B. TECH. SYLLABUS

Department of Chemical Engineering

Faculty of Technology

Dharmsinh Desai University,

Nadiad – 387 001, Gujarat, India.

(2021-2022 onwards)

https://www.ddu.ac.in

TEACHING SCHEME FOR THE COURSE DEGREE

CHEMICAL ENGINEERING

L – Lecture	**T – Tutorial**	**P – Practical**
Th. – Theory	**Ext - External**	**S – Sessional**
TW – Term Work	**Teaching Scheme – hr/week**	**V – Viva**

SEMESTER-I

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
BS102	Mathematics-I	3	1	0	60	40	0	0	100	4.0
BS103	Engineering Mechanics	3	1	0	60	40	0	0	100	4.0
ES111	Thermodynamics-I	4	0	0	60	40	25	25	150	4.0
ES112	Elements of Electrical Engineering	3	0	2	60	40	25	25	150	4.0
ES113	Computer Programming	2	0	3	40	0	25	25	90	3.5
ES114	Workshop Practice-I	0	0	2	0	0	25	25	50	1.0
SM101	Environmental Studies	2	0	0	40	0	0	0	40	0.0
	TOTAL	**17**	**2**	**7**	**320**	**160**	**100**	**100**	**680**	**20.5**

SEMESTER-II

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
BS203	Mathematics-II	3	1	0	60	40	0	0	100	4.0
BS204	Chemistry	3	0	0	60	0	0	0	60	3.0
ES203	Engineering Graphics	3	0	3	60	40	25	25	150	4.5
ES204	Basic Electronics	3	0	2	60	40	25	25	150	4.0
ES205	Mechanics of Solids	3	0	2	60	40	25	25	150	4.0
ES206	Workshop Practice-II	0	0	3	0	0	25	25	50	1.5
	TOTAL	**15**	**1**	**10**	**300**	**160**	**100**	**100**	**660**	**21**

SEMESTER-III

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
BS302	Chemistry-II	3	0	3	60	40	25	25	150	4.5
BS303	Physics	2	0	2	40	0	25	25	90	3.0
CH308	Introduction to Chemical Engineering	2	0	2	40	0	25	25	90	3.0
CH309	General Chemical Technology	3	0	2	60	40	25	25	150	4.0
CH310	Material & Energy Balance Computations	3	1	0	60	40	0	0	100	4.0
HS302	English	2	0	2	40	0	0	50	90	3.0
	TOTAL	**15**	**1**	**11**	**300**	**120**	**150**	**100**	**670**	**21.5**

SEMESTER-IV

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
CH419	Fluid Mechanics	3	0	3	60	40	25	25	150	4.5
CH420	Heat Transfer	3	0	3	60	40	25	25	150	4.5
CH421	Mass Transfer - I	3	1	0	60	40	0	0	100	4.0
CH422	Particles and Fluid Particle Processing	3	0	3	60	40	25	25	150	4.5
CH423	Thermodynamics -II	3	1	0	60	40	0	0	100	4.0
HS403	Effective Technical Communication	3	0	0	40	0	0	0	40	3.0
	TOTAL	**18**	**2**	**9**	**340**	**200**	**75**	**75**	**690**	**24.5**

SEMESTER-V

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
CH508	Chemical Reaction Engineering-I	3	0	3	60	40	25	25	150	4.5
CH509	Mass Transfer-II	3	1	3	60	40	25	25	150	5.5
---	Core Elective-I	3	1	0	60	40	0	0	100	4.0
---	Open Elective-I	3	0	0	60	0	0	0	60	3.0
CH514	Numerical Techniques in Chemical Engineering	3	0	2	60	40	25	25	150	4.0
HS501	Financial and Management Accounting	3	0	0	40	0	0	0	40	3.0
	TOTAL	**18**	**2**	**8**	**340**	**160**	**75**	**75**	**650**	**24**

SEMESTER-VI

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
CH613	Chemical Reaction Engineering-II	3	0	3	60	40	25	25	150	4.5
CH614	Chemical System Modeling	3	1	0	60	40	0	0	100	4.0
CH615	Process Equipment Design and Drawing	3	0	3	60	40	25	25	150	4.5
CH616	Instrumentation and Process Control	3	1	3	60	40	25	25	150	5.5
---	Core Elective-II (1), (2), (3)	3	0	0	60	0	0	0	60	3.0
---	Open Elective-II	3	0	0	60	0	0	0	60	3.0
	TOTAL	**18**	**2**	**9**	**360**	**160**	**75**	**75**	**670**	**24.5**

SEMESTER-VII

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
CH716	Design and Simulation Lab	2	0	4	60	40	25	25	150	4
CH717	Transport Phenomena	3	0	3	60	40	25	25	150	4.5
CH718	Process Technology and Economics	3	1	0	60	40	0	0	100	4.0
CH719	Material Science	3	0	0	40	0	0	0	40	3.0
---	Core Elective-III (1), (2)	3	0	0	40	0	0	0	40	3.0
---	Open Elective-III	3	0	0	40	0	0	0	40	3.0
CH723	Summer Internship						25	25	50	2.0
	TOTAL	**17**	**1**	**7**	**300**	**120**	**75**	**75**	**570**	**21.5**

SEMESTER-VIII

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
---	Universal Human Value-II	2	1	0	40	0	0	0	40	3
---	Core Elective-IV	2	0	2	40	0	25	25	90	3
PROJ	Industrial Internship	0	3	12	0	0	150	100	250	9
PROJ	Working Project	1	0	4	0	0	50	50	100	3
	TOTAL	**5**	**4**	**18**	**80**	**0**	**175**	**225**	**480**	**18**

SEMESTER-I

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
BSC101	Mathematics-I	3	1	0	60	40	0	0	100	4
ESC102	Thermodynamics	3	0	2	60	40	25	25	150	4
ESC103a	Basic Electrical Engineering	3	0	2	60	40	25	25	150	4
ESC105a	Engineering Mechanics	3	1	0	60	40	0	0	100	4
ESC103	Computer Programming	2	0	3	40	0	25	25	90	3.5
ESC106a	Workshop Practice-I	0	0	2	0	0	25	25	50	1
MC-II	Environmental Studies	2	0	0	40	0	0	0	40	0
	TOTAL	**16**	**2**	**9**	**320**	**160**	**100**	**100**	**680**	**20.5**

B. TECH. – SEMESTER-I (CH)
MATHEMATICS-I (BSC101)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE CONTENT

	TOPICS
1.	**Calculus: Integral Calculus** Evolutes and involutes, Applications of definite integrals to evaluate surface areas and volumes of revolutions
2.	**Calculus** Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Indeterminate forms and L'Hospital's rule, Maxima and minima.
3.	**Linear Algebra Matrices, Vectors, Determinants, Linear Systems** Matrices, Vectors: Addition and Scalar Multiplication, Matrix Multiplication, Rank of a matrix, Solutions of Linear Systems: Existence, Uniqueness, Determinants, Cramer's Rule, Inverse of a matrix, Eigenvalues, Eigenvectors, Symmetric, Skew-symmetric, Linear. Independence of vectors, Diagonalization
4.	**Sequence and Series** Convergence of sequence and series, Introduction to tests for convergence; Power series, Series for exponential, Trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.
5.	**Multivariable Calculus (Differentiation)** Partial derivatives, Total derivative; Tangent plane and normal line; Taylor series expansion for function of two variables, Jacobians, Maxima, minima and saddle points; Method of Lagrange multipliers, Introduction to Vector Differential Calculus; Directional derivatives, Gradient, Curl and divergence

B. TEXT / REFERENCE BOOKS

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 40th Edition, 2007
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Ed. Pearson, 2002
3. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006
4. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 2010
7. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010
8. V. Krishnamurthy, V.P. Mainra and J.L. Arora, An introduction to Linear Algebra, Affiliated East–West press, Reprint 2005

B. TECH. – SEMESTER-I (CH)
THERMODYNAMICS-I (ESC102)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	2	5	4	60	40	25	25	150

A. COURSE CONTENT

	TOPICS
1.	**Introduction** Macroscopic versus microscopic view point, thermodynamic systems and control volume, thermodynamic properties, processes and cycles, homogeneous and heterogeneous systems, thermodynamic equilibrium, quasi-static process, pure substance, concept of continuum, temperature and zeroth law of thermodynamics, ideal gas and gas laws
2.	**Energy and Energy Transfer** Forms of energy, energy transfer by heat and work, mechanical forms of work, first law of thermodynamics, energy conversion efficiencies
3.	**Properties of Pure Substances** Pure substance, phases and phase change process, thermodynamic properties, property diagrams, ideal gas equation of state, van der waal equation, virial equation of state
4.	**Energy Analysis of Closed System** *PdV* work in various quasi-static processes, energy balance, specific heats, internal energy, enthalpy and specific heats of solids, liquids and ideal gases
5.	**Energy Analysis of Open System** Conservation of mass, flow work and energy of a flowing fluid, energy analysis of steady and unsteady flow systems.
6.	**Second Law of Thermodynamics** Introduction to second law, thermal energy reservoir, heat engine, refrigerator and heat pump, Clausis and Kelvin-Plank statement, perpetual motion machines, reversible and irreversible processes, Carnot and reversed Carnot cycle, , entropy principle and isentropic process, *TdS* and Maxwell relation
7.	**Seam Boilers** Introduction, classification, mountings and accessories, classification and comparison of boiler draught systems
8.	**Applications of Thermodynamics** Construction and working of pumps, compressors, IC engine- Otto and Diesel engines, vapour compression refrigeration system, vapour absorption refrigeration system

B. TEXT / REFERENCE BOOKS

1. Yunus A. Cengel, Michael A. Boles., “Thermodynamics- An engineering approach”, Tata McGraw Hill publishing co. ltd.
2. Nag P.K., “Engineering Thermodynamics”, Tata McGraw Hill publishing co. ltd
3. Smith J.M., Van Ness H.C., Abbott M.M, “Introduction to chemical engineering thermodynamics”, McGraw Hill publishing co. Ltd
4. Sonntag. R.E., Borgnakke, C. and Van Wylen G.J.,” Fundamental of thermodynamics”, John Wiley and Sons
5. Moran M.J. and Shapiro H.N., “Fundamentals of engineering thermodynamics”, John Wiley and Sons

B. TECH. – SEMESTER-I (CH)
BASIC ELECTRICAL ENGINEERING (ESC103a)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	2	5	4	60	40	25	25	150

A. COURSE CONTENT

	TOPICS
1.	**DC Circuits** Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff current andvoltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first- order RL and RC circuits
2.	**AC Circuits** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.
3.	**Transformers** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto- transformer and three-phase transformer connections
4.	**Electrical Machines** Generation of rotating magnetic fields, Construction and working of a three- phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators
5.	**Electrical Installations** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthling. Elementary calculations for energy consumption, power factor improvement. DC-DC buck and boost converters. Single-phase and three-phase voltage source inverters; sinusoidal modulation
6.	**Semiconductors, Diodes and Applications** Semiconductor Diode - Ideal versus Practical, Resistance Levels, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) in brief

B. TEXT / REFERENCE BOOKS

1. Basic Electrical, Electronics and Computer Engineering, R. Muthu Subramanian, S. Salivahanan, K. A. Muraleedharan, 2ndEdition, Tata McGraw Hill
2. Principles of Electronics, V. K. Mehta & Rohit Mehta, 11th Edition, S. Chand & Company
3. Electrical Technology (Vol: II), B. L. Theraja , A. K. Theraja, 23rdEdition, S. Chand & Company
4. Basic Electrical Engineering, D.P. Kothari, I. J. Nagrath, 3rd Edition, Tata McGraw Hill

B. TECH. – SEMESTER-I (CH)
ENGINEERING MECHANICS (ESC105a)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE CONTENT

	TOPICS
1.	**Statics** Resultant force for 2D and 3D force system, concept of free body diagrams, equilibrium equations for particles and rigid body subjected to 2D and 3D force system, centroid and centre of gravity, moment of inertia.
2.	**Dynamics and Vibrations** Rotational Transformation of scalers and vectors, Newton's Laws for particle motion, Potential Energy function F=-Grad(V), conservative and non-conservative forces, Conservation of momentum, angular momentum, collision, energy equation, free harmonic motion, damped harmonic motion, forced oscillation and resonance, kinematics in a coordinate system rotating and translating in a plane.

B. TEXT / REFERENCE BOOKS

1. Engineering Mechanics, M. K. Harbola, 2nd Edition, Cengage Learning, 2013
2. Mechanics – J P Den Hartog, Dover Publications, 2003
3. Mechanical Vibrations - J P Den Hartog, Dover Publications, 1985
4. Theory of Vibrations with Applications – W. T. Thomson, 5th Edition, Pearson Education, 2008
5. Engineering Mechanics: Statics (V.1), Dynamics (V.2), J. L. Meriam and L. G. Kraige, 5th Edition, Wiley, 2017
6. Engineering Mechanics: Statics & Dynamics, Irving H. Shames, 4th Edition, Pearson Education, 2005
7. Vector Mechanics for Engineers: Statics (V.1), Dynamics (V.2), F. P. Beer and E. R. Johnson, 10th SI edition, McGraw Hill Education, 2017

B. TECH. – SEMESTER-I (CH)
COMPUTER PROGRAMMING (ESC103)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
2	0	3	5	3.5	40	0	25	25	90

A. COURSE CONTENT

	TOPICS
1.	**Introduction** Introduction to components of computer system, Idea of algorithm, Introduction to C, Constants, Variables & Data types in C, Managing input and Output operators
2.	**Operators and expressions** C Operators: Arithmetic, relational, logical, increment & decrement, assignment and conditional, Arithmetic Expressions & Precedence Rule, Type conversion in C, Mathematical
3.	**Decision Making and Branching** Decision making with If & If...else statements, goto statements
4.	**Decision Making and Looping** The while statement, the break statement & the do... while loop, the for loop, Jump within loops - Programs.
5.	**Arrays** Array 1D, 2D, Character Array as String
6.	**User Defined Functions** Categories of Functions (Including using built in library), Call by Value, Parameter passingto function, Recursion.
7.	**Structure** Defining structure, Assigning value to the structure members, Array of structure
8.	**Pointer** Idea of pointer, declaration and Initialization of pointer, passing address as function argument, passing array to function using pointer
9.	**File Handling**

B. TEXT / REFERENCE BOOKS

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
2. Yashvant Kanetkar, Let Us C, 12th Edition, BPB Publication
3. Yashvant Kanetkar, Let Us C, 12th Edition, BPB Publication
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

B. TECH. – SEMESTER-I (CH)
ENVIRONMENTAL STUDIES (MC-II)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
2	0	0	2	0	40	0	0	0	40

A. COURSE CONTENT

TOPICS

1. The Multidisciplinary Nature of Environmental Studies

Definition, scope and importance & Need for public awareness

2. Natural Resources

Renewable and non-renewable resource: Natural resources and associated problems, Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams, and their effects on forests and tribal people ,Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefit and problems, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies, Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies, Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification, Role of an individual in conservation of natural resources. Equitable use of resources of sustainable lifestyles

3. Ecosystems

Concept of an ecosystem, Structure and function of an ecosystem, producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, foodwebs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)

4. Biodiversity and Its Conservation

Introduction definition: Genetic, species and ecosystem diversity, Bio-geographical classification of India, Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, national and local levels, India as a mega diversity nation, Hot-spots of biodiversity, Threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity

5. Environmental Pollution

Definition, Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste management, causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides

6. Social Issues and The Environment

From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people: its problems and concerns. Case studies, Environmental ethics: Issues and possible solutions, Climate change: Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case studies, Wasteland reclamation, Consumerism and waste products, Environment Protection Act: Air (Prevention and Control of Pollution) Act, Water (Prevention &Control of Pollution) Act, Wildlife

	Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness
7.	**Human Population and The Environment** Population growth, variation among nations, population explosion, Family Welfare Program, environment and human health, human rights, Value education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environmental and human health, Case studies
8.	**Field Work** Visit to a local area to document environmental assets (river/ forest/ grassland/ hill/ mountain), Visit to a local polluted site - Urban/Rural/Industrial/Agricultural, Study of common plants, insects, birds, Study of simple ecosystems – pond, river, hill, slopes etc.

B. TEXT / REFERENCE BOOKS

1. Erach Bharucha Textbook of Environmental Studies; Second Edition, Universities Press: Hyderabad, 2013
2. Rajagopalan, R. Environmental Studies; Oxford University Press: India, 2015
3. Varandani, N. S. Basics of Environmental studies; Lambert Academic Publishing: Germany, 2013
4. Rao, C. S. Environmental Pollution Control Engineering; Wiley publishers: New Delhi, 2006
5. Clark, R. S. Marine Pollution; Clanderson Press Oxford: Bath, 2001
6. Cunningham, W.P.; Cooper; Gorhani, T. H. E.; Hepworth, M.T., Environmental Encyclopedia; Jaico Publ. House: Mumbai, 2001
7. De, A. K. Environmental Chemistry; Wiley Eastern: New Delhi, 2006

B. TECH. – SEMESTER-I (CH)
WORKSHOP PRACTICE-I (ESC106a)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
0	0	2	2	1	0	0	25*	25	50

***TW Marks includes Viva based on TW**

A. COURSE CONTENT

	TOPICS
1.	Introduction to Workshop, Basic Workshop types
2.	Safety requirement in workshop, Safety rules
3.	To Understand "5S" Concept for Workplace
4.	Demonstration of Tin smithy Tools and it's exercise
5.	To make job for Tin smithy shop
6.	Demonstration of Plumbing tools, It's accessories.
7.	To make job for Plumbing shop
8.	Introduction to Fabrication shop, Welding Equipment
9.	To make job for Fabrication shop
10.	Introduction of Machine shop
11.	Introduction and Demonstration of Lathe machine
12.	Introduction and Demonstration of Milling and Radial Drilling m/c

B. TEXT / REFERENCE BOOKS

1. Equipment Manuals

BACK

SEMESTER-II

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
BSC104	Mathematics-II	3	1	0	60	40	0	0	100	4
ESC101	Engineering Graphics	3	0	3	60	40	25	25	150	4.5
BSC103	Chemistry	3	0	0	60	0	0	0	60	3
ESC103b	Basic Electronics	3	0	2	60	40	25	25	150	4
BSC105b	Mechanics of Solids	3	0	2	60	40	25	25	150	4
ESC106b	Workshop Practice-II	0	0	3	0	0	25	25	50	1.5
	TOTAL	**15**	**1**	**10**	**300**	**160**	**100**	**100**	**660**	**21**

B. TECH. – SEMESTER-II (CH)

MATHEMATICS-II (BSC104)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE CONTENT

	TOPICS
1.	**First Order Ordinary Differential Equations and Introduction to Higher Order Differential Equations** Exact, linear and Bernoulli's equations, Introduction to second order linear differential equations with variable coefficients, Method of variation of parameters, Cauchy-Euler equation.
2.	**Series Solution of Ordinary Differential Equations By Power Series Method** Introduction, Validity of series solution of the equation, General Method, Forms of series solution.
3.	**Partial Differential Equations** Basic Concepts, Classification and Solutions of partial differential equations: Lagrange's linear equation of first order, Non-linear equations of first order- Charpit's method, Homogenous linear equations with constant coefficient to find the complementary functions and the particular integral, Introduction to non-homogenous linear equations with constant coefficients, Method of separation of variables.
4.	**Multivariable Calculus (Integration)** Multiple Integration: Double integrals (Cartesian), Change of order of integration in double integrals, Change of variables (Cartesian to polar), Introduction to Triple integrals (Cartesian), Vector line integrals, Vector surface integrals, Theorems of Green, Gauss and Stoke's.
5.	**Laplace Transform** Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions, finding inverse Laplace transform by different methods, Convolution theorem, Evaluation of integrals by Laplace transform, Solving ODE by Laplace Transform method

B. TEXT / REFERENCE BOOKS

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 40th Edition, 2007
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Ed. Pearson, 2002
3. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006
4. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009
5. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984
6. E. A. Coddington, An Intro. to Ordinary Differential Equations, Prentice Hall India, 1995
7. J. W. Brown & R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004
8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Pub., 2008

B. TECH. – SEMESTER-II (CH)
ENGINEERING GRAPHICS (ESC101)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE CONTENT

	TOPICS
1.	**Introduction to Engineering Drawing** Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic section curves (Ellipse, Parabola, Hyperbola), Cycloidal Curves (Cycloid, Epicycloid, Hypocycloid), Involutes; Archemedian Spiral
2.	**Solid Geometry** Projection of points, projection of lines and their applications. Projection of regular planes such as square, rectangle, triangle, circle, pentagon, hexagon, rhombus. Projection of right and regular solids inclined to both the planes (prisms, pyramids, cylinder and cone)
3.	**Orthographic Projections** First angle and third angle projection methods, conversion of pictorial views into Orthographic projections with dimensioning, sectional orthographic projection, special sections
4.	**Section of Solids and Development of Solids** Sections and Sectional Views of Right Angular Solids Covering, Prism, Cylinder, Pyramid,Cone
5.	**Envelopment of Surfaces** Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone
6.	**Isometric Projections** Principles of Isometric projection – Isometric Scale, Isometric projection and view, Conversion of orthographic views to isometric projections and views
7.	**Working Environment of CAD Software** Menu bar, Quick access toolbar, Dashboard/Ribbon, Toolbars, drawing space, Navigation bar (View controls: zoom, pan, orbit), Command prompt, Status bar, Drawing Area (Background, Crosshairs, Coordinate System), Shortcut Menu, Properties manager
8.	**Drawing Customization** Setting up the drawing sheet (drawing sheet templates, drawing limits, drawing units etc.), Coordinate system (User coordinate system, Absolute and relative coordinates, Cartesian and Polar coordinates), Modes of drawing (Grid, Snap, Ortho, Osnap, Otrack, Polar tracking, Iso draft, etc.) Formatting (colours, line type, line weight, point style etc.)
9.	**Preparing Computer Aided Drawing** Exploring various commands with exercises of Orthographic drawing views and Isometric drawing views using different drawing tools, modifying tools, dimensioning tools etc.
10.	**Plotting and Exchanging Drawing** Printing/Plotting the drawing (page setup, plot area, plot scale, drawing orientation, plot options etc.), Drawing standard (DXF), Generating PDF drawing documents, file management

B. TEXT / REFERENCE BOOKS

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

3. Shah P. J., (2014) Engineering Graphics, S. Chand Publishing
4. Luzadder W., Duff J., (1992), Fundamentals of Engineering Drawing, Peachpit Press
5. Gill P. S., (2009), Engineering Drawing, S. K. Kataria & Sons
6. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication

B. TECH. – SEMESTER-II (CH)
CHEMISTRY (BSC103)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	3	60	0	0	0	60

A. COURSE CONTENT

	TOPICS
1.	**Atomic and Molecular Structure** Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multi centre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.
2.	**Spectroscopic Techniques and Applications** Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.
3.	Intermolecular Forces and Potential Energy Surfaces Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.
4.	**Use of Free Energy in Chemical Equilibria** Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use offree energy considerations in metallurgy through Ellingham diagrams
5.	**Periodic Properties** Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries
6.	**Stereochemistry** Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.
7.	**Organic Reactions and Synthesis of a Drug Molecule** Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecules.

B. TEXT / REFERENCE BOOKS

1. University chemistry, by B. H. Mahan
2. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan

5. Physical Chemistry, by P. W. Atkins
6. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5thEdition

B. TECH. – SEMESTER-II (CH)
BASIC ELECTRONICS (ESC103)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	2	5	4	60	40	25	25	150

A. COURSE CONTENT

	TOPICS
1.	**Transistor & Characteristics** Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Voltage Divider Bias Configuration
2.	**Field Effect Transistor (FET)** Construction, Characteristics of Junction FET, Depletion and Enhancement type Metal Oxide Semiconductor (MOS) FETs, Introduction to CMOS circuit
3.	**Transistor Amplifiers and Oscillators** Classification, Small Signal Amplifiers – Basic Features, Common Emitter Amplifier, Coupling and Bypass Capacitors, Distortion, AC Equivalent Circuit; Feedback Amplifiers – Principle, Advantages of Negative Feedback, Topologies, Current Series Feedback Amplifiers; Oscillators – Classification, RC Phase Shift
4.	**Operational Amplifiers and Applications** Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, and inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator, wein bridge oscillator.
5.	**Digital Electronics Fundamentals** Difference between analogue and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification, Logic ICs, Implementation of combinational logic - half and full adder/subtractor, multiplexers, de-multiplexers
6.	**Sensors & Signal Conditioning Circuits** Types of sensors – pneumatic, electromagnetic, electronic, smart sensors. Diaphragm, bellows and bourdon tube, Resistive, Capacitive, Inductive, ultrasonic, LVDT, piezoelectric, optoelectronic transducers, thermocouple, RTD and thermistors, Application of sensors for flow, level, temperature and stress measurement, Bridge Circuit, Differential Amplifier, Instrumentation Amplifier
7.	**Transistor & Characteristics** Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Voltage Divider Bias Configuration

B. TEXT / REFERENCE BOOKS

1. Principles of Electronics, 11th Edition By V. K. Mehta & Rohit Mehta Publisher: Chand & Company
2. Electrical & Electronic Measurement & Measuring Instruments, 17th Edition By A.K. Sawhney Publisher: Dhanpat Rai
3. M. M. Mano, "Digital logic and Computer design", Publisher : Pearson Education India

B. TECH. – SEMESTER-II (CH)
MECHANICS OF SOLIDS (ESC105b)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	2	5	4	60	40	25	25	150

A. COURSE CONTENT

	TOPICS
1.	Concept of stress and strain, elasticity, generalized Hooke's law for 3D, concept of isotropy and homogeneity, plane stress and plane strain idealization, axial, volumetric and thermalstresses and strains
2.	Transformation of stress and strain at a point, Principal stresses and strains, Mohr's Circle, strain rossete
3.	Mechanical properties of metals – elasticity, plasticity, strain hardening, hardness, toughness, fatigue, strain energy
4.	Force-strain-deformation analysis for axial load, flexure, shear and torsion

B. TEXT / REFERENCE BOOKS

1. Strength of Materials: Part– I and II, Stephen Timoshenko, 3rd Edition, CBS Publisher, 2002
2. Strength of Materials, Sadhu Singh, 1st Edition, Khanna Book Publishing Company, 2016
3. Advanced Mechanics of Solid, L. S. Srinath, 3rd Edition, McGraw Hill Publication, 2017
4. Engineering Mechanics of Solids, E P Popov, 2nd Edition, Prentice Hall India Learning Pvt. Ltd, 2002

B. TECH. – SEMESTER-II (CH)
WORKSHOP PRACTICE-II (ESC106b)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
0	0	3	3	1.5	0	0	25	25	50

A. COURSE CONTENT

	TOPICS
1.	Introduction to Carpentry Shop, Application of various tools, demonstration & making ofJob 1 & 2, assignment.
2.	Introduction to Black smithy shop, demonstration & making of job
3.	Introduction to Fitting shop, application of various tools, demonstration & making of Job, assignment

B. TEXT / REFERENCE BOOKS

1. Equipment Manuals

BACK

SEMESTER-III

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
PCCXXX	Introduction to Chemical Engineering	2	0	2	40	0	25	25	90	3
BS107	Chemistry-II	3	0	3	60	40	25	25	150	4.5
PCC113	General Chemical Technology	3	0	2	60	40	25	25	150	4
PCC101	Material & Energy Balance Computations	3	1	0	60	40	0	0	100	4
BS102	Physics	2	0	2	40	0	25	25	90	3
HSMC101	English	2	0	2	40	0	0	50	90	3
	TOTAL	**15**	**1**	**11**	**300**	**120**	**150**	**100**	**670**	**21.5**

B. TECH. – SEMESTER-III (CH)
INTRODUCTION TO CHEMICAL ENGINEERING (PCC---)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
2	0	2	4	3	40	0	25	25	90

A. COURSE OVERVIEW

Motivation: Learn the basics and fundamentals of chemical engineering to entry level students
Objective: Objectives of this course is to understand Fundamental concepts of unit operations and unit processes, interpret data as table versus plot, draw and read PBD and PFD diagrams, apply suitable tools relevant to chemical engineering problems and calculations associated to the physio-chemical properties

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction and fundamentals** About the discipline of chemical engineering, concept of unit operations and unit processes, operations in batch, semi-batch and continuous mode, flow pattern as co-current, counter-current and cross-current, concept of fluid solid contacting using fixed, moving and fluid beds.	**CO1**
2.	**Overview of Chemical Process Industries (CPI)** Satisfactory definition of CPI/GCT, important chemical process industries, its typical raw materials, products and end usages.	**CO2**
3.	**Role of Chemical Engineer** Role of chemical engineer in various aspects such as research, process development,process design & evaluation, plant design, construction (EPC firms), process supervision, plant technical service, product sales, general aspects of chemical engineering such as communication, human relations, professional activities & technical reading. Environmental, safety and ethical aspects associated with chemical engineering profession.	**CO2**
4.	**Flowsheet Drawing** Symbols as per Indian Standards 3232, basics of PBD, PFD and P&ID, systematicanalysis of chemical processes by flowsheet reading and drawing.	**CO2** **CO3**
5.	**Useful Mathematical Methods** Presentation of data as table and chart, basics of regression and correlation, linear and polynomial curve fitting using graphical and numerical method, determining goodness of fit (R2 calculation), graphical and numerical methods for interpolation,integration and to find the root of an equation, graphical addition & subtraction of mass (inverse lever arm rule) and calculation of mean values etc.	**CO4**
6.	**Physical and Chemical Principles** Process variables like temperature, pressure, density, viscosity, composition and flow rate. Ideal and real gas calculations and associated laws like Dalton and Amagat. Concept of vapor-liquid equilibria, laws like Raoult's and Henry's, dew and bubble calculations.	**CO5** **CO6**

C. TEXT BOOKS

1. Andersen, L. B.; Wenzel, L. A. *Introduction to chemical engineering*; McGraw Hill Book Company, New York, 1961.

D. REFERENCE BOOKS

1. Ghosal, S. K.; Sanyal S. K.; Datta, S. Introduction to Chemical Engineering; McGraw Hill Education, 1st Ed, 2007
2. Himmelblau, D. M.; Riggs, J. B. Basic Principles and Calculations in Chemical Engineering; PHI Learning PVt Ltd, 7th Ed, 2013

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Conceptual Evaluation Designing Analytical Application Problem solving	Understand the concepts of various unit operation, their modeof operation and applications.
CO2		Define chemical process industries, the roles of chemical engineers and their ethical practices.
CO3		Systematically analyze the process flow diagrams and piping& instrumentation diagrams of industry.
CO4		Estimation of various physico-chemical properties using appropriate mathematical approaches.
CO5		Application of computational tools (excel/c programming) tosolve problems pertaining to process industries.
CO6		Evaluation of problems relevant to ideal and real gases.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	2	3	3	2	3	2.7
PO2	3	2	3	2	2	3	2.5
PO3	2	3	2	3	3	3	2.7
PO4	2	2	3	3	3	2	2.5
PO5	2	2	3	2	3	3	2.5
PO6	2	3	2	3	2	3	2.5
PO7	3	3	2	2	2	3	2.5
PO8	3	3	2	3	2	2	2.5
PO9	2	3	2	2	3	3	2.5
PO10	2	3	3	2	3	2	2.5
PO11	2	3	3	2	3	2	2.5
PO12	3	3	3	2	3	3	2.8
PSO1	2	3	3	3	3	3	2.8
PSO2	2	3	3	3	3	3	2.8
PSO3	3	2	3	3	3	3	28
PSO4	3	2	3	3	3	3	2.8

B. TECH. – SEMESTER-III (CH)
CHEMISTRY-II (BSC107)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE OVERVIEW

The course of Organic chemistry will enable students in the fields of Purification Methods & Detection of elements, Polymers, Dyes and Pigments which all are basics of Chemistry in Academia and as well as in Chemical industries. The course of physical chemistry is introducing the students to the fundamentals of adsorption, colloidal surfactant and catalysis. The course aims to provide basic knowledge of surface and colloid chemistry from a physical-chemical perspective. This course will also Introduces the student to principles and theory of important instrument analysis techniques.

B. COURSE CONTENT

	TOPICS	COs
1.	**Chemistry of Surfaces and Catalysis** Adsorption, Langmuir adsorption isotherm, reactions at surfaces, colloidal surfactants-classification anionic, cationic and non-inorganic surfactants, micelles, structure, applications of colloidal surfactants, Catalysis, Homogeneous Lewis acid base catalysts, organometallic catalysts and industrially examples. Heterogeneous catalysts basic concepts and industrial examples.	**CO2**
2.	**Electrochemistry** Theory, Principle and Application of the Electrolytic Dissociation. Osmotic Properties of Electrolytes, Thermochemical effect & Chemical Equilibrium in Electrolytic solution, Electrolytic Dissociation of Water, Buffer Capacity of Solution. Ionic Activity and Activity co-efficient, Dissociation constant and pH in terms of Activity, Ionic Strength, Ghosh's Theory of electrolytes, Debye Huckel Theory of electrolytes, Debye-Huckel Limiting Law, Theoretical Interpretation of the Electrical conductance of electrolyte, Debye Onsager Theory of Conductance, Wine Effect and Debye Falkenhagen effect.	**CO2**
3.	**Analytical Chemistry** Theory, Instrumentation and applications of pH Metry, Potentiometry, Conductometry, Polarography, Atomic absorption spectroscopy. Basics of Chromatography, Thermal Gravimetric Analysis, Differential Scanning Calorimetry and Calorimetry.	**CO5**
4.	**Purification, Detection & Estimation of Elements of Organic Compounds** Organic Compounds are purified by Purification Methods (Crystallization Sublimation & Different types of Distillation), Detection of elements (C, H, N, S, P & halogens), Estimation of elements (C, H, S, P & halogens), Combustion estimation of Nitrogen by Dumas method & Kjeldahl's method, Combustion estimation of S, P & halogens by Carius method.	**CO4**
5.	**Aromatic Compounds and Heterocyclic Compounds** General nature of Aromatic reaction with their mechanism (Electrophilic Substitution Reactions), Halogenation, Sulphonation, Nitration, Friedel Craft Alkylation, Friedel Craft Acylation, Hydrogenation and reductive alkylation. Preparation, chemical properties and uses of Furan, Furfural, Thiophene, Pyrrole, Pyridine.	**CO1**

6.	**Bio-Molecules** Preparation, Constitution, Chemical reactions and uses of Glucose, Fructose, Sucrose, Starch & Cellulose. Some typical conversions in Monosaccharide and Disaccharides Isolation of proteins, General and physical characteristics of Proteins, Analytical tests of Proteins.	**CO3**
7.	**Polymers** Types of Polymerization reactions, Thermoplastic & Thermosetting plastics Plasticizers, Classification of resins & plastics (polyethylene, polypropylene, polyester and nylon, etc.) Synthetic & natural rubbers –Polychloroprene, Buna-S and Buna-N.	**CO3**
8.	**Colour & Dyes** Constitution & colour of Dyes & Dyeing process, Chromophore –Auxochrome theory & Chromogen, Valence bond theory of colour Classification of dyes: Direct dies, Mordant dyes, Vat dyes, Classification based on chemical structure: - Nitro& Nitroso dyes, Triphenyl dyes	**CO3**

C. TEXT BOOKS

1. Mahan, Bruce H., University Chemistry 4th ed, Pearson Education India: Singapore, 2009
2. Soni, P. L.; Katyal, M., Textbook of Inorganic Chemistry; 20th ed.; Sultan Chand & Sons: New Delhi, 2017
3. Antropov, L., Theoretical Electrochemistry; 2nd ed.; Mir Publishers: Moscow, 1977
4. Skoog, Douglas A, Holler, F. James, and Crouch, Stanley R. Principles of Instrumental Analysis; 7th ed.; Cengage Learning India Pvt. Ltd: India, 2020
5. Bahl, A.; Bahl, B.S.; Tuli, G. D. A Textbook of Organic Chemistry; S.Chand New Delhi, 2012

D. REFERENCE BOOKS

1. Carey, Francis A., Sundberg, Richard A., *Advance Organic Chemistry*; 5th ed.; Charlottesville: Virginia, 2007
2. Morrison R.T.; Boyd R.N.; Bhattacharya S.K. *Organic Chemistry*; 7th ed; Pearson: New York, 2011
3. Finar, I. L. *Stereo Chemistry and the Chemistry of Natural Products (Volume -II)*; 5th ed; Pearson: London, 2002
4. Finar, I. L. *Organic Chemistry (Volume -I)*; 6th ed; Pearson: London, 2002
5. Hiemenz, P. C., and Rajagopalan, R., *Principle of colloid and surface chemistry*, 3rd ed.; CRC Press, 2016
6. M. J. Rosen, *Surfactants and Interfacial Phenomena*, Wiley Publication, 2004

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Evaluate	Examine the various classes of Aromatic and Heterocyclic compounds, as well as their chemical properties and applications.
CO2	Comprehension	Understand the fundamentals of Electrochemistry and Surface Science.
CO3	Application	Developing solutions for problems associated with synthetic organic chemistry, dyes, soaps, detergents, Biomolecules and polymers.
CO4	Synthesis	Students will learn to synthesize the chemical compounds by maneuvering the addition of reagents under optimum reaction conditions.

CO5	Analysis	Learn how to use various chromatographic techniques to separate and identify chemicals. Gain hands on experience of the thermal analysis technique, including its principles and instrumentation.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	AVG.
PO1	2	3	2	1	2	2
PO2	2	1	2	2	1	1.6
PO3	1	3	1	2	1	1.6
PO4	2	1	1	3	2	1.8
PO5	2	3	2	1	1	1.8
PO6	2	2	1	2	1	1.6
PO7	1	2	2	1	2	1.6
PO8	2	1	2	1	1	1.4
PO9	1	2	1	2	1	1.4
PO10	2	1	2	1	2	1.6
PO11	2	1	2	1	1	1.4
PO12	1	2	1	2	2	1.6
PSO1	2	1	3	1	2	1.8
PSO2	1	2	1	2	2	1.6
PSO3	2	1	2	1	2	1.6
PSO4	1	2	2	3	1	1.8

B. TECH. – SEMESTER-III (CH)
GENERAL CHEMICAL TECHNOLOGY (PCC113)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	2	5	4	60	40	25	25	150

A. COURSE OVERVIEW

Motivation: To inculcate the knowledge of various processes and operations of the chemical industries, among the undergraduate students of chemical engineering.

Objective:

- To study chemical manufacturing processes and their applications to specific chemical Industries.
- Main focus is on the raw materials, flow sheet, synthesis and detailed analysis of the processes.
- Enables the readers to integrate the fundamental knowledge of the basic disciplines & all other courses you have read or reading
- To understand the most important chemical processes, and to apply this knowledge and understanding to industrial processes.
- To familiarize the students with characteristics of Crude, its refining to get commercially important fractions and products.
- To help the students in understanding the unit operations and unit processes in manufacture of various petrochemicals and their downstream products like polymers, dyes, synthetic fibers and pharmaceuticals.
- To familiarize with environmental issues and engineering problems involved.

B. COURSE CONTENT

	TOPICS	COs
1.	**Water and Water Treatment** Industrial use of water, demineralization, deionization, RO system, water treatment, concept of water resources management.	**CO1** **CO2**
2.	**Fuels & Energy** Classification of fuels, Water gas, Producer Gas, Coke oven gas., Coal & coal chemicals, coking of coal, Various types of coal gasifiers.	**CO1** **CO3**
3.	**Cement & Glass Manufacturing** Lime stone beneficiation, types of cement, Manufacturing of cement. Types of glass, manufacturing of glass.	**CO1** **CO4**
4.	**Sulphur and Electrolytic Manufacturing of Aluminum & Magnesium** Manufacturing of elemental sulfur by Frasch process. Hydrogen sulfide conversion and from iron pyrites,	**CO1** **CO3** **CO4**
5.	**Pulp & Paper Manufacturing** Kraft process and sulfite process for manufacturing of pulp, chemical recovery system, types of paper, paper manufacturing process.	**CO1** **CO3** **CO4**
6.	**Sugar & Starch Industry** Manufacturing of sugar, starch, and dextrin	**CO1** **CO3** **CO4** **CO5**
7.	**Oils, Fats, Soaps & Detergents** Vegetable oil Extraction method using Mechanical and Solvent extraction process. Hydrogenation of oil, cleaning mechanism of soaps and detergents, manufacturing	**CO1** **CO3** **CO4**

	of soaps and glycerine, manufacturing of detergents	**CO5**
8.	**Overview of Petroleum and Petrochemical Industry Petroleum Refining** Origin, formation and composition of petroleum, Petroleum reservoirs in India and World, Evaluation of petroleum, thermal properties of petroleum fractions, Important products-properties and test methods, Dehydration and desalting of crudes, Distillation of petroleum, Fractions-impurities, Gasoline Treatment, Treatment of Kerosene, Treatment of Lubes, Wax and purification, Thermal and Catalytic cracking, Catalytic reforming, Naphtha cracking, Coking, Hydrogen processes, Alkylation. **Petrochemical Industry:** Overview of petrochemicals from petroleum feedstock.	**CO4** **CO6** **CO4** **CO6**
9.	**Introduction to Polymers and Synthetic Fiber Industries** Manufacture of phenol & urea formaldehyde resins, manufacture of PVC, polyethylene, etc, Manufacture of synthetic fibers (e.g. Industries nylon, polyester, acrylic, rayon etc)	**CO1** **CO3** **CO4** **CO6**
10.	**Fine Chemicals, Drugs, Intermediates and Dyes** Classification of pharmaceuticals, manufacture of important drugs and pharmaceuticals – salicylic acid, methyl salicylate, aspirin, antibiotics, & vitamins.	**CO1** **CO3** **CO4** **CO6**

C. PRACTICAL AND TERM WORK

- To determine Flash and Fire point of given sample using Able's apparatus.
- To determine Flash and Fire point of given sample using Pensky Martin apparatus.
- To determine Aniline point of given oil sample.
- To determine Smoke point of Kerosene sample.
- To determine viscosity of given oil sample.
- To determine Cloud and Pour point of given oil sample.
- To determine Softening Point of given sample.
- To do proximate analysis of coal.
- ASTM distillation Test.
- Carbon Residue Test.
- Synthesis of Soap

From the above list, selected experiments may be performed by students for betterunderstanding of theoretical concept.

D. TEXT BOOKS

1. Dryden's Outlines of Chemical Technology, 2nd Ed. By M. Gopala Rao & Marshall Sitting, East West Press Pvt. Ltd., New Delhi
2. Shreve's Chemical Process Industries, 5th Ed. By, George F. Austin McGraw Hill International Edition
3. George F. Austin, Shreve's Chemical Process Industries, 5th Ed. McGraw Hill International Edition, NY, 1984
4. Bhaskara Rao, B.K., Modern Petroleum Refining Processes, 6th Ed. Oxford & Ibh, NewDelhi, 2017
5. Bhaskara Rao, B.K., A Text On Petro Chemicals, 5th Ed, Khanna Publisher, New Delhi,2010

E. REFERENCE BOOKS

1. Chemical Process Industries, 4th Ed. by R. Norris Shreve & J. A. Brink, Jr. International Student's Edition
2. Pollution Control in Chemical Process Industries, 1st Ed. By S. P. Mahajan Tata McGraw Hill Publications, New Delhi

F. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Develop Explain Analyse Application Awareness and sustainability	Understand the fundamentals of general chemical process technologies and the importance of these technologies
CO2		Develop an ability to identify and quantify, various process conditions associated with chemical processes and operations.
CO3		Explaining the production processes of various chemical products.
CO4		Analyse the major engineering problems associated with production units of various chemical industries.
CO5		Application of the process drawing tools for process flow diagrams.
CO6		Create awareness among students for the research and innovation in the field of chemical process industries for environmental issues and sustainability.

G. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	2	3	3	3	3	2.8
PO2	3	2	3	3	3	3	2.8
PO3	2	2	3	3	3	3	2.7
PO4	3	2	2	3	2	3	2.5
PO5	3	3	3	2	2	2	2.5
PO6	3	3	3	3	2	3	2.8
PO7	3	2	3	3	2	3	2.7
PO8	3	2	3	3	2	3	2.7
PO9	3	3	3	3	2	2	2.7
PO10	3	2	3	3	3	2	2.7
PO11	3	2	2	3	3	3	2.7
PO12	3	3	3	3	2	2	2.7
PSO1	2	3	3	3	2	2	2.5
PSO2	2	3	3	3	2	2	2.5
PSO3	2	3	3	3	2	2	2.5
PSO4	2	3	3	3	2	2	2.5

B. TECH. – SEMESTER-III (CH)
MATERIAL AND ENERGY BALANCES (PCC101)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE OVERVIEW

The basics of units, dimensions, dimensional analysis, and engineering calculations related to unit operations and unit processes. Analysis of chemical processes in steady-state and unsteady-state domain along with mass and energy balance involving scenario of recycle bypass and purge.

B. COURSE CONTENT

	TOPICS	COs
1.	**Units, Dimensions and Dimensional Analysis** System of units, fundamental & derived units, dimensional consistency, dimensional equations & empirical equations, different ways of expressing units of quantities and physical constants. Conversion of empirical formula from one-unit system to another. Dimensional analysis using Rayleigh and Buckingham method.	**CO1** **CO2**
2.	**Basic Chemical Calculations** Composition of gaseous mixtures, liquid mixtures and solutions. Determination of hardness, elements present in compound, acidity-alkalinity and concentration based numerical. Behavior of real gas and determination of Van-der- Waals constants, and saturation pressure based numerical.	**CO1** **CO2**
3.	**Material Balance without Chemical Reaction** Schematic representation of process, selection of key component and degree of freedom analysis. Material balance over unit operations like distillation, mixing unit, evaporator, absorber, stripper, extractors, crystallizers, dryer, humidifier and dehumidifier. Complex mass balance involving recycle, bypass and purge stream. In addition, mass balance in unsteady state domain over simple unit operation.	**CO3** **CO4** **CO5**
4.	**Material Balance with Chemical Reaction** Concept of limiting & excess reactants, conversion, yield and selectivity, material balance involving reactions with special reference to fertilizers, chlor-alkali, petrochemicals, pharma and dyestuff industry.	**CO3** **CO4** **CO5**
5.	**Energy Balance** Heat capacity of gas and gaseous mixtures, heat capacity of liquids and solids, sensible heat change in liquids and gases, enthalpy changes during phase change transformation, enthalpy changes accompanied by chemical reactions, thermo chemistry of mixing process, dissolution of liquids and solids, energy balance at plant elevated conditions and adiabatic temperature rise calculations.	**CO3** **CO4** **CO5**
6.	**Mass and Energy Balance over Flowsheet** Mass and energy balance over connected equipment and complete mass and energy balance over at least one process flow sheet from Dryden. Ethics and decision making while performing mass and energy balance over flowsheet.	**CO6**
7.	**Fuels & Combustion** Types of fuels, proximate and ultimate analysis of fuel, calorific value of fuels as gross and net, problems on combustion of coal, liquid fuels, gaseous fuels, sulphur and sulphur pyrites.	**CO1** **CO2**

C. TEXT BOOKS

1. Bhatt, B. I., Thakore, S. B.; *Stoichiometry*; 5th Ed.; Tata McGraw Hill Education Pvt. Ltd.,2010.

D. REFERENCE BOOKS

1. Himmelblau, D. M., Riggs, J. B.; Basic Principles & Calculations in Chemical Engineering; 7th Ed.; Prentice Hall India Learning Pvt. Ltd., 2013
2. Felder, R.M., Rousseau R.W.; Elementary Principles of Chemical Processes; 3rd Ed.; JohnWiley & Sons Inc., 2005
3. Watson, K.M., Hougen, O.A., Ragatz, R.A.; Chemical Process Principles Part-I Material and Energy balances; 2nd Ed.; CBS Publishers & Distributors Pvt. Ltd., 2004

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Develop Apply Discuss Evaluate Analyse	Understand the basic principles and unit conversion-based calculation techniques used in the chemical industries.
CO2		Define and develop analogy for chemical processes in steady-state and unsteady-state domain.
CO3		Apply the basics of mass and energy balances and their applications in chemical industries by using examples primarily based on chemical operations.
CO4		Discuss the possible ways of solving complex mass balance problems involving scenario of recycle, bypass and purge in chemical industries.
CO5		Evaluate the energy consumption for both flow and non-flow processes.
CO6		Analyse the complete mass and energy balance calculation forthe entire chemical process.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	2	2	3	2.7
PO2	2	3	3	2	2	2	2.3
PO3	2	2	3	2	2	2	2.2
PO4	2	2	2.5	2	2	2	2.1
PO5	2	2	2	2.5	2	2	2.1
PO6	2	2.5	2	2	2	2	2.1
PO7	2	2	2	3	2	2	2.2
PO8	2	2	2	2	2	2.5	2.1
PO9	2	2	2.5	2	2	2	2.1
PO10	2	2.5	2	2	2	2	2.1
PO11	2	2	2	3	2	2	2.2
PO12	3	2	3	2	2	3	2.5
PSO1	2.5	2	2.5	2.5	2	2.5	2.3
PSO2	2.5	2.5	2	2.5	2.5	2.5	2.4
PSO3	2.5	2.5	2.5	2	2	2.5	2.3
PSO4	2.5	2	2.5	2	2.5	2.5	2.3

B. TECH. – SEMESTER-III (CH)
PHYSICS (BS102)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
2	0	2	4	3	40	0	25	25	90

A. COURSE OVERVIEW

To make a bridge between the physics in school and engineering courses.

Objective

To create general understanding regarding basic physical principles and orient themselves in implementation involved in living systems. To familiarize the student with basic concepts in physics as: classical optics used in microscopes. To familiarize students with concepts in digital electronics, lasers, sound waves, electricity. To introduce them to concepts in modern physics such as: production of X-ray, X-ray crystallography, quantum mechanics etc.

B. COURSE CONTENT

	TOPICS	COs
1.	**Optics** • **Interference:** Introduction to optics, Principles of superposition, Constructive & Destructive Interference, Types of Interference, Conditions for observing interference, interference due to thin films, wedge shaped films, Newton's rings, applications of interference • **Diffraction:** Concept of diffraction, Types of diffraction (Fraunhofer and Fresnel diffraction), difference between interference and diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; Diffraction grating and its applications. • **Polarisation:** Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity, Polarization of light waves, Polaroid, Optical activity. • **Optical Microscopy:** Basic principles and components, Different examination modes, Stereomicroscopy, Photo-microscopy, Color metallography, Specimen preparation, Applications.	**CO1** **CO2**
2.	**Laser and Fibre Optics** • **Lasers:** Introduction to interaction of radiation with matter, principles and working of laser, Characteristics of laser, Properties of lasers, laser types: solid state Laser, Ruby laser, He-Ne laser, semiconductor laser, applications of laser, Industrial applications, and Medical applications. • **Fibre Optics:** Introduction, Principle and propagation of light in optical fibres, Fermat's principle and Snell's law, structure of optical fibres, numerical aperture, acceptance angle, types of optical fibres (material, refractive index, mode), losses in fibres, optical fibre communication system, fibre optic sensors (displacement and pressure sensors). Fabrication: Double Crucible Technique, Vapour phase Oxidation Process, applications of optical fibres.	**CO1** **CO3**
3.	**Electromagnetism and Magnetic Properties of Materials** • **Electrostatics & Electrodynamics:** Introduction to electrostatics, Coulomb's law for distribution of charges, polarization and Gauss's law electric current and equation of continuity, magnetic induction, Electrostatic filed in matter: dielectric polarization, polarizability and susceptibility, types of polarization,	**CO1** **CO4**

and Claussius-Mosotti equation.

- **Magnetostatics & Magnetism:** Introduction to magnetostatics, Lorentz force, Steady current and equation of continuity, Biot Savart Law-Ampere's law, magnetization and magnetic intensity, Magnetostatic field in matter: torques and forces on magnetic dipoles, Magnetization: Faraday's laws of electromagnetic induction, Electromagnetic waves: wave equation, Electromagnetic energy density, Poynting theorem, Maxwell's equations, Physical significance of Maxwell's equations, propagation of EM waves in free space, Lenz's law, Displacement current

4. Quantum Mechanics **CO5**

- Introduction to Quantum Mechanics: Plank's Quantum Theory, Properties of Photon, Photoelectric effect, Inadequacy of classical mechanics (black body radiation, photoelectric effect)
- Classical mechanics and its limitations, Planck's radiation law, Wien's law, and Rayleigh Jean's law, wave and particle duality of radiation, de Broglie concept of matter waves, Davisson-Germer experiment, Heisenberg's uncertainty principle, Consequences of uncertainty principle
- Equation of motion of matter waves, Schrodinger time independent wave equation
- Physical significance and properties of wave function, interpretation of wave function, eigenvalues and Eigen functions, superposition principle, Particle in one dimensional box and extension to three dimensions, Tunnelling effect (qualitative) and Applications.

C. TEXT BOOKS

1. Bhatt, B. I., Thakore, S. B.; *Stoichiometry*; 5th Ed.; Tata McGraw Hill Education Pvt. Ltd.,2010.

D. REFERENCE BOOKS

1. Himmelblau, D. M., Riggs, J. B.; Basic Principles & Calculations in Chemical Engineering; 7th Ed.; Prentice Hall India Learning Pvt. Ltd., 2013
2. Felder, R.M., Rousseau R.W.; Elementary Principles of Chemical Processes; 3rd Ed.; JohnWiley & Sons Inc., 2005
3. Watson, K.M., Hougen, O.A., Ragatz, R.A.; Chemical Process Principles Part-I Material and Energy balances; 2nd Ed.; CBS Publishers & Distributors Pvt. Ltd., 2004

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Develop Apply Discuss Evaluate Analyse	Able to understand the general scientific concepts of optics, electromagnetism, microscopy, advance materials, and modern physics.
CO2		Students understand the concept of interference, diffraction which are very basic in the field of wave optics.
CO3		An ability to understand the basic concepts of optical fibers & their properties and the Laser fundamentals.
CO4		An ability to identify, formulate, and solve Electromagnetic problems.
CO5		Understand the importance of Nanomaterials along with their Engineering applications and their Synthesis and analysis.
CO6		To become familiar with modern physics like black body radiation, quantum mechanics and statistical physics.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	1	3	3	2	3	3	2.5
PO2	1	3	3	2	3	3	2.5
PO3	1	3	3	2	3	3	2.5
PO4	1	3	3	2	3	3	2.5
PO5	1	3	3	2	3	3	2.5
PO6	1	3	3	2	3	3	2.5
PO7	1	3	3	2	3	3	2.5
PO8	1	3	3	2	1	2	2
PO9	1	2	3	2	1	2	1.8
PO10	1	2	3	2	1	2	1.8
PO11	1	2	3	2	1	2	1.8
PO12	1	2	3	2	1	2	1.8
PSO1	1	2	2	2	1	1	1.5
PSO2	3	3	3	3	3	3	3
PSO3	3	3	3	3	3	3	3
PSO4	1	1	1	2	2	2	1.5

B. TECH. – SEMESTER-III (CH)
ENGLISH (HSM201)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
2	0	2	4	3	40	0	50*	0	90

***Marks include Viva based on TW**

A. COURSE OVERVIEW

This course will help students of engineering develop their Linguistic skills. Beginning with Vocabulary Building the course proceeds towards the Sentence Formation and Paragraph Formation which will help them to enhance their Writing skills and Communicative skills as well. Understanding the common errors, and nature and style of writing will mould students'' Writing competency for their professional growth in the world of competition. Understanding Paralinguistic features like stress, intonation, rhythm and so on will improve their Speaking skills to be efficient and confident for academic and professional purposes.

B. COURSE CONTENT

	TOPICS	COs
1.	**Vocabulary Building** The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in Englishto form derivatives, Synonyms, antonyms, and standard abbreviations.	**CO1**
2.	**Basic Writing Skills** Sentence Structures, use of phrases and clauses in sentences, Importance of proper punctuation, creating coherence, organizing principles of paragraphs in documents, Techniques for writing precisely	**CO1** **CO2**
3.	**Identifying Common Errors in Writing** Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés	**CO2** **CO3**
4.	**Nature and Style of Sensible Writing** Describing, Defining, Classifying, providing examples or evidence, Writing introduction and conclusion	**CO3** **CO4**
5.	**Writing Practices** Comprehension, Précis Writing, Essay Writing	**CO4**
6.	**Oral Communication** (This unit involves interactive practice sessions in Language Lab) Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common, EverydaySituations: Conversations and Dialogues, Communication at Workplace, Interviews,Formal Presentations	**CO5** **CO6**

C. TEXT / REFERNCE BOOKS

1. Practical English Usage. Michael Swan. OUP. 1995
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006
5. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

D. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Reading and Writing	Understand the vocabulary and their root forms to enhance vocabulary level
CO2	Errorless Writing	Enhance their Writing in effective way
CO3	Reading, Writing, and Speaking Proficiently	Rectify common errors in their Speaking and Writing
CO4	Focused and Organised Writing	Develop efficiency in writing
CO5	Speaking and Listening	Be competent at Public Speaking and Interviews
CO6	Specific Soft Skills	Acquire Proficiency in all four skills of Language

E. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1							
PO2	1	1	1	1			1
PO3							
PO4		1	1	1			1
PO5							
PO6							
PO7							
PO8							
PO9		1	1	1			1
PO10	3	3	3	3	3	3	3
PO11	1	1	1	1	1	1	1
PO12	1	1	1	1	1	1	1
PSO1	1	2	2	2	2	2	1.8
PSO2	1	2	2	2	2	2	1.8
PSO3	2	2	3	3	3	3	2.7
PSO4	1	2	2	2	2	3	2

BACK

SEMESTER-IV

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
PCC104	Heat Transfer	3	0	3	60	40	25	25	150	4.5
PCC105	Mass Transfer - I	3	1	0	60	40	0	0	100	4
PCC106	Fluid Mechanics	3	0	3	60	40	25	25	150	4.5
PCC111	Particles and Fluid Particle Processing	3	0	3	60	40	25	25	150	4.5
PCC103	Thermodynamics -II	3	1	0	60	40	0	0	100	4
HSMC201	Effective Technical Communication	3	0	0	40	0	0	0	40	3
	TOTAL	**18**	**2**	**9**	**340**	**200**	**75**	**75**	**690**	**24.5**

B. TECH. – SEMESTER-IV (CH)
HEAT TRANSFER (PCC104)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE OVERVIEW

The course will introduce the fundamental concepts of various modes of heat transfer. It will further elaborate these concepts with theories and applications to the solutions of practically relevant chemical engineering problems. Some aspects of process design principles of various heat transfer equipment will be taken up in the later part of this course.

B. COURSE CONTENT

	TOPICS	COs
1.	Modes of heat transfer: Conduction, Convection, and Radiation. Material propertiesof importance in heat transfer: Thermal conductivity, Specific heat capacity. Classification of heat transfer equipment's and processes	CO1
2.	Steady state conduction in one dimension. Basic law of heat conduction- Fourier's law, Steady state heat conduction through composite wall, Steady state heat conduction through a variable area: cylinder, sphere. Heat conduction in bodies with heat source: plane wall, cylinder, sphere.	CO2
3.	Newton's law of cooling. Dimensionless numbers and their physical significance, empirical correlations for free and forced convection. Thermal and hydrodynamic boundary layer, heat and momentum analogy.	CO2 CO1
4.	Definition, phenomena of boiling, boiling curve, regimes of boiling. Heat transfer to boiling liquids, the mechanism of nucleate boiling, correlation for pool boiling heat transfer: Nucleate boiling, critical heat flux, stable film boiling. Force convection boiling.	CO3 CO4
5.	Definition, phenomena of condensation, film type & drop wise condensation. Film condensation on vertical surface, condensation on horizontal tube or tube bank.	CO2 CO6
6.	Definition, basic principles, properties of solution. Performance of steam heated tubular evaporators: Capacity and economy, single and multiple effect evaporators, Boiling point elevation, heat transfer coefficient, enthalpy balance calculation. Method of feeding: forward & backward feed systems, Types of evaporators: natural circulation evaporator, forced circulation evaporator.	CO4 CO6
7.	Classification, heat exchanger analysis, LMTD for parallel and counter flow exchanger. Condenser and evaporator, overall heat transfer coefficient, fouling factor, correction factors for Multipass heat exchanger. Effectiveness and number of transfer unit for parallel and counter flow heat exchanger. Design of Double pipe heat exchanger and shell and tube heat exchanger (kern's method of heat Exchanger design, Bell Delaware method). Introduction to compact heat exchanger and their design aspects. Importance of Ethics in design of heat exchanger and its importance in process industry.	CO4 CO5 CO6
8.	Basic definition radiation: Absorptivity, reflectivity, and transmissivity. Blackbody radiation, laws of radiation: Planck's law, Wien's law, The Stefan-Boltzmann law for blackbody, Special characteristic of blackbody radiation, Kirchhoff's law, radiation between surfaces.	CO1 CO2

9.	Types of fins, heat flow through rectangular fin, infinitely long fin, fin insulated at the tip and fin losing heat at the tip, efficiency and effectiveness of fin.	**CO2**

C. TEXT BOOKS

1. Kern, D. Q., Process Heat Transfer, McGraw Hill, 1997
2. Dutta, B. K., Heat Transfer – Principles and Applications, PHI, 2004

D. REFERENCE BOOKS

1. Holman, J. P., Heat Transfer, 9 ed., McGraw Hill, 2008
2. Sinnott, R. K., Coulson & Richardson's Chemical Engineering Design, Vol. 6, ElsevierButterworth Heinemann,1996
3. Incropera Frank P., Dewitt David P., Bergman T. L., Lavine A. S., Seetharaman K.N., Seetharaman T. R., Fundamentals of Heat and Mass Transfer, Wiley, 2014

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Design Apply Analysis Evaluates Develop	Understand and analyse basic knowledge of heat transfer withthe help of science and engineering fundamentals
CO2		Design and solve conduction, convection and radiationproblems.
CO3		Build a bridge between theoretical and practical concept usedin industry.
CO4		Utilize heat transfer knowledge to design and analyse the performance of heat exchangers and evaporators.
CO5		Use the techniques, skills, and modern engineering tools necessary for engineering practice.
CO6		Analyse and calculate heat transfer in complex systems involving several heat transfer mechanisms.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	2	2	2	3	3	3	2.5
PO2	2	3	2	2	3	2	2.3
PO3	1	2	2	3	2	3	2.2
PO4	2	2	2	3	2	3	2.3
PO5	1	2	3	3	3	3	2.5
PO6	2	1	3	2	3	2	2.2
PO7	2	3	3	3	3	3	2.8
PO8	2	1	3	2	3	1	2
PO9	1	2	2	3	2	3	2.2
PO10	1	2	2	2	3	2	2
PO11	2	1	2	3	3	3	2.3
PO12	3	3	3	3	3	2	2.8
PSO1	3	2	2	3	2	3	2.5
PSO2	3	3	2	3	3	3	2.8
PSO3	2	3	3	2	3	2	2.5
PSO4	3	3	3	2	3	3	2.8

B. TECH. – SEMESTER-IV (CH)
MASS TRANSFER-I (PCC105)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE OVERVIEW

This course will provide an overview of mass transfer operation at basic to an intermediate level.
Objective: The purpose of this course is to introduce basic concepts of mass transfer and attain ability to identify, formulate, and solve mass transfer problems. To introduce basic concepts of mass transfer equipment and apply them for designing purpose. The goal is to provide students with the theoretical/analytical background to understand mass transfer operations as well as application and to tackle the sort of complex problems.

B. COURSE CONTENT

	TOPICS	COs
1.	Introduction to Mass Transfer Operations (MTO): Classification, methods of conducting MTO	**CO1**
2.	Molecular Diffusion in Fluids: Steady state molecular diffusion in fluids (both liquids & gases). Diffusivity of liquids & gases.	**CO1 CO2**
3.	Mass Transfer Coefficients: MT coefficients in laminar flow & turbulent flow. Theories of MT, heat, mass & momentum transfer in laminar & turbulent flow & their analogies. Simultaneous heat & mass transfer. Effect of chemical reaction on mass transfer.	**CO1 CO3**
4.	Diffusion in Solids: Fick's law. Unsteady state diffusion. Types of solid diffusion	**CO1 CO2**
5.	Inter Phase Mass Transfer: Equilibrium, diffusion between phases. Local & overall diffusion. Various processes & material balance for each of them	**CO1 CO3**
6.	Equipment for Gas – Liquid Operations: Gas dispersion. Liquid dispersion equipment	**CO4**
7.	Distillation: VLE data, flash distillation, simple distillation and continuous rectification. McCabe Thiele & Ponchon Savarit methods. Distillation in packed columns & vacuum distillation. Azeotropic distillation. Use of steam. Introduction tomulticomponent distillation. Moral issues and ethics	**CO5 CO6**

C. TEXT BOOKS

1. Treybal, R.E. *Mass Transfer Operations*,3rd Ed.; Tata McGraw Hill: New Delhi, 2012
2. McCabe, W.L.; Smith. J.C.; Harriot, P. *Unit Operations in Chemical Engineering,* 4th Ed.;McGraw Hill Publications: NY, 1985

D. REFERENCE BOOKS

1. Dutta, B. K. *Principles of Mass Transfer and Separation Processes*, 2nd ed.; Prentice Hall of India: New Delhi, 2007
2. Foust, S. *Principles of Unit Operations*, 2nd Ed.; Wiley: New York, 1980

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Explain Analysis Evaluates Application	Explain the basic mechanism of mass transfer including diffusion and convective mass transfer
CO2		Estimation of steady state molecular diffusion in fluids (both liquids and gases)
CO3		Find the mass transfer coefficient and evaluate the problems related to interphase mass transfer
CO4		Identify the equipment for different gas-liquid operations andsolve related problems
CO5		Generate VLE data and estimate the problems related todesign calculation of distillation and absorption column
CO6		Develop analytical skill of the students that helps in to solvethe problems associated with real situation

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	2	3	2	2.7
PO3	3	3	3	2	3	2	2.7
PO4	3	3	3	2	2	2	2.5
PO5	2	2	3	2	3	2	2.3
PO6	2	2	2	2	2	3	2.2
PO7	3	2	2	3	3	2	2.5
PO8	3	2	2	2	3	3	2.5
PO9	3	3	3	2	3	3	2.8
PO10	2	3	3	3	3	3	2.8
PO11	3	3	3	3	3	2	2.8
PO12	3	3	3	3	3	3	3
PSO1	2	2	3	3	3	3	2.7
PSO2	2	2	3	3	3	3	2.7
PSO3	2	2	3	3	3	3	2.7
PSO4	2	2	3	3	3	3	2.7

B. TECH. – SEMESTER-IV (CH)
FLUID MECHANICS (PCC106)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE OVERVIEW

Fluids are an integral part of our day to day life. Fluid Mechanics occupies a privileged position in the science. It is a field where multiple physical effects can be met and its knowledge is necessary to understand the nature of flowing medium. The students will have creative thinking, a deeper understanding and intuitive feel for fluid mechanics.

B. COURSE CONTENT

	TOPICS	COs
1.	Introduction to Fluid mechanics, Definition of fluid, Types of fluids, Various Fluid Properties, Dimensional analysis in fluid flow phenomena, Simple numerical examples related to fluid properties.	CO1
2.	**Fluid Statics** Laws of fluid statics: Pascal's law, Hydrostatic law, Barometric equation, Hydrostatic equilibrium equation in a centrifugal field, Pressure and types of pressure, Measurement of pressure using manometers and pressure gauges, Selection criteria for pressure measuring devices, Simple numerical examples related to hydrostatic law and pressure.	CO2
3.	**Fluid Kinematics** Methods of describing fluid motion, Types of Flow- steady, unsteady, uniform, non- uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, Types of flow patterns - stream lines, path lines, streak lines, Boundary layer concept.	CO2
4.	**Fluid Dynamics** Concept of Control Volume, Laws affecting fluid motion, Conservation of mass, linear momentum and energy, Basic equations derived using conservation principles- Continuity equation in Cartesian coordinates, Momentum equations, Bernoulli's equation, Kinetic and momentum correction factor, Simple numerical examples related to basic equations.	CO2
5.	**Fluid flow in pipes and ducts** Introduction pipe and pipe fittings, Selection criteria for pipe, Concept of equivalent length and pipe, pipes in series and parallel, Laminar flow through circular pipe and between two parallel plates, Introduction to turbulent flow and velocity distribution, Types of friction, Flow through non circular cross-section, Energy losses through pipes, Minor losses in pipe lines, TEL, HGL, Moody diagram. Simple numerical examples.	CO3
6.	**Flow around Immersed Bodies** Concept of Drag and lift, Types of drag, Drag coefficient, Flow through bed of solids, Fluidization- Conditions, Types and applications, Simple numerical examples.	CO5
7.	**Fluid Flow Measurement** Classification of flow-meter, Detailed study (Principle, construction and working) of Venturi meter, orifice meter, Rotameter, Pitot-tube, Various types of notches, Simple numerical examples.	CO4

8.	**Hydraulic pumps and Valves** Classification of pumps, Detailed study (Principle, construction and working) of Centrifugal pump, reciprocating pump, Characteristics curves for pump, Selection of pumps, Classification of valve, Main parts of a valve, Various types of valves like – Gate valve, Globe Valve, Ball Valve, Check valve	**CO4**

C. TEXT BOOKS

1. McCabe, W.L.; Smith. J.C.; Harriot, P. *Unit Operations in Chemical Engineering*, 7th Ed.; Tata McGraw Hill Publications: NY, 2017
2. Dr R.K. Bansal, *Fluid Mechanics and Hydraulic Machines*; 9th ed.; Laxmi Publications, New Delhi, 2010.

D. REFERENCE BOOKS

1. Dr. A. K. Jain, Fluid Mechanics including hydraulic machines; 12th ed., Khanna Publishers, New Delhi, 2014.
2. K. A. Gavhane, *Unit Operation -I*, 12th ed., Nirali Prakashan, Pune, 2015
3. A.P. Kulkarni, *Chemical Engineering Fluid Mechanics*, 4th ed., Nirali Prakashan, Pune, 2019

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Evaluate Comprehension Application Synthesis Analysis	Understand the basic properties of fluids and classify their behavior. Apply dimensional analysis to predict physical parameters that influence the flow in process fluid mechanics.
CO2		Apply the concept of fluid statics and fluid kinematics in real life engineering problems, create shell balance and ability to analyze fluid flow problems in different configurations with the application of continuity, momentum and energy equations.
CO3		Apply appropriate equations and principles to analyze pipe flow problems
CO4		Able to understand the functions and performances of various equipments and flow measuring.
CO5		Analyse fluid behavior in fixed bed and fluidized bed system.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	2	3	3	3	2	2.6
PO2	1	3	3	3	2	2.4
PO3	1	2	2	2	1	1.6
PO4	1	2	2	2	2	1.8
PO5	2	2	2	1	2	1.8
PO6	1	2	2	2	2	1.8
PO7	1	2	2	2	2	1.8
PO8	2	2	2	2	2	2.4
PO9	2	2	2	2	2	2.4
PO10	2	2	2	2	2	2.4
PO11	3	2	2	3	2	2.4
PO12	3	3	3	3	2	2.8
PSO1	1	2	2	2	1	1.2
PSO2	1	2	2	2	1	1.6
PSO3	1	2	2	2	1	1.6
PSO4	1	2	2	2	1	1.6

B. TECH. – SEMESTER-IV (CH)
PARTICLES AND FLUID PARTICLE PROCESSING (PCC111)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE OVERVIEW

Motivation: Describe basic concept of Mechanical Operations and troubleshooting of Industrial equipments for sustainable development of process industries.

Objectives: To develop basic concept of properties of particle and mixture along with its storage and transportation. Students are able understand of various mechanical operations like Screening, Size reduction & Enlargement, Filtration, Sedimentation, Agitation and Mixing used in Chemical Process Industries. The students are exposed to fundamental theory, calculations, and various types of equipment used in Chemical Process Industries related to Mechanical Operations.

B. COURSE CONTENT

	TOPICS	COs
1.	**Solids**	**CO1**
	• Introduction to solid particles	**CO2**
	• Characteristics of solid particles and Concept of Sphericity	**CO5**
	• Properties of mixture	
	• Introduction to nanoparticles properties & characterization	
2.	**Size Reduction & Enlargement**	**CO1**
	• Principle of comminution, Types of crushers, grinders & disintegrators for coarse and intermediate & fine grinding	**CO2** **CO4**
	• Energy & power requirement for size reduction, laws of crushers & work index,close & open circuit grinding, feed control, mill discharge and removal & supplyof heat in wet grinding	
	• Size enlargement– objectives, methods and equipment used in industries	
3.	**Screening & Other Separation Methods**	**CO2**
	• Screen Terminology and various screen series and Differential and cumulativemethod of screen analysis	**CO3**
	• Types of Industrial screen, comparison of ideal & actual screens and capacity &effectiveness of screens	
	• Principle of elutriation, floatation, jigging and electrostatic & magnetic separation processes	
4.	**Sedimentation**	**CO2**
	• Concept of sedimentation, terminal settling velocity, batch settling test andfree & hindered settling	**CO4**
	• Flocculation, types of thickener & thickener area calculation, batch & continuoussettling chambers and sorting of classifiers	
	• Centrifugal settling process, cyclone and principle of centrifugal sedimentation	
5.	**Filtration**	**CO2**
	• Types of filtration, requirements of filter media and filter aids	**CO3**
	• Principle of cake filtration, constant pressure filtration, batch & continuousfiltration equipments – filter press, leaf filter, cartridge filter & rotary drum filter	**CO4**

	• Theories of filtration, washing of cake, principle of centrifugal filtration and suspended basket centrifuge, etc.	
6.	**Mixing & Agitation** • Fundamentals of mixing & agitation, purpose of agitation and standard agitated vessel • Types of impellers, vortex formation in agitated vessel, power consumption in agitated vessels, scale of agitated vessel and power consumption • Characteristics of mixing equipment, mixing of pastes & paste masses, pony mixers, beater mixer, mixing of dry powder, ribbon blender & tumbler mixer etc	**CO3** **CO4** **CO5**
7.	**Storage and Conveying** • Storage of solid, liquid and gases and types of storage vessels • Types of flow in solid discharge and various problems • Types of Mechanical & pneumatic conveying system	**CO4** **CO6**
8.	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice	**CO1** **CO5** **CO6**

C. PRACTICAL AND TERM WORK

1. Experiments based on screening, screen efficiency, Size Reduction such as- Jawcrusher, Roll crusher and Ball mill
2. Sedimentation, filtration, Agitated vessel and Terminal settling velocity etc

D. TEXT BOOKS

1. McCabe, L. W.;Smith, J.C.;Peter,H.*Unit Operations of Chemical Engineering;* 7th ed; TataMc-Graw Hill Publication:New Delhi, 2017
2. Narayanan, C.M.;Bhattacharyya, B.C. *Mechanical Operations for Chemical Engineers;* 3rd ed; Khanna Publishers: New Delhi,2014

E. REFERENCE BOOKS

1. Harker, J.H.; Backhurst, J.R. *Richardson, Coulson & Richardson's Chemical EngineeringVolume 2*; 5th ed; Butterworth-Heinemann: Oxford Woburn MA,2002
2. Badger, L.W.; Banchero, J. *Introduction to Chemical Engineering*; McGraw Hill: Singapore,1984

F. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Analysing Synthesis Evaluating Applying Creating	**Describe** basic concept of Mechanical Operations used in chemical process industries
CO2		**Classify and Explain** solid-solid, solid-fluid related operations
CO3		**Identify** methods for measuring performance of equipments
CO4		**Examine** the factors affecting on solid handling related operations with respects to the sustainable development of process industries
CO5		**Experiment** related to various mechanical operations equipments during laboratory work including demonstration of advance instruments like particle size analyser and XRD
CO6		**Generating** reports for selection, Design and troubleshooting of Industrial equipments

G. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	3	2	3	2.8
PO3	3	3	3	2	3	2	2.7
PO4	3	3	3	2	2	2	2.5
PO5	2	1	2	2	3	2	2
PO6	2	2	2	3	3	3	2.5
PO7	2	2	3	3	3	3	2.7
PO8	3	2	2	2	3	3	2.5
PO9	2	2	2	2	3	3	2.3
PO10	2	2	2	3	3	3	2.5
PO11	3	3	2	3	3	3	2.8
PO12	3	3	3	3	3	3	3
PSO1	3	2	3	3	3	3	2.8
PSO2	2	3	3	3	2	3	2.7
PSO3	3	3	3	2	3	2	2.7
PSO4	2	2	3	3	3	3	2.7

B. TECH. – SEMESTER-IV (CH)
THERMODYNAMICS-II (PCC103)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE OVERVIEW

The subject aims to introduce the principles of Chemical Engineering Thermodynamics and illustrate their applications in the design of equilibrium governed separation processes like distillation, solvent extraction, etc. The course comprises the concept of chemical potential, fugacity, activity & activity coefficient, vapour-liquid equilibrium (VLE), liquid-liquid equilibrium (LLE) and reaction equilibrium. Introduction to molecular thermodynamics, the laws of thermodynamics & their applications.

B. COURSE CONTENT

	TOPICS	COs
1.	**Systems of Variable Composition. Ideal behavior** Review of first and second law of thermodynamics, concept of chemical potential, Concept of equilibrium, Chemical Potential as a Criterion of phase equilibrium, Property changes for mixing of ideal gas mixtures and ideal solution, Raoult's law and its applications, Binary phase diagrams and problems.	CO1 CO2
2.	**Solution Thermodynamics** Concept of partial properties, definition of fugacity and fugacity coefficient of pure species and species in solution, Vapor Liquid Equilibrium (VLE), VLE by modified Raoult's law, VLE from K-value correlations, Flash Calculations, Positive & negative deviations from Raoult's law.	CO2
3.	**Phase Equilibria** Phase rule, Duhem's theorem, Gibb's – Duhem equation, Definition of activity & activity coefficient, Lewis – Randall rule and Henry's law, excess properties, Models for excess Gibbs energy (Activity models) such as Redlich-kister equation, Wohl's equation, Van Laar equation, Margule's equation, Wilson equation, NRTL, UNIQUAC & UNIFAC, Thermodynamic consistency test for VLE data, Heat effects and property change of mixing processes, Liquid-Liquid Equilibria; Vapor-Liquid- Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas Equilibria, Ethics concern with VLE data.	CO3 CO4 CO5
4.	**Chemical Reaction Equilibria** Equilibrium criterion for a chemical reaction, concept of Equilibrium conversion (x), equilibrium constant (k), evaluation of equilibrium constants at different temperatures, equilibrium conversion of single reactions and multi-reaction equilibria, Phase rule for chemically reacting systems.	CO3
5.	**Introduction to Statistical Thermodynamics** Probability theory, Different thermodynamic distributions- Boltzmann, Bose – Einstein & Fermi-Dirac, Laws of thermodynamics & their applications, Properties of elementary particles.	CO6

C. TEXT BOOKS

1. Smith, J. M.; Van Ness, H. C. Introduction to Chemical Engineering Thermodynamics; Fourth Edition, McGraw Hill Book Company: Singapore, 1987

2. Sonntag, R. E. & Van Wylen, Gordon J. Fundamentals of Statistical Thermodynamics; First Edition, John Wiley & Sons: United States of America, 1968

D. REFERENCE BOOKS

1. Narayan, K. V. A Textbook of Chemical Engineering Thermodynamics; Second Edition, PHI Learning Private Limited: Delhi, 2013
2. Rao, Y.V.C. Chemical Engineering Thermodynamics; First Edition, Universities Press India Private Limited: Hyderabad, 1997
3. S. Sandler, "Chemical, Biochemical and Engineering Thermodynamics",4th edition, Wiley, India
4. Elliot, J.E.; Lira C.T. Introductory Chemical Engineering Thermodynamics; Second Edition, Pearson Education publishing as Prentice Hall: South Africa, 2012

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Knowledge Comprehension Application Analysis Synthesis Evaluation	Recall the laws of thermodynamics & relationship between the fundamental thermodynamic properties.
CO2		Discuss the thermodynamic properties for multiphase & multicomponent mixtures for the equilibrium separation processes.
CO3		Compute numerical problems involving equilibria of different phases such as VLE, LLE, VLLE, SLE, SVE as well as reaction equilibria.
CO4		Analyze the experimental VLE data for binary mixtures and estimate the VLE data using activity models.
CO5		Propose the appropriate classical models for a binary system.
CO6		Molecular interpretation of thermodynamic equilibrium & compare the of laws of thermodynamics statistical point of view.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	2	3	3	3	3	2	2.7
PO2	3	3	3	3	3	2	2.8
PO3	2	3	3	3	3	2	2.7
PO4	3	2	3	3	3	2	2.7
PO5	3	2	3	3	3	3	2.8
PO6	2	3	3	3	3	3	2.8
PO7	3	3	3	3	3	2	2.8
PO8	2	3	3	3	3	3	2.8
PO9	2	3	3	3	3	3	2.8
PO10	2	3	3	3	3	2	2.7
PO11	3	2	3	3	3	2	2.7
PO12	3	2	3	3	3	2	2.7
PSO1	2	3	3	3	3	2	2.7
PSO2	2	3	3	3	3	2	2.7
PSO3	2	3	3	3	3	2	2.7
PSO4	3	3	3	3	3	3	3

B. TECH. – SEMESTER-IV (CH)
EFFECTIVE TECHNICAL COMMUNICATION (HSMC201)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	3	40	0	0	0	40

A. COURSE OVERVIEW

This course will help students of engineering develop their Linguistic skills. Students will learn the effective ways of writing technically. Errorless writing and presenting will be developed. Understanding ways of self-development will make students competent to enhance their professional and Personal growth. Learning and understanding Professional ethics will help them be a better professional. Overall, the course is going to help student be competent and efficient professional

B. COURSE CONTENT

	TOPICS	COs
1.	**Module 1: Information Design and Development** Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and for online media.	**CO1**
2.	**Module 2: Technical Writing, Grammar and Editing** Technical writing process, forms of discourse, Writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Hunan factors, Managing technical communication projects, time estimation, Single sourcing, Localization.	**CO1 CO2**
3.	**Module 3: Self Development and Assessment** Self-assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning,Self-esteem. Managing Time; Personal memory, Rapid reading, taking notes; Complex problem solving; Creativity.	**CO3 CO5**
4.	**Module 4: Communication and Technical Writing** Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.	**CO1 CO4 CO6**
5.	**Module 5: Ethics** Business ethics, Etiquettes in social and office settings, Email etiquettes, Telephone Etiquettes, engineering ethics, managing time, Role and responsibility of engineer, Work culture in jobs, Personal memory, Rapid reading, taking notes, Complex problem solving, Creativity.	**CO3**

C. TEXT / REFERENCE BOOKS

1. David F. Beer and David McMurrey, *Guide to writing as an Engineer*, John Willey. NewYork, 2004
2. Diane Hacker, *Pocket Style Manual*, Bedford Publication, New York, 2003. (ISBN 0312406843)
3. Shiv Khera, Y*ou Can Win*, Macmillan Books, New York, 2003

D. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Speaking and Writing	Enhance Professional way of Speaking and Writing,
CO2	Errorless Writing	Understand basics of Grammar in Professionalwriting
CO3	Being professionally efficient	Understand the Business Ethics, Etiquettes andValues.
CO4	Focused, organised and competent Speaking	Present himself/herself in the effective way at Public,Group Discussion and Interview.
CO5	Understanding Oneself-knowing one's capabilities	Improve Self-awareness and Perception.
CO6	Specific Soft Skills	Enhance their soft skills required for their professional development.

E. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1		1	1	1			1
PO2							
PO3							
PO4							
PO5							
PO6		2		1			1.5
PO7							
PO8		1	3		1		1.7
PO9	2	1	2	3	2	2	2
PO10	3	3	3	3	3	3	3
PO11	2	2		2	1	2	1.8
PO12	1		2	2	2	1	1.6
PSO1	1	1	2	2	1	2	1.5
PSO2	1	2	3	3	2	2	2.2
PSO3	3	2	2	3	3	3	2.7
PSO4	2	2	3	3	2	3	2.5

BACK

SEMESTER-V

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
PCC108	Chemical Reaction Engineering-I	3	0	3	60	40	25	25	150	4.5
PCC109	Mass Transfer-II	3	1	3	60	40	25	25	150	5.5
PEC101	Core Elective-I	3	1	0	60	40	0	0	100	4
OEC101	Open Elective-I	3	0	0	60	0	0	0	60	3
PCC107	Numerical Techniques in Chemical Engineering	3	0	2	60	40	25	25	150	4
HS103	Financial and Management Accounting	3	0	0	40	0	0	0	40	3
	TOTAL	**18**	**2**	**8**	**340**	**160**	**75**	**75**	**650**	**24**

B. TECH. – SEMESTER-V (CH)
CHEMICAL REACTION ENGINEERING-I (PCC108)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE OVERVIEW

Selection, Design, Operation and Troubleshoot Ideal Reactors for various type of chemical reactions.

Objectives: Basic concepts of Kinetics and Rate law; Interpretation of rate of rate data; Design and Rating of Ideal Reactors involving homogeneous single reactions; Arrangement of different type and size of reactors for homogeneous reactions; Concept of Recycle Reactor for controlling mixing inside the reactors

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction** Introduction to chemical reaction engineering and Classification of chemical reactions Concept of Chemical kinetics. Role of Thermodynamics in chemical reaction engineering. Definition of Rate of reaction, Rate expression for various types of reactions. Variables affecting the rate of reaction: Temperature, Pressure, concentration, catalyst, inert, surface area etc.	**CO1** **CO2** **CO3**
2.	**Kinetics of Homogeneous Reactions** Effect of concentration on rate of reaction. Terminology in calculation of rate of reaction: Elementary vs non elementary reactions, Molecularity of reactions, order and rate constant of reaction, Irreversible vs Reversible reactions, concept of equilibrium constant. Effect of temperature on rate of reaction: Arrhenius theory, Collision theory & Transition state theory, comparisons of the theories. Kinetic of non-elementary reactions: matching reaction mechanism with rate law equation, Rule based derivation of rate law equation for given reaction mechanism and comparing with experimental rate law equation.	**CO1** **CO2** **CO3** **CO4**
3.	**Interpretation of Batch Reactor Data of Homogeneous Reactions** Conversion in terms of concentration and pressure. Using Integral and Differential method of analysis to obtain kinetics of chemical reaction from obtained experimental data. Constant and variable volume reaction: irreversible, reversible, series, parallel, catalytic, autocatalytic reactions, Concept of variable volume reaction. Differential method of analysis: partial analysis of rate of reaction. Reactions with shifting order: Reactions with shifting of order from Higher to lower and lower to higher.	**CO1** **CO2** **CO3** **CO4**
4.	**Introduction to Reactor Design** Introduction to concept of macro and micro mixing. Concept of ideal mixing in reactors. Definition and characteristics of various ideal reactors: Batch, CSTR, PFR, Selection of Batch or continuous mode of reactor operation.	**CO5** **CO6**
5.	**Single Ideal Reactors** Reactor terminology - space time, space velocity, steady state condition, local conversion, global conversion, uniform *vs*. constant T, P and Concentration,Extent of reaction. Derive equation for Ideal Reactors from first principal model.Apply design equations of Ideal reactors to real system for single reactions and reactor.	**CO4** **CO5** **CO6**
6.	**Design for Single Reactions** Comparison of various type of reactors for same order. Comparison of same type	**CO3** **CO4**

	of reactors for various feed ratios for order more than one, comparison of MFR with that of PFR for same order for constant volume and variable volume reactors. Comparison of ideal reactors using graphical and analytical method. Multiple reactor system in series and/or parallel, Equal/unequal size reactors in series, Reactors of different types in series. Introduction to recycle reactor, Design of recycle reactor, Solution using graphical method, application of recycle reactor to autocatalytic reaction	**CO5** **CO6**
7.	**Design for Multiple Reactions** Maximizing desired product for parallel and series reactions. Mixed complex reactions	**CO5** **CO6**

C. PRACTICAL AND TERM WORK

Experiment pertaining to determination of order and rate constant of reaction using integral & differential methods of analysis, effect of temperature on rate of reaction, study of pilot scale reactor. Application of computer by solving ordinary differential equation using numerical methods to compare the result predicted by numerical method with that of experimental data

D. TEXT BOOKS

1. Levenspiel, O. *Chemical Reaction Engineering*; 3rd ed.; John Wiley & Sons (Asia) Pvt. Ltd : Singapore, 2014

E. REFERENCE BOOKS

1. Scott, F. H. *Elements of Chemical Reaction Engineering;* 5th ed.; Prentice Hall India (p) Ltd.: New Delhi, 2016
2. Smith, J. M. *Chemical Engineering Kinetics*; 3rd ed.; McGraw Hill Incorporation: NewYork, 2000

F. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understanding Analysing Applying Remembering Creating Evaluating	**Understand** and **State** the fundamentals of chemical reactions (Classification, Definitions) and chemical kinetics
CO2		Discuss the thermodynamic properties for multiphase & multicomponent mixtures for the equilibrium separation processes.
CO3		**Explain** the **concept** of Rate of Reaction, **Evaluate** Kinetic Expression, **Examine** effect of various parameters on it
CO4		**Apply** Kinetic Expression to experimental data and **compare** the results
CO5		**Define** the **concept** of Ideal Reactor and **classify** the type ofideal reactors
CO6		**Select**, **Design, Operate and Sketch** different type of reactors

G. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	2	2	3	2	3	3	2.5
PO2	2	2	3	2	3	3	2.5
PO3	2	2	3	2	3	3	2.3
PO4	2	2	2	2	3	3	2.33
PO5	1	1	2	2	3	3	2
PO6	1	2	2	2	3	2	2
PO7	2	2	3	2	3	2	2.3

PO8	1	1	2	2	3	3	2
PO9	1	2	2	2	3	2	2
PO10	1	1	2	2	3	3	2
PO11	1	2	2	2	3	3	2.16
PO12	1	2	3	2	3	3	2.3
PSO1	2	3	3	3	2	3	2.67
PSO2	3	3	3	2	3	2	2.67
PSO3	2	3	2	2	2	2	2.17
PSO4	3	3	3	3	3	3	3

B. TECH. – SEMESTER-V (CH)
MASS TRANSFER-II (PCC109)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	3	7	5.5	60	40	25	25	150

A. COURSE OVERVIEW

Motivation: Study, Design, Operation and Application of various Mass transfer operation and equipments in Chemical Process Industry.

B. COURSE CONTENT

	TOPICS	COs
1.	**Gas Absorption** Equilibrium solubility of gases in liquids. Concept of idea and non-ideal solution. Material balance for single component transfer in absorption and stripping. Minimum Liquid-gas ratio and its significance. Counter current multi stage operation. Absorption factor and Stripping factor with significance. Solvent Selection Criteria for absorption. Multistage & packed tower operation. Concept of HETP and transfer units.	**CO1** **CO3** **CO5**
2.	**Humidification** VLE and Enthalpy for pure substances. Saturated & Unsaturated vapour–gas mixture and related terminologies such as dry bulb temperature, dew point, wet bulb temperature, percentage & relative saturation, adiabatic saturation temperature, humid heat, humid volume etc. Psychometric Chart in Humidification & dehumidification. Adiabatic saturation curves, wet bulb temperature theory, Lewis's relation Adiabatic & non-adiabatic operations. Types of cooling tower & design.	**CO2** **CO6**
3.	**Liquid-Liquid Extraction** Equilibrium in extraction. Ternary diagram & tie line data. System of three liquids-one pair & two pairs partially soluble. Single stage & multistage extraction, Co-current and cross current extraction, Continuous counter current multistage extraction with and without reflux, Theory & performance of continuous contact equipments, Single stage & multistage equipments	**CO2** **CO4** **CO5**
4.	**Adsorption & Ion Exchange** Adsorption, Definition and industrial application. Types of adsorption & most commonly used adsorbents. Adsorption Equilibria & hysteresis, Effect of temperature on adsorption & Heat of adsorption. Adsorption of solute from dilute liquid Material balance and Freundlich's equation for single stage operation and multistage cross-current operation, counter current operation, Equipments for adsorption. Ion-Exchange Principles, Applications, Equilibria and Rate of ion-exchange	**CO2**
5.	**Drying** Equilibrium in drying. Batch drying & its mechanism, Continuous drying. Various types of moisture in drying. Rate of drying & time of drying. Cross-circulation drying. Batch & continuous drying equipments-Tray dryer, Tunnel dryer, Rotary dryers, Spray dryers, Fluidized bed dryer, etc	**CO5** **CO6**
6.	**Leaching** Steady state and unsteady state leaching operations. Single stage leaching. Multistage cross current and counter current leaching. Rate of leaching.	**CO6**

	Application of leaching. Leaching equipments	
7.	**Crystallization** Principle of crystallization. Saturation & methods of saturation. Nucleation & Crystal Growth. Crystallization rate, Equilibria and yields. Caking of crystals, Application of crystallization, Crystallization equipments, Crystallization from melts	**CO1** **CO2**
8.	**Introduction to Novel Separation Techniques** Types of Novell Séparation techniques. Membrane Séparation processes like Ultra filtration, Nano filtration, Reverse Osmosis etc.	**CO1**

C. TEXT BOOKS

1. *Treybal, R.E. Mass Transfer Operations,3rdEd.; Tata McGraw Hill:New Delhi, 2012*
2. *McCabe, W.L.;Smith. J.C.; Harriot, P. Unit Operations in Chemical Engineering, 4th Ed.;McGraw Hill Publications: NY, 1985*

D. REFERENCE BOOKS

1. Dutta, B.K. *Principles of Mass Transfer and Separation Processes*, 2nd Ed.; Prentice Hall of India: 2007
2. Foust, S. *Principles of Unit Operations*, 2nd Ed.; Wiley: New York, 1980

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Relate Design Optimize Application Develop	**Understand** how to use the basic fundamentals of Masstransfer in designing the unit operation equipments.
CO2		**Relate** the theoretical fundamentals with practical aspects toimprove the performance.
CO3		**Design** (process) all Mass transfer equipments.
CO4		**Optimize** the process and design parameters related to masstransfer equipments.
CO5		**Apply** the design simulation tools to optimize the real process.
CO6		**Develop** analytical skill of the students that helps in to solvethe problems associated with real situation.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	2	2.8
PO2	3	3	3	3	2	2	2.5
PO3	3	2	3	2	2	2	2.3
PO4	2	2	2	2	2	2	2
PO5	2	2	2	2	2	2	2
PO6	2	2	2	2	2	2	2
PO7	2	2	2	2	2	2	2
PO8	3	2	3	2	3	3	2.7
PO9	2	2	2	2	2	2	2
PO10	3	3	3	2	2	2	2.5
PO11	2	2	2	2	2	2	2
PO12	3	3	3	2	2	2	2.5
PSO1	3	3	3	2	3	3	2.8
PSO2	3	3	3	3	3	3	3
PSO3	3	3	3	3	3	3	3
PSO4	3	3	3	3	3	2	2.8

B. TECH. – SEMESTER-V (CH)
NUMERICAL TECHNIQUES IN CHEMICAL ENGINEERING (PCC107)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	2	5	4	60	40	25	25	150

A. COURSE OVERVIEW

Numerical solutions of various mathematical models describing steady state and dynamic behaviours of Chemical Process Systems and parameter estimation using numerical methods in Chemical Engineering.

Objectives: To introduce students to numerical methods used for solving engineering problems, in particular chemical engineering problems, using numerical methods and computer programming. Fundamentals of numerical methods/algorithms to solve systems of different mathematical equations (e.g. linear/nonlinear algebraic equations, ordinary / partial differential equations) will be introduced. The course would enable students to write their own computer programs using programming languages like C/C++ and commercial software like MATLAB. Hands-on experience will be provided to apply these computer programs to solve problems in different areas of chemical engineering, e.g. fluid flow, heat and mass transfer, chemical reaction engineering etc. Practical are involved for solving actual chemical engineering problems through computer programming and coding.

B. COURSE CONTENT

	TOPICS	COs
1.	**Basics of Vectors, Scalars and matrix algebra** Addition/subtraction, multiplication/division of vectors, matrix multiplication, inverse of matrix, determinant and rank of matrix, eigen values, sparse matrices, Use of MATLAB for matrix algebra, approximation and concept of error and error analysis	**CO1 CO3**
2.	**Numerical methods for linear algebraic equations** Gauss elimination method, Gauss-Jordan method, Jacobi method, Successive – over relaxation method, tri-diagonal matrix, MATLAB programming	**CO1 To CO3**
3.	**Numerical methods for nonlinear algebraic equation** Successive substitution method, Newton-Raphson method, Secant method, False position method, single variable and multivariable case studies, MATLAB functions for nonlinear algebraic equations	**CO1 To CO5**
4.	**Eigen Value Problems** Eigen value analysis of linear and nonlinear systems and solution of homogeneous equations using eigen values	**CO1 To CO3**
5.	**Regression, interpolation, curve fitting, numerical integration** Simple interpolation, Lagrange's interpolation, Newton's interpolation, Simpson's rule, trapezoid method, linear regression, polynomial regression, exponential and power regression, MATLAB routines and commands	**CO1 To CO3**
6.	**Numerical methods for IVP and BVP ordinary differential equations** Explicit and implicit ODEs, Euler's explicit and implicit methods, explicit Adams- Bashforth methods, implicit Adams-Mouton methods, Predictor – corrector methods, Runge-Kutta methods, MATLAB solvers for ODEs, Finite difference, Orthogonal collocation and Orthogonal collocation on finite-element methods for ODE-BVP, Shooting Methods for solving BVP	**CO1 To CO6**

7.	**Numerical methods for Partial differential equations** Steady state and dynamic PDES, method of lines, Crank-Nicholson method, finite- difference, Orthogonal collocation and orthogonal collocation on finite element method	**CO1 To CO6**

C. PRACTICAL AND TERM WORK

Simulation experiments are designed to use MATLAB software for solving linear/nonlinear algebraic equations for steady state problems in Chemical Engineering and for solving dynamic problems in Chemical Engineering. Simulation experiments for parameter estimation problems in chemical engineering systems are also designed

D. TEXT BOOKS

1. Gupta, S. K. Numerical Methods for Engineers, 3rd ed.; New Age International Publishers: New Delhi, 2015
2. Chapra, S. C. Applied Numerical Methods with MATLAB for Engineers and Scientist, 3rd ed.; McGraw-Hill: New York, 2012

E. REFERENCE BOOKS

1. Beers, K J. *Numerical Methods for Chemical Engineering Applications in MATLAB*, Cambridge University Press: UK, 2006
2. Constantinides, A.; Mostoufi, N. *Numerical Methods for Chemical Engineers with MATLAB Applications*, Prentice Hall International Series: New Jercy, 1999

F. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understanding Analysing Applying Evaluating Creating Remembering Evaluating	**Remember** and **understand** the various numerical methods to solve various linear and nonlinear steady state and dynamic problems in chemical engineering systems described by ODE, PDE, AE and NAE
CO2		Carry out the **error analysis** in the numerical solutions of chemical engineering problems
CO3		**Apply** linear algebraic equation solution techniques and nonlinear algebraic equation techniques for solving steady states of chemical engineering systems. Use MATLAB to **implement** numerical methods in simulations.
CO4		**Do** critical evaluation of the performance of various numerical methods using simulations for solving chemical engineering problems.
CO5		**Develop** MATLAB codes for various numerical methods
CO6		**Generate** a MATLAB program for industrial application to carry out steady state and dynamics analysis.

G. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	2	2	2	3	2	3	2.3
PO2	1	1	3	3	3	3	2.3
PO3	1	2	3	3	3	3	2.5
PO4	1	1	2	3	2	3	2
PO5	0	0	2	3	3	3	1.8
PO6	2	2	3	3	3	3	2.7

PO7	2	3	3	3	3	3	2.8
PO8	1	1	2	2	2	3	1.8
PO9	2	2	3	2	3	3	2.5
PO10	1	2	3	2	2	3	2.2
PO11	2	3	3	2	2	3	2.5
PO12	3	3	3	2	3	3	2.8
PSO1	2	3	3	3	2	3	2.67
PSO2	3	3	3	2	3	2	2.67
PSO3	2	3	2	2	2	2	2.17
PSO4	3	3	3	3	3	3	3

B. TECH. – SEMESTER-V (CH)
FINANCIAL MANAGEMENT AND ACCOUNTING (HSMC103)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	0	40	0	0	0	40

A. COURSE OVERVIEW

Motivation: Analyze businesses' financial position and performance, selection of appropriate management accounting techniques to make informed decisions.

Objective: The need to understand concepts of accountancy is essential for better decision making in personal and professional life, principles of accounting applied to make financial statements which can be understood by the internal and external stakeholders. Management accounting for understanding the concepts of marginal costing and absorption costing, and Cost- Volume-Profit analysis. Concepts such as fundamental analysis, ratio analysis, and break-even analysis are important to compare different companies of the same industry.

B. COURSE CONTENT

	TOPICS	COs
1.	**Financial Accounting – An Introduction** Introduction. Meaning of Accountancy. Book-keeping and Accounting. Accounting Process. Objectives for accounting. Differences between book-keeping and accounting Users of accounting information. Limitations of Accounting and basic terminologies	**CO1**
2.	**Accounting Concepts, Principles, Bases and Policies** Introduction, Accounting Concepts, Principles, Policies and Standards, **Types of accounting concepts** - Business Separate entity concept, Going concern concept, Money measurement concept, Periodicity concept, Accrual concept, **Accounting Principles** - Principle of Income recognition, Principle of expense, Principle of matching cost and revenue, Principle of Historical costs, Principle of full disclosure, Double aspect principle, Modifying Principle, Principle of materiality, Principle of consistency, Principle of conservatism or prudence, **Accounting Policies** - Changes in Accounting Policies, Disclosure in case of changes in Accounting Policies, **Accounting Standards** - Scope and functions of Accounting Standards Board, International Financial Reporting System	**CO1** **CO3**
3.	**Double Entry Accounting** Introduction, meaning of double entry accounting, Classification of accounts under Traditional approach, Classification of accounts under Accounting Equation approach, Comparison of traditional approach with Modern approach equal approach, Accounting Trail, Transactions and events, Meaning and roles of debit and credit, Accounting equation	**CO2**
4.	**Secondary Books** Introduction, Secondary books, Purchases Book/Purchases Day book, Cash discount, Trade discount, Difference between cash discount and trade discount, Sales Book or Sales Day book, Purchase Returns Book, Sales Returns Book, bills receivable book, bills payable book, Cash book, Posting to Ledger accounts, Posting to Ledger	**CO2**

5.	**Trial Balance** Introduction, Meaning, Objectives of preparing a trial balance, Methods of preparing a trial balance, Preparation of Trial balance, Adjusting Entries, Errors and their rectification, Errors disclosed by Trial Balance, Errors not disclosed by Trial Balance, Steps to locate the errors	**CO2**
6.	**Final Accounts** Introduction, Adjustments before preparing final accounts, Depreciation, Bad Debts and accounting treatment of bad debts, Provision for doubtful debts, Reserves for Discount on Debtors, Reserve for Discount on Creditors, Closing Stock, Trading Account, Profit and Loss Account, Balance Sheet	**CO2** **CO3**
7.	**Introduction to Management Accounting** Introduction, Meaning of Management accounting, The Role of Management Accounting, Management Accounting Framework, Functions of Management Accounting, Tools of Management Accounting, The Balanced Scorecard, Cost Management System, Value Added Concept, Merits of Management Accounting, Demerits of Management Accounting Distinction between Management Accounting and Financial Accounting	**CO2** **CO4**
8.	**Financial Statement Analysis** Introduction, Meaning of Ratio, Steps in Ratio Analysis, Classification of Ratios, Du Pont Chart, Solved Problems, Advantages of Ratio Analysis, Limitation of Ratio analysis	**CO3**
9.	**Cash Flow Analysis** Introduction, Meaning of Cash Flow Statement, Purpose of Cash Flow Statement, Preparation of Cash Flow Statement, Format of Cash Flow Statement (AS3: Revised Method), Cash Flow from Operating Activities, Cash Flow Statement under Direct Method, Different between Cash Flow Analysis and Fund Flow Analysis, Uses of Cash Flow Statement	**CO2** **CO3**
10.	**Marginal Costing and Break-Even Analysis** Introduction, Concept of Marginal Costing, Characteristics of Marginal Costing, Difference between Absorption Costing and Marginal Costing, Marginal Cost, Contribution, Cost Volume Profit (CVP) Analysis, Break Even Chart, Break Even Point, Profit Volume ratio or MCSR, Target profit, Margin of Safety, Application of Marginal cost, Limitations of Marginal cost, Solved Problems	**CO2** **CO4** **CO5**
11.	**Basics of Financial Management** Introduction of Financial Management, Objectives of financial management, Role of finance manager, Functions of financial management, Concept of time value of money, Present value, Future value, Annuity concept, Solved problems	**CO2** **CO4** **CO6**

C. TEXT BOOKS

1. S.K. Bhattacharya, John Dearden, Financial Accounting for Managers – Text book & cases, Vikash Publishing House Private Limited, 2009
2. Ravi M. Kishore, Management Accounting, Taxman, 2018

D. REFERENCE BOOKS

1. M.N. Arora, A Text Book of Cost Accountancy, Vikas Publishing, 2010
2. B.K. Bhar, Cost Accounting: Method & Problems, Academic Publishers, 2012
3. Horngren, Foster & Datar, Cost Accounting – A Managerial Emphasis, Prentice Hall, 1997
4. N.K. Prasad & A.K. Prasad, Cost Accounting, Book Syndicate, 2016
5. Edmonds, Edmonds and Tsay, Fundamental Managerial Accounting Concept, Irwin McGraw Hill, 2013
6. Asish Bhattacharya, Principles and Practice of Cost Accounting, Sultan Chand, 2004
7. R.S.N. Pillai & Bhagavati, Management Accounting, S. Chand, 2010

8. Moriarty and Allen, Cost Accounting, John Wiley, 1991
9. Bhabatosh Banerjee, Cost Accounting – Theory & Practices, Sultan Chand & Sons, 2014
10. V.K. Saxena & C.D. Vashist, Advanced Cost & Management Accounting – Problems & Solutions, Prentice Hall of India (P) Ltd., 2015
11. R.S.N. Pillai & Bhagavati, Cost Accounting, S. Chand, 2010
12. S.N. Maheshwari, Studies in Cost Management, Sultan Chand & Sons, 2013
13. M.E. Thukaram Rao, Cost and Management Accounting, New Age International, 2004
14. M.E. Thukaram Rao, Management Accounting, New Age International, 2003

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Comprehension Analysis Evaluate Comprehension Application	**Understand** the concepts and principles of accounting, double-entry book-keeping, limitations and objectives of accounting
CO2		**Analyse** the accounting cycle and process involved in financialand management accounting
CO3		**Evaluate** financial statements given in annual reports of listed companies and **apply** the same knowledge in real life.
CO4		**Understand** the objectives of management accounting and**apply** the techniques utilized in management accounting
CO5		**Utilize** the concepts of break-even analysis and marginalcosting
CO6		**Outline** time value of money concepts and **implement** them to**analyse** real life situations

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	1	2	2	3	3	3	2.33
PO2	2	2	2	3	3	3	2.5
PO3	1	2	2	2	3	3	2.16
PO4	1	1	3	3	2	3	2.16
PO5	2	2	3	3	3	3	2.67
PO6	3	1	2	3	2	2	2.16
PO7	1	2	3	2	2	1	1.83
PO8	3	3	3	3	1	2	2.5
PO9	2	2	3	3	2	2	2.33
PO10	2	2	3	2	3	3	2.5
PO11	3	3	3	3	3	3	3
PO12	3	2	3	3	3	3	2.8
PSO1	2	2	2	2	2	3	2.17
PSO2	2	2	2	3	2	3	2.33
PSO3	2	3	3	3	3	3	2.83
PSO4	3	3	3	3	3	3	3

B. TECH. – SEMESTER-V (CH)
ENVIRONMENTAL ENGINEERING (PEC101)
(CORE ELECTIVE-I)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE OVERVIEW

Environmental engineering deals with the application of engineering principles to the control, modification and adaption of the physical, chemical and biological factors of the environment in the interest of human's health, comfort and social wellbeing. The student will identify and troubleshoot for environmental pollution problems.

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction to Environmental Pollution** Introduction to environment, Biosphere, Hydrological and nutrient Cycles, Types of pollution and Pollutant	**CO1**
2.	**Air Pollution** **Sources and Effects:** Air pollution – Definition and concentrations, classification and properties of air pollutants, criteria air pollutants, Photochemical smog, emission sources for air pollutants, Air pollution laws and standards in India, behaviour and fate of various air pollutants in atmosphere, Effects of air pollution on health, impact on vegetation and materials. **Meteorological aspects of air pollutant dispersion:** Meteorology – definition and parameters, Temperature lapse rate, Inversion and atmospheric stability, Plume behaviour, Dispersion of air pollutants – The Gaussian plume model **Air pollution sampling and measurement:** Ambient air sampling and stack sampling, Collection of gaseous air pollutants and Particulate pollutants, Analysis of air pollutants **Air pollution control methods and Equipments:** Control methods, Principle and design of particulate matter control devices- gravitational settling chambers, cyclone separators, bag house filters, electrostatic precipitators, wet and dry scrubbers. Control of specific gaseous pollutants: **Control of specific gaseous pollutants:** Modification of operating conditions, modification of design conditions, effluent gas treatment methods.	**CO2**
3.	**Waste water engineering** **Origin of waste water and waste water flow rates:** Introduction to waste pollution, Reasons for waste water treatment, Introduction to treatment operations, process and concepts, Components of waste water flow rates, Waste water sources and flow rates, Variation in wastewater flow, Analysis of waste water flow rate data, Reduction of waste water flows. **Waste water characteristics:** Physical, Chemical and Biological characteristics of wastewater **Waste water treatment:** Objective and classification of waste water treatment, Major factors for selection of system, Design parameters for waste water treatment, Reactor used in waste water treatment **Physical unit operation and their design:** Objective and Application of Physical unit operations in waste water treatment, Various unit operations – Screening,	**CO3** **CO4**

	Grit chambers, Flow equalization, Flocculation, Flotation., Sedimentation, Design of various units- Screening, Flow equalization, Flotation, Sedimentation. **Chemical Unit processes:** Objective and Application of Chemical unit processes in waste water treatment, Various chemical unit processes – Chemical Precipitation, Disinfection **Biological Unit processes:** Objective of Biological unit processes in waste water treatment, Important definition, Classification of biological unit processes, Bacterial growth and Kinetics of Bacterial growth, Suspended growth treatment process – Activated sludge process- Modification, Design, Aerated lagoons, Aerobic attached growth treatment processes – trickling filters & its design, rotating biological contractors, Introduction to anaerobic suspended growth treatment processes attached growth treatment process, sludge treatment & disposal, Introduction to advanced waste water treatment	
4.	**Solid waste management**	**CO5**

C. TEXT BOOKS

1. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse,15th ed.; Tata McGraw Hill, New Delhi, 2003
2. C. S. Rao., Environmental Pollution Control Engineering,3rd ed., New Age International Publishers, Delhi, 2018

D. REFERENCE BOOKS

1. Scott, F. H. Elements of Chemical Reaction Engineering; 5th ed.; Prentice Hall India (p) Ltd.: New Delhi, 2016
2. Smith, J. M. *Chemical Engineering Kinetics*; 3rd ed.; McGraw Hill Incorporation: NewYork, 2000
3. Peavy, H.S., Rowe, D.R., Tchobanoglous, G. *Environmental Engineering*, Indian editon,Tata McGraw Hills
4. Martin Crawford, *Air pollution control theory*, Tata McGraw-Hill
5. G. L. Karia and R. A. Christian, *Waste water treatment – Concepts and Design approach*,2nded.; East Economy Edition

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Evaluate Comprehension Application Synthesis Analysis	Understand the sources, effects and control measure ofdifferent types of pollution. (Air, Water, Land etc.)
CO2		Analyse general air pollution problems, meteorologicalaspects, control and measure of particulate pollutants and gaseous pollutants.
CO3		Apply the basic knowledge on water pollutants and waste water characteristics and build expertise in analysis and testing of water samples.
CO4		Evaluate the significance of various unit operations and unit processes involved in waste water treatment, Create design ofspecific treatment methods for effluents of various chemical process industries
CO5		Understand about solid waste, remember problems associated with solid waste disposal, evaluating various methods for solid waste treatment.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	AVG.
PO1	2	3	3	3	2	2.6
PO2	2	3	3	2	1	2
PO3	1	2	2	3	2	2
PO4	2	2	2	2	1	2.8
PO5	2	2	2	2	1	2.8
PO6	2	2	2	2	1	2.8
PO7	3	2	2	2	2	2.2
PO8	1	2	2	2	2	2.8
PO9	2	2	2	2	2	2
PO10	1	2	2	2	2	2.8
PO11	1	2	2	2	2	2.8
PO12	2	2	2	2	2	2
PSO1	1	2	2	1	1	2.4
PSO2	1	1	2	2	1	2.4
PSO3	1	1	1	2	1	2.1
PSO4	1	1	1	1	2	2.1

BACK

SEMESTER-VI

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
PCC112	Chemical Reaction Engineering-II	3	0	3	60	40	25	25	150	4.5
PCCXXX	Chemical System Modeling	3	1	0	60	40	0	0	100	4
PCC117	Instrumentation and Process Control	3	1	3	60	40	25	25	150	5.5
PCCXXX	Process Equipment Design and Drawing	3	0	3	60	40	25	25	150	4.5
PEC102	Core Elective-II (1), (2), (3)	3	0	0	60	0	0	0	60	3
OEC102	Open Elective-II	3	0	0	60	0	0	0	60	3
	TOTAL	**18**	**2**	**9**	**360**	**160**	**75**	**75**	**670**	**24.5**

B. TECH. – SEMESTER-VI (CH)
CHEMICAL REACTION ENGINEERING-II (PCC112)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE OVERVIEW

Motivation: Analysis, design, selection and operation of chemical reactors for non-ideal, non-isothermal and heterogeneous reactions in chemical process industries

Objectives: Fundamentals of non-ideality in reactors and change in conversion, Basic concepts of non-isothermal operations and design, Fundamentals of catalysis, mechanisms and kinetics of catalytic reactions, Basic analysis and design of fixed bed, fluidized bed, trickle bed and slurry reactors, Fundamentals and design of non-catalytic multiphase reactors (fluid-fluid, fluid-solid)

B. COURSE CONTENT

	TOPICS	COs
1.	**Non-ideal Reactors** RTD theory, understanding RTD curves and moments, Finding out RTD by experiments – Pulse and Step Input, Models for non-ideal flow – zero (segregation & maximum mixedness), one (Dispersion and TIS) and two parameter models	**CO1** **CO6**
2.	**Non-isothermal Operations and Design** Material and Energy balances for CSTR and PFR/PBR, Design Algorithms for CSTR and PFR/PBR, Adiabatic and non-adiabatic design Procedures, Unsteady-state Batch reactor design Procedures, Concept of Multiple Steady states in CSTR	**CO2** **CO6**
3.	**Fundamentals of Catalytic Reactions** Mechanism of solid catalyzed reaction, Experimental Methods for studying kinetics of catalytic reactions and data analysis, Design of Fixed bed catalytic reactors, Design of Fluidized bed catalytic reactors, Design of Trickle bed catalytic reactors	**CO3** **CO6**
4.	**Fundamentals of Fluid-Fluid Reactors and Reactor Design** Kinetic regimes for mass transfer & reaction, Enhancement factor in gas-liquid reactions, Design of towers/tanks for fast & slow reactions	**CO4** **CO6**
5.	**Fundamentals of Fluid-Solid Reactors and Reactor Design** Rate equation for heterogeneous reactions, the concept of rate controlling step, Design of Plug flow, Fluidized bed reactors	**CO5** **CO6**
6.	**Professional Ethics in Chemical Reaction Engineering** Discussion on engineering ethical considerations, focusing on problems followingbest practices, Discussion of social and environmental considerations, the importance of considering engineering ethics	

C. PRACTICAL AND TERM WORK

Experiments to determine RTD & conversion form RTD for various geometries under laminar & turbulent flows, heterogeneous reaction system, and application of tank in series & dispersion models, RTD in a pilot scale batch reactor

D. TEXT BOOKS

1. Levenspiel, O. Chemical Reaction Engineering; 3rd ed.; John Wiley & Sons (Asia) Pvt.Ltd : Singapore, 2014
2. Scott, Fogler. H. Elements of Chemical Reaction Engineering; 5th ed.; Prentice Hall India

(p) Ltd.: New Delhi, 2016

E. REFERENCE BOOKS

1. Smith, J. M. *Chemical Engineering Kinetics*; 3rd ed.; McGraw Hill Incorporation: NewYork, 2000

F. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Analysis Evaluate Application Create	**Understand** and **Analyse** the non-ideality in the reactors and**Evaluate** its performance
CO2		**Apply** energy balance, **Analyse** and **Design** PFR, CSTR andBatch type non-isothermal reactors
CO3		**Develop** Kinetic Expression from heterogeneous reaction experimental data and **analyze** the reaction mechanism involved
CO4		**Analyse** different control regimes and **design** fluid-fluidcontactors accordingly
CO5		**Analyse** and **Design** of non-catalytic fluid-solid reactors
CO6		**Critiquing** Industrial Reactor and Implement solution Methodology for **optimum Design** of actual reactors

G. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	3	3	3	3
PO3	3	3	3	3	3	3	3
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	3	3	3
PO6	3	3	3	3	3	3	3
PO7	3	3	3	3	3	2	2.8
PO8	3	3	3	3	3	3	3
PO9	3	3	3	3	2	2	2.7
PO10	3	3	3	3	2	2	2.7
PO11	3	3	3	3	3	3	3
PO12	3	3	3	3	2	2	2.7
PSO1	3	3	3	3	2	2	2.7
PSO2	3	3	3	3	2	2	2.7
PSO3	3	3	3	3	2	2	2.7
PSO4	3	3	3	2	2	3	2.7

B. TECH. – SEMESTER-VI (CH)
CHEMICAL SYSTEM MODELING (PCCxxx)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE OVERVIEW

Motivation: To have a good grasp of mathematical modelling and its basic classification of various process, such as deterministic and stochastic processes. Students are made aware with specific applications of mathematical modelling in chemical engineering, which is generally referred to as chemical systems modelling

Objectives: The basic objective of this subject to give general approach for the model formulation of various chemical engineering systems, Applying the basic principles of chemical engineering to the various systems

B. COURSE CONTENT

	TOPICS	COs
1.	**Modeling Overview** Physical modelling, mathematical modelling and its classification, principles of similarity in physical modelling, concepts of independent variables, dependent variables, boundary conditions partial Differential Equations & finite Difference	**CO1**
2.	**Mathematical Modelling in Mass Transfer** Single stage, 2 stage & N stage extraction of steady state mass transfer process, unsteady state formulation of single stage extraction, unsteady state mass transfer (Fick's second law), gas absorption accompanied by chemical reaction (mathematical model formulation), finite difference – solvent extraction in N stage process, gas absorption in N stages (Kremser – Brown), N stirred tanks reactors in series, etc.	**CO2** **CO6**
3.	**Mathematical Modelling in Heat Transfer** Steady state heat conduction through hollow cylindrical pipe using various boundary conditions, unsteady state process of steam heating of liquid, heat transfer through extended surfaces (triangle & rectangle), steady state counter current cooling of tanks, unsteady state heat loss through maturing tank, unsteady state heat conduction, gas pre-heater, heat loss through circular flanges	**CO3** **CO6**
4.	**Mathematical Modeling in Reaction Engineering** The model of the chemical reaction with diffusion in a tubular reactor, chemical reaction with heat transfer in a packed bed reactor, gas absorption accompanied by chemical reaction and reactors in series.	**CO4** **CO6**
5.	**Mathematical Modelling in Fluid Mechanics** Continuity equation, model formulation of flow through a packed bed column, models on momentum transfer such as laminar flow in a narrow slit, model of flow between concentric cylinders and concentric spheres	**CO5** **CO6**
6.	**Professional Ethics in Chemical System Modeling** Ethical considerations for Modeling approach. Motivating the students to consider socio-environmental issues in a serious manner. Best practices to be followed with engineering ethics	

C. TEXT BOOKS

1. B.V. Babu, Process Plant simulation, Oxford University Published in India
2. Jensen V. G.; Jeffreys G. V., Mathematical Methods in Chemical Engineering, AcademicPress, New York
3. Mickley H S; Sherwood T S; Reed C E, Applied Mathematics in Chemical Engineering2nd Ed. Tata McGraw Hill Publishing Co. Ltd., New Delhi

D. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understanding	Understand and State the fundamentals of general approachon the modeling of chemical systems
CO2	Application Analysis	Explanation of the concept of mathematical modeling of masstransfer unit operations
CO3	Application Analysis	Conceptual modeling of heat transfer unit operations
CO4	Application Analysis	Fundamentals of mathematical modeling in reaction engineering
CO5	Application Analysis	Explain the concept of mathematical modeling of fluid flowunit operations
CO6	Create	Discussion on the modelling approach of real industrialproblems

E. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	3	2	3	2.8
PO3	3	3	3	3	3	2	2.8
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	3	3	3
PO6	3	3	3	3	3	3	3
PO7	3	3	3	3	3	2	2.8
PO8	3	3	3	3	3	3	3
PO9	3	3	3	3	2	2	2.7
PO10	3	3	3	3	2	2	2.7
PO11	3	3	3	3	3	3	3
PO12	3	3	3	3	2	2	2.7
PSO1	3	3	3	3	3	2	2.8
PSO2	3	3	3	3	2	2	2.7
PSO3	3	3	3	3	2	3	2.8
PSO4	3	3	3	2	2	3	2.7

B. TECH. – SEMESTER-VI (CH)
INSTRUMENTATION AND PROCESS CONTROL (PCC117)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	3	7	5.5	60	40	25	25	150

A. COURSE OVERVIEW

Design of feedback, feedforward and other control structures and its application to process industries.

B. COURSE CONTENT

	TOPICS	COs
1.	Introductory Concepts: Need for control and automation, control logic, servo and regulatory control-block diagrams, control structures (feedback vs. feedforward), process and instrumentation diagrams. Laplace transforms, solution of ODEs using Laplace transform. Temperature measuring devices	CO1 CO2
2.	Transfer function approach, response of first order systems: step, impulse and sinusoidal response, first order systems in series. Level measurement	CO1 CO6
3.	Second order systems, higher order systems, transportation lag and dead time. Flow measuring instruments	CO1
4.	Linear closed loop systems, development of block diagrams, classical feedback controllers. Final control element (control valves), block diagram reduction Closed loop response, servo and regulatory problems Pressure measuring instruments/sensors	CO2 CO1
5.	Stability analysis, Routh stability criterion, Root locus diagrams (rule based). Introduction to frequency response, notion of stability. Bode diagrams, Nyquist plots, Bode and Nyquist stability criterion	CO3 CO5 CO6
6.	Controller tuning: Ziegler-Nichol's method, Cohen-Coon method. Introduction to advanced controllers: cascade control, feed forward control, ratio control, Smith- predictor, IMC, MPC, dead-time compensation. Introduction to digital control	CO4 CO6

C. TEXT BOOKS

1. Coughanowr D R; LeBlanc S E, Process System Analysis & Control,3rd Edition, Chemical Engineering series, McGraw Hill Publishing Co.: Newyork,2009
2. Eckman D, Industrial Instrumentation, Wiley & Sons: 1950

D. REFERENCE BOOKS

1. Stephanopoulos G, Chemical Process Control: An introduction to theory and practice, P TR Prentice Hall: New Jersey, 2003

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Design Troubleshoot Application	Understand the system and analyse the same with the help ofscience and engineering fundamentals
CO2		Design and draw Piping and instrumentation diagram for given process

CO3	Analysis Develop	Modify and trouble shoot the control systems and loops
CO4		Build a bridge between theoretical and practical concepts while implementing systems engineering concepts
CO5		Utilize the process knowledge and existing simulation tools while analysing loops.
CO6		Develop analytical thinking to overcome simple system engineering related problems

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	3	3	3	3
PO3	3	3	3	3	3	3	3
PO4	2	3	2	3	3	2	2.5
PO5	3	3	3	3	3	2	2.8
PO6	3	3	3	2	3	2	2.7
PO7	2	3	3	2	2	2	2.3
PO8	3	3	2	2	2	2	2.3
PO9	2	3	2	2	2	2	2.2
PO10	1	1	2	1	2	2	1.5
PO11	1	2	2	2	2	2	1.8
PO12	3	3	3	3	3	2	2.8
PSO1	3	2	3	3	2	3	2.7
PSO2	3	3	2	3	3	3	2.8
PSO3	3	3	3	2	2	3	2.7
PSO4	3	2	3	2	3	3	2.7

B. TECH. – SEMESTER-VI (CH)
PROCESS EQUIPMENT DESIGN AND DRAWING (PCC---)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE OVERVIEW

Design and fabrication of components of Industrial Chemical Vessels under various operating conditions

Objectives: The main objective of the course is to carry out mechanical design of Process Equipment in chemical process industries. The subject deals with introduction to Mechanical properties of Material of constructions and its selection for fabrication of vessels. The design of process vessel is done for Unfired Pressure vessels. The course focuses on designing main components of pressure vessel. It also deals with designing special components of pressure vessel for particular vessel as per their functions.

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction**	**CO1**
	• Introduction to design and drawing.	**CO3**
	• Basic considerations in mechanical design of process equipment.	
	• Concept of pressure vessel, definition and type, selection of type of vessel.	
	• Methods of fabrication of vessel, economic consideration.	
2.	**Vessel Design**	**CO1**
	• Selection Criteria for vessel design.	**CO2**
	• Design Preliminaries like excessive allowable stress, design stress, factor of safety, Poisson's ratio, elastic deformation, plastic instability, brittle rupture, creep, thickness of vessel wall.	**CO3**
	• Introduction to vessel codes and standards.	
3.	**Vessels under Internal Pressure**	**CO2**
	• Design of pressure vessels under internal pressure	**CO3**
	• Design of wall thickness based on Lame theorem and membrane stress theory	**CO4** **CO5**
	• Types of closers for pressure vessel, design thickness of closer	
	• Selection and Design of nozzles and reinforcement pads	
	• Introduction to flanges and gasket, types and selection, design of flanges for pressure vessels.	
4.	**Vessels under External Pressure**	**CO2**
	• Industrial pressure vessels under external pressure	**CO3**
	• Design of vessel wall in presence and absence of stiffeners using analytical &graphical methods	**CO4** **CO5**
	• Design of circumferential stiffeners	**CO6**
	• Design of closers subjected to external pressure.	
5.	**Reaction vessels**	**CO3**
	• Introduction to various components of reaction vessel	**CO4**
	• Selection and design of various jackets and Coil	**CO5**
	Selection and design of Agitators based on torque, moment and critical speed.	**CO6**
6.	**Storage Vessels**	**CO3**
	• Identification for storage for non-volatile & volatile liquids, storage of gases	**CO4**

	• Types & constructional features of storage vessels • Rectangular storage tank design • Design of cylindrical storage tank, course to course calculation of wall thickness,bottom design, roof design	**CO5** **CO6**
7.	**Design of Tall Columns** • Industrial requirement of tall vessels • Construction & features in column stress & determination of shell thickness	**CO3** **CO4** **CO5** **CO6**
8.	**High Pressure Vessel** • Types of high-pressure vessel • Design of high-pressure vessel • Construction features, materials for high pressure shell design, vessel closures	**CO3** **CO4** **CO5** **CO6**
9.	**Design of Heat Exchanger** • Basic introduction to heat exchanger and selection of heat exchanger, • Fluid allocation in heat exchanger, • process design of various components like tube, baffles, shell etc and • Mechanical design of shell and tube heat exchanger based on TEMA class. Pressure drop on shell side and tube side in heat exchanger.	**CO3** **CO4** **CO5** **CO6**
10.	**Supports for Vessels** Selection and design of different types – bracket or lug support, skirt support & saddle support, design calculations	**CO3** **CO4** **CO5** **CO6**

C. PRACTICAL AND TERM WORK

Students are Divided in to two groups, one of the groups will go to computer centre, where they will use excel to carry out design of pressure vessel and its components based on theory class, whereas second group will go to drawing hall, where they will draw the pressure vessel components, they designed in computer centre with dimensions. They will be judged based on both design and drawing, as the title of subject emphasis on both.

D. TEXT BOOKS

1. Umarji, S. B.; Mahajani, V.V. *Joshi's Process Equipment Design*; 5th ed.; Trinity Press:New Delhi, 2016
2. Brownel, L. E.; Young, E. H. *Process Equipment Design & Drawing*; 2nd ed.; WileyEastern Ltd.: New Delhi, 2005

E. REFERENCE BOOKS

1. Bhattacharya, B.C. *Process Equipment Design: Mechanical Aspect*; 1st ed.; CBS Publisher and Distributors Pvt. Ltd.: New Delhi, 2014
2. Bhattacharya, B.C.; Narayanan, C.M. *Computer Aided Process Equipment Design*; 1sted.; New Central Book agency (p) ltd.: Kolkata, 1992

F. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understanding Analysing Applying Evaluating Creating	**Understand and state** the process condition and **Interpret** Process Flow Diagram
CO2		**Classify** the type of Pressure Vessels along with all itscomponents
CO3		**Implementing** Codes and Standards to **Design** of PressureVessels and its components
CO4		**Critiquing** Real life Industrial Problem and **Implement** solution

	Remembering Evaluating	Methodology for optimum Design
CO5		**Organize** a trouble shoot path using various tools forbetterment of society
CO6		**Generate** a detail design report along with drawing to **plan** the fabrication of pressure vessel

G. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	2	2	2	3	2	3	2.3
PO2	1	1	3	3	3	3	2.3
PO3	1	2	3	3	3	3	2.5
PO4	1	1	2	3	2	3	2
PO5	0	0	2	3	3	3	1.8
PO6	2	2	3	3	3	3	2.7
PO7	2	3	3	3	3	3	2.8
PO8	1	1	2	2	2	3	1.8
PO9	2	2	3	2	3	3	2.5
PO10	1	2	3	2	2	3	2.2
PO11	2	3	3	2	2	3	2.5
PO12	3	3	3	2	3	3	2.8
PSO1	2	3	3	3	2	3	2.67
PSO2	3	3	3	2	3	2	2.67
PSO3	2	3	2	2	2	2	2.17
PSO4	3	3	3	3	3	3	3

B. TECH. – SEMESTER-VI (CH)
ENERGY TECHNOLOGY (PEC102)
(CORE ELECTIVE-II)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	3	60	0	0	0	60

A. COURSE OVERVIEW

The motivation of the course is students shall understand current practices of fuel usages and future prospectus of new and non-conventional energy resources exploration. Moreover, they shall understand various energy sources including conventional and non-conventional including solar thermal, geothermal, wind, Ocean, biomass, etc. and also demonstrate knowledge of various energy technologies and learn present energy scenario and the need for energy conservation.

B. COURSE CONTENT

	TOPICS	COs
1.	**An Introduction to Energy Sources** energy sources (conventional & non-conventional), renewable energy resources, primary & secondary energy sources, energy chain, energy demand, national energy strategy & plan, energy management, energy audit & conservation **Definitions, Units & Measures** proximate & ultimate analysis, calorific values, rank of coal, coking & caking, gasification, basis for reporting results of analysis, units & conversion factors	**CO1** **CO2**
2.	**Solid Fuels** wood & charcoal, peat, lignite, sub-bituminous & bituminous coals, semi-anthracite and anthracite coals, cannel & boghead coal, origin of coal, composition of coal, analysis & properties of coal, problems	**CO1** **CO2** **CO3**
3.	**Processing of Solid Fuels** coal preparation, washability curve, dry & wet washing methods of coal, washer efficiency, gasification & liquefaction of solid fuels, problems	**CO1** **CO2** **CO7**
4.	**Solar Energy** solar constant, solar radiation & related terms, measurement of solar radiation, solar energy collectors – flat plate collector, air collector, collectors with porous absorbers, concentrating collectors, applications & advantages of various collectors, selective absorber coatings, solar energy storage systems (thermal, electrical, chemical & mechanical), solar pond, applications of solar energy	**CO1** **CO3** **CO7**
5.	**Wind Energy** basic principles, power in wind, force on blades & turbines, wind energy conversion, site selection, basic components of wind energy conversion systems (WECS), classification of WECS, wind energy collectors, applications of wind energy	**CO1** **CO3** **CO7**
6.	**Energy from Biomass** introduction, energy plantation, biomass conversion technologies, photosynthesis, biogas generation, factors affecting biogas generation, classification of biogas plants & their comparisons, types of biogas plants (including those used in India), biogas from plant wastes, community plants & site selection, digester design considerations, design calculations, methods of maintaining & starting biogas plants, properties & utilization of biogas, thermal gasification of biomass, pyrolysis, alternative liquid fuels	**CO1** **CO3** **CO4** **CO7**

7.	**Geothermal Energy** Geothermal resources, hydrothermal resources, liquid dominated systems, geopressured resources, petrothermal systems, magma resources, energy conservation & comparison with other resources, applications of geothermal energy	**CO1** **CO3** **CO7**
8.	**Energy from Oceans** OTEC, methods (open cycle & close cycle) energy from tides, components of tidal power plants, operation, methods of utilization of tidal energy, storage, ocean waves, wave energy conversion devices	**CO1** **CO5** **CO7**
9.	**Fuel Cell** introduction, hydrogen – oxygen fuel cell, ion exchange membrane cell, fossil fuel cell, molten carbonate cell, advantages & disadvantages, conversion efficiency,polarization, type of electrodes, applications of fuel cells	**CO1** **CO6** **CO7**
10.	**Hydrogen & Methanol** properties of Hydrogen, production of hydrogen, thermochemical methods, fossil fuel methods, solar methods, storage & transportation, safety & management	**CO1** **CO6** **CO7**
11.	**Magneto Hydro-Dynamic (MHD) Power Generation** principle, MHD system, open cycle system, closed cycle system, design problems &developments, advantages, materials for MHD generators, magnetic field & superconductivity	**CO1** **CO6** **CO7**
12.	**Nuclear Energy** fission, fusion, fuel for nuclear fission reactor (exploration, mining, milling, concentrating, refining, enrichment, fuel fabrication, fuel use, reprocessing, waste disposal), storage & transportation, fast & slow neutrons, multiplication factors & reactor control, uranium enrichment process, nuclear reactor power plant, fast breeder reactor, boiling water reactor, pressurized heavy & light water reactor	**CO1** **CO6** **CO7**

C. TEXT BOOKS

1. Energy Sources 2nd Ed. by G. D. Rai, Khanna Publications, New Delhi
2. Fuels & combustion by Samir Sarkar, Orient Longmans (1974)

D. REFERENCE BOOKS

1. Solar Energy by Sukatame. Tata McGraw Hill, New Delhi
2. Energy Technology by Rao & Parulaker

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Comprehension Application Analysis	Understand the types of energy sources, forms of energiesbasic definition and terminology.
CO2		Explain the origin of solid fuel coal and its characteristic,analysis and properties of coal and various coal washing process.
CO3		Classify the non-conventional energy resources like solar energy, WECS and biomass conversion techniques.
CO4		Design the biogas plant and analyses the factors affecting the biochemical biomass conversions.
CO5		Demonstrate the basic knowledge of renewable energy resources like geothermal energy and OTEC systems for electricity generation.
CO6		Apply the use of chemical energy sources like hydrogen, fuelcell and MHD for satisfy the energy need at various sectors.
CO7		Analyse the National energy strategies and policies for energy conservation, energy Audit and causes of increase in energy demand.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	CO7	AVG.
PO1	3	2	3	3	3	2	2	2.6
PO2	1	2	3	2	2	2	1	1.9
PO3	1	2	3	1	3	1	3	2
PO4	1	1	2	1	3	1	3	1.7
PO5	2	2	3	2	3	1	3	2.3
PO6	3	1	2	3	3	2	2	2.3
PO7	2	1	2	2	2	3	2	2
PO8	2	2	1	2	2	2	2	1.9
PO9	2	2	2	3	1	2	2	2
PO10	2	2	2	3	1	3	2	2.1
PO11	1	2	1	2	1	2	1	1.4
PO12	3	2	1	3	2	2	3	2.3
PSO1	1	2	3	2	3	2	1	2
PSO2	2	3	3	2	2	3	1	2.3
PSO3	1	2	2	3	2	3	2	2.1
PSO4	3	3	2	2	2	2	3	2.4

B. TECH. – SEMESTER-VI (CH)
CHEMICAL PROCESS SAFETY (PEC102)
(CORE ELECTIVE-II)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	3	60	0	0	0	60

A. COURSE OVERVIEW

To inculcate the safety culture among the undergraduate students of chemical engineering. To teach fundamentals of safety in process industries, current safety practices in industry by using various tools. To study industrial case studies and standards approved/recommended by CCPS, NFPA and Directorate of Industrial Safety and Health (DISH).

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction to Process Safety** Define: safety, hazard, risk, accident, incident, likelihood, consequence, loss prevention, domino effect, first aid, incident rate, lost workdays, occupational injury and illness, frequency rate, severity rate, fatality rate and fatal accident rate. Theory of accident causation, nature of accident process.	**CO1**
2.	**Process Safety Strategies and Case Studies** Concept of Active, Passive, Inherent and Procedural Strategies. Case Studies: Analysis of mistakes made and lessons to learn from four significant chemical industry disasters: Flixborough (England), Pasadena (Texas), Seveso (Italy) and Bhopal (India).	**CO1** **CO3**
3.	**Toxicological Studies** Entry routes of toxicants into biological system and appropriate control strategy. Elimination of toxicants from biological system by various ways, target organ, acute and chronic toxicity and its toxicological studies, chemical and physical asphyxiates, TLV-TWA, TLV-STEL and TLV-C, LD 50 and LC 50. Detection of possible hazard through senses.	**CO4**
4.	**Industrial Hygiene** Laws and regulations in Indian context and US context, role of OSHA, NIOSH, ACGIH, EPA, PSM vs. RMP. Safety work permits, Pre-start up and shut down procedures, emergency planning and response, mock drill, safety audit. Role of industrial hygienist: Identification using MSDS and NFPA diamond, Evaluation (quantification methods) and Control methods like Dyke and Enclosures, dilute and local ventilation, wet methods, good housekeeping and Personal Protective Equipment (PPE).	**CO2** **CO4**
5.	**Fire and Explosion** Basic definitions like fire, combustion, explosion, fire and flash point, auto-ignition etc., concept of fire triangle, flammability limits (LFL and UFL). Classification of fires, various extinguishing medium and its selection, mobile and stationary fire- fighting methods. Explosion types like mechanical explosion, detonation and deflagration, deflagration to detonation transition (DtoD transition), confined and unconfined explosion, dust explosions, vapor cloud explosion. BLEVE their causes and prevention, Numerical on fire & explosion.	**CO1** **CO2** **CO3**
6.	**Source Models** Concept of source models, flow of liquids and vapors through various geometries,	**CO1** **CO5**

	flashing liquids, liquid pool evaporation, Realistic and worst-case releases.	
7.	**Chemical Reactivity Hazard** Concept of chemical reactive hazard, thermal run-away models and parametric sensitivity. Use of calorimeters and its types like DSC, ARC, ARRST, APTAC, VSP2 etc. Characterization of reactive chemical hazard using calorimeters. Strategies to control reactive hazard, case study of T2 laboratory for reactive hazard.	
8.	**Introduction to Reliefs and Relief Devices** Need for relief devices, few terminologies like set pressure, max. Allowable working pressure, operating pressure, accumulation, overpressure, backpressure, blow down, max. allowable accumulated pressure etc., Location of reliefs, various reliefdevices like spring loaded (relief valve, safety valve and safety relief valve), mechanical, buckling pin and rupture dick. Selection criteria and combination criteria, effluent system, knock-out drum, cyclone, condenser, quench tank, scrubber, flare and incinerator. Concept of Basic process control systems (BPCS) and Safety instrumented system (SIS), sensor location criteria and redundancy of system, safety interlocks and alarm systems.	**CO1** **CO2**
9.	**Hazard Identification and Hazard Analysis** HAZID tools like hazard checklist, job safety assessment, hazard survey (Calculation of Dow and Mond Index). Hazard Operability (HAZOP case study), safety reviews, ALARP and Risk Management (RM). HAZAN using probabilistic methods, revealed and unrevealed failures, common failure modes and reliability calculations. Use of tools like FTA, ETA and LOPA analysis.	**CO1** **CO5** **CO6**
10.	**Safety Guidelines and Standards** Safety in laboratory of academic institute and R&D houses, safety during loading and unloading of chemicals, safety while operating positive pressure and negative pressure systems, safety in tank farm, plant lay outing for safer operations, piping and electrical color code. Brief discussion on coverage of factories act (1948), Boiler act (1923), hazardous waste (management and handling) rules (1989), OISD guidelines and ISO-14000 (EMS), 18000 (OHSAS) and 31000 (RM).	**CO4** **CO6**

C. TEXT BOOKS

1. Crawl, D. A.; Louvar, J. F. *Chemical Process Safety (fundamentals with applications)*; 3rd Ed.; Prentice Hall International Series, 2011

D. REFERENCE BOOKS

1. Lees, F. P. *Loss* Prevention in the Process Industries (Hazard Identification, Assessment and Control); 2nd Ed.; Butterworth-Heinemann, 1980
2. Kletz, T. Learning from Accidents; 3rd Ed.; Gulf Professional Publishing, 2001
3. Stoessel, F. Thermal Safety of Chemical Processes (Risk Assessment and Process Design);Wiley-VCH, 2008
4. Banerjee, S. Industrial Hazards and Plant Safety; 1st Ed.; CRC Press, 2002

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Development Determine Analyse Evaluate Awareness	Understand the fundamentals of chemical process safety and the importance of process safety.
CO2		Develop an ability to identify and quantify the potentialhazards associated with chemical processes.
CO3		Determining the issues pertaining to occupational safety andethical aspects associated with process safety.
CO4		Analyse the major industrial safety related regulations and

		guidelines.
CO5		Evaluate the process system through mathematical modelling and implementation of the outcomes for the mitigation and prevention of accidents.
CO6		Create awareness among students for the research andinnovation in the field of process safety for sustainable future

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	2.5	2.5	2.5	2.8
PO2	3	3	2.5	2.5	2.5	2.5	2.7
PO3	2.5	2.5	2.5	2.5	2.5	2.5	2.5
PO4	2.5	2.5	2.5	3	2.5	2.5	2.6
PO5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
PO6	3	3	2.5	2.5	2.5	2.5	2.7
PO7	3	3	3	2.5	2.5	2.5	2.8
PO8	3	3	3	2.5	2.5	2.5	2.8
PO9	2.5	2.5	2.5	2.5	2.5	2.5	2.5
PO10	2.5	3	2.5	2.5	2.5	2.5	2.6
PO11	2.5	2.5	2.5	2.5	2.5	2.5	2.5
PO12	3	3	3	3	3	2.5	2.9
PSO1	2	3	3	3	2	2	2.5
PSO2	2	3	3	3	2	2	2.5
PSO3	2	3	3	3	2	2	2.5
PSO4	2	3	3	3	2	2	2.5

B. TECH. – SEMESTER-VI (CH)
OPTIMIZATION TECHNIQUES (PEC102)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	3	60	0	0	0	60

A. COURSE OVERVIEW

Motivation: Study, Understand and Utilize the appropriate mathematical models and tools to optimize and solve the process and problems associated with any field and industry

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction to Operational Research** • Introduction, • Engineering Application, • Methods of Operation Research, • Formulation, • Graphical method of Solution	**CO1** **CO3** **CO4**
2.	**Linear Programming** • Simplex method • Degeneracy • Big-M method • Revised Simplex method	**CO2** **CO3** **CO4**
3.	**Transportation Model** • North-West Corner rule, • Row and Column Minima method, • Least-cost method, • Vogel's approximation method, • Degeneracy in transportation problem, • stepping stone method, • modified distribution method, • unbalanced supply and demand, • profit maximization problem, • trans-shipment problems	**CO3** **CO4** **CO5**
4.	**Assignment Model** • Hungarian method for solution • Variation of the assignment problem - non-square matrix, restriction on assignments. • Maximization problem • Travelling salesman problem • Travelling salesman problem (shortest cyclic route models)	**CO2** **CO3** **CO4**
5.	**Scheduling Optimization and Related Models on Sequencing** • Batch Scheduling • Formulation of sequencing models and its applications. • Introduction to Gantt Chart and its Application to Different types of Transferpolicies.	**CO5** **CO6**
6.	**Advanced topics in Linear Programming** • Duality in Linear Programming	**CO2** **CO3**

	• Primal to Dual conversion • Duality Theorem and Dual Simplex method	**CO4**
7.	**Dynamic programming** • Bellman's principle of optimality, • Examples on the application of routing problem, inventory problem, marketing problem.	**CO4** **CO5** **CO6**
8.	**Non-Linear Programming** • Elimination Methods — Unrestricted Search, Exhaustive Search, Dichotomous search, Fibonacci method, Golden Section Method, • Kuhn tucker condition	**CO1** **CO2** **CO3** **CO4**

C. TEXT BOOKS

1. Gupta P., Hira D.S., "Operation Research", S. Chand & Company Ltd
2. Rao S.S., "Engineering Optimization: Theory and Practice", Willey Publication
3. Vohra N D, Quantitative Techniques in Management, Tata McGraw Hill, New Delhi

D. REFERENCE BOOKS

1. Sharma S D & Sharma H, Operations Research: Theory, methods & applications
2. K. Nath R. Nath Arora J.S., "Introduction to Optimum Design", Elsevier Academic Press
3. Hiller & Libermann, Introduction to Operations Research, Tata McGraw Hill
4. Hamdy A. Taha, "Operation Research", Pearson Education
5. Operation Research – V. K. Kapoor, S. Chand Publication

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Define Describe Application Solution Development Use	**Define** the type of the problem in terms of Linear programmingproblem or Non-linear programming problem
CO2		**Describe** the formulation of the problem into mathematical approach/model
CO3		**Apply** the types of numerical/mathematical methods to be used in industry to have optimal solution
CO4		**Solve** the type of the problem using the appropriate method
CO5		**Develop** a skill to deal with type of problem to get best possibleresult
CO6		**Use** the mathematical tool to solve the trickiest problem

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	2	2	2.7
PO2	3	3	3	3	2	2	2.7
PO3	3	3	2	2	2	2	2.3
PO4	2	2	2	2	1	2	1.8
PO5	2	2	2	2	3	3	2.3
PO6	2	2	2	2	1	1	1.7
PO7	2	2	1	1	1	1	1.3
PO8	2	2	1	1	1	1	1.3
PO9	2	2	1	1	1	1	1.3
PO10	2	2	1	1	1	1	1.3
PO11	2	2	1	1	1	1	1.3
PO12	2	1	1	1	1	1	1.2

PSO1	3	3	3	2	3	3	2.8
PSO2	3	3	3	2	3	3	2.8
PSO3	3	3	3	2	2	2	2.5
PSO4	3	3	3	3	3	2	2.8

BACK

SEMESTER-VII

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
PCC116	Design and Simulation Lab	2	0	4	60	40	25	25	150	4
PCC113	Process Technology and Economics	3	1	0	60	40	0	0	100	4
PCC102	Transport Phenomena	3	0	3	60	40	25	25	150	4.5
ESC107	Material Science	3	0	0	40	0	0	0	40	3
PEC104	Core Elective-III (1), (2)	3	0	0	40	0	0	0	40	3
OEC103	Open Elective-III	3	0	0	40	0	0	0	40	3
	TOTAL	**17**	**1**	**7**	**300**	**120**	**50**	**50**	**520**	**21.5**

B. TECH. – SEMESTER-VII (CH)
DESIGN AND SIMULATION LAB (PCC116)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
2	0	4	6	4	60	40	25	25	150

A. COURSE OVERVIEW

Motivation: Use modern softwares to get an insight on various chemical processes and unit operations, analyze and evaluate them qualitatively through modeling and simulations.
Objectives: Process Simulation – Operating Aspen Plus Basic unit operations; Developing flowsheets and performing simulations; Parameter estimation and sensitivity study. **CFD Simulation** – Operating ANSYS FLUENT; Developing geometry and perform meshing; Performing simulations and analyzing the transport behavior of different systems

B. COURSE CONTENT

	TOPICS	COs
1.	**Process Simulation – Aspen Plus**	**CO1**
	• Introduction to Aspen Plus, Setting up the model	**CO2**
	• Steady state and Unsteady state Simulation	**CO3**
	• Concept of Flowsheeting, sequential modular and EO approach	**CO6**
	• Parameter estimation of experimental data, Sensitivity study	
2.	**CFD Simulations**	**CO4**
	• Introduction to the concept of CFD	**CO5**
	• Introduction to ANSYS Workbench, FLUENT Environment	**CO6**
	• Developing geometry for the Simulations	
	• Meshing the geometry	
	• Setting up of model for simulations – boundary and initial conditions	
	• Solver strategies	
3.	**Professional Ethics in Design and Simulation Lab**	
	• Computer Ethics and Computer supported co-operative world, value sensitive design	
	• Human welfare, confidentiality, data safety and management, trust, accountability	

C. PRACTICAL AND TERM WORK

Aspen Plus based simulations for basic unit operations such as – mixing tanks, distillation columns, reactors, absorption columns, heat exchangers and process flowsheets
CFD simulations using FLUENT for different geometries – pipe flow, venturi/orifice meter, annular flow, annular flow with heat transfer, CSTR

D. TEXT BOOKS

1. Aspen Plus Manuals
2. ANSYS FLUENT Manuals

E. REFERENCE BOOKS

1. Chemical Process Design and Simulation - Aspen Plus and Aspen HYSYS Applications Juma Haydary, AIChE / John Wiley & sons
2. ASPEN PLUS - Chemical Engineering Applications, Kamal I.M. Al-Malah, John

Wiley & sons
3. Computational flow modeling for Chemical Reactor Engineering, V. V. Ranade, AcademicPress

F. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Application Analysis Evaluate Create	**Develop** process flowsheet and understand to perform simulation by using ASPEN PLUS
CO2		**Solve** various chemical engineering problems with unit operations such as mixing, mass transfer, heat transfer, reactions
CO3		**Apply** Sequential modular and EO approach to solve problems
CO4		**Understand** the concept of CFD, create geometry, mesh andset initial and boundary conditions using ANSYS FLUENT
CO5		**Analyse** the transport behavior in different geometries suchas pipe flow, Venturi/orifice meters, annular flow, heat transfer
CO6		**Analyse** the technical feasibility of Industrial scale chemical manufacturing facility and **Evaluate** performance

G. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	3	3	3	3
PO3	3	3	3	3	3	3	3
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	3	3	3
PO6	3	3	3	3	3	3	3
PO7	3	3	3	3	2	2	2.7
PO8	3	3	3	3	3	3	3
PO9	3	3	3	3	2	2	2.7
PO10	3	3	3	3	2	2	2.7
PO11	3	3	3	3	3	3	3
PO12	3	3	3	3	2	2	2.7
PSO1	3	3	3	3	2	2	2.7
PSO2	3	3	3	3	2	2	2.7
PSO3	3	3	3	3	2	2	2.7
PSO4	3	3	3	2	2	3	2.7

B. TECH. – SEMESTER-VII (CH)
PROCESS TECHNOLOGY AND ECONOMICS (PCC113)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	1	0	4	4	60	40	0	0	100

A. COURSE OVERVIEW

Motivation: To equip the students with fundamental concepts and principles of manufacturing of various industrially important chemical products through the economics.

Course Objectives:

- To familiarize students with manufacturing aspects of industrially relevant chemicals.
- Economics is introduced to fill the gap between technical knowledge & commercial sustainability of any plant by imparting brief description of any plant from top to bottom approach.

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction to Process Technology** Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram formanufacture of inorganic chemicals, such as: inorganic acids, chlor-alkali, ammonia, fertilizers, etc.	**CO3** **CO6**
2.	**Introduction to Petrochemicals** Description, raw material and energy sources and consumptions, operating conditions, catalysts, basic block diagram and simplified process flow diagram formanufacture of Petrochemicals: C1, C2, C3, C4, etc., benzene, toluene, xylene and other petrochemicals from these basic building blocks.	**CO3** **CO6**
3.	**Industrial Fuels and Utilities** Industrially relevant fuels, Common utilities such as electricity, cooling water, steam, hot oil, refrigeration and chilled water.	**CO3** **CO6**
4.	**Cost Estimation** Factors involved in project cost estimation, total capital investment, fixed capital investment, fixed capital & working capital, type & methods for estimation of totalcost, investment, estimation of cost of equipment & cost of production.	**CO1** **CO2** **CO4** **CO5**
5.	**Estimation of Total Product Costs** Factors involved in total cost of production, factors affecting investment & production cost, Direct Production cost, Plant overhead cost, Fixed Charges & General Expenses.	**CO1** **CO2** **CO4** **CO5**
6.	**Analysis of Projects** Analysis of working results project: Balance sheets, Project financing, concept ofinterest, time value of money, depreciation. Profitability Analysis of Projects. Ethics to develop the moral conditions of professionalism.	**CO1** **CO2** **CO4** **CO5**

C. TEXT BOOKS

1. Shreve's Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984
2. Dryden's Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East WestPress, 1997

3. Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005

D. REFERENCE BOOKS

1. Chemical Process Technology, Moulijn, M. and van Dippen, Wiley, 2013.

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Development Explanation Analysis Application Awareness	Understand the basic economic concepts and apply them in theproject works undertaken.
CO2		Develop an ability to carry out the primary techno-economic feasibility of project and to identify various process conditions associated with chemical processes and operations.
CO3		Explaining the production processes of various chemicalproducts.
CO4		Analyse the project cost including capital investment, productcost, time value, total project cost and the major engineering problems associated with production units of various chemical industries.
CO5		Application of basics of depreciation, profitability and projectfinance and process drawing tools for process flow diagrams.
CO6		Create awareness among students for the research and innovation in the field of process technology and economics for environmental issues and sustainability.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	2	3	3	2.8
PO2	3	3	3	2	3	3	2.8
PO3	3	3	3	2	3	3	2.8
PO4	3	3	3	2	3	3	2.8
PO5	3	2	3	2	2	3	2.5
PO6	3	2	2	3	3	3	2.7
PO7	3	3	2	2	3	2	2.5
PO8	3	3	3	2	3	2	2.7
PO9	3	2	3	3	2	2	2.5
PO10	3	3	3	3	2	2	2.7
PO11	3	3	3	2	3	2	2.7
PO12	3	3	2	3	3	2	2.7
PSO1	2	3	3	3	2	2	2.5
PSO2	2	3	3	3	2	2	2.5
PSO3	2	3	3	3	2	2	2.5
PSO4	2	3	3	3	2	2	2.5

B. TECH. – SEMESTER-VII (CH)
TRANSPORT PHENOMENA (PEC102)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	3	6	4.5	60	40	25	25	150

A. COURSE OVERVIEW

The objective of this course is to make students aware and to teach them how to deal with the movement of different physical quantities such as momentum, energy and mass in any chemical or mechanical process and combination of the basic principles (conservation laws) and laws of various types of transport.

B. COURSE CONTENT

	TOPICS	COs
1.	Review of momentum, energy & mass transport by molecular motion, Vector andTensor Analysis: Basic concepts, Euler/ Lagrangian viewpoint, laminar and turbulent flows, boundary layers, stress tensor	CO1
2.	**Momentum Transport:** shell momentum balances, velocity profiles in cases like adjacent flow of two liquids. **Energy Transport:** shell energy balances, temperature profiles, heat conduction with an electrical heat source, heat conduction viscous heat source & heat conduction chemical heat source. **Mass Transport:** concentration distribution in solids & laminar flow, shell mass balances, diffusion with heterogeneous chemical reaction, diffusion in falling liquid film	CO2, CO3 CO4 CO6
3.	**Momentum Transport:** equation of change for isothermal system, equation of continuity & motion in rectangular, cylindrical & spherical co-ordinates. **Energy Transport:** non-isothermal systems, equation of energy of motion for forced & free convection in non-isothermal flow. **Mass Transport:** equation of continuity for binary mixtures, equation of change for multi-component systems, mass flux in terms of transport properties, use of equation of change	CO2, CO3 CO4 CO5 CO6
4.	**Momentum Transport:** unsteady state viscous flow, two-dimensional viscous flow, boundary layer momentum transport. Energy Transport: heat conduction in viscous flow, boundary layer energy transport. **Mass Transport:** unsteady diffusion,diffusion in viscous flow, two-dimensional diffusion in solids, boundary layer theory	CO2 CO3 CO6
5.	**Momentum Transport:** time smoothing of equation of change for incompressible fluid & review of logarithmic law of viscosity. **Energy Transport:** temperature fluctuations & time smoothing of temperature & energy equation, semi-empirical equations for turbulent energy flux. **Mass Transport:** time smoothing of equation of change, turbulent concentration profiles	CO2 CO3 CO4 CO5 CO6
6.	**Momentum transport:** friction factors for flow in tubes, flow rate & pressure drop relations, friction factor for packed beds. **Energy Transport:** non-isothermal system, heat transfer coefficients, dimensionless correlations for forced & free convection in tubes & around submerged objects, heat transfer coefficient for forced convection through packed bed. **Mass Transport:** mass transport coefficient, correlations for binary systems in one phase & at low mass transfer rates, definition & correlation for binary mass transfer coefficients in two phases at low mass transfer rates, transfer coefficients for high mass transfer rates, boundary layer theory	CO3 CO4 CO6

7.	**Microscopic mass balance & mechanical energy balances,** estimation of friction losses, macroscopic energy balance in non-isothermal systems, use of balances to solve steady state & unsteady state problems. **Ethical practices for designing of equipment's using change equations**	**CO3 CO4 CO6**

C. TEXT BOOKS

1. Bird R B; Stewart W E; Lightfoot F W,, Transport Phenomena, John Wiley & Sons
2. Gupta S K, Momentum Transfer Operations, Tata McGraw Hill Corp

D. REFERENCE BOOKS

1. Laddha G S; Degaleesan T E , Transport Phenomenon in Liquid Extraction , McGraw Hill Publishing
2. Sherwood T K; Pigford R L, Absorption & Extraction, McGraw Hill Publishing
3. Holland D D, Multi-component Distillation, Prentice Hall, India

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Design Troubleshoot Application Analysis Develop	Understand the system and analyse the same with the help ofscience and engineering fundamentals
CO2		Design momentum, heat and mass transfer systems
CO3		Modify and trouble shoot the process equipment for betterefficiency
CO4		Build a bridge between theoretical and practical concepts
CO5		Utilize the process knowledge and existing simulation tools while analysing process using commercial solvers
CO6		Develop analytical thinking to overcome simple systemengineering related problems

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	3	3	3	3
PO3	3	3	3	3	3	3	3
PO4	3	3	2	3	3	2	2.7
PO5	2	3	3	2	3	2	2.5
PO6	2	3	3	2	3	2	2.5
PO7	2	3	3	2	3	2	2.5
PO8	3	2	2	2	2	2	2.2
PO9	2	2	2	2	2	2	2
PO10	1	1	2	2	2	1	1.5
PO11	2	2	2	2	2	2	2
PO12	3	3	3	3	3	2	2.8
PSO1	3	2	3	3	3	3	2.8
PSO2	3	3	2	3	3	3	2.8
PSO3	3	3	3	2	3	3	2.8
PSO4	3	3	2	2	3	3	2.7

B. TECH. – SEMESTER-VII (CH)
MATERIAL SCIENCE (ESC107)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	3	40	0	0	0	40

A. COURSE OVERVIEW

Motivation: Learning different classes of materials, their properties, processing and performance characteristics relevant to chemical engineering. Objective of course is to learn different classes of materials relevant to chemical industries, understand the performance characteristics of materials, development of knowledge pertaining to the application of materials based upon processing, evaluate the possible failures due to stress and corrosion and analyze and understand experimental characterization techniques.

B. COURSE CONTENT

	TOPICS	COs
1.	**Basic concepts of materials and material science** Introduction to materials, bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Van der Waals bond, thermal expansion, elastic modulus and melting point of materials, Role of materials selection in design, structure-property-processing-performance relationships. Mechanical properties: Isotropy and anisotropy, Stress and strain relation, Hooke's law, Modulus of material, Poisson's ratio.	**CO1**
2.	**Fundamental Properties and failures** Miller indices of directions and planes, packing of atoms inside solids, close-packedstructures, structure of ceramics, ionic solids, glass and polymers, density of variousmaterials. Imperfections in solids: vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults. Yield strength, tensile strength and ductility of materials: stress strain behavior of metals, ceramicsand polymers, tensile test. Plastic deformation, necking, creep behavior and fatigue and related knowledge of safety, and welfare of coworkers due to failure.	**CO3** **CO5**
3.	**Ferrous materials** Ferrous metals, cast iron and its types, Steel, stainless steel, classification of steel, manufacturing process of steel. Alloy steels and its classification, Advantages and Disadvantages of Alloy Steel, Purpose of Alloying, effect of alloying elements on mechanical properties of steel, their safety and health impacts.	**CO1** **CO3**
4.	**Materials** Semi-crystalline materials, their classification, structure and configuration of ceramics, polymers, copolymers, liquid crystals and amphiphiles. Non-crystalline/amorphous materials: Silicates, glass transition temperature, viscoelasticity. Polymer nano-composite materials: Nanocomposites, role of reinforcement-matrix interface strength on composite behavior. Biomaterials, material related to catalyst such as zeolites, silica etc. and other selected materials	**CO2**
5.	**Corrosion, Degradation and Recycling** Mechanism of corrosion, dry & wet corrosion, other forms of corrosion, Passivity, factors influencing corrosion, atmospheric corrosion. Control & prevention of	**CO5** **CO6**

	corrosion – cathodic & anodic control, inhibitors & other protective measures. Protective coatings, metallic coating & metal cladding, physico-chemical principles involved, chemical conversion coating, organic coating, enamels, ceramic protective materials.	
6.	**Experimental techniques** Introduction to experimental techniques: XRD, NMR, PSA, etc. for material characterization highlighting links between molecular structure and macroscopic properties	**CO6**

C. TEXT BOOKS

1. Hajra Chaudhary, S.K. Material science and Processes; Indian Book Distributing Co., 2009
2. Raghavan, V. Materials Science and Engineering, fifth edition, Prentice Hall of India Private Limited: New Delhi, 2011

D. REFERENCE BOOKS

1. S. Upadhyaya and A. Upadhyaya, Material Science and Engineering, Anshan Publications, 2007
2. Vijaya, M.S.; Rangarajan, G. Materials Science; Tata McGraw-Hill Education, 2004
3. Jastrzebski, Z.D. The Nature and Properties of Engineering Materials; (ed 2), Wiley & Sons: New York, 1976
4. Van Vlack, L.H. Elements of Material Science and Engineering; Thomas Press: India, 1998
5. William, D.; Callister, Jr. Materials Science and Engineering – An introduction; sixth edition, John Wiley & Sons, Inc., 2004
6. B. S. Mitchell An Introduction to Materials Engineering and Science for Chemical and materials Engineers, John Wiley & Sons, 2004

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Comprehensive Remembering Understand Application Evaluate Analysis	Develop basic concepts of materials.
CO2		Classify various engineering materials.
CO3		Understanding of performance characteristics of materials.
CO4		Application of materials in industries as per the safety, health and welfare of co-workers.
CO5		Evaluation of possible failures due to stress and corrosion.
CO6		Analyse various experimental characterization techniques.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	2	3	3	3	2.8
PO2	3	2	3	3	3	3	2.8
PO3	3	3	3	3	3	2	2.8
PO4	2	2	3	2	3	3	2.5
PO5	2	2	2	3	3	3	2.5
PO6	2	2	3	3	3	2	2.5
PO7	2	2	2	3	3	3	2.5
PO8	2	2	3	3	3	2	2.5
PO9	2	2	3	2	3	3	2.5
PO10	2	2	3	3	3	3	2.7

PO11	2	2	2	3	3	3	2.5
PO12	3	3	3	3	3	2	2.8
PSO1	3	3	3	3	2	3	2.8
PSO2	3	3	3	3	3	2	2.8
PSO3	2	2	3	3	3	3	2.7
PSO4	2	3	3	3	3	3	2.8

B. TECH. – SEMESTER-VII (CH)
CHEMICAL PROCESS OPTIMIZATION (PEC104)
CORE ELECTIVE-III

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	3	40	0	0	0	40

A. COURSE OVERVIEW

Motivation: Examine the different optimization techniques associated with the field of Chemical engineering and other fields

Objectives: Formulate the objective functions for constrained and unconstrained optimization problems; Implement different optimization techniques; solve problems using non-traditional techniques; use of different optimization techniques for integrated planning, scheduling and control in the process industries

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction** • Process optimization • Nature and Organization of Optimization Problems • Formulation of various process optimization problems and their classification • Formulation of the Objective Function	**CO1** **CO2**
2.	**Optimization Theory and Methods** • NLP Problem Statement • Convexity and Its Applications • Optimality conditions for a single-variable and multi-variable function • Structure of a single-variable and multi-variable optimization problems withand without constraints (qualitative treatment)	**CO1** **CO2** **CO3**
3.	**Optimization programming with applications** • Linear programming (LP) & Nonlinear programming (NLP) with applications • Mixed-Integer Programming- MILP & MINLP • Global Optimization for Problems with Continuous and Discrete Variables	**CO2** **CO3** **CO5**
4.	**Chemical engineering optimization problems** • Part 1: Pipe diameter, Optimization of a Multi-Effect Evaporator, OptimalShell-and-Tube Heat Exchanger Design, Reflux ratio of distillation column. • Part 2: Thermal cracker, Alkylation reactor, Optimal Design of an AmmoniaReactor. • Integrated Planning, Scheduling and Control in the Process Industries	**CO4** **CO5** **CO6**

C. TEXT BOOKS

1. Edgar, T. F., Himmelblau, D. M. and Lasdon, L.S. *Optimization of Chemical Processes*,McGraw-Hill,2001
2. Babu, B.V., *Process Plant Simulation*, Oxford University Press ,2004

D. REFERENCE BOOKS

1. Kalyanmoy, D., *Optimization for Engineering Design*, Prentice Hall,1998
2. Reklaitis, G. V., Ravindran, A., and Ragsdell, K. M., *Engineering Optimization - Methodsand Applications*, John Wiley,1983
3. Reklaitis, G. V., Ravindran, A., and Ragsdell, K. M., *Engineering Optimization - Methodsand Applications*, John Wiley,1983
4. Box, G. E. P., Hunter, W. G., Hunter, J. S., *Statistics for Experimenters – An Introductionto Design, Data Analysis, and Model Building*, John Wiley,1978

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Synthesis Applying Evaluating Creating Planning Applying	**Describe** the basic concept of optimization techniques in thechemical process industry.
CO2		**Identify** the different solving methods with containing the different Linear Programing Models (LP Models & NLPModels)
CO3		**Apply the basic knowledge** on real-time problems related tochemical engineering or other fields of engineering.
CO4		**Evaluate** the economical aspect of the chemical process ordesign engineering
CO5		**Generating** reports for selection, Design and troubleshooting of Industrial optimization.
CO6		**Integrated Planning**, Scheduling and Control in the Process Industries by considering environmental & safety constraints.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	3	3	3	3
PO3	3	3	3	2	3	3	2.8
PO4	3	3	3	2	2	2	2.5
PO5	2	3	3	2	3	2	2.5
PO6	2	2	2	3	3	3	2.5
PO7	2	3	3	3	3	3	2.8
PO8	3	2	2	2	3	3	2.5
PO9	2	2	2	2	3	3	2.3
PO10	2	2	2	2	3	3	2.3
PO11	3	3	2	3	3	3	2.8
PO12	3	3	3	3	3	3	3
PSO1	3	2	3	2	3	3	2.7
PSO2	2	3	2	3	2	3	2.5
PSO3	3	3	3	2	3	2	2.7
PSO4	2	2	3	3	3	3	2.7

B. TECH. – SEMESTER-VII (CH)
ADVANCE PROCESS CONTROL (PEC104)
CORE ELECTIVE-III

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
3	0	0	3	3	40	0	0	0	40

A. COURSE OVERVIEW

Expose students to the advanced control methods used in industries and research. Students will be able to analyse, design and tune the advanced controller used for solving the critical problems in the industries related to safety, economy and optimization.

B. COURSE CONTENT

	TOPICS	COs
1.	Review of Single Input Single Output (SISO) Control.	**CO3**
2.	Linearization of Mechanistic models . Introduction to z-transform. Development of grey-box models	**CO1 CO3**
3.	Development of output error models. Introduction to stochastic processes Development of ARX and ARMAX models. Model structure selection and issues in model development	**CO2 CO3**
4.	Stability analysis of discrete time systems. Lyapunov Functions and interaction analysis. Multi-loop control. Multivariable-decoupling control Soft sensing and state estimation	**CO3 CO4**
5.	Development of Luenberger observer. Introduction to Kalman filtering	**CO2 CO5**
6.	State feedback control design. Introduction to Linear Quadratic Gaussian control (LQG). Design of Linear Quadratic Gaussian regulator and controller. Design of DMC and Model Predictive control	**CO4 CO5 CO6**

C. TEXT BOOKS

1. B. Wayne Bequette, Process Control Modeling, Design & Simulation, PHI
2. L.Ljung, "System Identification - Theory for the User", Prentice Hall, 1987
3. E. Camacho and C. Bordons, "Model Predictive Control in the Process Industry", 1995

D. REFERENCE BOOKS

1. Process Dynamics and Control, D. E. Seborg, T. F. Edgar, D.A. Mellichamp, Wiley, 2003
2. Control System Design, by Graham C. Goodwin, Stefan F. Graebe, Mario E. Salgado, Prentice Hall, 2000
3. Franklin, G. F., Powell, J. D., and M. L. Workman, Digital Control Systems, Addison Wesley, 1990
4. Astrom, K. J., and B. Wittenmark, Computer Controlled Systems, Prentice Hall India (1994)

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understand Synthesis Applying Evaluating Creating Planning Applying	Analyze and design advanced control systems.
CO2		Understand industrial applications of control theory.
CO3		Apply the knowledge of process control to design the control algorithms and its tuning.
CO4		Evaluate and judge the comparative performance of the different control strategies.
CO5		Design of digital control systems.
CO6		Optimization and safety evaluation of the overall process control system of an industry.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	3	3	3	3	3	3	3
PO3	3	3	3	3	3	3	3
PO4	3	3	2	3	3	2	2.7
PO5	2	3	3	2	3	2	2.5
PO6	2	3	3	2	3	2	2.5
PO7	2	3	3	2	3	2	2.5
PO8	3	2	2	2	2	2	2.2
PO9	2	2	2	2	2	2	2
PO10	1	1	2	2	2	1	1.5
PO11	3	3	3	3	3	3	3
PO12	3	3	3	3	3	3	3
PSO1	3	2	3	3	2	3	2.7
PSO2	3	3	2	3	3	3	2.8
PSO3	3	3	3	2	2	3	2.7
PSO4	3	2	3	2	3	3	2.7

BACK

SEMESTER-VIII

Subject Code	Subject Name	Teaching Scheme (hr/w)			Exam Scheme (Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
HS104	Universal Human Value-II	2	1	0	40	0	0	0	40	3
PEC103	Core Elective-IV	2	0	2	40	0	25	25	90	3
PROJ	Industrial Internship	0	3	12	0	0	150	100	250	9
PROJ	Working Project	1	0	4	0	0	50	50	100	3
	TOTAL	**5**	**4**	**18**	**80**	**0**	**175**	**225**	**480**	**18**

B. TECH. – SEMESTER-VIII (CH)
UNIVERSAL HUMAN VALUES-II (PEC104)

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
2	1	0	3	3	40	0	0	0	40

A. COURSE OVERVIEW

Motivation: Development of holistic perspective based on self-exploration. Discussion about individual role in the society and nature.

Course objective is to understand the general perspective based on self-exploration about themselves, family and nature. The harmony in the human being, family, society and nature. Strengths of self-reflection. Importance of commitment and courage to act

B. COURSE CONTENT

	TOPICS	COs
1.	**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education** Purpose and motivation for the course, recapitulation from Universal Human Values-I. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.	
2.	**Understanding Harmony in the Human Being - Harmony in Myself** Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health.	
3.	**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship** Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.	
4.	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence** Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self- regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence	

5. Implications of the above Holistic Understanding of Harmony on Professional Ethics

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations

C. TEXT BOOKS

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

D. REFERENCE BOOKS

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004
3. The Story of Stuff (Book)
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English); Gandhi - Romain Rolland (English)

E. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Development Understanding Comprehensive Creation Analysing Problem solving	Development of a holistic perspective based on self-exploration about human being and surrounding.
CO2		Understanding of the harmony in the human being, family, society and nature/existence.
CO3		Defining and strengthening of self-reflection.
CO4		Development of commitment and courage to act.
CO5		Analysing issues/problems and their role in society.
CO6		Improving human values and humanities.

F. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	3	3	3	3	3	3	3
PO2	2	3	3	2	3	3	2.7
PO3	3	3	2	3	3	3	2.8
PO4	2	3	3	3	3	3	2.8
PO5	3	3	3	2	3	3	2.8

PO6	3	3	3	3	3	3	3
PO7	3	3	2	3	3	3	2.8
PO8	3	3	3	3	3	3	3
PO9	3	3	2	2	3	3	2.7
PO10	3	3	3	3	3	3	3
PO11	2	2	3	3	3	3	2.7
PO12	3	3	3	3	3	3	3
PSO1	3	3	3	3	3	3	3
PSO2	3	3	2	3	3	3	2.8
PSO3	2	3	2	3	3	3	2.7
PSO4	3	2	3	3	3	3	2.8

B. TECH. – SEMESTER-VIII (CH)
COMPUTER AIDED DESIGN IN CHEMICAL ENGINEERING (PEC104)
CORE ELECTIVE-IV

Teaching Scheme (Hours/Week)				Credits	Examination Scheme				
L	T	P	Total		Ext	S	TW	P	Total
2	0	2	4	3	40	0	25	25	90

A. COURSE OVERVIEW

Development of customized solution of chemical engineering design / optimization problems using various CAD tools. Use of computer for solving complex problems reduces human error, improves efficiency, removes redundancy and cost-effective optimal solutions can be obtained

Objectives:

To study applications of computer aided tools in design, optimization and control of chemical engineering systems. Emphasis is to develop CAD modules using MATLAB for solving various design problems, dynamic problems and optimization problems in chemical engineering

B. COURSE CONTENT

	TOPICS	COs
1.	**Introduction to Computer Aided Design** Motivation for using CAD in chemical engineering, Preliminaries of CAD, Tools of CAD, Onion model of process design	**CO1 CO3**
2.	**Computer aided design of process equipment** Computer aided design of pressure vessel and algorithm development, Computer aided Nozzle design, Computer aided Head design, CAD module generation for Pressure Vessel using MATLAB	**CO1 CO2 CO3**
3.	**Computer aided optimization in Chemical engineering** Introduction of Optimization, Linear Programming, Simplex and Big M method and its variants, Application of MATLAB for solving linear programming optimization problems, Nonlinear optimization in chemical engineering, Convexity and its determination, Unconstraint and constraint nonlinear optimization methods, Newton's method, Nelder-Mead method, Steepest descent method, Nonlinear optimization using MATLAB, CAD module generation for Optimization	**CO1 TO CO6**
4.	**Process Synthesis and Pinch Technology** Optimal Distillation column sequencing, Direct and indirect sequencing, side-rectifier, side-stripper columns, Prefractionator with heat integration, Petluyk column, Simulation studies of column sequencing, Heat Exchanger network design, energy target, computer aided design of HENS	**CO1 TO CO6**
5.	**Process Flow-sheeting and simulation** Flow sheet simulation algorithms, sequential modular and simultaneous modular approaches, Equation Oriented approach, tearing of recycle streams, Simulation examples using process simulators	**CO1 TO CO6**

C. PRACTICAL AND TERM WORK

Simulation experiments are designed to use various CAD tools such as MATLAB, ASPEN PLUS software for solving developing CAD modules for solving design problems, dynamic problems and optimization problems

D. TEXT BOOKS

1. Bhattacharya, C. M.; Narayanan, C. M. *Computer Aided Design of Chemical Equipment*; New Central Book Agency (P) Ltd.: Calcutta, India, 1992
2. Husain, A. *Chemical Process Simulation*, Wiley Eastern Limited: New Delhi, 1986
3. Smith, R. *Chemical Process Design and Integration*, John Wiley & Sons Ltd.: England, 2005
4. Seborg, D. E.; Edger, T. F.; Mellichamp, D. A. *Process Dynamics and Control*, 2nd ed.; Wiley India, New Delhi, 2004

E. REFERENCE BOOKS

1. Edger, T. F.; Himmelblau, D. M.; Lasdon, L. S. *Optimization of Chemical Processes*; 2 nd ed. McGraw-Hill: New York, 2001
2. B. V. Babu, *Process Plant Simulations*; Oxford Press, 2004

F. COURSE OUTCOMES

COs	SKILLS	STATEMENT
CO1	Understanding Analysing Applying Evaluating Creating Remembering evaluating	Formulate standard single/multivariable optimization Problem, **Understand** and Apply various optimization techniques to solve problems in Chemical Engineering using MATLAB. **Understand** distillation sequences using process simulation software
CO2		Develop and **Analyse** energy target-based heat exchanger network using process simulation software. Analyse steady state and dynamic problems and create simulation modules for chemical processes using process simulation software. **Understand** the ethics and morality in the context of CAD in Chemical Engineering
CO3		**Apply** various CAD tools for solving design problems, Steady state and dynamic Analysis problem, optimal control problems
CO4		**Do** critical evaluation of the performance of various CAD tools simulations for solving chemical engineering problems.
CO5		Create CAD modules for design of process equipment
CO6		**Generate** a matlab program for industrial application to carry out steady state and dynamics analysis.

G. COURSE MATRIX

	CO1	CO2	CO3	CO4	CO5	CO6	AVG.
PO1	2	2	2	3	2	3	2.3
PO2	1	1	3	3	3	3	2.3
PO3	1	2	3	3	3	3	2.5
PO4	1	1	2	3	2	3	2
PO5	0	0	2	3	3	3	1.8
PO6	2	2	3	3	3	3	2.7
PO7	2	3	3	3	3	3	2.8
PO8	1	1	2	2	2	3	1.8
PO9	2	2	3	2	3	3	2.5
PO10	1	2	3	2	2	3	2.2
PO11	2	3	3	2	2	3	2.5
PO12	3	3	3	2	3	3	2.8
PSO1	2	3	3	3	2	3	2.67
PSO2	3	3	3	2	3	2	2.67
PSO3	2	3	2	2	2	2	2.17
PSO4	3	3	3	3	3	3	3