case study of Risk analysis using ML.

10 hours

Text Books

1. Vasandhani V.P. and Kumar D.S., Heat Engineering, Metropolitan Book Co. Pvt. Ltd., 2009.
2. Crowl D.A. and Louvar J.F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, 2002.
3. Lees F.P., Prevention in Process Industries, Butterworths, 1996.
4. Banerjee S., Industrial Hazards and Plant Safety, Taylor & Francis, 2003.

Reference Book

1. Sanders R.E., Chemical Process Safety: Learning from Case Histories, Oxford, 2005.
2. Perry R.H. and Green D.W., Perry's Chemical Engineer's Handbook, McGraw Hill, 1997.

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Oils and Fats		Course Code: 22ECEE308
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction Classification of fats and oils

Characteristic of oils. Utilization of fat and oils. Composition of oils (general). Obtaining Oils and Fats from Source Materials: Mechanical pretreatment. Mechanical expression. Solvent extraction (two types of extractors).

07 hours

Chapter 2: Process Techniques

Refining and hydrogenation (H_2 production and catalyst). Degumming. Alkali refining and bleaching.

08 hours

Unit II

Chapter 3: Deodorization

Theoretical consideration and operation of commercial deodorizer. Vegetable Oils: Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil.

08 hours

Chapter 4: Vegetable Oils

Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil. Refining processes and uses of palm oil, Soya bean oil, peanut oil, sunflower oil.

07 hours

Unit III

Chapter 5: Marine Oils

Composition, extraction, refining processes, and uses of fish oils. Processing of marine oils by degumming, neutralisation, bleaching, and deodorisation to purify the oil.

10 hours

Text Books

1. Bailey's Industrial Oil and Fat Products Vol. I to V by Y.H. Hui, John Wiley International, 2nd Edition, 1976.
2. Chemistry and Technology of Oil and Fats by Devine J. and Williams P.N., 1961.
3. Shreve's Chemical Process Industries by Austin G.T., 5th Edition, McGraw-Hill International Book Company, Singapore, 1984.
4. Outlines of Chemical Technology by C.E. Dryden, edited by M. Gopala Rao and M. Sittig, 2nd Edition, Affiliated East-West Press, 1993.
5. Hand Book of Industrial Chemistry (Riegel's) edited by J.A. Kent, Van Nostrand Reinhold, 1974.

Reference Books

1. Industrial Organic Chemistry by Klaus Weissermel and Hans-Jürgen Arpe, 4th Edition, Wiley-VCH, 2003.
2. Encyclopedia of Chemical Technology edited by Kirk-Othmer, 5th Edition, Wiley-Interscience, multiple volumes, 2004–2007.

Back to Semester – VI

Program: Bachelor of Engineering		Semester: VI
Course Title: Instrumental Methods of Analysis		Course Code: 22ECEE303
L-T-P: 3-0-0	Credits:3	Credits: 3
Category: PMC&O	ESA Marks:50	Contact Hours: 3
ISA Marks: 50	Examination Duration:3 Hrs	ESA Marks: 50

Unit -I

Chapter 1: Introduction to Instrumental Analysis and Sustainability:

Importance of instrumental analysis in chemical engineering, Classification of instrumental methods (spectroscopic, chromatographic, etc.), Sampling techniques for various analytes (solids, liquids, gases), Data analysis and calibration methods for instrumental measurements, Sustainability considerations in analytical methods (minimizing sample size, solvent.

07 hours

Unit -II

Chapter 2: Spectroscopic Techniques:

Ultraviolet-visible (UV-Vis) spectroscopy and its applications, Atomic absorption spectroscopy (AAS) and emission spectroscopy (AES) for elemental analysis, Infrared (IR) spectroscopy for functional group identification, Mass spectrometry (MS) principles and applications for molecular analysis.

08 hours

Unit -III

Chapter 3: Chromatographic Techniques:

Gas chromatography (GC) principles, separation mechanisms, and applications, High-performance liquid chromatography (HPLC) principles and modes of separation, Introduction to other chromatographic techniques (ion chromatography, gel permeation chromatography), Sustainability considerations in chromatography (column selection, solvent recycling).

07 hours

Unit - IV

Chapter 4: Electroanalytical Techniques and Thermal Analysis:

Potentiometry and its applications in chemical analysis, Voltammetry and its applications for electrochemical characterization, Thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) for thermal behaviour analysis.

08 hours

Unit – 5

Chapter 5: Advanced Analytical Techniques and Case Studies:

Introduction to emerging analytical techniques (X-ray analysis, Raman spectroscopy) Chemometrics and data analysis for complex datasets, Case studies of instrumental analysis applications in chemical engineering processes, Sustainability considerations in process monitoring and control using analytical data.

10 hours

Textbook:

1. Gary D. Christian, Instrumental Methods of Chemical Analysis, 7th Edition, Oxford University Press.

Reference Books:

1. Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch, Fundamentals of Analytical Chemistry, 9th Edition, Brooks/Cole.
2. Howard Mark and James Workman Jr., Modern Instrumental Analysis, 7th Edition, Elsevier.
3. Standard Methods for the Examination of Water and Wastewater, Latest Edition, American Public Health Association (APHA).

Curriculum Content - Course wise (Semester – 7)

Program: Bachelor of Engineering		**Semester: VII**
Course Title: Process Equipment Design and Drawing		**Course Code: 25ECEC401**
L-T-P: 3-1-0	**Credits: 4**	**Contact Hours: 4Hrs/week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 Hrs**	
Note: Drawing/Sketching to be given as assignments and shall not be included in the ESA.		

Unit I

Chapter 1 Introduction

General design procedure, equipment classification, design codes, design pressure, design temperature, design stress, factor of safety, design wall thickness, corrosion allowance, and weld joint efficiency factor. Basic drawing and design considerations of vessel components, vessel enclosure, supports, types of welding, flanges and reinforcement.

10 hours

Unit II

Chapter 2 Shell and Tube Heat Exchanger

Basic design procedure of heat exchangers. Process requirements, including temperature profiles, pressure constraints, and material compatibility. Design a shell-and-tube heat exchanger, including the configuration of shell and tube arrangements, and optimise the heat transfer area and pressure drop.

08 hours

Chapter 3 Condenser

Basic design procedure of heat exchangers. Process requirements, including temperature profiles, pressure constraints, and material compatibility. Condenser design, including the configuration of shell and tube arrangements, and optimisation of heat transfer area and pressure drop, as well as the design of horizontal and vertical condensers.

08 hours

Chapter 4 Evaporator

Calculate the required heat transfer area for effective evaporation. Determine the appropriate number and size of tubes for the evaporator, ensuring optimal vapour-liquid separation and efficient evaporation. Calculation of the size of the vapour drum to handle the vapour load and to maintain process stability. Aspects of mechanical design, including material selection, pressure vessel design, structural integrity, and compliance with industry standards and safety regulations.

08 hours

Chapter 5 Sieve Tray Distillation Column

Design and operation of sieve tray towers, focusing on the principles of vapour-liquid contact and mass transfer in distillation processes. Evaluate and prevent operational issues such as weeping, downcomer flooding, and liquid entrainment. Calculation of total height of the distillation column, taking into account the number of trays, tray spacing, and height of the feed, vapour and liquid flow rates, and the height required for proper vapour-liquid disengagement at the top of the column.

08 hours

Chapter 6 Packed Bed Absorption Column

Selection of appropriate packing materials based on factors like surface area, void space, pressure drop, and material compatibility with the process fluids. Determine the optimal tower diameter, considering both gas and liquid flow rates, as well as the type of packing. Calculate the number of transfer units (NtoG) and the height of transfer units (HtoG) required to achieve the desired mass transfer, and how to use these values to determine the total height of the packing needed for efficient absorption.

08 hours

Text Books

1. Process Equipment Design by M. V. Joshi, 3rd Edition, Reprint, McMillan & Co. India, Delhi, 1998.
2. Process Design of Equipment – Volume 1 by S. D. Dawande, 6th Edition, Central Techno Publications, 2003.
3. Perry's Chemical Engineers' Handbook by R. H. Perry and D. W. Green, 7th Edition, McGraw-Hill, 1998.
4. Process Heat Transfer by Donald Q. Kern, McGraw-Hill, 1997.
5. Chemical Engineering Volume VI: Chemical Engineering Design by J. M. Coulson and J. F. Richardson, Pergamon Press, 1993.
6. Chemical Process Equipment: Selection and Design by James R. Couper, W. Roy Penney, James R. Fair, and Stanley M. Walas, Gulf Professional Publishing (Elsevier).

Reference Books:

1. Specifications for Shell and Tube Heat Exchanger – Code Book IS 4503:1963, Bureau of Indian Standards.
2. Specifications for Pressure Vessels – IS 2825:1969, Bureau of Indian Standards.
3. Process Equipment Design: Vessel Design by L. E. Brownell and E. H. Young, John Wiley & Sons, 1959.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Process control and IIoT		Course Code: 22ECEC402
L-T-P: 3-0-0	Credits: 3	Contact Hours:4 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Instrumentation

Fundamentals: Static and dynamic characteristics. Indicators and recorders. Pressure measurement- Bourdon, diaphragm and bellow type gages. Vacuum measurements. Temperature measurement- Bimetal and resistance thermometers, thermocouples and pyrometers.

8 hours

Chapter 2: First-Order Systems

First-Order Systems: Thermometer, level, mixing tank, STR, Linearization, I-order systems in series. Response for various input forcing functions.

Second Order Systems: Characteristics of the manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for the underdamped case – Terms associated with it. Transportation lag.

8 hours

Unit II

Chapter 3: Closed Loop System

Basic components. Servo and regulator control. Controllers – P, I, D and On–Off modes. Controller Combinations - Final Control Elements: Valves, Actuators, and Valve Positioners. Closed Loop Response: Block diagram, Closed loop transfer function, Transient response of servo and regulator control systems with various controller modes and the characteristics.

8 hours

Chapter 4: Stability

Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams. Control System Design by Frequency Response: Bode criterion. Gain and Phase margins, Ziegler–Nichols controller tuning, Cohen-Coon controller tuning. Root Locus: Rules for plotting and problems.

8 hours

Unit III

Chapter 5: Introduction to Industrial IIoT Systems

The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories. Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology. Case studies and data analysis based on environmental, agriculture, and hydroponics parameters such as humidity, temperature, and the effect of pesticides and fertilisers.

8 hours

Text Books

1. Process System Analysis and Control, Coughner & Koppel, 2nd ed., McGraw-Hill, New Delhi, 1991.
2. Process Modelling, Simulation & Control for Chemical Engineers, Luyben, 2nd edn, McGraw-Hill, 1990.
3. Chemical Engineering, Vol. III, 3rd Edition, Coulson & Richardson, Pergamon Press, 1998.
4. Chemical Process Control-An Introduction to Theory & Practice, George Stephanopoules, Vol 3, Prentice Hall, New Delhi, 1998.
5. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, published by Apress in 2016

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Introduction to Sustainable Technologies		Course Code: 25ECEE401
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours: 40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction to Sustainable Engineering and Life Cycle Assessment (LCA)

Definition and principles of sustainable engineering, The three pillars of sustainability (environmental, economic, and social), Life Cycle Assessment (LCA) methodology and its application in chemical engineering, Environmental impact assessment (EIA) and its role in sustainable process design.

5 hours

Chapter 2: Green Chemistry and Catalysis for Sustainability:

Principles of Green Chemistry and the 12 Principles of Green Engineering, Design of environmentally benign chemical reactions and processes, role of catalysis in sustainable chemical production, Biocatalysis and its applications in the chemical industry.

8 hours

Unit II

Chapter 3: Renewable Resources and Energy Efficiency:

Transitioning to a renewable energy future (solar, wind, biomass), Integration of renewable energy sources in chemical processes, Energy efficiency principles and process optimisation for reduced energy consumption, Carbon capture, utilisation, and storage (CCUS) technologies.

8 hours

Chapter 4: Sustainable Water Management and Wastewater Treatment):

Water scarcity and its implications for the chemical industry, Water conservation strategies in process design and operation, Sustainable wastewater treatment technologies (biological, membrane-based), Water reuse and resource recovery from wastewater (considering water, carbon capture, air pollution control, and soil management).

8 hours

Unit III

Chapter 5: Sustainable Life Cycle Management and Case Studies :

Design for sustainability across the entire product life cycle, Industrial symbiosis and eco-industrial parks for resource exchange, Life cycle costing and techno-economic analysis of sustainable technologies, Case studies of successful implementation of sustainable technologies in the chemical industry, and adoption of sustainable technologies at the campus.

8 hours

Text Books

1. Green Engineering: Environmentally Conscious Design of Chemical Processes by David T. Allen and David R. Shonnard, published by Prentice Hall in 2001.

Reference Books:

2. Sustainable Design for Chemical Processes: A Systematic Approach by Natarajan Gowindan and David P. Rao, published by Academic Press in 2020.
3. Introduction to Sustainable Engineering by R. L. Rag and Lekshmi Dinachandran Remesh, published by PHI Learning in 2015
4. Elements of Sustainable Chemical Process Design by Robert Smith, published by Wiley in 2005
5. Industrial Ecology and Sustainable Engineering by T. E. Graedel and Braden R. Allenby, published by Prentice Hall (Pearson) in 2009 (1st Edition) and updated/copyright 2010.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Food Technology		Course Code: 22ECEE402
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Food Processing and Sustainability:

Importance of food processing in the modern world, Unit operations in food processing (mixing, heat transfer, mass transfer, size reduction), Role of Chemical engineers in food processing design and optimisation, Sustainability considerations in food processing (energy efficiency, water conservation, waste minimisation), Life Cycle Assessment (LCA) applied to food production systems.

8 hours

Chapter 2: Food Chemistry and Engineering Properties:

Chemical composition of major food components (carbohydrates, proteins, lipids, vitamins, minerals), Chemical reactions and interactions affecting food quality and safety, Physical properties of food materials relevant to processing (rheology, thermal properties, mass transfer), Role of water activity in food preservation and stability.

8 hours

Unit II

Chapter 3: Unit Operations in Food Processing :

Application of heat transfer principles in food processing (pasteurisation, sterilisation, drying, freezing), Mass transfer operations in food processing (Filtration, evaporation, concentration, extraction), Design considerations for food processing equipment (heat exchangers, evaporators, filters), Emerging technologies in food processing (microwave, ohmic heating, high-pressure processing).

8 hours

Chapter 4: Food Safety and Quality Control

Sources of foodborne illness and spoilage microorganisms, Food preservation methods and their impact on quality, Chemical hazards in food and their mitigation strategies, Quality control measures in food processing (HACCP, sensory Evaluation).

8 hours

Unit III

Chapter 5: Food Product Design and Innovation:

Formulating food products based on desired functionalities and consumer preferences, role of chemical engineers in developing novel food products, Sustainable food packaging materials and technologies, Food product labelling and regulations, Case studies of innovative and sustainable food processing technologies.

8 hours

Text Books

1. Introduction to Food Engineering by R. Paul Singh, Dennis R. Heldman, and Ferruh Erdogdu, published by Academic Press (Elsevier) in 2024

Reference Books:

2. Food Process Engineering by Ashim K. Datta, CRC Press, 2005, 3rd Edition)
3. Emerging Technologies in Food Processing by Sunil Kumar, Apple Academic Press
4. Food Chemistry by Owen R. Fennema, 4th Edition, CRC Press, 2007

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Advanced Process Control		Course Code: 22ECEE403
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

1. **Chapter 1: Introduction to Advanced Control Schemes:**
   Cascade, Feed-forward, Feed-forward plus Feedback, Ratio control, Inferential control, Dead time and Inverse response compensation, Adaptive control, Model reference adaptive control, Self-tuning regulator, Interactions and Decoupling of Control Loops: Design of cross controllers and selection of loops using Relative Gain Array.

   08 hours

2. **Chapter 2: Distributed Control System (DCS):**
   Evolution and advantages of computer control, Configuration of Supervisory, Direct digital control (DDC) and DCS.

   07 hours

Unit II

3. **Chapter 3: Artificial Intelligence in Process Control:**
   Expert systems, Neural networks, Fuzzy logic, NeuroFuzzy, Genetic algorithm, Virtual instrumentation.

   08 hours

4. **Chapter 4: Programmable Logic Controllers:**
   Comparison with hard-wired relay and semiconductor logic, Hardware, Ladder diagram programming, Case studies, Introduction to CPLD, SPLD, FPGA.

   07 hours

Unit III

5. **Chapter 5: Digital Control:**
   Sampling and reconstruction, Discrete systems analysis, Stability and controller design using z transform and difference equations, Smoothing filter realisation using difference equations.

   10 hours

Text Books

1. Stephanopoulos, G., Chemical Process Control, Prentice Hall of India Private Limited, 1983.

Reference Books

1. Liptak, B. G., Instrument Engineers Handbook, Chilton Book Company, 1994.
2. Deb, S. R., Robotics Technology and Flexible Automation, Tata McGraw-Hill, 1994.
   Johnson, C. D., Process Control Instrumentation Technology, Prentice Hall of India Private Limited, 2007.
3. Zaidi, A., SPC Concepts, Methodologies and Tools, Prentice Hall of India Private Limited, 1995.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Waste Management		Course Code: 22ECEE404
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Waste Management and Sustainability:

Importance of waste management in the chemical process industry, classification of waste (hazardous, non-hazardous, solid, liquid, and gaseous), Environmental regulations and legislation governing waste management, Life Cycle Assessment (LCA) for waste management systems, and Introduction to sustainable waste management principles (waste hierarchy and circular economy).

8 hours

Chapter 2: Waste Minimisation and Resource Recovery:

Source reduction strategies in chemical processes to minimise waste generation, Process design for waste minimisation and pollution prevention, recycling and reuse of waste materials in the chemical industry, and Techno-economic analysis of waste minimisation and recovery options (e-waste and biomedical waste).

8 hours

Unit II

Chapter 3: Treatment and Disposal of Hazardous Waste:

Characterisation of hazardous waste and its potential environmental impacts, Physical, chemical, and biological treatment methods for hazardous waste, landfill and incineration of hazardous waste (with a focus on environmental safeguards), and Technologies for hazardous waste treatment and disposal.

8 hours

Chapter 4: Treatment and Disposal of Non-Hazardous Waste:

Treatment of non-hazardous waste (municipal solid waste, industrial waste), Biological treatment of organic waste (composting, anaerobic digestion), Thermal treatment of non-hazardous waste (waste-to-energy), Landfilling of non-hazardous waste with leachate management strategies.

8 hours

Unit III

Chapter 5: Case Studies and Waste Management Planning:

Analysis of real-world case studies of successful waste management practices in the chemical industry, Waste management planning for a hypothetical chemical process, Sustainability considerations in waste management planning, Public perception, and social aspects of waste management.

8 hours

Text Books

1. The Solid Waste Handbook: A Practical Guide, William D. Robinson, Wiley-Interscience, 1st Edition, 1986.
2. Hazardous Waste Management, Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans, and Environmental Resources Management, 2nd Edition, McGraw-Hill International Edition.

Reference Books:

1. Municipal Solid Waste Management: Strategies and Technologies for Sustainable Solutions, Christian Ludwig, Stefanie Hellweg, Samuel Stucki, Springer Nature, 2012.
2. Sustainable Waste Management Challenges in Developing Countries, Agamuthu Pariatamby, Fauziah Shahul Hamid, Mehran Sanam Bhatti, IGI Global, 2020.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Petroleum and Petrochemicals Engineering		Course Code: 22ECEE405
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Petroleum

Indian Petroleum Industry, Prospects and Future. Offshore and onshore, Origin, composition and classification of petroleum, Evaluation of petroleum by UOP-k factor, TBP analysis, EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions.

8 hours

Chapter 2: Product Properties and Test Methods:

Gas. Various types of gas and LPG. Reid vapour pressure analysis. Gasoline and naptha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterisation for flash point or fire point, volatility, burning qualities, octane testing, and viscosity. Grades of diesels: HSD, LDO. Diesel additives. Lube oils: Types, tests, carbon residue and viscosity index, Sustainability considerations in the petroleum sectors.

7 hours

Unit II

Chapter 3: Crude processing and treatment methods:

Pretreatment of crude for Refining, Dehydration and desalting, Atmospheric distillation, Vacuum distillation of residue products, Types of trays, flow pattern in the trays, Reflux types and their significance. Production and treatment of LPG, sweetening of petroleum products, including merox: ethanolamine, and copper chloride. Treatment of kerosene: De-aromatisation. Treatment of diesel, naptha and lubes: sulphuric acid, clay treatment and solvent treatment.

8 hours

Chapter 4: Theory of Cracking and Processes

Thermal cracking: Theory of thermal cracking, Properties of cracked materials and factors influencing the properties of cracked materials, Vis breaking, Dubs' coil cracking process. Catalytic cracking: Carbonium ion chemistry, Fixed bed crackers, Moving bed crackers. Fluid catalytic cracking: Flexi cracking-ortho-flow reactor. Naptha cracking for ethylene as feed selection and gas yield. Hydro cracking. Theory of hydro cracking. Catalysts for hydrocracking.

7 hours

Unit III

Chapter 5: Introduction to petrochemicals and their derivatives:

Overview of Petrochemical Industry, Feedstock selections for Petrochemicals – Steam cracking of natural gas and naphtha to produce olefins, diolefins and production of acetylene. Synthesis gas, and the Production of Methanol.

5 hours

Chapter 6: Unit Processes in Petrochemical Industries.

Production of major petrochemicals (ethylene, propylene, aromatics) from petroleum fractions, Alkylation, Nitration, Hydrolysis, sulfonation, sulfation, and Isomerisation.

5 hours

Text Books

1. Nelson, "Petroleum Refinery Engineering", McGraw-Hill, 4th Edition, 14th reprint, 1982.
2. Bhaskar Rao, "Modern Petroleum Refining Processes", Oxford and IBH Publishers, 3rd Edition, reprint, 2000.
3. Bhaskara Rao, B. K., "A Text on Petrochemicals", Khanna Publishers, 2012.

Reference Books:

1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers, First Edition, 2000.
2. Sami Matar and Lewis F. Hatch, "Chemistry of Petrochemical Processes", 2nd Edition, Gulf Professional Publishing.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Process Modelling & Simulation		Course Code: 22ECEE406
L-T-P:3-0-0	Credits: 3	Contact Hours: 3 Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Process Modelling and Simulation :

Definition and importance of process modelling in chemical engineering, Types of process models (steady-state, dynamic, lumped, distributed), Introduction to process simulation software (Aspen Plus®, HYSYS), Applications of process simulation in process design, optimisation, and troubleshooting, Sustainability considerations in process modelling (e.g., integrating energy efficiency calculations).

8 hours

Chapter 2: Material and Energy Balances in Modelling:

Applying stoichiometry and conservation principles to develop process models, Degrees of freedom analysis for model solvability, Introduction to thermodynamic property estimation methods for simulations, Case studies: Modelling simple unit operations (mixing, splitting, reactors).

8 hours

Unit II

Chapter 3: Modelling of Unit Operations and Equipment:

Steady-state modelling of common unit operations (distillation, evaporation, heat exchangers), Introduction to reactor modelling (plug flow, stirred tank) and kinetic parameter estimation, Integration of unit operation models to simulate flow sheets, Sustainability considerations in unit operation modelling (e.g., including energy consumption data).

8 hours

Chapter 4: Process Simulation Software and Case Studies :

Hands-on training on using process simulation software for model building and simulation, Case studies: Simulation of complex chemical processes (e.g., ammonia production, petroleum refining), Data analysis and interpretation of simulation results, Sustainability assessments using process simulation tools (e.g., carbon footprint calculations).

8 hours

Unit III

Chapter 5: Process Optimisation and Design Improvement :

Introduction to process optimisation techniques for improving process performance, Integration of process simulation with optimisation algorithms, Case studies: Optimising process parameters for efficiency, yield, and sustainability metrics, Future trends in process modelling and simulation (e.g., Integration with machine learning).

8 hours

Text Books

1. Introduction to Chemical Engineering Computing by Bruce A. Finlayson, published by Wiley-Interscience (2nd Edition, May 12, 2014)

Reference Books:

1. Computer Aided Process Engineering by Rafiqul Gani and John M. Evans.
2. Aspen Plus® User Guide (Latest Version).
3. Process Modelling and Simulation: A Practical Approach to Design Processes by Michael L. Darby, Wiley, 2022.
4. Sustainable Design for Chemical Processes: A Systematic Approach by Himadri B. Baskar, CRC Press, 1st Edition, 2021

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Pollution Control Technologies		Course Code: 22ECEE407
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Pollution Control and Sustainability:

Types of environmental pollution (air, water, soil) and their sources, Environmental regulations and legislation governing pollution control, Introduction to pollution prevention strategies and waste minimisation techniques, Life Cycle Assessment (LCA) for evaluating environmental impact of processes and pollution control systems, The role of chemical engineers in designing sustainable pollution control solutions.

8 hours

Chapter 2: Air Pollution Control Technologies :

Characteristics and control of major air pollutants (particulate matter, SOx, NOx, VOCs), Control technologies for particulate matter (Filtration, cyclones, electrostatic precipitators), Gaseous pollutant control technologies (scrubbing, adsorption, incineration), Emerging air pollution control technologies (biofiltration, plasma technology), Sustainability considerations in air pollution control (energy efficiency, waste minimisation).

8 hours

Unit II

Chapter 3: Wastewater Treatment Technologies :

Characteristics and treatment of industrial wastewater, Physical, chemical, and biological wastewater treatment processes, Design considerations for primary, secondary, and tertiary wastewater treatment systems, Sludge management and disposal options, Sustainability considerations in wastewater treatment (water conservation, resource recovery).

8 hours

Chapter 4: Pollution Control for Other Environmental Media :

Control of soil and groundwater contamination (remediation techniques), Solid waste management strategies (landfills, incineration, recycling), Noise pollution control methods, Sustainability considerations in managing other environmental contaminants.

8 hours

Unit III

Chapter 5: Case Studies and Design Applications :

Analysis of real-world case studies of successful pollution control implementations in the chemical industry. Design project: Students will design a pollution control system for a specific industrial process, considering both technical and sustainability aspects, as well as sustainability considerations in pollution control system design and operation.

8 hours

Text Books

1. Air Pollution Control Engineering (2nd Edition), edited by Lawrence K. Wang, Norman C. Pereira, and Yung Tse Hung, Humana Press, 2nd Edn, published on July 2, 2004.

Reference Books:

1. Wastewater Engineering: Treatment and Reuse (5th Ed.), by Metcalf & Eddy Inc., McGraw-Hill Education.
2. Environmental Management Systems (2nd Edition) by Norman R. Council and Fredric C. Elliott, American Water Works Association (AWWA), 2011.
3. Introduction to Environmental Engineering and Science (3rd Edition) by Gilbert M. Masters and William P. Ela, Prentice Hall, 2007.
4. Green Engineering: Design for Environmental Sustainability (2nd Edition) by David T. Allen and David R. Shonnard, Prentice Hall.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Pulp & Paper Technology		Course Code: 22ECEE408
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Pulp & Paper Industry and Sustainability:

Importance of pulp and paper products in society, Raw materials for pulp and paper production (wood resources, fibres), Overview of the pulping, bleaching, and papermaking processes, Environmental impact of the pulp and paper industry (air and water pollution, resource depletion), Sustainability initiatives and best practices in pulp and paper manufacturing.

8 hours

Chapter 2: Pulping Processes:

Chemical pulping methods (kraft, sulfite pulping) and their principles, Mechanical pulping methods (groundwood, thermomechanical pulping), role of chemical engineers in pulping process design and optimisation, Sustainability considerations in pulping (reduced chemical usage, energy efficiency**).**

8 hours

Unit II

Chapter 3: Bleaching Processes:

Purpose and stages of bleaching (delignification, brightening), Chemical bleaching agents and their mechanisms (chlorine, chlorine dioxide, oxygen), Environmental concerns associated with bleaching processes, Alternative bleaching technologies and sustainable practices (enzymatic bleaching, ozone bleaching).

8 hours

Chapter 4: Papermaking Processes and Paper Properties:

Stock preparation and papermaking unit operations (beating, refining, sheet forming), Paper additives and their functions (fillers, coatings, sizing agents), Paper testing methods for key properties (strength, brightness, opacity), Sustainability considerations in papermaking (recycled fibre utilisation, water conservation).

8 hours

Unit III

Chapter 5: Process Integration and Future Trends:

Integration of pulping, bleaching, and papermaking processes for efficiency, Life Cycle Assessment (LCA) for evaluating the environmental impact of paper products, Emerging technologies in pulp and paper manufacturing (biorefining, nanocellulose), The future of the pulp and paper industry in a sustainable bioeconomy.

8 hours

Text Books

1. Pulp & Paper Chemistry and Technology, 4th Edition by James P. Casey; Wiley-Interscience, 1983 (3rd volume edition of the 4-volume set)

Reference Books:

1. Bleaching of Pulp, 3rd Edition by Carlton W. Dence and Douglas W. Reeve; TAPPI Press, 1996; ISBN 0898520630/9780898520637

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Data Analytics & Applications in Chemical Engineering		Course Code: 22ECEE409
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Data Analytics and Sustainability:

Importance of data analytics in chemical engineering, Types of data relevant to chemical processes (sensor data, historical records, experimental data), Introduction to data science tools and programming languages (Python, R), Sustainability metrics and data-driven approaches for sustainable process design, Case studies: Applications of data analytics in sustainability initiatives (e.g., energy optimisation, waste reduction).

8 hours

Chapter 2: Data Acquisition, Preprocessing, and Exploration:

Data acquisition methods from sensors, experiments, and databases, Data cleaning, handling missing values, and outlier detection, Data visualisation techniques for exploring and understanding process data, Sustainability considerations in data acquisition (e.g., minimising sensor energy consumption).

8 hours

Unit II

Chapter 3: Statistical Analysis and Process Monitoring:

Statistical methods for analysing process data (descriptive statistics, hypothesis testing), Statistical process control (SPC) techniques for monitoring process performance, Fault detection and diagnosis using data analytics, Sustainability considerations in process monitoring (e.g., early detection of inefficiencies for energy savings).

8 hours

Chapter 4: Machine Learning and Process Optimisation:

Introduction to machine learning algorithms (regression, classification), Building and evaluating predictive models for process variables and product properties, Process optimisation using machine learning models, Sustainability considerations in process optimisation (e.g., optimising for reduced emissions).

8 hours

Unit III

Chapter 5: Case Studies and Advanced Applications:

Analysis of real-world case studies on data analytics applications in chemical engineering plants, Introduction to advanced data analytics techniques (e.g., big data analytics, artificial neural networks), The future of data analytics in chemical engineering and its role in sustainability advancements.

8 hours

Text Books

1. Data Science for Chemical Engineering: Applications in Process Optimisation, Product Design, and Materials Discovery (2nd Edition) by Yongjie Lin, et al.

Reference Books:

1. Machine Learning for Chemical Engineers: With Examples Using Scikit-learn (2nd Edition) by F. Joel Ayres, CRC Press, 2023.
2. Chemical Process Design and Integration: From Creativity to Sustainability (2nd Edition) by Robin Smith, John Wiley & Sons, 2016.
3. Elements of Chemical Reaction Engineering (5th Edition) by H. Scott Fogler (originally by Octave Levenspiel), Pearson, 2016.
4. Sustainable Design for Chemical Processes: A Systematic Approach (3rd Edition) by Himadri B. Baskar, CRC Press, 2024

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Unit Operations in Environmental Engineering		Course Code: 22ECEE410
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Unit Operations and Environmental Engineering :

Definition and importance of unit operations in environmental engineering, Overview of water and wastewater treatment processes, Air pollution control principles and unit operations, Sustainability considerations in environmental engineering design (e.g., energy efficiency, resource recovery), Life Cycle Assessment (LCA) for evaluating environmental impact of treatment systems.

8 hours

Chapter 2: Physical Unit Operations :

Fluid mechanics and applications in environmental engineering (pumping, mixing), Particle size distribution and characterisation, Filtration (media filtration, membrane filtration) for water and air treatment, Sedimentation and thickening processes, Sustainability considerations in physical unit operations (e.g., low-energy Filtration).

8 hours

Unit II

Chapter 3: Chemical and Biological Unit Operations :

Chemical equilibria and applications in water and wastewater treatment (e.g., pH adjustment, precipitation), Disinfection methods for water and wastewater treatment, Biological wastewater treatment processes (activated sludge, trickling filters), Introduction to advanced oxidation processes (AOPs) for pollutant removal, Sustainability considerations in chemical and biological processes (e.g., bioenergy production from wastewater).

8 hours

Chapter 4: Gas Transfer and Air Pollution Control :

Mass transfer principles and applications in air pollution control, Gas absorption and stripping for air pollutant removal, adsorption and biofiltration for air pollution control, Particulate matter control technologies (cyclones, electrostatic precipitators), Sustainability considerations in air pollution control (e.g., energy-efficient scrubbers).

8 hours

Unit III

Chapter 5: Case Studies and Design Applications :

Analysis of real-world case studies on successful applications of unit operations in environmental projects. Design project: Students will design a treatment system for a specific water/wastewater or air pollution control challenge, considering technical and sustainability aspects, including Sustainability considerations in unit operation selection and the design process.

8 hours

Text Books

1. Unit Operations of Environmental Engineering (2nd Edition) by William G. Weber Jr.

Reference Books:

1. Environmental Engineering (5th Edn) by Howard S. Peavy, Donald R. Rowe, and George Tchobanoglous; McGraw-Hill, 1987 (ISBN 0-07-049134-8)
2. Water Quality & Treatment: A Handbook of Community Water Supplies (7th Edition) by American Water Works Association (AWWA); AWWA, 2017 (ISBN 978-1625761910)
3. Air Pollution Control Engineering (2nd Edition) by W. C. Sinnott; Humana Press, July 2, 2004
4. Introduction to Environmental Engineering and Science (3rd Edition) by Gilbert M. Masters and William P. Ela; Prentice Hall, 2007

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Polymer Science & Technology		Course Code: 22ECEE411
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to Polymers and Sustainability:

Definition, classification, and structure of polymers, Polymerisation mechanisms (condensation, addition), Relationship between polymer structure and properties (mechanical, thermal, electrical),

Importance of polymers in various applications (plastics, fibres, coatings), sustainability in polymer science (bio-based polymers, biodegradability, recycling), Life Cycle Assessment (LCA) for evaluating the environmental impact of polymers.

4 hours

Chapter 2: Polymer Characterisation Techniques:

Molecular weight determination methods (GPC, light scattering), Thermal characterisation techniques (DSC, TGA), Spectroscopic techniques for polymer analysis (FTIR, NMR), Mechanical testing methods for polymers (tensile testing, rheometry), Introduction to surface and morphological characterisation techniques.

12 hours

Unit II

Chapter 3: Polymer Processing Techniques :

Polymer melt extrusion and its applications (films, fibres), Injection moulding and blow moulding for plastic parts, Solution processing and casting techniques, Polymer blends and composites (reinforcement), Sustainability considerations in polymer processing (energy efficiency, waste minimisation).

8 hours

Chapter 4: Functional Polymers and Emerging Applications :

Conducting polymers and their applications (electronics), Biodegradable polymers and their medical applications, Polymer hydrogels and their use in drug delivery, Polymer membranes for separation processes (Filtration, desalination), Sustainable advancements in functional polymer development.

8 hours

Unit III

Chapter 5: Case Studies and Design Projects :

Analysis of real-world case studies on successful applications of polymers in various industries. Design project: Students will design a polymer-based product for a specific application, considering both technical and sustainability aspects (e.g., biocompatible materials for medical devices, recyclable packaging materials). Life Cycle Analysis of the Designed Polymer Product.

8 hours

Text Books

1. Introduction to Polymers (3rd Edition) by Robert J. Young and Peter A. Lovell, CRC Press, 2011.

Reference Books:

1. Polymer Chemistry (2nd Edition) by Malcolm P. Stevens, Oxford University Press, 1990.
2. Biodegradable Polymers and Composites (2nd Edition) by Michael Vert, Springer, 2002.
3. Polymer Physics (4th Edition) by Michael Rubinstein and Ralph H. Colby, Oxford University Press, 2003.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Machine Learning for Process Optimisation in Chemical Engineering		Course Code: 22ECEE412
L-T-P:3-0-0	Credits: 3	Contact Hours: 3 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction & Foundation:

Introduction to Machine Learning and Process Optimisation, Supervised Learning vs. Unsupervised Learning, Common Machine Learning Algorithms (e.g., Linear Regression, K-Nearest Neighbours, Decision Trees), Data Preprocessing for Chemical Engineering Applications, Model Evaluation Metrics (e.g., R-squared, Mean Squared Error), Introduction to Python Programming for Machine Learning, Introduction to Scikit-learn Library.

4 hours

Chapter 2: Advanced Machine Learning Techniques:

Support Vector Machines (SVM) for Classification and Regression, Ensemble Methods (e.g., Random Forests, Gradient Boosting), Introduction to Deep Learning and Artificial Neural Networks, Feature Engineering for Chemical Process Data, Model Selection and Hyperparameter Tuning, Dimensionality Reduction Techniques (e.g., PCA, t-SNE), Case Studies of Machine Learning Applications in Chemical Engineering.

12 hours

Unit II

Chapter 3: Process Monitoring & Control:

Principal Component Analysis (PCA) for Process Monitoring, Fault Detection and Diagnosis using Machine Learning, Multivariate Statistical Process Control (MSPC), Model-Predictive Control (MPC) with Machine Learning Integration, Reinforcement Learning for Process Optimisation, Introduction to Cloud-based Machine Learning for Chemical Processes. Ethical Considerations in Machine Learning Applications.

8 hours

Chapter 4: Optimisation & Integration:

Introduction to Optimisation Techniques (e.g., Gradient Descent), Integration of Machine Learning with Optimisation Algorithms, Multi-objective Optimisation for Chemical Processes, Uncertainty Quantification and Robust Machine Learning, Machine Learning for Real-time Process Optimisation, Emerging Trends in Machine Learning for Chemical Engineering, Open-source Software Tools for Machine Learning.

8 hours

Unit III

Chapter 5: Project & Case Studies:

Selection and Definition of a Machine Learning Project in Chemical Engineering, Data Collection and Preparation for the Project, Model Development, Training, and Evaluation, Case Studies: Application of Machine Learning for Specific Chemical Processes, Project Presentations and Discussions.

8 hours

Text Books

1. Machine Learning for Chemical Engineers: With Applications in Process Optimisation (2nd Edition) by Edgar Sánchez-Mondejar, Springer, 2021.

Reference Books:

1. Chemical Process Data Reconciliation and Gross Error Detection by Rakel Mackenzie and James Davis, 3rd Edition, Wiley, 2018.
2. Elements of Chemical Process Control by Stephen Seborg, Duncan A. Mellichamp, Thomas F. Edgar, and Daniel L. Lutz, 3rd Edition, Prentice Hall, 2013.
3. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow by Aurélien Géron, 2nd Edition, O'Reilly Media, 2019.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: CIPE & EVS		Course Code: 15EHSA401
L-T-P: Audit	Credits: Audit	Contact Hours: 3 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 32	Examination Duration: 3 Hrs	

Unit – 1

Chapter 1: Features of the Indian Constitution:

Features of the Indian Constitution, Preamble to the Constitution of India, Fundamental rights under Part III – details of Exercise of rights, Limitations & Important cases. Berubari Union and Exchange of Enclaves, Kesavanand Bharati vs. UOI, Maneka Gandhi vs. UOI, Air India Ltd. vs. Nargees Meerza, T.M.A. Pai Foundation v. State of Karnataka, M.C. Mehta vs. UOI.

4 Hrs

Chapter 2: Relevance of Directive Principles of State Policy:

Relevance of Directive Principles of State Policy under Part IV, Fundamental Duties & their significance. SarlaMudgal v. UOI.

3 Hrs

Chapter 3: Union:

Union – President, Vice President, Union Council of Ministers, Prime Minister, Parliament & the Supreme Court of India.

4 Hrs

Chapter 4: State:

State – Governors, State Council of Ministers, Chief Minister, State Legislature and Judiciary.

2 Hrs

Chapter 5: Constitutional Provisions for Scheduled Castes & Tribes

Constitutional Provisions for Scheduled Castes & Tribes, Women & Children & Backward classes,Emergency Provisions.

2 Hrs

Chapter 6: Electoral process

Electoral process, Amendment procedure, 42^{nd}, 44^{th}, and 86th Constitutional amendments.

2 Hrs

Unit – 2

Chapter 7: Scope & Aims of Engineering Ethics

Scope & Aims of Engineering Ethics: Meaning and purpose of Engineering Ethics, Responsibility of Engineers, Impediments to responsibility, Honesty, Integrity and reliability, risks, safety & liability in engineering. Bhopal Gas Tragedy, Titanic case.

5 Hrs

Chapter 8: Intellectual Property Rights

Intellectual Property Rights (IPRs)- Patents, Copyright and Designs.

3 Hrs

Chapter 9: Ethical perspectives of professional bodies

Ethical perspectives of professional bodies- IEEE, ASME, NSPE, ABET, ASCE, etc.

3 Hrs

Unit – 3

Chapter 10: Effects of human activities on the environment

Effects of Human Activities on the Environment: Agriculture, Housing, Industry, Mining, and Transportation, Environmental Impact Assessment, Sustainability, and Sustainable Development.

2Hrs

Chapter 11 Environmental Protection

Environmental Protection – Constitutional Provisions and Environmental Laws in India.

2Hrs

Text Books (List of books as mentioned in the approved syllabus)

1. Dr. J. N. Pandey, "Constitutional Law of India", Central Law Agency, 2005
2. Dr. M.K. Bhandari, "Law relating to Intellectual Property Rights", Central Law Publications,Allahabad, 2010.
3. Charles E. Harris and others, "Engineering Ethics: Concepts and Cases", Thomson Wadsworth, 2003

References

1. Durga Das Basu, "Introduction to the Constitution of India", Prentice-Hall EEE, 2001
2. Mike Martin and Ronald Schinzinger, "Ethics in Engineering", Tata McGraw-Hill Publications.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Senior Design Project		Course Code: 22ECEW401
L-T-P: 0-0-6	Credits: 6	Contact Hours: 6 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

About the Course:

The Senior Design project course employs a user experience design (UX) approach to solve complex engineering problems. In this course, students are challenged to solve complex engineering problems at the frontier of smart manufacturing, green engineering, design engineering, and advanced materials. The objective of the course is to instil lifelong qualities in students, such as research, design thinking, innovation, and entrepreneurial qualities. Upon completing this course, students will be able to convert customer pain points into effective business solutions.

Back to Semester – VII

Program: Bachelor of Engineering		Semester: VII
Course Title: Process Control Lab.		Course Code: 22ECEP401
L-T-P:0-0-1	Credits: 1	Contact Hours: 2 Hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hours: 28	Examination Duration: 3 Hrs	

List of Experiments

1. First-order system
2. Second Order System
3. Flapper Nozzle
4. P/I and I/P converter
5. Simple tank
6. Interacting System
7. Non-Interacting System
8. Level control trainer
9. Temperature/flow control trainer
10. Control Valve characteristics

Text Books:

1. Process System Analysis and Control by Donald R. Coughanowr and Steven E. LeBlanc, 2nd Edition, McGraw-Hill, New Delhi, 1991.
2. Process Modelling, Simulation & Control for Chemical Engineers by William L. Luyben, 2nd Edition, McGraw-Hill, 1990.

Reference Books:

1. Chemical Process Control – An Introduction to Theory and Practice by George Stephanopoulos, Vol. 3, Prentice Hall, New Delhi, 1998.

Curriculum Content - Course wise (Semester – 8)

Program: Bachelor of Engineering		Semester: VIII
Course Title: Internship – Training		Course Code: 22ECEI401
L-T-P: 0-0-6	Credits: 6	Contact Hours: ---
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours:	Examination Duration: 3 Hrs	

Internships are educational and career development opportunities that provide practical experience in a field or discipline. They are structured, short-term, supervised placements often focused on particular tasks or projects with defined timelines.

An internship may be compensated, non-compensated, or partially paid. The internship must be both meaningful and mutually beneficial to the intern and the organisation. The objectives and the activities of the internship program must be clearly defined and understood. The following are the intended objectives of internship training:

- Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence create competent professionals for the industry.
- Provide opportunities to learn, understand, and sharpen the real-time technical/managerial skills required for the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Experience gained from the 'Industrial Internship' will be applied in classroom discussions.
- Create conditions conducive to the pursuit of knowledge and its practical application in the workplace.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Internship - Project		Course Code: 22ECEW403
L-T-P: 0-0-11	Credits: 11	Contact Hours: ---
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
	Examination Duration: 3 Hrs	

An internship is an experiential academic experience in which a student has intentional learninggoals/objectives with measurable outcomes. These learning goals/objectives may include:

- *Academic Learning:* The student may apply and test knowledge learned in the classroom to a professional work environment.
- *Career Development:* The student may explore a specific field of interest, expand their professional network, and gain an understanding of the qualifications and duties involved in a particular profession or career field.
- *Skill Development:* The student gains an understanding of the transferable skills and knowledge required for success in a professional work environment and integrates those skills into theiracademic learning.
- *Personal Development:* The student gains decision-making skills, self-confidence, business acumen, ethics, and teamwork skills required for success in a professional work environment.

An internship is designed as an exchange. The student agrees to complete work that will benefit the host organisation, and in return, is offered the opportunity to learn new skills, expand their knowledge of a particular field, and explore career options. Employers offer internships for many reasons. They view student interns as valuable and cost-effective resources that enable them to accomplish projects that would otherwise be impossible. They believe that interns bring enthusiasm and new ideas into work settings and help develop strong employees. Just as importantly, employers feel an increasing commitment to education and want to help train students to assume responsible roles in society.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Capstone Project		Course Code: 22ECEW402
L-T-P: 0-0-11	Credits: 11	Contact Hours: 22 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
	Examination Duration: 3 Hrs	

An academic capstone project is a comprehensive project that culminates a student's academic and intellectual experience. Most commonly, capstone projects are undertaken during the final year of school or at the conclusion of an academic program.

The purpose of this project is to prepare students for future career challenges. Even the topics students are assigned (or choose for themselves) are designed to help them analyse real-life problems and come up with suitable solutions, thus contributing to their wisdom, knowledge, and problem-solving abilities. In the process of researching a solution to the problem students intend to solve for their capstone project, students will also gain insight into the latest trends in their field.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Fuels, Furnaces and Refractories		Course Code: 22ECEE421
L-T-P:3-0-0	Credits:3	Contact Hours: 3 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks:100
Teaching Hours: 40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Fuels and Types:

Definition of Fuel, Types of Fuel, Conventional and Non-conventional Fuel. Types of Energy Resources: Potential of Energy Resources and Their Exploitation. Types of solid fuels. Origin and formation of coal. Classification of Coal.

08 hours

Chapter 2: Furnaces and types:

Types of furnaces and their classification, industrial applications of furnaces, and design and construction aspects of furnaces. Chimney design, process efficiency.

07 hours

Unit II

Chapter 3: Refractories:

Refractories: refractory material and characterisation, types of Refractories and their application in boilers and furnace construction. Properties and testing methods of Refractories. Manufacture of fire basic bricks, acidic and neutral Refractories, refractory mortars, cements and monoliths, special refractory and ceramics. Role of refectories in energy conservation.

08 hours

Chapter 4: Synthetically Prepared Materials:

Importance of synthetic ceramic raw materials. Methods of powder preparation. General idea of technique of powder preparation: Sol gel, Co-precipitation, solvent vaporisation. Preparation, composition, characterisation and uses of Sinter Al2O3 powders (prepared from different routes), Fused Al_2O_3, Mullite, Mag- Al Spinel, ZrO_2, TiO_2, Ba-titanate, ferrite, fumed silica, silicic acid sol, silica gel. Other synthetic materials: Sea water magnesia, Blast furnace slag, fly ash, red mud, Rice husk ash, electrolytes, etc. Synthetic abrasives: General ideas about their properties and uses**.**

07 hours

Unit III

Chapter 5: Material Characterisation:

Characterisation and specification of ceramic materials, Including Chemical and Phase compositions, Particle size and shape, Density, pore structure, and specific surface area.

05 hours

Particle mechanics and rheology:

Particle packing characteristics – Models of one and two spherical balls. Gap grading, continuous grading. Rheological behaviour of slurries and pastes: Newtonian fluid, plastic flow, dilatant liquid, thixotropic, Deflocculating, Zeta potential, effect of electrolytes on Zeta potentials, applications in ceramic processing.

05 hours

Text Books

1. Fuel, Furnaces and Refractories by J. D. Gilchrist, 2nd Edition, Pergamon Press, 1977.
2. Introduction to the Principles of Ceramic Processing by James S. Reed, Wiley-Blackwell, 1988.
3. Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods by Prof. Yang Leng, 1st Edition, Wiley, 2013.
4. Elements of Fuels, Furnaces and Refractories by O. P. Gupta, Khanna Publishers, 1999.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Nano Materials & Applications		Course Code: 22ECEE422
L-T-P:3-0-0	Credits: 3	Contact Hours: 3 Hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Fundamentals of Nanomaterials :

Introduction to nanoscience and nanotechnology: size dependence, unique properties (electrical, optical, mechanical), classification of nanomaterials (fullerenes, nanotubes, nanoparticles, quantum dots), Characterisation techniques for nanomaterials (XRD, SEM, TEM), Sustainability considerations in nanomaterial design and synthesis.

8 hours

Chapter 2: Synthesis of Nanomaterials :

Top-down and bottom-up approaches for nanomaterial synthesis, Chemical vapour deposition (CVD) techniques, Sol-gel processing for nanoparticle synthesis, Biological and green synthesis methods for nanomaterials, Life cycle assessment (LCA) of nanomaterial synthesis processes.

8 hours

Unit II

Chapter 3: Applications of Nanomaterials in Chemical Engineering :

Catalysis: design of nanocatalysts for efficient and selective reactions, Drug delivery and bioengineering applications of nanomaterials, Energy applications: solar cells, batteries, fuel cells using nanomaterials, Water treatment and pollution remediation using nanomaterials, Sustainable applications of nanomaterials in chemical processes.

8 hours

Chapter 4: Environmental, Health, and Safety (EHS) Considerations :

Potential environmental and health risks associated with nanomaterials, characterisation of nanoparticle toxicity and exposure assessment, Environmental regulations and safe handling practices for nanomaterials, Sustainable life cycle management of nanomaterials.

8 hours

Unit III

Chapter 5: Case Studies and Design Project :

Analysis of real-world case studies of nanomaterial applications in chemical engineering, Student-led design project: design a sustainable process utilising nanomaterials to address a specific engineering challenge, considering synthesis, application, and life cycle impact**.**

8 hours

Text Books

1. Introduction to Nanoscience and Nanotechnology by K. K. Chattopadhyay and Arghya Narayan Banerjee, PHI Learning, 2009.
2. Nanoscience and Nanotechnology: Fundamentals to Frontiers by Shubra Singh and M. S. Ramachandra Rao, Wiley Publishers, 2013.

Reference Books:

1. Feynman Lectures on Physics Vol. 3: Quantum Mechanics by Richard P. Feynman, Robert B. Leighton, and Matthew L. Sands, Addison-Wesley, 1965

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: AI & ML for Chemical Engineers		Course Code: 22ECEE423
L-T-P:3-0-0	Credits: 3	Contact Hours: 3 Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to AI and ML :

Fundamentals of artificial intelligence and machine learning, Types of machine learning (supervised, unsupervised, reinforcement learning), Applications of AI and ML in chemical engineering (process optimisation, control, materials science), Potential impacts of AI/ML in the chemical industry.

8 hours

Chapter 2: Machine Learning Fundamentals and Tools :

Data acquisition and preprocessing for machine learning, Feature engineering and selection techniques, Introduction to machine learning algorithms (linear regression, decision trees, neural networks), Introduction to Python programming and machine learning libraries (Scikit-learn, Tensor Flow).

8 hours

Unit II

Chapter 3: Applications in Process Engineering :

Machine learning for process modelling and prediction, AI-powered process optimisation and control strategies, Machine learning for anomaly detection and fault diagnosis, Case studies of AI/ML applications in specific chemical engineering processes (e.g., reaction engineering, distillation), Integration of AI/ML models into process simulation software.

8 hours

Chapter 4: Sustainability and Ethical Considerations :

Utilising AI/ML for sustainable process design and energy efficiency, Life Cycle Assessment (LCA) with machine learning for environmental impact evaluation, Explainability and bias in machine learning models, Ethical considerations and responsible use of AI/ML in chemical engineering.

8 hours

Unit III

Chapter 5: Project and Case Studies :

Student-led project: apply machine learning techniques to a real-world chemical engineering problem (e.g., process optimisation, data analysis), Analysis of case studies showcasing the successful implementation of AI/ML in sustainable chemical engineering practices.

8 hours

Text Books

1. Chemical Process Engineering with Chemometrics: A Practical Guide by Daniel Marquardt

Reference Books:

1. Machine Learning for Chemical Engineers: With Chemometrics Applications by Jorge Ancheyta and Carlos M. Górecki, CRC Press, 2020 (2nd edition).
2. Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow by Aurélien Géron, O'Reilly Media, 2nd edition, 2019.
3. Introduction to Chemical Engineering Computing by Bruce A. Finlayson, Wiley-Interscience, 2nd Edition, 2014.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Environmental Impact Assessment		Course Code: 22ECEE424
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Introduction to EIA, Indian Regulations and Sustainability :

Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI, Step-by-step procedure for conducting EIA, Limitations of EIA, Prevention of Significant Deterioration (PSD) Programme. Carrying capacity concept and baseline evaluation.

8 hours

Chapter 2: EIA Methodology and Scoping :

Stages of the EIA process (screening, scoping, impact assessment, mitigation, and monitoring). The scoping process involves identifying key environmental issues and stakeholders. Public participation and stakeholder engagement in EIA are also important considerations. Additionally, Data collection and analysis methods for EIA are crucial.

8 hours

Unit II

Chapter 3: Impact Assessment of Chemical Processes :

Identifying potential environmental impacts of chemical processes (air emissions, water pollution, waste generation), Assessment methodologies for air, water, and soil impacts, Risk assessment and mitigation strategies for environmental hazards, Sustainable design considerations for minimising environmental impacts.

8 hours

Chapter 4: EIA Report Preparation and Review :

Content and structure of an EIA report, Effective communication of environmental impacts in EIA reports, Review process and decision-making based on EIA findings, Content and structure of an EIA report as per Indian EIA Notification Guidelines, Effective communication of environmental impacts in EIA reports for Indian audiences, Review process for EIA reports by SEIAA and State Pollution Control Boards, Case studies of EIA approvals and rejections in Indian chemical industries.

8 hours

Unit III

Chapter 5: Case Studies and Project :

Analysis of real-world case studies of EIAs for chemical engineering projects, Student-led project: conduct a simplified EIA for a hypothetical chemical process, considering impact assessment, mitigation strategies, and sustainability aspects.

8 hours

Text Books

1. Environmental Impact Assessment for Dummies by John Glasson, Julian Godfrey, and Karen Chadwick; Routledge, 2019.

Reference Books:

1. Industrial Ecology: Parasites or Symbionts? by T. E. Graedel and B. R. Allenby, Prentice Hall, 2003 (Reprint of 1995 edition).

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Corrosion Engineering		Course Code: 22ECEE425
L-T-P:3-0-0	Credits: 3	Contact Hours: 3Hrs / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hours: 40	Examination Duration: 3 Hrs	

Unit I

Chapter 1: Fundamentals of Corrosion :

Introduction to corrosion and its types (electrochemical, galvanic, stress corrosion cracking), Thermodynamics and kinetics of corrosion processes, Factors influencing corrosion rates (material properties, environment, temperature), Sustainability considerations of corrosion and its economic impact.

8 hours

Chapter 2: Corrosion Mechanisms and Material Selection :

Understanding different corrosion mechanisms (uniform, pitting, crevice), Corrosion behaviour of various engineering materials (metals, polymers, ceramics), selection of corrosion-resistant materials for specific chemical environments, Life cycle assessment (LCA) of materials and their corrosion resistance.

8 hours

Unit II

Chapter 3: Corrosion Control Strategies :

Cathodic and anodic protection for corrosion mitigation, Protective coatings and linings for equipment, Corrosion inhibitors and their selection, Design considerations for minimising corrosion risks (e.g., avoiding stagnant areas, minimising stress), Sustainable corrosion control methods (e.g., bio-based inhibitors).

8 hours

Chapter 4: Corrosion Monitoring and Inspection:

Techniques for corrosion monitoring (visual inspection, electrochemical methods), Non-destructive testing (NDT) methods for corrosion detection, Failure analysis of corroded components, Life prediction and maintenance strategies for corroding equipment.

8 hours

Unit III

Chapter 5: Case Studies and Design Project :

Case studies of corrosion failures in the chemical process industry, Student-led design project: propose a solution for a corrosion problem in a specific chemical process, considering material selection, corrosion control strategies, and sustainability aspects.

8 hours

Text Books

1. Uhlig's Corrosion Handbook, 3rd Edition, edited by R. Winston Revie, published by Wiley, 2011

Reference Books:

1. Corrosion Engineering: Principles, Forms and Protection by N. Ranganathan, Ane Books Pvt Ltd, 2023.
2. Materials Science and Engineering: An Introduction by William D. Callister Jr. and David G. Rethwisch, John Wiley & Sons, 10th Edition (2014).
3. Handbook of Corrosion Engineering, edited by Pierre Roberge, McGraw-Hill (2000).
4. Metals Handbook, Volume 13: Corrosion, edited by ASM International, 9th Edition (1987)
5. Green Corrosion Inhibitors: Principles and Practices, edited by Xiangxiang Liu et al. (Springer, 2022).

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Green Technology		Course Code: 22ECEO401
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction to Green Technologies:

Definition and principles of green chemistry and engineering, sustainability and the twelve principles of green chemistry, Environmental impact assessment (EIA), Life cycle assessment (LCA), Green metrics (atom economy, E-factor).

07 hours

Chapter 2: Green Chemical Processes:

Design for prevention: waste minimisation and pollution control, Green reaction design: alternative solvents, catalysts, and reaction conditions, Biocatalysis and enzymatic processes, Supercritical fluids and microwave-assisted reactions, Solvent-free reactions and green separations.

08 hours

Unit II

Chapter 3: Sustainable Energy Technologies:

Renewable energy sources: solar, wind, biomass, geothermal, tidal, ocean and hydropower. Energy storage technologies: batteries, fuel cells, and hydrogen storage. Biofuels and their production. Energy efficiency in chemical processes. Carbon capture and sequestration (CCS).

07 hours

Chapter 4: Green Material Science and Engineering:

Design for sustainability: life cycle analysis of materials, Biodegradable and compostable materials, Green polymers and composites, Nanotechnology for Environmental Remediation, Life cycle assessment (LCA) of materials.

08 hours

Unit III

Chapter 5: Green Engineering Practices:

Cleaner production methodologies, Industrial waste minimisation and treatment, Green supply chain management, Life cycle design and eco-design, Environmental regulations and green certification programs.

10 hours

Text Books

1. Solar Energy Utilisation, G.D. Rai, 4th Edn., Khanna Publications, 2006.

Reference Books:

1. Introduction to Green Chemistry, 3rd Edition by John Andraos and Albert Matlack, CRC Press (Taylor & Francis), 2014.
2. Green Chemistry: Theory and Practice by Paul T. Anastas and John C. Warner, Oxford University Press, 1998.
3. Sustainable Design: The Science of Sustainability and Green Engineering by Daniel A. Vallero and Chris Brasier, John Wiley & Sons, Inc., 2008.
4. Industrial Green Chemistry: Atom Economy and the Design of Chemical Syntheses by Robert M. Anastas and John C. Warner, Oxford University Press, 1998.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Process Air Pollution & Control		Course Code: 22ECEO402
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction:
Definition of Air Pollution, sources, characterisation and classification of atmospheric pollutants, air pollution episodes. Effects of air pollutants on human health, vegetation, animals, materials and monuments. Composition and structure of the atmosphere, Visibility and other related atmospheric characteristics.

07 Hours

Chapter 2: Meteorology
Wind circulation, solar radiation, lapse rates, atmospheric stability conditions, Maximum Mixing Depth, Temperature Inversions, plume behaviour, wind rose diagram, general characteristics of stack emissions, heat island effect.

08 hours

Unit II

Chapter 3: Monitoring of particulate matter
Respirable, non-respirable and nano-particulate matter. Monitoring of gaseous pollutants – CO, CO_2, Hydrocarbons, SO_X and NO_X, photochemical oxidants. Monitoring equipment and sampling devices include stack sampling (Isokinetic sampling), air samplers, and a gas exhaust analyser. Air Pollution Index.

08 hours

Chapter 4: Pollutant dispersion models
Point, line and areal sources models. Box model, Gaussian plume dispersion model – for point source (with and without reflection), Gaussian dispersion coefficient, Determination of ground level concentrations. Infinite line source Gaussian model. Plume rise and effective stack height calculations.

07 hours

Unit III

Chapter 5: Air Pollution Control Equipment:
Mechanisms, Control equipment for particulate matter – gravity settling chambers, centrifugal collectors, wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP) - Control Equipment for gaseous pollutants – adsorption, absorption, condensation and combustion.

10 hours

Text Books

1. Air Pollution Control Technology Handbook by Karl B. Schnelle Jr. and Paul O. Warner, CRC Press, 2002.
2. Environmental Pollution Control Engineering by C. S. Rao, New Age International Publishers, 2nd Edition, 2006.
3. Pollution Prevention for Chemical Processes by Ryan P. Messinger and Eric D. Brill, Wiley, 1994.
4. Introduction to Environmental Engineering and Science by Gilbert M. Masters and Wendell P. Ela, Prentice Hall, 3rd Edition, 2007.

Reference Books

1. Anjaneyulu Yerramilli, Air Pollution: Prevention and Control Technologies, BS Publications/BSP Books, 2018.
2. C. S. Rao, Environmental Pollution Control Engineering, New Age International Publishers, 2nd Edition, 2006.
3. M. N. Rao and H. V. N. Rao, Air Pollution, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1999.
4. Wark, K., Warner, C. F., and Davis, W. T., Air Pollution: Its Origin and Control, Addison Wesley Longman Inc., Menlo Park, 3rd edition, 1998.Crawford, M., Air Pollution Control Theory, TATA McGraw-Hill, 1980.
5. Howard S. Peavy, Donald R. Rowe and George Technobanoglous. Environmental Engineering, McGraw-Hill International Publications, 1985.
6. Stern, A. C., Air Pollution: The Effects of Air Pollution, Academic Press, 3rd edition, 1977.

Program: Bachelor of Engineering		Semester: VIII
Course Title: Environmental Protection and Management		Course Code: 22ECEO403
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction to Environmental Protection and Sustainability:

Environmental challenges and their impact on society (climate change, air and water pollution, resource depletion), Principles of sustainability: environmental, economic, and social dimensions, Role of chemical engineers in environmental protection.

08 hours

Chapter 2: Environmental Regulations and Management Systems:

Major environmental regulations (e.g., the Clean Air Act, the Clean Water Act), Environmental impact assessment (EIA) and permitting processes, Environmental management systems (EMS) based on ISO 14001 standards, the Pollution prevention (P2) hierarchy, and waste minimisation strategies.

07 hours

Unit II

Chapter 3: Sustainable Process Design and Engineering:

Design for inherent safety principles for minimising environmental impact, Green chemistry principles for reducing pollution in chemical processes, Cleaner production techniques and process optimisation for sustainability, Energy efficiency in chemical processes, Carbon capture, utilisation, and storage (CCUS) technologies.

08 hours

Chapter 4: Environmental Treatment Technologies:

Wastewater treatment: biological, physical, and chemical methods. Air pollution control technologies. Solid waste management: recycling, composting, landfills, and waste-to-energy technologies. Remediation of contaminated sites (soil and groundwater). Emerging technologies for environmental protection.

07 hours

Unit III

Chapter 5: Case Studies and Sustainability Project:

Analysis of real-world case studies of environmental challenges in the chemical industry, Student-led project: design a sustainable solution for an environmental problem, considering technical feasibility, economic viability, and environmental impact.

10 hours

Text Books

1. Environmental Management in the Chemical Industry (edited by the Institution of Chemical Engineers, IChemE/Wiley)

Reference Books:

1. Introduction to Environmental Engineering and Science by Gilbert M. Masters and Wendell P. Ela, Prentice Hall, 3rd Edition, 2007.
2. Sustainability in the Process Industries: Strategies for Energy Efficiency, Pollution Reduction, and Resource Conservation by Frank P. Robinson, Elsevier, 2008.
3. Industrial Ecology: Parasites or Symbionts? by T. E. Graedel and B. R. Allenby, Prentice Hall, 2003 (original 1995).
4. Environmental Life Cycle Assessment by Olivier Jolliet et al., CRC Press, 1st edition, 2016
5. Green Engineering: A Practical Approach to Reducing Pollution by David T. Allen and David R. Shonnard, Prentice Hall, 2003.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Solid Waste Management		Course Code: 22ECEO404
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

1. **Chapter 1: Introduction:**
   Sources and engineering classification, characterisation, generation, and quantification; Objectives, principles, and functional elements of a solid waste management system – Regulatory aspects of solid waste management, major problems. Environmental implications of open dumping, Construction debris management and handling, e-waste management, Rag pickers, and their role.

   08 hours

2. **Chapter 2: Waste Generation:**
   Rate of generation, frequency, storage, and refuse collection; physical and chemical composition; quantity of waste; engineering properties of waste; prediction and modelling concepts. Collection services, Segregation, and Transport: handling and segregation of waste at the source, collection (primary & secondary) and storage of municipal solid waste, collection equipment, transfer stations, collection route optimisation, and economics, regional concepts.

   07 hours

Unit II

3. **Chapter 3: Waste Minimization:**
   4R: reduce, recover, recycle and reuse, case study, guidelines.

   05 hours

4. **Chapter 4: Processing Techniques:**
   Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting, vermicomposting, and Digestion. Incineration of solid wastes.

   10 hours

Unit III

5. **Chapter 5: Disposal Methods**:
   Factors affecting disposal methods, open dumping and ocean dumping.
   Sanitary land filling - Site investigation and selection, Types, geotechnical considerations, design criteria, and design. Liners include earthen, geosynthetic, and geotextile materials.
6. **Chapter 6: Operational Aspects of MSW Landfills**
   Daily cover, leachate disposal, Groundwater monitoring, leachate and gas collection systems – Design, leachate treatment. Landfill Final Cap Design and Water Balance, Modelling (HELP – Hydraulic Evaluation of Landfill Performance), post-closure environmental monitoring; landfill remediation.

   10 hours

Text Books

1. Integrated Solid Waste Management: Engineering Principles and Management Issues by George Tchobanoglous, Hilary Theisen, and Samuel A. Vigil, McGraw-Hill, 2nd illustrated edition, January 1993

Reference Books:

1. Biological Waste Treatment by Metcalf & Eddy Inc., *Wastewater Engineering: Treatment and Reuse* by Metcalf & Eddy, Inc., 5th edition, McGraw-Hill, 2002
2. Waste Management for the Chemical Industry by William E. Franklin
3. Introduction to Materials for Environmental Engineering by Albuquerque et al.
4. Handbook of Thermal Desorption by Theodore Vermeulen et al.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Occupational Safety and Health Administration		Course Code: 22ECEO405
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Introduction to OSHA:

Introduction – concept and scope of occupational safety and environmental health, basic requirements for a healthy environment and environmental quality, human exposure and impact of environmental factors on health.

Occupational Safety and Health Administration - Laws governing OSHA and Right to Know, National Safety Law, types of diseases and their spread, Health Emergencies.

08 hours

Chapter 2: Environmental Regulations and Management Systems:

Ergonomics at the workplace - Preventing ergonomic hazards, Ergonomic task analysis, Ergonomic standards, and Ergonomic programs.

Occupational hazard and control – Hazard analysis, Human error and fault tree analysis, Emergency response, Principles of Safety.

07 hours

Unit II

Chapter 3: Fire prevention and protection:

Fire prevention and protection – fire triangle, fire development and its severity, effect of enclosures, early detection of fire, classification of fire and fire extinguishers. Electrical safety, Product safety, safe handling of chemicals, and safety procedures for nuclear installations.

08 hours

Chapter 4: Accident causation and investigation– causation, investigation, methods of acquiring accident facts, supervisory role in accident investigation.

07 hours

Unit III

Chapter 5: Personal Protective Equipment:

Types of Personal Protective Equipment and their advantages, effects of exposure and treatment in engineering industries, and municipal solid waste. Environment management plans (EMP) for safety and sustainability.

05 hours

Chapter 6: Occupational health and safety considerations:

Water and wastewater treatment plants, handling of chemicals, and safety measures in water and wastewater treatment plants and laboratories, as well as Construction material manufacturing industries such as cement plants, RMC plants, precast plants, and construction sites. Policies, roles and responsibilities of workers, managers and supervisors Performance), post-closure environmental monitoring, landfill remediation.

05 hours

Reference Books:

1. Goetsch D.L., Occupational Safety and Health for Technologists, Engineers and Managers, Prentice Hall, 1999.
2. Colling D.A., Industrial Safety Management and Technology, Prentice Hall, New Delhi, 1990.
3. Della D.E. and Giustina, Safety and Environmental Management, Van Nostrand Reinhold International Thomson Publishing Inc., 1996.
4. Trevethick R.A., Environmental and Industrial Health Hazards, William Heinemann Medical Books Ltd., London, 1973.
5. Biomedical Waste (Handling and Management) Rules, Ministry of Environment, Forest and Climate Change, Government of India, 2016.

Back to Semester – VIII

Program: Bachelor of Engineering		Semester: VIII
Course Title: Nano Science and Technology		Course Code: 22ECEO406
L-T-P:3-0-0	Credits:3	Contact Hours:3Hrs/week
ISA Marks:50	ESA Marks:50	Total Marks:100
Teaching Hours:40	Examination Duration:3 Hrs	

Unit I

Chapter 1: Basics of Nanoscience:

Definition and historical background, nanoscience vs. nanotechnology, Nanoscale materials and their unique properties, Applications in various engineering disciplines: civil, mechanical, electrical, electronics, computer science, artificial intelligence, and biomedical engineering.

08 hours

Chapter 2: Synthesis and Characterisation of Nanomaterials:

Top-down and bottom-up approaches, Physical, chemical, and biological methods, Characterisation techniques: SEM, TEM, AFM, XRD, and spectroscopy.

07 hours

Unit II

Chapter 3: Types of Nanomaterials:

Carbon-based nanomaterials: Classification, metal and organic, vesicle, Properties and classification.

08 hours

Chapter 4: Nanotechnology in Engineering Fields

Civil Engineering: Nanomaterials in concrete, coatings, and structural health monitoring; Mechanical Engineering: Nanotribology, nanofluids, and nanoscale mechanical systems; Electrical and Electronics Engineering: Nanoelectronics, nanosensors, and flexible electronics; Computer Science and AI: Quantum computing, nanorobotics, and data storage; Biomedical Engineering: Drug delivery, imaging, tissue engineering, and diagnostics.

07 hours

Unit III

Chapter 5: Environmental Impact:

Types of Personal Protective Equipment and their advantages, effects of exposure and treatment in engineering industries, and municipal solid waste. Environment management plans (EMP) for safety and sustainability.

05 hours

Environmental Health and Safety:

Toxicology of nanomaterials, Safety protocols for handling nanomaterials, Regulatory guidelines and ethical considerations, Impact of NM on health.

05 hours

Textbook

1. Introduction to Nano science and Nanotechnology by Gabor L. Hornyak, H. F. Tibbals, Joydeep Dutta, and Anil K. Rao — CRC Press, 1st edition, published December 22, 2008.

Reference Books

1. Nanotechnology: Principles and Practices (3rd Edition) by Sulabha K. Kulkarni, Springer Cham, 4th ed. 2025.
2. Nanomaterials: An Introduction to Synthesis, Properties and Applications (2nd edition) by Dieter Vollath, Wiley)
3. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications by Guozhong Cao and Ying Nanotechnology for Dummies by Richard Booker and Earl Boysen, Wiley Publishing, 2010