BMS COLLEGE OF ENGINEERING BENGALURU
Autonomous College under VTU

VISION	MISSION
PROMOTING PROSPERITY OF MANKIND BY AUGMENTING HUMAN RESOURCE CAPITAL THROUGH QUALITY TECHNICAL EDUCATION & TRAINING	ACCOMPLISH EXCELLENCE IN THE FIELD OF TECHNICAL EDUCATION THROUGH EDUCATION, RESEARCH AND SERVICE NEEDS OF SOCIETY

DEPARTMENT OF CHEMICAL ENGINEERING
Program Accredited by NBA in Tier-1 format for 6 years

SECOND, THIRD, AND FORTH YEAR SYLLABUS BOOK
(3rd, 4th, 5th, 6th, 7th, and 8th Semesters)
With effect from the A.Y. 2019-20

DEPARTMENT VISION

Be a globally recognized Chemical Engineering Department by imparting quality education

DEPARTMENT MISSION

- High-quality education and experience to the budding Chemical Engineers
- Chemical Engineering graduates to assume positions in process and other allied industries
- Foster and encourage the pursuit of excellence in chemical science and engineering
- Inculcate global research potential

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates pursue profession in chemical & allied engineering
PEO2: Graduates work in diversified team
PEO3: Graduates will pursue higher education & research

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Graduates will apply the knowledge of basic sciences and chemical engineering for techno feasible synthesis, separation and purification of products
PSO2: Graduates will ensure process safety and sustainability by automation and control of processes
PSO3: Graduates will optimize and design process equipment for engineering applications

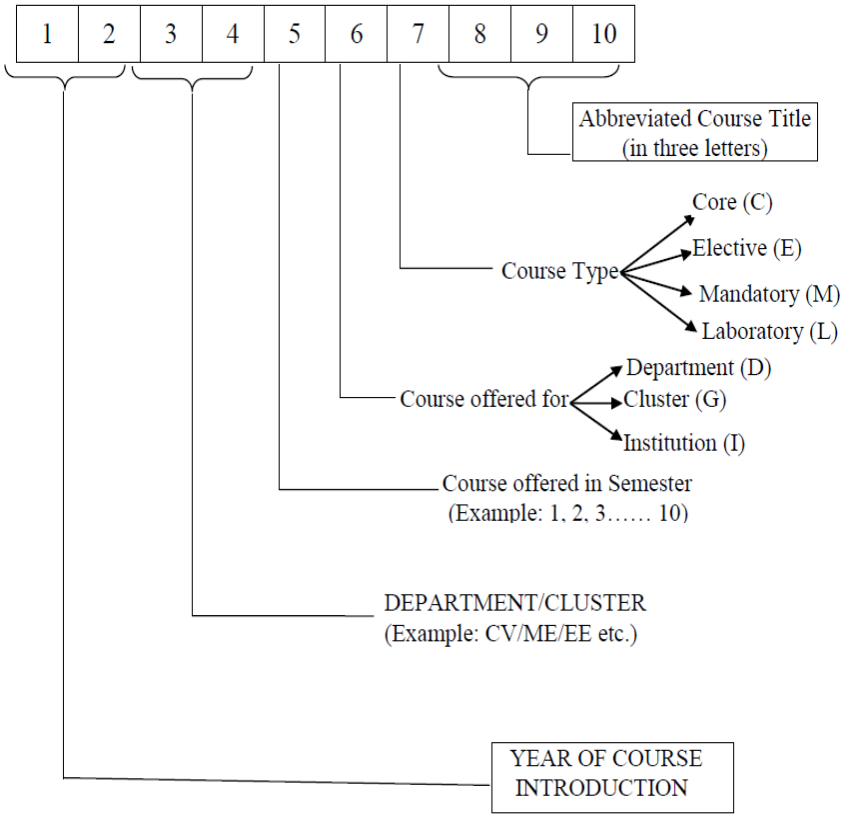
PROGRAM OUTCOMES (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

NOTATIONS

AY	Academic Year
AAT	Alternative Assessment Tools
BOE	Board of Examiners
BOS	Board of Studies
CBCS	Choice Based Credit System
CGPA	Cumulative Grade Point Averages
CIE	Continuous Internal Evaluation
CO	Course Outcomes
DC	Departmental Core
GC	Group Core
HSS	Humanity and Social Science courses
IC	Institutional Core
IE	Institutional Elective
IL	Institutional Lab
LTP	Lecture-Tutorial-Practical
NFTE	Not Fit for Technical Education
PCC	Professional Core Courses
PSO	Programme Specific Outcomes
PO	Programme Outcomes
PEC	Professional Elective Courses
SEE	Semester End Examination
SGPA	Semester Grade Point Average
ST	Studio

NOMENCLATURE FOR THE COURSE CODE



SCHEME OF INSTRUCTION FOR THIRD SEMESTER

S No	Course Type	Code	Course Title	Credits			Total	Contact Hours/ week
				L	T	P		
1.	BS-5	19MA3BSAPM	Applied Mathematics	3	0	0	3	3
2.	ES-7	19CY3DCMCA	Materials Chemistry and Applications	3	0	0	3	3
3.	PC-1	19CH3DCFME	Fluid Mechanics	3	0	1	4	5
4.	PC-2	19CH3DCMOP	Mechanical Operations	3	0	1	4	5
5.	PC-3	19CH3DCTD1	Process Engineering Thermodynamics-I	3	0	0	3	3
6.	PC-4	19CH3DCPPC	Process Principles and Calculations	3	1	0	4	5
7.	HS-1	19CH3HSESP	Environmental Studies and Pollution Control	3	0	0	3	3
8.	MC	20CHDHMC1	Kannada Language	1	0	0	1	1
9.	NC-3	19HS3NCPDC	Personality Development and Communication Skills	Non-credit mandatory Course				
TOTAL				22	1	2	25	28

SCHEME OF INSTRUCTION FOR FOURTH SEMESTER

S No	Course Type	Code	Course Title	Credits			Total	Contact Hours/ week
				L	T	P		
1.	PC-5	19MA4BSSAP	Statistics and Probability	3	0	0	3	3
2.	PC-6	19CH4DCTD2	Process Engineering Thermodynamics-II	3	1	0	4	5
3.	PC-7	19CH4DCHTR	Process Heat Transfer	3	0	1	4	5
4.	PC-8	19CH4DCANI	Analytical Instruments	3	0	1	4	5
5.	PC-9	19CH4DCMT1	Mass Transfer-I	3	0	0	3	3
6.	HS-2	19IC4HSCPH	Constitution of India-professional ethics and human rights	1	0	0	1	1
7.	PE-1	19CH4DELA1	Chemical Plant utilities	3	0	0	3	3
		19CH4DELA2	Food engineering					
8.	HS-3	19HS4CHEDM	Entrepreneurship Development & Management	3	0	0	3	3
	TOTAL			22	1	2	25	28

Humanities and Social Sciences including Management Courses (HS); Basic Science Courses (BS); Engineering Science Courses (ES); Professional Core Courses (PC); Professional Elective Courses (PE); Open Electives (OE); Project Work (PW); Technical Seminar (SR); Internship in industry or Institution (IN); Non-Credit Mandatory Courses (NC).

SCHEME OF INSTRUCTION FOR FIFITH SEMESTER

S No	Course Type	Code	Course Title	Credits			Total	Contact Hours/ week
				L	T	P		
1.	PC-09	19CH5DCTRP	Transport Phenomena	3	0	0	3	3
2.	PC-10	19CH5DCPCE	Process Control Engineering	3	0	1	4	5
3.	PC-11	19CH5DCMT2	Mass Transfer-II	3	0	1	4	5
4.	PC-12	19CH5DCCR1	Chemical Reaction Engineering-I	3	0	0	3	3
5.	PC-13	19CH5DCCED	Chemical Equipment Design	3	0	0	3	3
6.	PE-02	19CH5DELB1	Operations Research	3	0	0	3	3
		19CH5DELB2	Optimization of Chemical Processes					
7.	PE-03	19CH5DELC1	Petroleum Refining	3	0	0	3	3
		19CH5DELC2	Recycling and Reuse of Waste for Sustainable Development					
8.	PW-01	19CH5DCPW1	Project Using Modern Simulation Software Tools	0	0	2	2	4
TOTAL				21	0	4	25	29

SCHEME OF INSTRUCTION FOR SIXTH SEMESTER

S No	Course Type	Code	Course Title	Credits			Total	Contact Hours/ week
				L	T	P		
1.	PC-14	19CH6DCPED	Process Equipment Design	3	0	0	3	3
2.	PC-15	19CH6DCPMS	Process Modeling Simulation	3	0	1	4	5
3.	PC-16	19CH6DCCR2	Chemical Reaction Engineering-II	3	0	1	4	5
4.	HS-04	19CH6HSEIE	Economics in Engineering	3	0	0	3	3
5.	PE-04	19CH6DELD1	Numerical Techniques in Chemical Engineering	3	0	0	3	3
		19CH6DELD2	Interfacial phenomena					
6.	OE-01	19CH6OECOM	Composite Materials	3	0	0	3	3
7.	PW-02	19CH6DCPW2	Chemical Plant Design Project	0	0	3	3	6
8.	SR-01	19CH6DCSR1	Seminar-1: Based on certified MOOC course on NPTEL/SWAYAM	0	0	2	2	2
TOTAL				18	0	7	25	30

Humanities and Social Sciences including Management Courses (HS); Basic Science Courses (BS); Engineering Science Courses (ES); Professional Core Courses (PC); Professional Elective Courses (PE); Open Electives (OE); Project Work (PW); Technical Seminar (SR); Internship in industry or Institution (IN); Non-Credit Mandatory Courses (NC).

SCHEME OF INSTRUCTION FOR SEVENTH SEMESTER

S No	Course Type	Code	Course Title	Credits			Total Credits	Contact Hours
				L	T	P		
1.	BS-7	19CH7BSBFE	Biology for Engineers	2	0	0	2	2
2.	PC-17	19CH7DCBCE	Biochemical Engineering	3	0	0	3	3
3.	PC18	19CH7DCCTN	Chemical Technology	3	0	0	3	3
4.	PC-19	19CH7DCRSM	Risk and Safety Management in Process industries	0	0	2	2	4
5.	OE-2	19CH7OENTN	Advances in Energy Technology	3	0	0	3	3
6.	PE-5	19CH7DELE1	Advances in Separation Techniques	3	0	0	3	3
		19CH7DELE2	Pilot Plant and Scale up studies					
7.	PW-3	19CH7DCPPW	Pre-Final project Work	0	0	2	2	4
8.	SR-2	19CH7DCSR2	Seminar 2: Based on review of Research Publication/ Patent	0	0	1	1	2
TOTAL				14	0	5	19	24

SCHEME OF INSTRUCTION FOR EIGHTH SEMESTER

S No	Course Type	Code	Course Title	Credits			Total Credits	Contact Hours
				L	T	P		
1.	HS-5	19CH8HSPMF	Project Management and Finance	3	0	0	3	3
2.	OE-3	19CH8OEISO	Industrial Safety and Occupational Health	3	0	0	3	3
3.	PW-4	19CH8DCFPW	Final Project Work	0	0	9	9	18
4.	SR-3	19CH8DCSR3	Seminar 3: Based on Summer/Winter Internship	0	0	1	1	2
TOTAL				05	0	10	16	26

Humanities and Social Sciences including Management Courses (HS); Basic Science Courses (BS); Engineering Science Courses (ES); Professional Core Courses (PC); Professional Elective Courses (PE); Open Electives (OE); Project Work (PW); Technical Seminar (SR); Internship in industry or Institution (IN); Non-Credit Mandatory Courses (NC).

THIRD SEMESTER

Course Title	APPLIED MATHEMATICS													
Course Code	1	9	M	A	3	B	S	A	P	M	Credits	04	L – T – P	3 – 1 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Basic concepts of Trigonometry, methods of differentiation, methods of integration, solution of ordinary differential equations.

COURSE OBJECTIVES: The purpose of the course is to make the students conversant with concepts of Fourier Series, Fourier Transforms, extreme of functional and develop computational skills using efficient numerical methods for problems arising in science and engineering.

UNIT-I

MATRICES: Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of a system of linear equations and solution. Solution of a system of non-homogenous equations: Gauss elimination method, Gauss-Seidel method. Eigenvalues and eigenvectors of matrices. **[8L+2T =10 Hrs].**

UNIT-II

NUMERICAL METHODS: Solution of algebraic and transcendental equations: Newton-Raphson method. Finite Differences and interpolation Forward differences, backward differences. Newton-Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation, Numerical integration: Trapezoidal rule, Simpson's 1/3rd rule. Numerical solution of ordinary differential equations: Runge-Kutta method of fourth order. **[10L+2T =12 Hrs].**

UNIT-III

FOURIER SERIES: Periodic functions, Dirichlet's conditions, Fourier series of a periodic functions of period 2l, Fourier series of functions having points of discontinuity.

FOURIER TRANSFORMS: Infinite Fourier transform, Fourier Sine and Cosine transforms, Inverse transforms.

[10L+2T=12 Hrs].

UNIT-IV

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS: Finite-Difference formulas to partial derivatives. Applications: Solution of one-dimensional heat equation using 2-level formula and Schmidt explicit formula and Crank-Nicolson two-level implicit formula. Solution of one-dimensional wave equation using explicit three level formula and implicit scheme.

[7L + 2T =09 Hrs].

UNIT-V

CALCULUS OF VARIATIONS: Variation of a functional, Euler's equation, variational problems. Applications: Geodesic on a plane, minimal surface of revolution, hanging cable problem, Brachistochrone problem. **[7L + 2T =09 Hrs].**

On completion of the course the student will have the ability to:

CO #	COURSE OUTCOME (CO)	PO's
CO 1	Apply Numerical techniques to solve problems arising in engineering.	PO1
CO 2	Demonstrate an understanding of Fourier Series and Fourier Transforms.	
CO 3	Apply the concepts of calculus to functionals.	

TEXT BOOKS:

1. Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. Advanced Engineering Mathematics, Dennis G. Zill and Cullen, 4th edition, 2011, Jones and Bartlett India Pvt. Ltd.

REFERENCE BOOKS:

1. Higher Engineering Mathematics, B.V. Ramana, 7th reprint, 2009, Tata Mc. Graw Hill.
2. Numerical methods for Scientific and Engineering Computation, M. K. Jain, S.R. K Iyengar,
3. R. K. Jain, 6th edition, 2010, New Age International (P) Limited Publishers.

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, IV, V and two questions each from Unit II and III.

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**
Theory Component	Three Internals Test (Best of Two)	80%
	Quiz (Two Quizzes or AAT)	20%
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

(Common to All Branches)

Course Title	Additional Mathematics-I													
Course Code	1	9	M	A	3	I	M	M	A	T	Credits	00	L – T – P	3 – 1 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		
Contact hours	48 hours (36L+12T)										III semester Lateral Entry students			

PREREQUISITES: Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.

COURSE OBJECTIVES: To provide students with a solid foundation in mathematical fundamentals such as differentiation, differential equations, vectors and orthogonal curvilinear coordinates for different branches of engineering.

UNIT- I

DIFFERENTIAL AND INTEGRAL CALCULUS: List of standard derivatives including hyperbolic functions, rules of differentiation. Taylor's and Maclaurin's series expansion for functions of single variable. List of standard integrals, integration by parts. Definite integrals – problems.

[7L+2T = 09Hrs]

UNIT -II

POLAR COORDINATES AND PARTIAL DERIVATIVES: Polar curves: Polar coordinates, angle between radius vector and tangent, angle between two polar curves. Partial differentiation. Total differentiation-Composite and Implicit functions. Jacobians and their properties (without proof) – Problems. **[7L+3T = 09Hrs]**

UNIT- III

VECTOR CALCULUS AND ORTHOGONAL CURVILINEAR COORDINATES: Recapitulation of scalars, vectors and operation on scalars and vectors. Scalar and vector point functions. Del operator, gradient-directional derivative, divergence, curl and Laplacian operator. Vector identities (without proof). Cylindrical and Spherical polar coordinate systems. Expressing a vector point function in cylindrical and spherical systems. Expressions for gradient, divergence, curl and Laplacian in orthogonal curvilinear coordinates. **[7L+3T = 10Hrs]**

UNIT -IV

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS: Introduction to first order differential equations. Linear equation and its solution. Bernoulli's equation and its solution. Exact differential equation and its solution. Orthogonal Trajectories. **[7L+2T = 09Hrs]**

UNIT -V

SECOND AND HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS:

Ordinary differential equations with constant coefficients: Homogeneous differential equations, non-homogeneous differential equations – Particular integral for functions of the type $f(x) = e^{ax}$, sin(ax), cos(ax), x^n, method of variation of parameters, Cauchy's and Legendre linear differential equations. **[8L+2T =10Hrs]**

On completion of the course, students will have the ability to:

CO #	COURSE OUTCOME (CO)	PO
CO 1	Understand the basic concepts of differentiation and integration.	PO1
CO 2	Apply the concepts of polar curves and multivariate calculus.	
CO 3	Apply analytical techniques to compute solutions of first and higher order ordinary differential equations.	
CO 4	Apply techniques of vector calculus to engineering problems.	
CO 5	Comprehend the generalization of vector calculus in curvilinear coordinate system.	

TEXT BOOK:

1. Higher Engineering Mathematics, B. S. Grewal, 43rd edition, 2014, Khanna Publishers
2. Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

REFERENCE BOOK:

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley- India.
2. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.

E BOOKS AND ONLINE COURSE MATERIALS:

1. Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001
2. http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
3. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
4. http://ocw.mit.edu/courses/mathematics/ (online course material)

ONLINE COURSES:

1. https:// www.khanacademy.org/Math
2. https:// www.class-central.com/subject/math (MOOCS)

Course Title	MATERIALS CHEMISTRY AND APPLICATIONS													
Course Code	1	9	C	Y	3	D	C	M	C	A	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

COURSE OBJECTIVES:

1. To provide students with knowledge of engineering materials for building technical competence in industries.
2. To impart the knowledge of fundamentals in material science and engineering principles involved in catalytic materials, smart materials, ceramics, glass and lubricants

UNIT-I

INTRODUCTION TO MATERIALS CHEMISTRY: The periodic properties: Atomic and ionic radii, ionization energy, electron affinity and electronegativity.

STRUCTURE AND BONDING: Types of bonds, Ionic bond: Lattice energy, Born-Haber Cycle. Calculation of lattice energies of NaCl and MgO, effect of lattice energy on solubility of ionic compounds.

COVALENT BOND: Valence bond approach: hybridization and directional nature of orbitals. VSEPR theory: shapes of molecules. Molecular orbital theory (stability, bond order, and magnetic properties).

METALLIC BOND: Band theory, electrical properties of metals, semiconductors and insulators, band gaps, doping.

SECONDARY BONDING: dipole-dipole, dipole –induced dipole, London dispersion/Van der Waals, Hydrogen bond (Intra molecular and Inter molecular types). Effect of secondary bonding on properties of materials. **8Hrs**

UNIT-II

STRUCTURE OF SOLIDS: Types of solids: General features and classification. Crystal systems and unit cells, Symmetry, Bravais lattices, Lattice planes and Miller indices, Reciprocal lattice, X-ray diffraction-Bragg's equation - numericals. PXRD, Neutron diffraction.

NON-STOICHIOMETRY - DEFECTS: point, line, surface, bulk, relevance of defect in material science. Intercalation compounds. Electron diffraction- Scanning electron microscopy, Transmission electron microscopy. **8Hrs**

UNIT-III

MATERIALS FOR CATALYSIS: Catalysts - Definition, significance to industry. Types of catalysts-positive and negative catalyst, Catalytic promoters and poisons/inhibitors. Types of catalytic reactions-homogeneous, heterogeneous, autocatalysis and enzyme catalysis. Mechanism of catalysis by taking an example. Acid and base catalysis, metal ions, organo-metallic complexes- meaning, significance, Two examples in each case with mechanism

SHAPE SELECTIVE CATALYSIS: zeolites as catalysts-composition and structure, Preparation, properties and applications. Catalysts used in Steam reforming and cracking. Environmental catalysis-catalysts used in catalytic converters. **8Hrs**

UNIT-IV

PHASE DIAGRAM AND PHASE TRANSFORMATIONS: Phase rule, Single component system for Iron, Binary phase diagrams for Lead-Tin, Copper-Zinc and Iron- Iron-Carbide systems. Isothermal transformation (TTT) Curves for eutectoid steel.

TYPICAL ENGINEERING MATERIALS: Metals and non-metals, General properties of ferrous metals, non-ferrous metals and alloys, Copper and its alloys, lead and its alloys, Nickel and its alloys, Alloys for high temperature service. **8Hrs**

UNIT-V

INDUSTRIAL MATERIALS: Ceramics: Raw materials and their roles, varieties of clay, production of ceramic ware, glazing, ceramic insulators. Glass: properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

LUBRICANTS: General Introduction — Types of Lubricants with examples (Solid lubricants, liquid lubricants, Greases, emulsion lubricants, Gaseous lubricants). Functions and mechanism of action. **7Hrs**

TEXT BOOKS:

1. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited; 6th revised edition, V. Raghavan
2. Engineering Chemistry - Fundamentals and Applications, Shikha Agarwal, Cambridge university press, 2016 edition
3. Inorganic Chemistry: Principles of Structure and Reactivity, James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Pearson Education India, 4th Edition.

REFERENCE BOOKS:

1. Shriver and Atkins' Inorganic Chemistry, Peter Atkins, Tina Overton, Oxford University Press, 5th Edition
2. Solid state chemistry and its applications - A.R. West, 2nd edn, John Wiley & Sons, Inc.
3. Callister's Materials Science and Engineering, R. Balasubramaniam, 2nd edition, John Wiley & Sons, Inc.
4. Solid State Physics, S. O. Pillai, New Age International, 2006, 8th edition
5. Atkins' Physical Chemistry, Peter Atkins, Julio de Paula, Oxford University Press, 11th Edition

MOOCs

1. https://nptel.ac.in/noc/individual_course.php?id=noc18-cy01
2. https://nptel.ac.in/courses/104104101/
3. https://nptel.ac.in/courses/104103019/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, II, V and two questions each from Unit III and IV.

On completion of the course, the student will have the ability to:

Course outcomes:		**PROGRAMME OUTCOMES**
CO 1	Describe the principles of Chemistry involved in catalytic materials, ceramics, glass and lubricants.	PO1
CO 2	Apply the learnt principle of materials chemistry in addressing societal problems.	PO2
CO 3	Based on the acquired knowledge analyze the structure, topology, composition, catalytic properties and applications of materials.	PO2
CO 4	Understand to rationalise the main physical properties of soft materials in terms of their dependence on polymer composition, molecular weight and microstructure.	PO2
CO 5	Comprehend the impact of advance materials for sustainable development	PO7
CO6	Recognize the need for lifelong learning for selecting suitable materials for industrial applications	PO12

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**
Theory Component	Three Internals Test (Best of Two)	80%
	Quiz (Two Quizzes or AAT)	20%
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**

Assessment Pattern:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	FLUID MECHANICS													
Course Code	1	9	C	H	3	D	C	F	M	E	Credits	04	L – T – P	3 – 0 – 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Physics and Engineering Maths

SYLLABUS:

UNIT-I

FLUID STATICS AND ITS APPLICATIONS: Introduction, fluid properties, Pressure concept- Pascals's Law, Hydrostatic law, Pressure at a point in compressible fluid (Barometric Eq.), Measurement of fluid pressure-U-tube manometers, Inverted U-Tube manometer and Differential manometers.

FLUID FLOW PHENOMENA: Types of fluids - shear stress and velocity gradient relation, Newtonian and non - Newtonian fluids, Viscosity of gases and liquids. Types of fluid flow, Reynolds stress, Reynolds number Eddy viscosity, Flow in boundary layers, Boundary layer separation and wake formation. **10Hrs**

UNIT-II

KINETICS OF FLOW: Average velocity, Mass velocity, Continuity equation.

DYNAMICS OF FLOW: Euler and Bernoulli equations, Modified equations for real fluids with correction factors. Applications of Bernoulli's Equation- Venturimeter, Orifice meter, Pitot tube, Rotameter, Pump work.

FLOW THROUGH PIPES: Energy loss due to friction (Minor and Major losses), friction factor chart, Laminar Flow through circular and non-circular pipe. Notches and Weir - classification and discharge calculation. **10Hrs**

UNIT-III

FLOW OF COMPRESSIBLE FLUIDS: Introduction**,** Thermodynamic relations, Basic equations of Compressible flow (Continuity, Bernoulli's or Energy equations, Momentum Equations and Equation of state), Velocity of sound or Pressure wave in a fluid, Stagnation properties, Concept of Mach number, Area–velocity relationship for compressible flow, Mass flow rate of compressible fluid through Venturimeter, Pitot static tube. **7Hrs**

UNIT - IV

TRANSPORTATION OF FLUIDS: Pumps & Classification, construction and working of centrifugal pump, Heads and efficiency, Introduction to Priming and Cavitation, Characteristic curves of centrifugal pump, Net positive suction head and suction height. **7Hrs**

UNIT- V

DIMENSIONAL ANALYSIS: Introduction, Primary and derived quantities, Dimensional homogeneity, Methods of dimensional analysis (Rayleigh's and Buckingham's II – method). Significance of different dimensionless numbers, Model analysis, Model laws and Similitude. **5Hrs**

LABORATORY COMPONENT

1. Determination of Friction factor in circular pipes
2. Determination of Friction factor in non-circular pipes.
3. Friction in helical spiral coils.
4. Flow rate measurement using Orifice meters (incompressible fluid)
5. Measurement of pressure drop in Packed bed
6. Measurement of pressure drop in Fluidized bed
7. Study and development of characteristics for centrifugal pump
8. Study of various pipe fittings and their equivalent lengths
9. Fluid flow measurement using Venturi and Orifice meters (incompressible fluid)
10. Reynold's apparatus

TEXT BOOK:

1. McCabe. W. L. f et. al. "Unit Operations of Chemical Engineering", 5th edition., McGraw Hill New York 1993.
2. Bansal R.K, A Textbook of Fluid Mechanics (VTU), Edition 2005, Laxmi Publications.

REFERENCE BOOKS:

1. R. K Rajput, "A Text Book on Fluid Mechanics", 2nd Edition 2002, S Chand and company Ltd.

2. Coulson J. and Richardson. J.F.., 'Chemical Engineering' Vol.II L., 5th edn., Asian Books (p) Ltd., New Delhi, 1998.

E BOOKS

1. Multimedia Engineering Fluid Mechanics: https://ecourses.ou.edu/cgi-bin/ebook.cgi?topic=fl
2. Elementary Fluid Mechanics: http://www.worldscientific.com/worldscibooks/10.1142/5895

MOOC's &ONLINE COURSES:

1. http://www.learnerstv.com/video/Free-video-Lecture-2626-Engineering.htm#
2. http://www.myopencourses.com/subject/fluid-mechanics-2#downloads

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit III, IV, V and two questions each from Unit I and II.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Apply basic principles of pressure & conservation laws to solve fluid flow problems	PO1
CO2	Possess familiarity with the construction and working of fluid flow equipment with an understanding of the requirements of professional engineering practice	PO3
CO3	Develop correlations / solutions for flow processes that meet specific needs	PO3
CO4	Estimate energy requirements and losses in transportation and metering of fluids.	PO2
CO5	Conduct fluid flow experiments in team and derive valid conclusions.	PO9
CO6	Present the experimental observations in the form of a lab report.	PO2

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (One Quiz or AAT)	10%	Course Instructor
Laboratory Component	Laboratory Component	50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Theory (50%)			Practical (40%)		Total Marks
	Test 1	Test 2	Quiz/AAT	Records & Performances	Lab Test	
Max.Marks	20	20	10	30	20	100
Reduced CIE	10	10	5	15	10	50

Course Title	MECHANICAL OPERATIONS													
Course Code	1	9	C	H	3	D	C	M	O	P	Credits	04	L – T – P	3 – 0 – 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Mechanics and Engineering Mathematics

SYLLABUS:

UNIT- I

Particle Technology: Ideal and actual screen, Differential and cumulative size analysis, Particle size analysis, Specific surface area, Effectiveness and Problems. Standard screen series, Motion of screens, Gyratory screen shaker, Vibrating screen shaker, Trammels and Sub sieve analysis. **7Hrs**

UNIT- II

SIZE REDUCTION: Forces used, Characteristics of products, Laws of size reduction, Work Index, Verification of laws, Problems. Open circuit grinding, Closed circuit grinding, Wet & dry grinding, Equipment: Jaw crusher, Gyratory crusher, Attrition mill, Ball mill, Roll crusher, Fluid energy mill & Hammer mill. **6Hrs**

UNIT- III

FLOW OF FLUID PAST IMMERSED BODIES: Drag, Drag coefficient, Particle Reynolds number. Ergun equation and its modifications, Particle size determination by Kozeny Carmen equation, Types of fluidization &Applications. Conveying of solids-Belt conveyors Chain conveyors.

FILTRATION: Classification, Modification of Kozeny - Carman equation for filtration. Industrial filters: Filter press, Leaf filter, Rotary drum filter, Bag filter, Suspended batch centrifuge; Filter aids. Principles of cake filtration. **10Hrs**

UNIT- IV

MOTION OF PARTICLES THROUGH FLUIDS: Equation for one dimensional motion of particles through a fluid in gravitational and centrifugal field, Terminal settling velocity, motion of spherical particle in different regions, Criterion for settling, Hindered settling, Cyclones, hydro cyclones and air elutriator, Heavy media separation.

SEDIMENTATION: batch settling test, theories, Application of batch settling test to design a continuous thickener and related problems, Storage of solids, open and closed storage. **10Hrs**

UNIT- V

AGITATION AND MIXING: Types of impellers. Flow patterns in agitated vessels, Prevention of swirling, Power correlation and calculation. **Mixers:** Muller mixer, Ribbon blender, internal screw mixer, tumbling mixer. **Separations:** Electrostatic separation, Jigging, Froth floatation. **Size enlargement:** Pelletization, agglomeration **6Hrs**

LABORATORY COMPONENT:

1. Air elutriation
2. Air permeability
3. Batch sedimentation
4. Beaker decantation
5. Drop weight crusher
6. ICI sedimentation
7. Jaw crusher
8. Leaf filter
9. Plate and frame filter press
10. Screen effectiveness

TEXTBOOKS:

1. McCabe, Warren, L., Smith, Julian, C. and Harriott, Peter, Unit operations of chemical engineering, 5th edition, McGraw-Hill, Singapore, 2000.
2. Kiran D Patil, Mechanical Operations Fundamental Principles and Applications, 2nd Edition Nirali Prakashan, India, 2012

REFERENCE BOOKS:

1. Badger, Walter, L. and Banchero, Julius, T. Introduction to Chemical Engineering, 3rd edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.
2. Richardson, J.F., Harker, J. H., and Backhurst, J. R.Particle Technology and Separation Processes, 2nd volume, 5th edition, Replika Books Pvt. Ltd., New Delhi, 2003

E BOOKS

1. Mechanical Operations Fundamental Principles and Applications: https://books.google.co.in/books/about/Mechanical_Operations_Fundamental_Princi.html?id=O0DPOKxC0YEC&hl=en
2. Ebook Library chemical engineering mechanical Operations: http://csfbook.sourceforge.net/pdf/chemical-engineering-mechanical-operations.pdf

MOOC's &ONLINE COURSES:

1. http://nptel.ac.in/courses.php
2. http://www.msubbu.in/sp/mo/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit III, II, V and two questions each from Unit III and IV.

COURSE OUTCOMES:

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Apply basic principles of mechanical operations	PO1
CO2	Develop solutions by applying mass and force balance for unit operations.	PO2
CO3	Analyse the working of equipment with an understanding of the requirements of professional engineering practice.	PO3
CO4	Apply the knowledge of solid-solid and gas-solid separation techniques for various applications including coal, mineral beneficiation, environmental pollution control etc.	PO4
CO5	Conduct experiments and evaluate in team for different mechanical operations to derive valid conclusion.	PO9
CO6	Present the experimental observations in the form of a lab report.	PO2

ASSESSMENT:

Continuous Internal Assessments		**Marks 100% (Weightage 50%)**	**Assessment**
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (One Quiz or AAT)	10%	Course Instructor
Laboratory Component	Laboratory Component	50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	**Theory (50%)**			**Practical (40%)**		**Total Marks**
	Test 1	**Test 2**	**Quiz/AAT**	**Records & Performances**	**Lab Test**	
Max. Marks	20	20	10	30	20	100
Reduced CIE	10	10	5	15	10	50

Course Title	PROCESS ENGINEERING THERMODYNAMICS-I													
Course Code	1	9	C	H	3	D	C	T	D	1	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Engineering mathematics

SYLLABUS:

UNIT- I

INTRODUCTION: The scope of Thermodynamics, Different approaches, Heat and work, State and its forms, Intensive and extensive properties, System and types of system, Energy and its evaluation for various types of system, Equilibrium concept, Processes and types, Concept of stability, Zeroth law of thermodynamics, Phase rule, Temperature scale **6Hrs**

UNIT- II

FIRST LAW OF THERMODYNAMICS: Joule's Paddle wheel experiment, Internal energy, First law of thermodynamics, Reversible and irreversible processes with examples, First law application to closed, open and steady state flow systems.

EVALUATION OF VARIOUS FORMS OF ENERGY: Enthalpy and its evaluation, Principle and working of flow calorimeter **10Hrs**

UNIT- III

VOLUMETRIC PROPERTIES OF PURE FLUIDS: P-V-T behavior of pure fluids, Equations of state and ideal gas law, Equations of state for real gases: Virial equation and its applications, Ideal gas temperatures and universal gas constant; Cubic equations of state- Vander Waals equation and determination of parameters, Theorem of corresponding states; acentric factor, Pitzer correlations and compressibility charts.

PROCESSES INVOLVING IDEAL GAS LAW: Implied property relations for an ideal gas law, Equations for process calculations –constant volume, constant pressure, constant temperature, adiabatic and polytrophic processes, Numerical to evaluate energy interactions of various processes **10Hrs**

UNIT-IV

HEAT EFFECTS: Sensible heat effects, Temperature dependence of the heat capacity, Latent Heat effects of pure substances, Standard heat of reaction, Standard heat of formation, Standard heat of combustion, Temperature dependency of ΔH_0, Heat effects of industrial reactions **6Hrs**

UNIT- V

SECOND LAW OF THERMODYNAMICS: Limitations of first law of thermodynamics, General statements of the Second law, Entropy, Carnot theorem and equations, Clausius inequality, Concept of entropy increase-Mathematical statement of the second law, Calculation of entropy changes, Ideal work and lost work; Third law of thermodynamics **7Hrs**

TEXT BOOKS:

1. Smith J. M. and Van Ness H.C, "Introduction to Chemical Engineering Thermodynamics", 5th edition, McGraw Hill, New York, 1996.
2. Narayanan, K. V. "Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.

REFERENCE BOOKS:

1. Rao, Y.V.C Chemical Engineering Thermodynamics, New Age International Publication, Nagpur, 2000.
2. Halder, Gopinath, "Introduction to chemical engineering thermodynamics", PHI Learning Pvt. Ltd., New Delhi, 2009

E BOOKS

1. Kevin Dahm, "Fundamentals of Chemical Engineering Thermodynamics": https://books.google.co.in/books
2. DimitriosTassios, "Applied Chemical Engineering Thermodynamics": https://books.google.co.in/books

MOOC's and ONLINE COURSES:

1. http://elearning.vtu.ac.in/06ME33.html
2. MOOC's Course on Thermodynamics: https://www.iitbombayx.in/courses/IITBombayX/ME209xA15/2015_T1/about

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, IV, V and two questions each from Unit II and III.

COURSE OUTCOMES (Cos):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Understanding of the fundamental concepts of thermodynamics viz. Closed/open/steady flow systems, Intensive and extensive properties, Equilibrium, Phase rule etc.	PO1
CO2	Knowledge of the inter-conversion of heat and work	PO1
CO3	Develop correlations for interrelated thermodynamic properties of systems.	PO3
CO4	Interpret the directional change by applying the thermodynamic concepts for steady state process.	PO4
CO5	Understand the concepts of entropy, enthalpy and Ideal gas equation and various gas Laws and thermodynamic processes	PO8
CO6	Ability to apply various thermodynamics laws to real systems	PO6

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**
Theory Component	Three Internals Test (Best of Two)	80%
	Quiz (Two Quizzes or AAT)	20%
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PROCESS PRINCIPLES AND CALCULATIONS													
Course Code	1	9	C	H	3	D	C	P	P	C	Credits	04	L – T – P	3 – 1– 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Mathematics and Engineering Chemistry

SYLLABUS:

UNIT- I

UNITS AND DIMENSIONS: Fundamental and derived units, conversion of units, dimensional consistency of equations, dimensionless groups and constants, conversion of equations.

BASIC CHEMICAL CALCULATIONS: Concept of mole, mole fraction, compositions of mixtures of solids, liquids and gases. Concept of normality, molarity, molality, parts per million. Use of semi log and triangular graphs, Ideal gas law, Amagat's law and Dalton's law and related problems. **[6L+2T=8Hrs]**

UNIT -II

MATERIAL BALANCE WITHOUT REACTION: General material balance equation for steady and unsteady state operations. Typical steady state material balances in distillation, absorption, extraction, crystallization

MATERIAL BALANCES INVOLVING BYPASS, RECYCLE AND PURGING: drying, mixing and evaporation. **[9L+3T=12Hrs]**

UNIT- III

STEADY STATE MATERIAL BALANCE WITH REACTION: Principles of stoichiometry, concept of limiting and excess reactants and inert, fractional and percentage conversion, fractional yield and percentage yield, selectivity and related problems. **[8L+2T=10Hrs]**

UNIT-IV

CALCULATIONS RELATED FUELS AND COMBUSTION: Ultimate and proximate analysis of fuels, calculations involving burning of solid, liquid and gaseous fuels, excess air, air-fuel ratio calculations. **[9L+3T=12Hrs]**

UNIT- V

ENERGY BALANCE: General steady state energy balance equation, heat capacity, enthalpy, heat of formation, heat of reaction, heat of combustion, and heat of mixing, determination of heat of formation at standard and elevated temperatures, theoretical flame temperature and adiabatic flame temperature. **[8L+2T=10Hrs]**

TEXT BOOKS

1. K. V. Narayanan and B. Lakshmikutty Stoichiometry and Process Calculations, 2nd edition, 2009, PHI Learning private Ltd. New Delhi.
2. Bhatt B. L. and Vora S. M. Stoichiometry, 3rd edition, 1996,Tata McGraw Hill Publishing Ltd., New Delhi.

REFERENCE BOOKS:

1. Hougen O. A., Waston K. M. and Ragatz R.A., Chemical Process Principles Part -I' Material and Energy Balances, 2nd edition, CBS publishers and distributors, New Delhi, 1995.
2. Himmelblau D.M., Basic Principles and Calculations in Chemical Engineering, 6th edition, Prentice Hall of India, New Delhi 1997. Charts: Psychrometric chart, steam tables

E-BOOKS

1. K. V. Narayanan, B. Lakshmikutty, "Stoichiometry and process calculations", https://books.google.co.in/books?id=52tqCFSC0ZgC&printsec
2. Gavhane, K. A, "Introduction to Process Calculations Stoichiometry", https://books.google.co.in/books?id=80v3hRHoEv0C&printsec

MOOC's and ONLINE COURSES:

1. http://www.nptel.ac.in/syllabus/103102017/
2. http://elearning.vtu.ac.in/10BT46.html

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, III, V and two questions each from Unit II and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Familiarity with conversion of units and dimensional consistency of equations	PO1
CO2	Formulate material balances for processes involving single/ multiple components with/without reactions.	PO2
CO3	Solve material for processes involving single/ multiple components without reactions.	PO2
CO4	Perform material balance calculations for chemical reaction.	PO3
CO5	Apply the basics of material balance for air-fuel ratio calculations, excess and limiting reactant calculations	PO3
CO6	Formulate and solve energy balance equations for various reactions.	PO3

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment by
Theory Component	Three Internals(Best of Two)	80%	Course Instructor
	Quiz (Two Quizzes or AAT)	20%	Course Instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
educed CIE	20	20	5	5	50

Course Title	ENVIRONMENTAL STUDIES AND POLLUTION CONTROL													
Course Code	1	9	C	H	3	H	S	E	S	P	Credits	03	L – T – P	3– 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Engineering Physics

SYLLABUS:

UNIT - I

INTRODUCTION TO ENVIRONMENT: Definition about Earth, atmosphere, hydrosphere, lithosphere and biosphere. Structure of Atmosphere: Troposphere, Stratosphere, Mesosphere, Ionosphere, Exosphere. Internal structure of the Earth: Crust, Mantle, Core. Ecosystem, types of Ecosystem: Land, Forest, Water, Desert, Marine.

ENVIRONMENTAL PROTECTION ACTS: Air, Water, land and Noise (Prevention and Control of pollution), Forest conservation, Wildlife protection. **6Hrs**

UNIT - II

SOCIAL ISSUES AND ENVIRONMENT: Population growth, Climatic changes: Global warming, acid rain, ozone layer depletion. Water conservation: rain water harvesting and ground water recharging. Disaster management: floods, earthquakes, landslides-case studies.

WATER POLLUTION: Water as Resource, Drinking water quality, water consumption standards, Types of Water Pollutants and sources, State and central wastewater quality and various prevailing discharge standards. Wastewater Sampling and Characteristics - Physical, Chemical and Biological characteristics of wastewater: Solving numerical on the sampling, characteristics **10Hrs**

UNIT – III

WASTEWATER TREATMENT: Preliminary/Primary/physical unit operations, Chemical unit processes, Secondary/Biological treatment process, aerobic/anaerobic attached and suspended growth process, Sludge treatment & Disposal.

TERTIARY/ADVANCED WASTEWATER TREATMENT: Ultrafiltration, Filtration, Adsorption on Activated Carbon, Ion Exchange, Reverse Osmosis.

WASTEWATER TREATMENT IN SPECIFIC INDUSTRIES: Sugar & distillery, Leather, Dairy and Textile. **10Hrs**

UNIT- IV

AIR POLLUTION: Definition, Sources, Classification, Properties of air pollutants, and Effects of air pollution on health, vegetation and materials

AIR SAMPLING & CONTROL: Ambient sampling and Stack sampling & Analysis of air pollutants, Control methods and Equipment for particulates and gaseous pollutants. **6Hrs**

UNIT –V

NOISE POLLUTION: Definition, Sources, Effects of Noise, Equipment for Noise Measurement, Approaches for Noise Control.

SOLID WASTE MANAGEMENT: Definitions, Characteristics, Types, Sources and Properties of solid waste –Numerical problems **7Hrs**

TEXT BOOKS:

1. Environmental Studies by R Geetha Balakrishna, KG Lakshminarayana Bhatta, Sunstar Publisher, 2016.
2. Environmental Engineering by Howard S. Peavey, Donald R. Rowe, George Techobanolous, McGraw-Hill International Editions.
3. Wastewater Engineering – Treatment, Disposal and Reuse, METCALF AND EDDY, INC. 3rd Edition Tata McGraw-Hill Publishing Company Limited.

REFERENCE BOOKS:

1. Environmental studies by Dr. D.L.Manjunath, 1st Edition, PEARSON, 2006.
2. C S Rao, Environmental Pollution Control Engineering, New Age International Publisher, 2011.
3. M N. Rao, Air Pollution, Tata McGraw-Hill Publishing Company Limited

E BOOKS

1. Air Pollution by Mn Rao and Hvn Rao: http://www.avlib.in/ebook/title/air-pollution-mn-rao-and-hvn-rao-.html
2. https://www.free-ebooks.net/ebook/introduction-to-wastewater-treatment

MOOC's & ONLINE COURSES:

1. http://www.openculture.com/free_certificate_courses
2. https://www.class-central.com/subject/civil-environmental-engineering
3. https://www.class-central.com/subject/environmental-science

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, IV, V and two questions each from Unit II and III.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Understand the effect of environmental pollution on ecosystem	PO6
CO2	Identify the impact of recovery, recycle and reuse for sustainable development.	PO7
CO3	Engage in lifelong learning for abatement and control of environmental pollution	PO12
CO4	To acquire analytical skills in assessing environmental impacts through a multidisciplinary approach	PO2
CO5	Make an informed choice of equipment for pollution control.	PO6
CO6	Develop practical, efficient, cost effective and ethical solutions for challenges in environmental sciences and engineering.	PO8

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PERSONALITY DEVELOPMENT AND COMMUNICATION SKILLS													
Course Code	1	9	H	S	3	N	C	P	D	C	Credits	00	L – T – P	1 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

SYLLABUS:

UNIT – I

PERSONALITY DEVELOPMENT: Meaning, need, Introduction to Personality, Definition and Determinants –Personality Traits – Ways of developing positive personality traits, Self-awareness, Habits – Ways of forming good habits.

SELF ESTEEM: Introduction, Definition and Types –Faces of low self-esteem – Steps to improve low self-esteem. Self-Motivation: Definition – Ways of Building self-motivation.

LEADERSHIP: Key Elements of Leadership –Types of Leaders, Traits of an effective leader.

6Hrs

UNIT – II

TEAMS: Difference between a team and a group – Stages of Team development (The Five-Stage Model), Team effectiveness. Activity 1: Lost at Sea Activity 2: Team building exercise.

BUSINESS LETTERS: Types, Layouts, Structure Reports: Purpose, Types, Structure.

EMPLOYMENT COMMUNICATION: Resume and Cover Letter, Group Discussions and Employment Interviews Activity 1: Extempore Activity 2: Students are expected to write a one-page resume – Block format letter Activity 3: Short Report Writing for an event **7Hrs**

TEXT BOOKS:

Personality Development

1. Personality Development: Harold R. Wallace and Ann Masters Cengage Learning.
2. Personality Development and Soft Skills: Barun Mitra, OUP India.

REFERENCE BOOKS:

1. The Skills of Communicating: Bill Scott, Jaico Books.
2. Developing Effective People: Lesley Morrissey, Jaico Books.

E-BOOKS:

1. Personality Development and Soft Skills: Barun Mitra, OUP India.
2. Effective Communication Skills by MTD Training

MOOCs:

1. Communication in the 21st Century Workplace – offered by Coursera
2. Communicating strategically –offered by edX

COURSE OUTCOMES:

COURSE OUTCOMES		Programme Outcomes
CO1	Understand and explain the aspects of personality development, team development, communication skills, time and stress management	PO9
CO2	Apply the principles of communication for functional effectiveness	PO10
CO3	Analyse the behavioural dimensions of individuals which have far reaching impact in the development of an organization	PO10
CO4	Effectively communicate through verbal/oral communication and improve the listening skills	PO9
CO5	Actively participate in group discussion / meetings / interviews and prepare & deliver presentations	PO10
CO6	Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality	PO9

FOURTH SEMESTER

Course Title	STATISTICS AND PROBABILITY													
Course Code	1	9	M	A	4	B	S	S	A	P	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Mathematics-1, Engineering Mathematics-2, and Applied Mathematics

COURSE OBJECTIVES: To prepare students with adequate knowledge in Probability and Statistics, Complex Analysis and develop computational skills using efficient numerical methods for problems in science and engineering. Student will get acquainted with the procedure of collecting, designing.

UNIT-I

STATISTICS & PROBABILITY: Curve fitting – Principle of least squares, fitting a straight line, fitting of a parabola, fitting of exponential curve of the form $y = a\ b^{x}$. Correlation and regression.

Probability distributions: Discrete distribution - Poisson distribution. Continuous distribution- Normal distribution. **9Hrs**

UNIT-II

JOINT PROBABILTY AND MARKOV CHAIN: Joint Probability Distributions: Discrete random variables, Mathematical expectations, Covariance and Correlation.

MARKOV CHAIN: Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chain. **7Hrs**

UNIT-III

DESIGN OF EXPERIMENTS: Principles of experimental design – Randomization, Replication, Local Control. Randomized block design, Completely Randomized block design, Latin Square Design, Factorial Experiments –Problems. **7Hrs**

UNIT-IV

STATISTICAL INFERENCE – I: Introduction, estimation – point, interval; procedure for testing of hypothesis, level of significance, construction of confidence interval.

[Large sample] Test of significance for single mean, difference between two means, single proportion, difference between two proportions, and difference of two Standard deviations for the biological data sets. **7Hrs**

UNIT-V

STATISTICAL INFERENCE – II: [Small sample] Test of significance for single mean, difference between two means, paired t-test, ratio of variances (F-distribution), Chi-Square distribution-goodness of fit, independence of attributes. Analysis of variance (one-way and two-way classifications). **9Hrs**

On Completion of the course the student will have the ability to:

CO #	COURSE OUTCOME (CO)	PO
CO 1	Appreciate the use of Statistical methods to Analyze and interpret the data from real world examples.	1,2,9,10
CO 2	Apply the basic principles of probability and Probability distributions to the problems in Engineering.	1,2
CO 3	Apply the concepts of Markov chain to the field of genetics.	1,2
CO 4	Demonstrate an understanding of sampling distributions and principles of experimental design.	1,2
CO5	Describe and discuss the key terminology, concepts tools and techniques used in business statistical analysis	1,2
CO6	Design experiments, carry them out, and analyze the data they yield	1,2

TEXT BOOKS:

1. P. S. S. Sundar Rao and J. Richard – An Introduction to Biostatistics, 4th edition, 2006, Prentice Hall of India.
2. Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2013, Khanna Publishers.

REFERENCE BOOKS:

1. Advanced Modern Engineering Mathematics, Glyn James, 3rd edition, 2004, Pearson Education.
2. Higher Engineering Mathematics, B.V. Ramana, 7th reprint, 2009, Tata Mc.Graw Hill.

E BOOKS AND ONLINE COURSE MATERIALS:

1. https://www.coursera.org/learn/basic-statistics
2. https://www.coursera.org/learn/probability-intro
3. https://www.classcentral.com/course/udacity-intro-to-statistics-361
4. http://wiki.stat.ucla.edu/socr/index.php/Probability_and_statistics_EBook

ONLINE COURSES AND VIDEO LECTURES:

1. http://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics- spring-2014/
2. http://nptel.ac.in/courses/*111105041/1* NPTEL >> Mathematics >> Probability and Statistics
3. https:// www.khanacademy.org/Math
4. https:// www.class-central.com/subject/math (MOOCS)

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit II, III, IV and two questions each from Unit I and V.

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**
Theory Component	Three Internals Test (Best of Two)	80%
	Quiz (Two Quizzes or AAT)	20%
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

DEPARTMENT OF CHEMICAL ENGINEERING
BMS COLLEGE OF ENGINEERING, BENGALURU
Autonomous College under VTU

(Common to All Branches)

Course Title	Additional Mathematics-II													
Course Code	1	9	M	A	4	I	M	M	A	T	Credits	00	L – T – P	3 – 1 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		
Contact hours	48 hours (36L+12T)										IV semester Lateral Entry students			

PREREQUISITES: Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.

COURSE OBJECTIVES: To provide students with a solid foundation in mathematical fundamentals such as Laplace Transforms, Solution of ordinary differential equations using Laplace Transforms, vector integration, computation of area and volume using double and triple integrals respectively.

UNIT- I

LAPLACE TRANSFORMS: Laplace transforms of standard functions. Properties and problems. Laplace Transform of Periodic functions with plotting, unit step function and dirac-delta function. **[7L+2T = 09Hrs]**

UNIT -II

INVERSE LAPLACE TRANSFORMS: Inverse Laplace transforms of standard functions. Properties and problems. Solution of ODE- Initial and Boundary value Problems.

[7L+3T = 10 Hrs]

UNIT- III

DOUBLE INTEGRALS : Evaluation of double integral. Change of order of integration. Change of variables to polar coordinates. Application: Area.

[8L+3T = 11 Hrs]

UNIT -IV

TRIPLE INTEGRALS AND IMPROPER INTEGRALS: Evaluation of triple integral. Application: Volume. Beta and Gamma functions-definition, relation between Beta and Gamma functions, properties and problems. **[7L+2T= 09Hrs]**

UNIT -V

VECTOR INTEGRATION: Line integral, Green's theorem, Stokes' theorem and Gauss divergence theorem. **[7L+2T = 09Hrs]**

TEXT BOOK:

1. Higher Engineering Mathematics, B. S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. Higher Engineering Mathematics, B. V. Ramana, 2007, Tata McGraw Hill.

REFERENCE BOOK:

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley- India.
2. Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd

E BOOKS AND ONLINE COURSE MATERIALS

1. Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001 http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZnc L- xB8dEC&redir_esc=y
2. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3. http://ocw.mit.edu/courses/mathematics/ (online course material)

ONLINE COURSES:

1. https:// www.khanacademy.org/Math
2. https:// www.class-central.com/subject/math (MOOCS)
3. E-learning: www.vtu.ac.in

Course Title	PROCESS ENGINEERING THERMODYNAMICS-II													
Course Code	1	9	C	H	4	D	C	T	D	2	Credits	04	L–T–P	3–1–0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry, Engineering mathematics and Process Engineering Thermodynamics -I

SYLLABUS:

UNIT - I

THERMODYNAMIC PROPERTIES OF PURE FLUIDS: Thermodynamic properties, Relationships among thermodynamic properties, Heat capacity, Entropy and other forms of energy relations, Two phase systems-Clapeyron and Clausius-Clapeyron equations, Temperature dependence of vapor pressure of liquids, Alternative equations for liquids, Joule-Thomson coefficient, Gibbs-Helmholtz equation, Thermodynamic diagrams **[9L+3T=12Hrs]**

UNIT - II

RESIDUAL PROPERTIES: Residual properties, Fugacity, Fugacity coefficient, Fugacity in solutions, Henry's law and dilute solutions, Activity, Activity in solutions, Activity coefficients, Property changes of mixing

SOLUTION THERMODYNAMICS: Partial molar properties and Gibbs- Duhem equations, Numerical on estimation of partial molar properties **[9L+3T=12Hrs]**

UNIT- III

PHASE EQUILIBRIA: Criteria of phase equilibrium, Chemical potential, Criterion of stability, Duhem's theorem, Vapour-Liquid Equilibrium, Phase diagrams for binary solutions, VLE in ideal solutions, Simple models for vapor liquid equilibrium, VLE-Qualitative behaviour, Raoult's law, Henry's law and Modified Raoult's laws, Numerical on Dew and bubble point temperature and pressure, VLE from K value correlations, Flash calculations. **[8L+2T=10Hrs]**

UNIT - IV

NON-IDEAL SOLUTIONS: Excess properties, Azeotropes, Activity coefficient equations: Van Laar equation, Margules and Willson equations; Consistency test for VLE data: Slope method, Midpoint method, Redlich-Kister method and Partial pressure data **[8L+2T= 10Hrs]**

UNIT - V

CHEMICAL REACTION EQUILIBRIUM: Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Feasibility of chemical reaction; Equilibrium constant: Effect of temperature, Evaluation, Effect of pressure; Equilibrium conversion: Effect of pressure, inert materials, excess of reactants, products, Phase rule for reacting system. **[6L+2T=08Hrs]**

TEXT BOOKS:

1. Smith J. M. and Van Ness H.C, "Introduction to Chemical Engineering Thermodynamics", 5th edition, McGraw Hill, New York, 1996.
2. Narayanan, K. V. "Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.

REFERENCE BOOKS:

1. Rao, Y.V.C Chemical Engineering Thermodynamics, New Age International Publication, Nagpur, 2000.
2. Halder, Gopinath, "Introduction to chemical engineering thermodynamics", PHI Learning Pvt. Ltd., New Delhi, 2009

E BOOKS

1. Kevin Dahm, "Fundamentals of Chemical Engineering Thermodynamics": https://books.google.co.in/books
2. DimitriosTassios, "Applied Chemical Engineering Thermodynamics": https://books.google.co.in/books

MOOC's and ONLINE COURSES:

1. http://elearning.vtu.ac.in/06ME33.html
2. MOOC's Course on Thermodynamics: https://www.iitbombayx.in/courses/IITBombayX/ME209xA15/2015_T1/about

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit III, IV, V and two questions each from Unit I and II.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Apply the knowledge of classical thermodynamics to predict the thermodynamic properties of ideal and real gases	PO1
CO2	Derive thermodynamic relations between thermodynamic properties	PO2
CO3	Estimate properties of ideal and real gases from the thermodynamic relations.	PO2
CO4	Apply equations of state for describing the phase behaviour of various fluids.	PO3

CO5	Evaluate the equilibrium conversion in a reversible reaction using the Gibbs phase rule criteria	PO3
CO6	Assessment of the phase behaviour and equilibrium data of both pure and multicomponent systems by using phase equilibrium criteria.	PO3

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment by**
Theory Component	Three Internal Tests (Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PROCESS HEAT TRANSFER													
Course Code	1	9	C	H	4	D	C	H	T	R	Credits	04	L – T – P	3 – 0 – 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Mathematics and Engineering Physics

SYLLABUS:

UNIT -I

INTRODUCTION: Various modes of heat transfer Viz. Conduction, Convection and Radiation.

Conduction: Fourier's law, Steady state unidirectional heat flow through single and multiple layer slabs, spheres and cylindrical surfaces for constant and variable thermal conductivity. **7Hrs**

UNIT-II

INSULATION: Properties of insulation materials, Types of insulation, Critical and Optimum thickness of insulation.

FIN: Types of fins, Heat dissipation from a fin loosing heat at tip, Heat flow through infinitely long rectangular fin, heat dissipation from fin insulated at tip. Fin efficiency and fin effectiveness-derivation and problems. Elementary treatment of unsteady state heat conduction. **10Hrs**

UNIT -III

CONVECTION: Individual and over all heat transfer coefficient, LMTD, LMTD correction factor, Heat Transfer with Phase Change: Boiling phenomena, Nucleate and film boiling.

CONDENSATION: Film and Drop wise condensation, Nusselt's equations. **10Hrs**

UNIT -IV

EVAPORATION: Methods of Feeding multi effect evaporator, working of single effect natural Circulation evaporator. Enthalpy Balance for single effect evaporator and calculations, BPE, Durhring's Chart, Economy and capacity of Evaporators. **6Hrs**

UNIT-V

RADIATION: Definitions for absorptivity, reflectivity, emissive power and intensity of radiation, black body radiation, grey body radiation Stefan-Boltzman's Law, Wien's displacement Law, Kirchoff'sLaw, view factors. Radiation between surfaces-different shapes, radiation involving gases and vapors, radiation shields. **6Hrs**

LABORATORY COMPONENT

1. Shell and Tube Heat Exchanger
2. Double Pipe Heat Exchanger
3. Vertical condenser
4. Emissivity
5. Helical coil Heat Exchanger
6. Transient Heat Conduction (constant temperature)
7. Bare Tube Heat Exchanger
8. Fin Tube Heat Exchanger
9. Packed Bed Heat Exchanger
10. Transient Heat Conduction (constant flux)

TEXTBOOKS:

1. Kern D. Q.,"Process Heat Transfer" McGraw-Hill, NewYork,1965
2. McCabe, Warren, L., Smith, Julian, C. and Harriott, Peter, "Unit operations of chemical engineering", 5th edition, McGraw-Hill, Singapore, 2000.

REFERENCE BOOKS:

1. Coulson J. M. and Richardson J. F. "Unit Operations of Chemical Engineering, 5th edition, Chemical Engineering Pergamon and ELBS, McGraw Hill, New York 2000.
2. P. K. Nag, Heat and Mass Transfer, 2nd edition, Tata McGraw hill publications.

E-BOOKS

1. Rao Y. V. C, Heat Transfer, 1st edition, Universities Press (India) Ltd., New Delhi, 2000.
2. Dutta, B. K, Heat Transfer: Principles and Applications, PHI Learning Pvt. Ltd., New Delhi,2006

MOOC's and ONLINE COURSES:

1. http://textofvideo.nptel.iitm.ac.in/103103031/lec1.pdf
2. https://www.mooc-list.com/course/heat-transfer-saylororg%3Fstatic%3Dtrue+&cd=7&hl=en&ct=clnk&gl=in

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, IV, V and two questions each from Unit II and III.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Understand the principles of heat transfers and perform heat flux calculations for constant & variable area elements	PO2
CO2	Estimation of optimum insulation thickness and select different shapes of extended surfaces to enhance overall heat transferee co-efficient.	PO2
CO3	Perform preliminary design of heat transfer equipment using data with and without phase change	PO3
CO4	Comprehend and apply the laws governing radiation mode	PO2
CO5	Conduct experiments in teams and estimate the heat transfer co-efficient for fluids with and without phase change	PO9
CO6	Present the experimental observations in the form of a lab report.	PO2

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (One Quiz or AAT)	10%	Course Instructor
Laboratory Component	Laboratory Component	50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Theory (50%)			Practical (50%)		Total Marks
	Test 1	Test 2	Quiz/AAT	Records & Performances	Lab Test	
Max. Marks	20	20	10	30	20	100
Reduced CIE	10	10	5	15	10	50

Course Title	ANALYTICAL INSTRUMENTS													
Course Code	1	9	C	H	4	D	C	A	N	I	Credits	04	L – T – P	3 – 0– 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Physics, Engineering Chemistry and Technical Chemistry

SYLLABUS:

UNIT – I

INTRODUCTION: Introduction to classical qualitative and quantitative analysis, classification of instrumental methods, Errors, precision and accuracy of instruments, Types of calibration curves for data handling and interpretation. **6Hrs**

UNIT – II

SPECTROSCOPY: UV spectral region, Origin of light absorptions in UV and IR, Electronic transitions of organic compounds, Modes of vibrations in IR spectra, Beer's Law, deviation of Beer's Law.

INSTRUMENTATION OF UV AND IR SPECTROSCOPY: Monochromatic Source, grating systems and types of detectors, different sampling techniques and application of UV & IR Spectroscopy.

10Hrs

UNIT – III

GRAVIMETRIC ANALYSIS: Principle of Thermogravimetric 44nalyse44 (TGA), construction of TGA, principle of bomb Calorimeter (BC), principle of Differential scanning calorimeter (DSC), Instrumentation of TGA and BC, Application of TGA and BC instruments.

7Hrs

UNIT – IV

GAS CHROMATOGRAPHY: Introduction, Principle, carrier gas, stationary phase, instrumentation, principles of column detectors: TCD, FID, ECD and PID, qualitative and quantitative analysis. **10Hrs**

UNIT – V

HIGH PERFORMANCE LIQUID CHROMATOGRAPHY: Principle, instrumentation, types of columns, sample injection, detectors used like (absorbance, refractive index, and electrochemical measurements), criteria for mobile phase selection and application of HPLC

6Hrs

LABORATORY COMPONENT

1. Determination of Pka value of a component using UV-spectroscopy
2. Qualitative Analysis of UV-spectroscopy of $KmnO_4$.
3. Effect of temperature on viscosity of oils using red wood viscometer
4. Determination of concentration of alkali metal by Flame photometer
5. Determination of moisture content in a liquid and solid samples using KF titration
6. Qualitative Analysis using Turbidometer
7. Thin layer Chromatography
8. Bomb calorimeter for analysis of calorific value of given sample.
9. Electro analytical instrument like conductivity cell and its measurements

TEXT BOOK:

1. Instrumental Methods of Chemical Analysis; Gurudeep R. Chatwal and Sham K. Anand, Himalaya Publishing House
2. Douglas A. Skoog, F. James Holler, Stanley R. Crouch., "Principles of Instrumental Analysis", 6th Edition, published by Thomson Brooks/Cole, 2007.

REFERENCE BOOKS:

1. Lloyd R. Snyder, Joseph J. Kirkland, John W. Dolan., "Introduction to Modern Liquid Chromatography"., 3rd Edition, Wiley-Blackwell, scholarly publishing.
2. H.H. Willard, L.L. Merritt, J.N. Dean and F.A. Settle, "Instrumental methods of analysis"., I.B.H. Publishing House, New Delhi

E-BOOKS

1. Gregory S. Patience, "Experimental Methods and Instrumentation for Chemical Engineers": https://books.google.co.in/books?id
2. Sharma, B. K, "Instrumental Methods of Chemical Analysis":https://books.google.co.in/books?id

MOOC's and ONLINE COURSES:

1. http://www.myopencourses.com/subject/modern-instrumental-methods-of-analysis
2. http://nptel.ac.in/courses/103108100/module1/module1.pdf

Question Paper Pattern:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, III, V and two questions each from Unit II and IV.

COURSE OUTCOMES (Cos):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Understand the theoretical concepts behind the functioning of analytical instruments	PO1
CO2	Understand the impact, complexity, strength and limitations of each instrument	PO2
CO3	Select suitable instruments based on their applicability	PO2
CO4	Conduct experiments in teams using various instruments for physical and chemical analysis	PO9
CO5	Present the experimental observations in the form of a lab report.	PO2
CO6	Ability to engage in life-long learning in context of technological change in instrumentations.	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (One Quiz/AAT)	10%	Course Instructor
Laboratory Component	Laboratory Component	50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Theory (50%)			Practical (50%)		Total Marks
	Test 1	Test 2	Quiz/AAT	Records & Performances	Lab Test	
Max.Marks	20	20	10	30	20	100
Reduced CIE	10	10	5	15	10	50

Course Title	MASS TRANSFER-I													
Course Code	1	9	C	H	4	D	C	M	T	1	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry, Engineering Maths and Technical Chemistry

SYLLABUS:

UNIT–I

INTRODUCTION: Diffusion in fluids, Diffusion in solids, Measurement and Calculations of diffusivities.

Eddy diffusion: Mass Transfer coefficients and their correlations, Theories of Mass Transfer, Interphase Mass Transfer. **10Hrs**

UNIT-II

HUMIDIFICATION OPERATIONS: Vapour pressure Curve, Enthalpy of pure substance, Humidity and related terminologies, Psychometric chart and evaluation of absolute humidity, molal humidity, relative humidity and others.

Adiabatic-Saturation Curves, Wet bulb temperature, Lewis Relation and gas liquid contact operations, Dehumidification. Equipment-Water Cooling towers and spray chamber. **10Hrs**

UNIT-III

DRYING: Introduction to drying operation, Equilibrium, Drying rate curves, Mechanism of drying. Equipment: Direct, and indirect batch driers, and rotary, spray and drum continuous driers. **6Hrs**

UNIT – IV

ADSORPTION AND ION EXCHANGE: Theories of adsorption, Industrial adsorbents. Material balance for co-current, cross current and counter current operations: Fixed Bed Adsorption, Adsorption of liquids and Ion Exchange. **7Hrs**

UNIT- V

CRYSTALLIZATION: Factors governing nucleation and crystal growth rates, Controlled growth of crystals, Incorporation of principles into design of equipment, Crystallizer equipment: Vacuum crystallizers and Draft Tube- Baffle Crystallizer. **6Hrs**

TEXT BOOK:

1. Robert E. Treybal, "Mass transfer operations", 3rd edition, McGraw Hill publications, 1980.
2. McCabe & Smith, "Unit operations in chemical engineering", 6th edition, McGraw Hill publications, 2001.

REFERENCE BOOKS:

1. Coulson and Richardson, "Chemical Engineering", Vol I, II , IV & V, 4th edition, Pergamon press.
2. Badger, W.L. and Banchero J.T.,"Introduction to Chemical Engineering", 3rd edition, McGraw Hill International Edition., 1999.

E BOOKS

1. Mass Transfer in Chemical Engineering Processes, by Jozef Markoš http://www.e-booksdirectory.com/details.php?ebook=6659
2. Ion Exchange: Studies and Applications, Ayben Kilislioglu, http://www.e-booksdirectory.com/details.php?ebook=10637

3.Transport Processes and Unit Operations by Geankoplis http://chembookneed.blogspot.in/2010/08/transport-processes-and-unit-operations.html

MOOC's:

1. Mass Transfer operations 1 https://www.coursebuffet.com/sub/chemical-engineering/480/mass-transfer-operations-i
2. Mechanical heat and mass transfer https://www.springboard.com/udemy/mechanical-heat-and-mass-transfer/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit III, IV, V and two questions each from Unit I and II.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Formulate equations to estimate diffusivities in fluids and solids using first principles of engineering sciences	PO2
CO2	Apprehend the analogies in transport processes for validating and reaching substantiated conclusions.	PO3
CO3	Apply mass transfer fundamentals to calculate rates of mass transfer.	PO2
CO4	Knowledge of the operation/mechanism of adsorption, ion-exchange and crystallization.	PO7
CO5	Understanding of the concept and operation of various types of gas liquid contacts equipment.	PO3
CO6	Design the system components for various mass transfer operations.	PO3

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment by
Theory Component	Three Internal Tests (Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		Marks 100 (Weightage 50%)	

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	CONSTITUTION OF INDIA-PROFESSIONAL ETHICS AND HUMAN RIGHTS													
Course Code	1	9	I	C	4	H	S	C	P	H	Credits	01	L – T – P	0 – 0 – 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

COURSE OBJECTIVES:

1. To educate students about the Supreme Law of the Land.
2. To value human dignity and to save the liberties of the people against discriminations.
3. To raise awareness and consciousness of the issues related to the profession and discuss the issue of liability of risks and safety at work place.

UNIT-I

INTRODUCTION TO INDIAN CONSTITUTION: Historical Background of the Indian Constitution. Framing of the Indian constitution: Role of the Constituent Assembly – Preamble and Salient features of the Constitution of India, Fundamental Rights and its limitations. Fundamental Duties and their significance. Directive Principles of State Policy: Importance and its relevance. Case Studies **3Hrs**

UNIT –II

UNION EXECUTIVE AND STATE EXECUTIVE: The Union Executive – The President and The Vice President, The Prime Minister and The Council of Ministers. The Union Parliament – Lok Sabha & Rajya Sabha. The Supreme Court of India. State Executive – The Governors, The Chief Ministers and The Council of Ministers. The State Legislature – Legislative Assembly and Legislative Council. State High Courts. **3Hrs**

UNIT –III

ELECTION COMMISSION OF INDIA, AMENDMENTS AND EMERGENCY PROVISIONS: Election Commission of India – Powers & Functions – Electoral Process in India. Methods of Constitutional Amendments and their Limitations. Important Constitutional Amendments – 42nd, 44th, 61st,74th, 76th, 77th, 86th and 91st. Emergency Provisions. Case Studies. **2Hrs**

UNIT-IV

SPECIAL CONSTITUTIONAL PROVISIONS/ HUMAN RIGHTS: Special Constitutional Provisions for Schedule Castes, Schedule Tribes & Other Backward Classes. Women & Children. Case Studies. Human Rights/values – Meaning and Definitions, Legislative Specific Themes in Human Rights and Functions/ Roles of National Human Rights Commission of India. Human Rights (Amendment Act) 2006. **2Hrs**

UNIT-V

PROFESSIONAL ETHICS: Scope and Aims of Engineering Ethics, Responsibilities of Engineers and impediments to responsibilities. Honesty, Integrity and Reliability; Risks – Safety and Liability in Engineering. Case Studies. **3Hrs**

QUESTION PAPER PATTERN:

1. Online Examination: Objective Type

COURSE OUTCOMES:

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Understand and explain the significance of Indian Constitution as the Fundamental Law of the Land.	PO6
CO2	Analyse the concepts and ideas of Human Rights.	PO6
CO3	Apply the practice of ethical responsibilities and duties to protect the welfare and safety of the public.	PO8
CO4	Discover of the set of justified moral principles of obligation, ideals that ought to be endorsed by the engineers and apply them to concrete situations	PO8
CO5	Appreciate the Ethical issues and Know the code of ethics adopted in various professional body's and industries	PO8
CO6	Appreciate the Ethical issues and Know the code of ethics adopted in various professional body's and industries	PO8

TEXT BOOKS:

1. "An Introduction to Constitution of India and Professional Ethics" by Merunandan K.B. and B.R. Venkatesh, Meragu Publications, 3rd edition, 2011.
2. "Constitution of India & Professional Ethics & Human Rights" by Phaneesh K. R., Sudha Publications, 10th edition, 2016.

REFERENCE BOOKS:

1. "V.N. Shukla's Constitution of India" by Prof (Dr.) Mahendra Pal Singh (Revised), Eastern Book Company, Edition: 13th Edition, 2017, Reprint 2019.
2. "Ethics in Engineering" by Martin, W. Mike.,Schinzinger, Roland., McGraw-Hill Education; 4th edition (February 6, 2004) .

E-Book:

1. https://books.google.co.in/books/about/Constitution_of_India_and_Professional_E.html?id=VcvuVt-d88QC
   Constitution of India and Professional Ethics, by G.B. Reddy and Mohd Suhaib, I.K. International Publishing House Pvt. Ltd., 2006.
2. http://www.scribd.com/doc/82372282/Indian-Constitution-M-Raja-Ram-2009#scribd
   Indian Constitution, by M. Raja Ram, New Age International Pvt. Limited, 2009.

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**
Theory Component	Three Internals Test (Best of Two) Online Test: Multiple Choice	80%
	Two Alternate Assessment Tool(AAT): Essay	20%
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	CHEMICAL PLANT UTILITIES													
Course Code	1	9	C	H	4	D	E	L	A	1	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering physics and chemistry

SYLLABUS:

UNIT- I

COMPRESSED AIR: Types, construction and working: Reciprocating (Single and double), centrifugal and gear compressors, fans and blowers. Power requirement and performance calculations.

VACUUM SYSTEMS: Basic Concepts of vacuum and pressure, Components of vacuum system like vacuum chamber, pumps, gauges, valves, seals, and many other subsidiary components., Vacuum generation and Piping. **10Hrs**

UNIT- II

STEAM AND POWER: Fire tube boilers and water tube boilers, examples, boiler mountings and accessories, boiler performance and its calculation, Cogeneration power plants.

Fuels: Types, Proximate and ultimate analysis, Calorific value and its calculation. **6Hrs**

UNIT- III

REFRIGERATION AND COLD STORAGE: Refrigeration cycles, Refrigerants and their characteristics, chilled water plant, Coefficient of performance, Power requirement and related calculations.

AIR CONDITIONING: Air-conditioning system and its, components

INSULATION: Types of insulation, Different types of insulating materials and their characteristics, Selection criteria for insulating materials. **10Hrs**

UNIT-IV

COOLING WATER: Principle, types and construction of cooling towers, related calculations, humidification and dehumidification chambers.

UTILITY PIPING: Colour codes for piping, Chilled Water Insulation Piping, Compressed Air Piping, Water Utility Piping, Cooling Coil Heat Transfer, Anti Fire Pipes and steam piping.

7Hrs

UNIT- V

WATER AND ITS TREATMENT: Sources of water, hard and soft water, Requisites of industrial water and its uses, Methods of industrial water treatment: Chemical softening, Demineralization Resins used for water softening, reverse osmosis and membrane separation, Effects of impure boiler feed water & its treatment. **6Hrs**

TEXT BOOKS:

1. Power Plant Engineering, P.K. Nag, Tata Mc Graw Hill-1998
2. Thermal Engineering, B.K. Sarkar, Tata Mc Graw Hill
3. Refrigeration and Air conditioning, C.P. Arora, Third Edition, McGraw Hill Companies

4. D. B. Dhone, Plant utilities, 2 nd Edition, Nirali Prakashan, Pune
5. Sathiyamoorthy Manickkam, Chemical Plant Utilities, Lambert Academic Publishing, 978-3-659-97828-9.

REFERENCE BOOKS:

1. Handbook for process Plant Project Engineers, Peter Water mayer, Professional Engineering Publishing, 2002.
2. Perry's Chemical Engineering Hand Book, 8th Edition, McGraw Hill
3. Facility Piping Systems Handbook: For Industrial, Commercial, and Healthcare Facilities", Michael Frankel, 3rd edition, McGraw-Hill Professional publication

E BOOKS:

1. Chemical Plant Utilities by Sathiyamoorthy Manickkam, https://www.lap-publishing.com/catalog/details//store/gb/book/978-3-659-97828-9/chemical-plant-utilities
2. Steam Plant Operation by Everett B. Woodruff, Herbert B. Lammers, Thomas F. Lammers, https://www.accessengineeringlibrary.com/browse/steam-plant-operation-ninth-edition

MOOC's and ONLINE COURSES:

1. http://tafeqld.edu.au/course/15418/certificate-iv-process-plant-technology
2. https://training.gov.au/Training/Details/PMA40108

QUESTION PAPER PATTERN:

1.Overall question paper pattern to have seven questions from five units
2.Five questions to be answered.
3.One question each from Unit II, IV, V and two questions each from Unit I and III.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Enlist the applications of utilities in chemical processes	PO1
CO2	Identify the equipment used for a utility, describe their construction and working.	PO1
CO3	Apply thermodynamic principles involved in utility generation and perform the relevant calculations.	PO3
CO4	Compare equipment based on their relative advantages and disadvantages.	PO6
CO5	Evaluate equipment based on their performance and efficiency calculations	PO7

CO6	Aim for sustainable development in process by selecting suitable alternatives	PO7

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**
Theory Component	Three Internals Test (Best of Two)	80%
	Quiz (Two Quizzes or AAT)	20%
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	FOOD ENGINEERING													
Course Code	1	9	C	H	4	D	E	L	A	2	Credits	03	L – T – P-	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Technical Chemistry

SYLLABUS:

UNIT - I

INTRODUCTION TO FOOD ENGINEERING: Introduction: general aspects of food industry, world food demand and Indian scenario, Physical properties of food materials: Rheological models, Water activity, Fluid Flow in Food Processing: Liquid Transport Systems; Pipes for Processing Plants, Pumps for food plants; Numerical on fluid flow in food processing. **6Hrs**

UNIT – II

FOOD PROCESSING AND PRESERVATION: Food deterioration – Causes, Aims and objectives of preservation and processing.

FOOD CONTAMINATION AND ADULTERATION: Types of adulterants and contaminants, Intentional adulterants, Metallic contamination, Incidental adulterants, Nature and effects, food laws and standards, Hazard analysis and critical control points or HACCP**,** Food Safety and Standards Authority of India (FSSAI) **7Hrs**

UNIT- III

HIGH-TEMPERATURE PRESERVATION: Introduction to Thermal Processing; Pasteurisation; Commercial Sterilization Kinetics of Microbial Death; Thermal Death Time; Heat Transfer in Thermal Processing; Integrated F Value; Numericals; Batch & continuous Retorts for Thermal processing

NON THERMAL PRESERVATION: Cold sterilization: Gamma irradiation; Microwave & Ohmic heating, Pulsed Electric Field, High Pressure Processing

LOW-TEMPERATURE PRESERVATION: principles of low temperature preservation; freezing rate & freezing point; physical properties of frozen food; food quality during frozen storage; freezing equipment, plate freezer, blast freezer, fluidised bed freezer, scraped surface freezer; cryogenic and immersion freezing; prediction of freezing time using Plank's equation & Nagaoka's equation. **10Hrs**

UNIT- IV

FOOD ADDITIVES: Introduction and need for food additives, Types of additives – antioxidants, chelating agents, colouring agents, curing agents, emulsions, flavors and flavor enhancers, flavor improvers, humectants and anti-caking agents, leavening agents, nutrient supplements, non-nutritive sweeteners, pH control agents. Preservatives: types and applications, Stabilizers and thickeners, other additives, Additives and food safety. **6Hrs**

UNIT –V

EXTRUSION PROCESSES: Introduction to Extrusion, Basic Principles, Extrusion Systems, Cold Extrusion, Extrusion Cooking, Single Screw Extruders, Twin-Screw Extruders.

PACKAGING CONCEPTS: Introduction to packaging, food protection, product containment, commutation, convenience, mass transfer in packaging materials, and permeability of packaging material to fixed gases, innovations in food packaging, passive packaging, active packaging, intelligent packaging, food packaging and product shelf-life. Advances in aseptic processing and packaging, nutrition labelling. **10Hrs**

TEXT BOOKS:

1. R.Paul Singh and Dennis R. Introduction to Food Engineering, Elsevier Science & Technology, 5th Edition, ISBN: 9780123985309, 2013.

REFERENCE BOOKS:

1. P.G. Smith, Introduction to Food Process Engineering Second Edition, Springer Press, ISBN 978-1-4419-7661-1, 2009
2. Subbulakshmi G. and Shobha A. Udupi, Food Processing and Preservation, New Age International Pvt. Ltd., ISBN: 8122412831, 2001

E BOOKS

[1] Food Engineering 1, Gustavo V. Barbosa-Canovas & Pablo Juliano
http://www.eolss.net/ebooklib/ebookcontents/e5-10-themecontents.pdf
[2] Food Processing, Carl J. Schaschke: http://bookboon.com/en/food-processing-ebook

MOOC's & ONLINE COURSES:

[1] https://www.coursetalk.com/subjects/food-nutrition/courses
[2] https://www.springboard.com/topic/food-engineering
[3] http://elearning.vtu.ac.in/06BT74.html

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, II, IV and two questions each from Unit III and V.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Identify sources of contaminants, adulterants and hazard analysis to ensure the safe food processing.	PO2
CO2	Understand the need of food additives and its safety aspects	PO2
CO3	Comprehend the engineering solutions for preservation of food	PO2
CO4	Understand the impact of nutritional properties of food on societal and	PO6

	health	
CO5	Comprehend the engineering solutions involved in the packaging improvements for sustainable development of food industry.	PO7
CO6	Discern different technological change and recent advancements involved in food preservation	PO12

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT												
Course Code	1	9	H	S	4	C	H	E	D	M	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)	

PREREQUISITES: Personality Development and communication skill

SYLLABUS:

UNIT-I

MANAGEMENT: Introduction-meaning-nature and characteristics of management, scope and functional area of management, management as a science or art of profession, management and administration roles of management, levels of management, Development of management thought -Early management approaches, Modern management approaches. **7 Hrs**

UNIT-II

ENTREPRENEUR: Meaning, evolution of the concept, functions of an Entrepreneur, Characteristics of an Entrepreneur, types of entrepreneur, Entrepreneur – an emerging class. Difference between Entrepreneur, Entrepreneur & Manager, Stages in Entrepreneurial process, Scope of Entrepreneur & Problems of Entrepreneur, Role of Entrepreneurs in economic development, Entrepreneurship- Meaning & Importance of Entrepreneurship in India. Its barriers, Women entrepreneur – Concept & steps to develop Women Entrepreneur. **10 Hrs**

UNIT-III

SMALL SCALE INDUSTRY: Ancillary Industry and Tiny Industry , Definition;, Characteristics; Objectives, Scope and role of SSI in economic Development, Advantages of SSI, problems of SSI, Steps to start an SSI, Government Policy towards SSI; Introduction to GATT/ WTO/ LPG. Forms of ownership. supporting agencies of government for ssi: Meaning, Nature of support; Objectives, functions. **6 Hrs**

UNIT-IV

INSTITUTIONAL SUPPORT: Different Schemes, TECKSOK, KIADB, KSSIDC, DIC,SISI NSIC, SIDBI, KSFC. Sources of financing an enterprise- long term and short term **6 Hrs**

UNIT-V

PREPARATION OF PROJECT: Meaning, Project identification, Project selection, Project Report - Need of Project, Contents: formulation:, Network Analysis Errors of project report, Project Appraisal, Feasibility Study-Market Feasibility Study, Technical Feasibility Study, Financial Feasibility Study, Social Feasibility Study. **10 Hrs**

TEXT BOOKS

1. Havinal Veerabhadrappa, Management and Entrepreneurship, New Age International Publishers, 2009.
2. S Nagendra and V S Manjunath, Entrepreneurship and Management, Pearson Publication 4TH Edition, 2009.
3. PC Tripathi and P N Reddy, Principles of Management, Tata MacGraw Hill.

REFERENCE BOOKS

1. Entrepreneurship Development – Poornima M Charanthimath Pearson Education 2006.
2. Entrepreneurship and management - Shashi k Gupta- Kalyani publishers, Latest edition.
3. Dynamics of Entrepreneurial Development and Management-Vasant Desai-Himalaya Publishing House.

E-BOOKS

[1] Organizational behaviour, Stephen P Robbins, Timothy A. Judge, Neharika Vohra, Pearson, 14/e, 2012
[2] Financial Management- Shashi k Gupta- Kalyani publishers, Latest edition

MOOC's and ONLINE COURSE

1) https://www.mooc-list.com/course/entrepreneurship-openlearning
2) http://www.iimb.ernet.in/iimbx

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, III, IV and two questions each from Unit II and V.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Knowledge of management concepts and their evolution for professional engineering practice	PO6
CO2	Apply managerial skills and develop the necessary attributes to function effectively in diverse teams.	PO9
CO3	Ability to explore for business opportunities.	PO12
CO4	Compile information about the support available from various agencies for starting an enterprise	PO11
CO5	Possess knowledge of the entrepreneurial process	PO11
CO6	Ability to formulate, prepare and present a project report.	PO10

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

FIFTH SEMESTER

Course Title	TRANSPORT PHENOMENA													
Course Code	1	9	C	H	5	D	C	T	R	P	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Mathematics, Fluid Mechanics, Heat Transfer, and Mass Transfer-I

SYLLABUS:

UNIT – I

INTRODUCTION: Momentum, Energy and Mass Transport operations, Newton's law of viscosity(NLV), Newtonian and Non-Newtonian fluids, Fourier's law of heat conduction(FLHC), Fick's law of diffusion (FLD), Numerical problems. **06 Hrs**

UNIT – II

STEADY STATE SHELL MOMENTUM BALANCES: Different Flow situations, Steady state Shell momentum balances Boundary conditions applicable to momentum transport problems, Flow over a flat plate for Newtonian fluid and Non-Newtonian fluid, Flow through a circular tube for Newtonian fluid and Non-Newtonian fluid, Flow through Annulus. Flow between parallel plates and a slit. Numerical problems. **10 Hrs**

UNIT- III

STEADY STATE SHELL ENERGY BALANCES: General Boundary conditions applicable to energy transport problems of chemical engineering, Heat conduction through compound walls, Overall heat transfer coefficient based on inner and outer surface area. Heat conduction with internal generation by electrical, nuclear, viscous energy sources, Numerical problems. **10 Hrs**

UNIT- IV

STEADY STATE SHELL MASS BALANCES: Steady state shell mass balances, General Boundary conditions applicable to mass transport problems of chemical engineering, Diffusion through stagnant gas and liquid films, Equimolar counter diffusion. Numerical problems.

STEADY STATE SHELL MASS BALANCES WITH REACTION: Diffusion with homogeneous and heterogeneous reaction. Diffusion into falling film- Forced convection mass transfer. Numerical problems. **07 Hrs**

UNIT –V

ANALOGIES BETWEEN MOMENTUM, HEAT AND MASS TRANSPORT: Reynold's, Prandtl's and Chilton & Colburn analogies.

EQUATIONS OF CHANGE: Various coordinate systems, Equation of continuity, Equation of motion; Navier-Stokes equation, Euler's equation. **06 Hrs**

TEXTBOOKS:

1. Bird, Stewart and Lightfoot, 'Transport Phenomena', 2nd Edition, Wiely Publications, 2006.
2. Bodh Raj, Introduction to Transport Phenomena, PHI Learning Publications, 2015.

REFERENCE BOOKS:

1. Christe John Geankoplis, Transport Process and Separation Process Principles, 4th Edition, Pearsons, 2015.
2. Welty, Wikes and Watson,' Momentum Heat and Mass Transport'', 4th Edition. John Wiley.
3. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot and Daniel J. Klingenberg Introductory Transport Phenomena Wiley; 1st Edition, 2015.

E-BOOKS

1. http://www.freeengineeringbooks.com/Chemical/Transport-Phenomena.php
2. http://www.hailienene.com/resources/transport-phenomena.pdf

MOOC's & ONLINE COURSES:

1. https://swayam.gov.in/nd1_noc20_bt30/preview
2. https://www.edx.org/course/the-basics-of-transport-phenomena

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, IV, V and two questions each from Unit II and III.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO 1	Understand the relevance of transport phenomena in transport process	PO1
CO 2	Infer and analyze for steady state operation for momentum, heat & mass transfer.	PO2
CO 3	Apply the knowledge and reasoning to solve problems based on shell momentum, energy & mass balances across various boundary conditions.	PO4
CO 4	Extend the knowledge of transport phenomena with reaction and without reactions	PO3
CO 5	Apply the equation of changes for systems of various geometry	PO3
CO 6	Liken the similarities of transport process between momentum, heat and mass transport.	PO2

ASSESSMENT:

Continuous Internal Assessment		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	80%	Course Instructor
	Quiz (One Quiz or AAT)	20%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PROCESS CONTROL ENGINEERING													
Course Code	1	9	C	H	5	D	C	P	C	E	Credits	04	L – T – P	3 – 0 – 1
CIE	100 marks (50% weightage)									SEE		100 marks (50% weightage)		

PREREQUISITES: Engineering Mathematics I and Engineering Mathematics II

SYLLABUS:

UNIT – I

FIRST ORDER SYSTEMS: Thermometer level in a tank, mixing tank, STR, Linearization of I-order systems in series, Response for various input forcing functions. **05 Hrs**

UNIT – II

SECOND ORDER SYSTEMS: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case-terms associated, transportation lag. **10 Hrs**

UNIT- III

CLOSED LOOP SYSTEM: Basic components, Servo and regulator control, Controllers- P, I, D and On-Off modes, Controller combinations - Final control elements -Valves, actuators and valve positioners **07 Hrs**

UNIT- IV

CLOSED LOOP RESPONSE: Block diagram, closed loop transfer function, Transient response of servo and regulator control systems with various controller modes and their characteristics **07 Hrs**

UNIT –V

STABILITY: Stability of linear control systems, Routh Test, Frequency Response- Bode diagrams,
CONTROL SYSTEM DESIGN BY FREQUENCY RESPONSE: Bode criterion, Gain and Phase margins. Ziegler-Nichols controller tuning, Cohen-Coon controller tuning
ROOT LOCUS: Rules for plotting and problems. **10 Hrs**

LABORATORY COMPONENT

1. Thermometer
2. Single Tank-Step Response
3. Non Interacting Tanks-Step Response
4. Interacting Tanks-Step Response
5. Pressure Vessel
6. Single Tank-Impulse Response
7. Non Interacting Tanks-Impulse Response
8. Interacting Tanks-Impulse Response
9. Level Control-P controller, PI controller, PD controller, PID controller
10. Valve characteristics

TEXTBOOK:

1. Donald R. Coughanowr & Steven E. LeBlanc, Process Systems Analysis and Control, 3rd Edition (Indian Edition), McGrawHill Education.
2. Instrumentation and Process Control, D.C. Sikdar, 1st Edition, Khanna Publishing House, 2019

REFERENCE BOOKS:

1. George Stephanopoulos, Chemical Process Control-An Introduction to Theory & Practice, (Indian Edition) Pearson, 2015.
2. Coulson& Richardson, Chemical Engineering Vol 3, 3rd Edition-Pergamon Press, 1998.

E BOOKS

1. http://www.ourmumbaicity.com/ebooks
2. http://www.leka.lt/sites/default/files/dokumentai/process-control.pdf

MOOC's &ONLINE COURSES:

1. https://nptel.ac.in/courses/103/106/103106148/
2. https://nptel.ac.in/courses/103/105/103105064/
3. https://www.mooc-list.com/
4. http://elearning.vtu.ac.in/06IT64.html

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered
3. One question each from Unit I, III, IV and two questions each from Unit II and V.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Develop the transfer function of simple first order systems, first order systems in series and second order systems	PO2
CO2	Predict the response of first and second order systems	PO2
CO3	Describe the components of a control system, develop its closed loop transfer function and predict the control action of P, PI, PD and PID controllers.	PO2
CO4	Comment on the stability of control systems using Root Locus Method, Frequency Response Method and perform rudimentary controller tuning.	PO2
CO5	Conduct experiments in a team and draw inferences.	PO9
CO6	Engage in individual/peer learning and communicate effectively.	PO10

ASSESSMENT:

Continuous Internal Assessment		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (One Quiz or AAT)	10%	Course Instructor
Laboratory Component	Laboratory Component	50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Laboratory Work	Laboratory Test	Total Marks
Max. Marks	20	20	10	30	20	100
Reduced CIE	10	10	5	15	10	50

Course Title	MASS TRANSFER-II													
Course Code	1	9	C	H	5	D	C	M	T	2	Credits	03	L – T – P	3 – 0 – 1
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Mass Transfer I

SYLLABUS:

UNIT–I

GAS LIQUID CONTACTING SYSTEMS: Liquid and gas dispersion: Types, Construction and working of tray and packed columns, Types and properties of packing, tray efficiencies, HETP and HTU concepts, Concept of flooding, weeping, and entrainment, Comparison of tray and packed columns.

ABSORPTION: Solubility of gases in liquids, one component transferred: Material balances, Counter current multistage operations: Isothermal only, Continuous contact equipment: Overall coefficients and transfer units, Dilute solutions, Overall heights of transfer units, Design of packed towers from the data of NTU. **10 Hrs**

UNIT-II

DISTILLATION: Introduction, Vapour liquid equilibrium, Estimation of VLE data, VLE for multicomponent systems, Flash vaporization, Simple distillation, Steam distillation, Continuous rectification, Design of distillation column using McCabe Thiele method for binary mixtures and related problems. **10 Hrs**

UNIT-III

DESIGN OF DISTILLATION COLUMN: Ponchon-Savarit method, Efficiencies- overall, local, and Murphree plate efficiencies: Reboilers, Use of open steam, Vacuum, Molecular, Extractive and Azeotropic distillations. **06 Hrs**

UNIT – IV

LIQUID-LIQUID EXTRACTION: Introduction, Ternary equilibrium, Solvent selection, Equipment and flow sheets: Single stage, Multi-stage cross-current, Insoluble systems, Continuous counter current multistage extraction, Equipment: Stage efficiency, stage type extractors (no design aspects): Mixer-settler cascades, Continuous contact equipment: Rotating disc contactor, Pulsed column, and Centrifugal extractor. **07 Hrs**

UNIT- V

LEACHING OPERATION: Introduction, Preparation of solid, Equipment for unsteady state operation and steady state operation: Dorr thickener, Kennedy extractor and Bollman extractor, Methods of calculation: Equilibrium diagrams, Single stage and multi-stage cross and counter current operations, Counter current leaching operation with constant underflow. **06 Hrs**

LABORATORY COMPONENT

1. Single stage adsorption
2. Diffusion co-efficient of organic vapour into air
3. Drying characteristics
4. Wetted wall column
5. Multistage adsorption
6. Simple distillation
7. Packed column distillation
8. Single stage Liquid-Liquid extraction
9. Solid Dissolution
10. Single Stage Leaching

TEXTBOOKS:

1. Robert E. Treybal, "Mass transfer operations", 3rd Edition, McGraw Hill publications, 1980.
2. McCabe & Smith, "Unit operations in chemical engineering", 6th Edition, McGraw Hill, publications, 2001.

REFERENCE BOOKS:

1. Coulson and Richardson, "Chemical Engineering", Vol II, & IV, 4th Edition, Pergamon press, 1998
2. Badger, W.L. and Banchero J.T., "Introduction to Chemical Engineering", 3rd Edition, McGraw Hill International Edition., 1999.

EBOOKS

1. Mass Transfer in Chemical Engineering Processes, by Jozef Markoš, http://www.e-booksdirectory.com/details.php?ebook=6659
2. Transport Processes and Unit Operations by Geankoplis, http://chembookneed.blogspot.in/2010/08/transport-processes-and-unitoperations.html

MOOC's & ONLINE COURSES:

1. http://elearning.vtu.ac.in/BT32.html
2. http://nptel.ac.in/courses/103104046/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit III, IV, V, and two questions each from Unit I and II.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Apply the understanding of interfacial mass transfer to various gas/liquid/solid contact systems	PO2
CO2	Acquainted with the knowledge of construction & working of industrial-scale equipment for mass transfer	PO3
CO3	Conversant with the skill to do an elementary design of mass transfer equipment	PO4
CO4	Investigate engineering tasks and accustomed to industrial applications of the mass transfer operations	PO2
CO5	Conduct the hands-on experiments in a team; examine the observation and present record.	PO9
CO6	Perform the experiment and calculations individually and draw/state conclusions based on engineered/plotted data.	PO3

ASSESSMENT:

Continuous Internal Assessment		**Marks 100% (Weightage 50%)**	**Assessment**
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (One Quiz or AAT)	10%	Course Instructor
Laboratory Component	Laboratory Component	50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Laboratory Work**	**Laboratory Test**	**Total Marks**
Max. Marks	20	20	10	30	20	100
Reduced CIE	10	10	5	15	10	50

Course Title	CHEMICAL REACTION ENGINEERING–I													
Course Code	1	9	C	H	5	D	C	C	R	1	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry, Engineering Maths and Technical Chemistry

SYLLABUS:

UNIT–I

INTRODUCTION: Scope of Chemical Reaction Engineering, Classification of reactions, Rate equation and rate of reaction, Factors affecting rate of reaction, Chemical kinetics and Thermodynamics Equilibrium, Temperature-dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reactions. **07 Hrs**

UNIT-II

NON-ELEMENTARY REACTIONS: Difference between elementary and non- elementary reactions. Kinetic models and mechanisms for non-elementary reactions and types of reactors. **06 Hrs**

UNIT-III

HOMOGENEOUS REACTIONS: Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis: Differential method, Integral method, half-life method, method of excess and method of isolation (for Reversible and Irreversible reactions up to second order).

DESIGN OF IDEAL REACTORS: Concept of ideality, Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors. **10 Hrs**

UNIT – IV

MULTIPLE REACTOR SYSTEMS: Plug flow and Mixed flow reactors in Series & parallel reactions, Reactors of different types and sizes in series, Comparison of Ideal Reactors and General graphical comparison.

DESIGN OF REACTORS FOR MULTIPLE REACTIONS: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered). **10 Hrs**

UNIT - V

NON-ISOTHERMAL REACTORS: Introduction, Material, Energy balances and conversions, Design procedure (For single/simple reactions only). Optimum temperature Progression. **06 Hrs**

TEXTBOOK:

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

REFERENCE BOOKS:

1. J.M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1984.
2. K.A. Gavhane, Chemical Reaction Engineering-I, Volume-1, Nirali Prakashan., ISBN-13: 9788185790879, 2011.

EBOOKS

1. Fundamentals of Chemical Reaction Engineering by M E Davis: http://authors.library.caltech.edu/25070/1/FundChemReaxEng.pdf

2. Chemical Reaction Engineering: Beyond the Fundamentals by *Doraiswamy* : https://www.crcpress.com/Chemical-Reaction-Engineering-Beyond-the-Fundamentals/Doraiswamy-Uner/9781439831229
3. Fundamentals of Chemical Reaction Engineering, Mark E. E. Davis, Robert J. J. Davis http://www.e-booksdirectory.com/details.php?ebook=2512

MOOC's & ONLINE COURSES:

1. http://ocw.mit.edu/courses/chemistry/5-68j-kinetics-of-chemical-reactions-spring-2003/index.htm
2. https://nptel.ac.in/courses/103/106/103106116/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Units I, II, and V, and two questions each from Units III and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Formulate the rate equations for different reactions using suitable mechanism for reaching a sustainable conclusions	PO2
CO2	Analyse the rate equations for different reactions using suitable mechanism for reaching a sustainable conclusions	PO3
CO3	Analyse and interpret the data to determine rate equation and estimate the performance equation of ideal systems	PO4
CO4	Develop optimal operational conditions for ideal reactor with single and multiple reactions	PO3
CO5	Apply the thermodynamic principles to understand the non-isothermal behaviour of reactions	PO3
CO6	Predict reactor performance for non-isothermal conditions with consideration of public health and safety during operations	PO4

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	CHEMICAL EQUIPMENT DESIGN													
Course Code	1	9	C	H	5	D	C	C	E	D	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Heat & Mass Transfer, Chemical Reaction Engineering.

SYLLABUS:

UNIT – I

INTRODUCTION: General design procedure, Equipment classification. Various components of process equipment, Design parameters and Pressure vessel codes.

DESIGN CONSIDERATIONS: Material selection, factors affecting design, Stresses due to static and dynamic loads (Internal & External), Temperature effects and Economic considerations.

DESIGN OF PRESSURE VESSELS: Design of shell and other vessel components. Introduction to vessel closures: Formed: Elliptical, Hemispherical and Cylindrical heads. Design of Torispherical heads and related Numerical design problems. **10Hrs**

UNIT- II

VESSEL COMPONENT DESIGN: Introduction to supports for vessels: Bracket, Lug, Leg, Saddle and Skirt supports and design of Skirt Supports.

FLANGES AND NOZZLES: Introduction to standard and Non-Standard flanges

DESIGN OF NON- STANDARD FLANGES: Flange thickness calculation, Gasket selection and design, Bolt selection and calculation, Nozzle design. **10Hrs**

UNIT – III

REACTION VESSELS: Introduction, components of a reaction tank with agitator, Types of agitators, baffles, Design of an Anchor type agitator to determine the diameter, thickness, Power requirement with Numerical problems. **07Hrs**

UNIT IV

STORAGE VESSELS: Process conditions and design parameters for storage of volatile, non-volatile fluids & gases, Design of cylindrical tanks with fixed roofs, Annular ring, Baseplate and selection of vessels accessories & mountings. Numerical problems with bill of materials and cost estimation. **07Hrs**

UNIT – V

SPECIFICATIONS OF AUXILLARY EQUIPMENT: Introduction to Economics, Concepts of P&I Diagrams, P&I Diagram for simple processes, Power and pipe size requirement for processes. **05Hrs**

TEXTBOOKS:

1. V V Mahajani & S B Umarji, "Joshi's Process Equipment Design" – Trinity Press, Delhi, India 4th Edition.
2. B.C. Bhattacharyya, "Introduction to Chemical Equipment Design", 1st Edition, CBS Publication, 2008.

REFERENCE BOOKS:

1. Don W. Green & Robert H. Perry, "Chemical Engineers Handbook", 8th Edition, McGraw Hill, 2014.
2. S. D. Dawande, "Process Design of Equipment", Vol 1, Central Techno Publications. 3rd Edition, 2003.

3. Code for United Pressure Vessel, IS 2825, Bureau of Indian standards, New Delhi, 1969.
4. Brownell & Young, "Process equipment design" Willy student, 1st Edition, 2009.

EBOOKS

1. Joshi's Process equipment design https://books.google.co.in/books/about/Joshi_s_Process_Equipment_Design.html?id=UTC1bc3PCNcC&redir_esc=y

MOOC's and ONLINE COURSES:

[1] http://nptel.ac.in/courses/103103027/28

[2] http://nptel.ac.in/courses/103103027/8

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Units III, IV, and V, and two questions each from Unit I and II

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Realize the practical applications of basic engineering design principles using the first principles of mathematics and engineering sciences.	PO2
CO2	Apply reasoning and select suitable materials based on the process to assess the health and safety of society.	PO6
CO3	Design of various reaction/pressure vessel components with environmental consideration.	PO3
CO4	Recognize and design the various types of support, flange, agitator and other vessel accessories required in process vessels by adjudging the various factors influencing it.	PO3
CO5	Estimate the sizing of pumps & storage vessel with its accessories to provide the valid conclusions for their use.	PO4
CO6	Incorporate economic consideration while designing the required auxiliary equipment.	PO11

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment By
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	OPERATIONS RESEARCH													
Course Code	1	9	C	H	5	D	E	L	B	1	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Mathematics

SYLLABUS:

UNIT - I

INTRODUCTION: Definition. Scope of Operations Research, Approach and limitations of O.R-Models, Characteristics and phases of O.R

LINEAR PROGRAMMING PROBLEMS: Mathematical formulation of L.P, Problems and Graphical solution method. **06 Hrs**

UNIT – II

ASSIGNMENT PROBLEMS: Balanced and Unbalanced assignment problems, Maximization assignment problems, traveling salesman problems. **06 Hrs**

UNIT- III

TRANSPORTATION PROBLEM: Transportation Problems definition, Linear form, Basic feasible solutions by different methods, finding optimal solution, Solution methods: North West corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. **10 Hrs**

UNIT- IV

SEQUENCING: Johnson's algorithm, njobs-2machines, njobs-3, machines and njobs-n machines without passing sequence, 2jobs-n, machines, Graphical solutions. **07 Hrs**

UNIT –V

PERT-CPM TECHNIQUES: Network construction, determining time estimates and critical path, in network analysis, Variance and probability of completing the project, Calculation of different floats, Project duration, Crashing of simple networks. **10 Hrs**

TEXTBOOKS:

1. S.D. Sharma, Operations Research- Theory, Methods and Applications, 8th Edition, Kedarnath & Co, 2012, ISBN-13: 978-9380803388
2. S Kalavathy, Operations Research, 4th Edition, Vikas Publishing House, 2012, ISBN-13: 978-9325963474.

REFERENCE BOOKS:

1. L.S. Srinath, Introduction to Pert and CPM, 3rd Edition, East West, 1998.
2. J.K. Sharma, Operations Research- Theroy and Applications, Laxmi Publications, 6th Edition, 2017, ISBN-13**:** 978-9385935145.
3. Kanti Swaroop, P. K. Gupta and Manmohan, Operations Research, 9th Edition, Sultan Chand and Sons, 2019, ISBN-13: 978-9351611011.

E-BOOKS

1. http://www.faadooengineers.com/threads/3345-Operations-Research-(OR)-Ebook
2. http://www.freetechbooks.com/operations-research-f54.html

MOOC's & ONLINE COURSES:

1. https://www.springboard.com/topic/operations-research
2. https://www.quora.com/Are-there-good-online-courses-for-Operations-Research

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, II, IV and two questions each from Unit III and V.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO 1	Understand the mathematical tools that are needed to solve optimization problems.	PO2
CO 2	Identify and develop operational research models for real complex problems.	PO3
CO 3	Develop the model to solve and analyze the results for decision-making processes in Management Engineering.	PO4
CO 4	Select the best strategy based on decision criteria for uncertain real-world problems with sustainable solutions.	PO6
CO 5	Apply the fundamentals of operations research methods for modern management techniques.	PO10
CO 6	Understand the fundamentals of operations research methods to solve economic issues, which help to make a decision.	PO11

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)
Theory Component	Three Internals Test (Best of Two)	80%
	Quiz (Two Quizzes or AAT)	20%
Semester End Examination (Written Examination for Three Hours)		

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	OPTIMIZATION OF CHEMICAL PROCESSES													
Course Code	1	9	C	H	5	D	E	L	B	2	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Fluid Mechanics, Heat Transfer, Mass Transfer, and Applied Mathematics

SYLLABUS:

UNIT-I

INTRODUCTION AND PROBLEM FORMULATION: Scope and hierarchy of optimization, essential features of optimization problems, procedure for solving optimization problems, and obstacles to optimization.

ECONOMIC OPTIMIZATION: Economic Objective Functions, Time Value of Money, Measures of Profitability, and related Problems. **07Hrs**

UNIT-II

OPTIMIZATION THEORY AND METHODS: Continuity of functions, NLP problem statement, convexity and its applications, optimizing a Function of one variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods for one dimensional and multidimensional, and Polynomial Approximation Methods.

06Hrs

UNIT-III

LINEAR PROGRAMMING AND APPLICATIONS: Geometry of Linear Programs, Basic Linear Programming, Simplex Algorithm, barrier method, Sensitivity Analysis, Linear Mixed Integer Programs.

Mixed Integer Programming: Problem Formulation, Branch-and-Bound Methods, Problems on MINLP. **06Hrs**

UNIT-IV

HEAT TRANSFER AND ENERGY CONSERVATION: Optimum recovery of waste heat, optimum shell and tube heat exchanger design, optimization of heat exchanger networks, optimization of multistage evaporators, optimization of liquid-liquid extraction processes, optimal design and operation of staged distillation columns.

10Hrs

UNIT-V

FLUID FLOW SYSTEMS: Optimal pipe diameter, minimum work of gas compression, economic operation of fixed bed filter, optimal design of gas transmission network, optimal design and operation of chemical reactors. **10Hrs**

TEXTBOOKS:

1. T.F.Edger and D.M.Himmelblau, “Optimization of Chemical Processes”, Mc.Graw Hill, 2001.
2. A. Ravindran, G. V. Reklaitis, “Engineering Optimization: Methods and Applications”, Wiley-InterScience publication, 1983.

REFERENCE BOOKS

1. Dominic C. Y. Foo, “Recent Advances in Sustainable Process Design and Optimization”, World Scientific, 2012.
2. Kalyanmoy Deb, “Optimization for Engineering Design”, John Wiley, 1995.

E- BOOKS

1. J. K. Walters P. K. Andow A.V. Bridgwater, "Process Optimisation" https://www.elsevier.com/books/process-optimisation/walters/978-0-85295-205-4
2. Frank (Xin X.) Zhu, "Energy and Process Optimization for the Process Industries", https://onlinelibrary.wiley.com/doi/book/10.1002/9781118782507

MOOC's and ONLINE COURSES:

1. Process Plant Optimization Technology and Continual Improvement: http://petroknowledge.com/sign-up-pdf?dl=course&file=ME175.

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, II, III and two questions each from Unit IV and V.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Apply the knowledge of Mathematics in arriving at optimum conditions	PO2
CO2	Realize the need of optimization as a part of Process Industries.	PO7
CO3	Appreciate the Importance and Economic constraints involved in Industrial Processes	PO11
CO4	Know the intricacies involved in optimal operation by utilizing resources from waste.	PO6
CO5	Envision the benefits of waste recovery concerning economics and society	PO7
CO6	Envisage the requirement of optimal sizing of process utilities and inputs for economic operation of processes	PO8

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment By
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PETROLEUM REFINING													
Course Code	1	9	C	H	5	D	E	L	C	1	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Technical Chemistry

SYLLABUS:

UNIT-I

COMPOSITION OF CRUDE: Classification, Evaluation of petroleum, UOP-k factor, TBP analysis, EFV analysis, Average boiling point, ASTM curves, Thermal properties of petroleum fractions**. 06 Hrs**

UNIT-II

PRODUCTS - PROPERTIES AND TEST METHODS: Crude Distillation, Products from crude; Gasoline: ASTM Distillation, Reid Vapor Pressure Analysis, Octane Number, Oxidation stability, Additives; Kerosene: Flash point, Fire point, Smoke Point, Burning Quality; Diesel Fuels: Classification, Pour Point, Aniline Point, Viscosity, Additives for diesel; Lube Oils: Categories, Carbon Residue: Conradson Residue, Rams bottom Method and Bitumen: Softening Point, Penetration Index. **07 Hrs**

UNIT-III

CRUDE PRETREATMENT: Pumping of crude oil, Dehydration of crude: Chemical, gravity, centrifugal, electrical de-salter.

TREATMENT TECHNIQUES: Types of impurities present, Sweetening operations for gases: Ethanolamine Treatment, Stretford Operation; Treatment of gasoline: Catalytic desulphurization; and Treatment of kerosene: Liquid SO_2 extraction of aromatics. **10 Hrs**

UNIT - IV

CATALYTIC CRACKING: Catalytic cracking: Carbonium ion chemistry, catalysts, reaction variables; Fluid catalytic cracking - Texaco, ESSO, Kellog; Naphtha cracking; and Hydrocracking: Chemistry, catalysts, reaction conditions.

CATALYTIC REFORMING: Chemistry, Reaction variables, catalysts, feedstock requirements.**10 Hrs**

UNIT- V

THERMAL PROCESSES: Thermal cracking: Chemistry, theory, properties of cracked materials and factors influencing the properties of cracked materials, Visbreaking, Dubb's two coil cracking.

Coking: Types of coking processes, Dubb's two coil coking, delayed coking, fluid coking **06 Hrs**

TEXT BOOK:

1. Bhaskara Rao, Modern Petroleum Refining Processes Oxford & IBH Publication, 3rd Edition, Reprint, 1999.
2. Nelson, Petroleum Refinery Engineering - McGraw Hill, 4th Edition, Reprint, 1982.

REFERENCE BOOKS:

1. Ram Prasad, Petroleum Refining Technology- Khanna Publishers, 1st Edition, 2000.
2. Sland W.F. and Davidson R.L., Petroleum Processing - McGraw Hill, 1967

MOOC's &ONLINE COURSES:

1. http://nptel.ac.in/courses/103102022/1
2. https://www.mooc-list.com/tags/refining?static=true
3. https://www.class-central.com/subject/engineering

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered
3. One question each from Unit I, II, V and two questions each from Unit III and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Possess knowledge of the composition, properties, and evaluation of crude and its fractions.	PO1
CO2	Ability to describe the properties of products and their test methods.	PO2
CO3	Identify the pre-treatment and treatment processes for fractions of crude.	PO2
CO4	Possess introductory knowledge of the technologies for converting crude to valuable products	PO3
CO5	Demonstrate the sequence of operations involved in a process	PO2
CO6	Acquainted with the environmental impact and the need for sustainability in refining	PO7

ASSESSMENT:

Continuous Internal Assessment		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	80%	Course Instructor
	Quiz (One Quiz or AAT)	20%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	RECYCLE AND RESUE OF WASTE MATERIALS FOR SUSTAINABLE DEVELOPMENT													
Course Code	1	9	C	H	5	D	E	L	C	2	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Engineering Chemistry and Engineering Physics,

SYLLABUS:

UNIT- I

CURRENT PRACTICE AND FUTURE SUSTAINABILITY: Introduction to waste management and treatment; Incineration, Landfill, Zero pollution and 7Rs rule, Life cycle analysis and extended producer responsibility and Cradle-to-cradle concept**.** **06 Hrs**

UNIT- II

CLEANER PRODUCTION: Promoting cleaner production, Benefits of cleaner production, Obstacles to cleaner production and solutions, Cleaner production techniques, Cleaner production opportunity assessment, Cleaner production case studies**.** **10 Hrs**

UNIT -III

SOLID WASTE SOURCE REDUCTION AND RECYCLING: Solid Waste Source Reduction; Paper Recycling, Metals Recycling, Plastics Recycling, Glass Container Recycling, Environmental Impacts and benefits of recycling. **10 Hrs**

UNIT - IV

SUSTAINABILITY OF INDUSTRIAL WASTE MANAGEMENT: Cement industry case study; Iron and steel industry case study; Aluminium foundries case study; petroleum sector case study; Integrated sugar industry case study. **07 Hrs**

UNIT - V

COSTS AND MANAGEMENT OF WASTE FACILITIES AND SYSTEMS: Capital and Operating Costs of Facilities; Lifecycle Cost Analysis, Management Responsibilities, Pre-Consumer and Post-Consumer Recyclable Waste, Markets for Recyclables**.** **06 Hrs**

TEXTBOOKS:

1. Salah M. El-Haggar, Sustainable Industrial Design and Waste Management Cradle-to-cradle for Sustainable Development, 1st Edition, Elsevier Publications, 2007.
2. Charles R. Rhyner, Leander J. Schwartz, Robert B. Wenger, Mary G. Kohrell, Waste management and resource recovery, 1st Edition, CRC Press, 1999.

REFERENCE BOOKS:

1. C. S. Rao, Environmental Pollution Control Engineering, New Age International Publisher, 2011.
2. Richard Ian Stessel, Recycling and Resource Recovery Engineering-Principles of Waste Processing, Springer, 1996.

E-BOOKS

1. Air Pollution by M N Rao and HV N Rao: http://www.avlib.in/ebook/title/air-pollution-mn-rao-and-hvn-rao-.html
2. https://www.free-ebooks.net/ebook/introduction-to-wastewater-treatment

MOOC's & ONLINE COURSES:

1. https://sustainabledevelopment.un.org/content/dsd/csd/csd_pdfs/csd-9/learningcentre/presentations/May%209%20am/1%20-%20Learning_Centre_9May_ppt_Mohanty.pdf
2. https://nptel.ac.in/courses/120108005/module6/lecture6.pdf

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, IV & V and two questions each from Unit II and III

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Identify the appropriate remedial engineering conceptual design to solve the waste management problem.	PO3
CO2	Know the responsibility of an individual to engineer the reduction and reuse of waste for societal benefit.	PO6
CO3	Acquainted with the knowledge on the environmental impact of waste and know its remedial processes for sustainable development.	PO7
CO4	Recognize the economic impact on the cost of production by adopting "Reduce, Recycle and Reuse".	PO11
CO5	Implement the concept of process integration to produce value-added products that can be obtained from industrial waste.	PO7
CO6	Accustomed to the generation and management of waste with advances in process technology and device new waste management techniques.	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

DEPARTMENT OF CHEMICAL ENGINEERING
B. M. S. COLLEGE OF ENGINEERING, BENGALURU
Autonomous College under VTU

Course Title	PROJECT USING MODERN SIMULATION SOFTWARE TOOLS													
Course Code	1	9	C	H	5	D	C	P	W	1	Credits	02	L – T – P	0 – 0 – 2
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITE: Core subjects from the preceding semesters.

A group of students will be assigned/select one case study or an analytical problem, which they need to solve under the supervision of a guide/faculty using modern IT tools. The project to be assigned at the beginning of the fifth semester. The project group should complete the preliminary literature survey & plan to execute the project and submit the synopsis at the end of the first month. The project work with a report should be completed by the end of the fifth semester. This project will be evaluated by a committee constituted by the HoD for internal assessment.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Select a suitable case study or an analytical problem amongst the various options available through a literature survey.	PO4
CO2	Apply the modern Engineering and IT tools for prediction and modelling the identified engineering problem	PO5
CO3	Identify a challenge related to process industries and/or the society with or without multidisciplinary facets.	PO6
CO4	Demonstrate the need for sustainability for an optimal process.	PO7
CO5	Develop the ability to function effectively as an individual, and as a member or leader in diverse teams.	PO9
CO6	Make effective presentations and communicate effectively on the activities carried during the project work with the engineering community and with society at large.	PO10

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Practical Component	Presentation 1	40%	Committee constituted by HOD
	Presentation 2	40%	Committee constituted by HOD
	Report and Training Undergone	20%	Course Instructor/ Guide
Semester End Examination – Presentation and write up (Weightage 50%)			

ASSESSMENT PATTERN:

Component	Presentation 1	Presentation 2	Report	Total Marks
Max. Marks	40	40	20	100
Reduced CIE	20	20	10	50

SIXTH SEMESTER

Course Title	PROCESS EQUIPMENT DESIGN													
Course Code	1	9	C	H	6	D	C	P	E	D	Credits	03	L – T – P	3– 0 – 0
CIE	100 marks (50% weightage)							SEE			100 marks (50% weightage)			

PREREQUISITES: Heat Transfer, Mass Transfer, and Chemical Equipment Design

SYLLABUS:

The detailed chemical engineering process design of the following equipment. The necessary aspects studied in "Chemical Equipment Design" are to be applied for mechanical design. The use of standard codebooks is to be taught. The detailed dimensional drawings shall include a sectional front view, top/side view depending on equipment, and major component drawing with dimensions and the part template.

UNIT I

DESIGN OF HEAT TRANSFER EQUIPMENT: Double pipe Heat exchanger, Shell and Tube Heat exchanger, Horizontal Condenser, Vertical condenser, and Rotary Dryer. **20Hrs**

UNIT II

DESIGN OF MASS TRANSFER EQUIPMENT: Single Effect Evaporator, Bubble Cap Distillation Column, Packed Bed Absorption Column. **19Hrs**

NOTE:

- The question paper contains two full design problems (100 Marks each) for the equipment from the above list and student to answer anyone.
- One question should be framed from each unit.
- A choice between Unit 1 and Unit 2
- Perry's Chemical Engineers Handbook and IS Code 4503 for heat exchangers shall be allowed in the examination as reference.

TEXTBOOKS:

1. S B Thakore and B I Bhatt, Introduction to Process Engineering and Design, 3rd Edition, Tata McGraw-Hill, 2011.
2. Donald Q. Kern, Process Heat Transfer, McGraw Hill, 1997.
3. Robert E Treybal, Mass Transfer Operations, McGraw Hill, 1981.

REFERENCE BOOKS:

1. R. H. Perry and D. W. Green, Chemical Engineering Handbook, 7th Edition, McGraw Hill, 1998.
2. J. M. Coulson and J. F. Richardson, Chemical Engineering, Vol. 6, Pergamon Press, 1993.
3. Shell and Tube Heat exchanger IS Code, IS 4503, BIS, New Delhi, 1969.

E BOOKS

1. S. D. Dawande, Process Design of Equipment, Vol. 2, 3rd Edition, Central Techno Publications, 2003.
2. R. H. Perry and D. W. Green, Chemical Engineering Handbook, 7th Edition, McGraw Hill, 1998.

MOOC's & ONLINE COURSES:

1) http://nptel.ac.in/courses/103103027/
2) https://ocw.mit.edu/courses/chemical-engineering/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have two questions from all the units.
2. One question to be answered.
3. One question each from Unit I and Unit II.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Congregate the data from the literature, Handbook, Codebook	PO2
CO2	Analyze, interpret the literature data required for the functional design	PO4
CO3	Design the heat and mass transfer equipment	PO3
CO4	Select the details of accessories based on technical needs and availability	PO12
CO5	Decide on the incorporation of inherent safety standards	PO8
CO6	Draft the equipment as per the design	PO3

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment By
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PROCESS MODELLING & SIMULATION													
Course Code	1	9	C	H	6	D	C	P	M	S	Credits	04	L – T – P	3 – 0 – 1
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Chemical reaction engineering, Heat transfer, Mass transfer, Thermodynamics and Numerical techniques

SYLLABUS:

UNIT - I

FUNDAMENTALS OF MODELING: Introduction to process modeling, needs of model and their classification, Model building, Precautions in model building, Principles of model formulation, Fundamental laws, Review of shell balance approach, Models based on thermodynamic principles, Concept of the degree of freedom analysis, Concept of equilibrium and kinetics. **06 Hrs**

UNIT- II

MODELS OF REACTORS: Batch reactor model, Semi Batch reactor, Interacting and Non-Interacting Tanks, two heated tanks, Gas phase pressurized CSTR, Non isothermal CSTR: Perfectly mixed cooling jacket, Plug flow cooling jacket, Lumped Jacket Model, Lumped metal model, Reactor model with mass transfer, Bioreactor models. Fluidized bed reactor model, Trickle Bed Reactor Model. **10 Hrs**

UNIT - III

MODELS OF HEAT TRANSFER EQUIPMENT: One- and Two-dimensional heat conduction, Numerical solution of one-dimensional transient heat conduction in a rectangular slab, cylinder, and sphere using the finite difference method. **07 Hrs**

UNIT – IV

MODELS OF SEPARATION PROCESSES: Development of detailed Single-Component Vaporizer, Development of detailed mathematical models of multicomponent flash drum, Binary Batch & Continuous Distillation Column, Multicomponent non-ideal distillation column, Batch distillation with holdup, Activity coefficient model (Wilson, NRTL, UNIQUAC, UNIFAC), Equation of State Models (RK, SRK, PR). **10 Hrs**

UNIT - V

SIMULATION: Introduction to process simulation, Tools of simulation- Features, Advantages and limitations; Approaches of simulation: Modular approach and Equation solving approach, Flow sheeting, Introduction to dynamic simulation and process optimization. **06 Hrs**

LABORATORY COMPONENT

Simulation Using *UniSim*® Simulation Software

1. Simulation of Mixer, Heater and Pump.
2. Simulation of Heat Exchanger
3. Simulation of Flash Drum for Binary Mixture
4. Simulation of Distillation Column
5. Simulation of Refrigeration Gas Plant
6. Simulation of Conversion Reactor
7. Simulation of Equilibrium Reactor
8. Simulation of Two Stage Compression System
9. Simulation of Absorption Column
10. Oil Characterization / Introduction to Dynamic Simulation

TEXT BOOKS:

1. William. L Luyben, "Process Modeling Simulation and Control for Chemical Engineering", 2nd Edition., McGraw Hill, 1990.
2. B. V. Babu, "Process Plant Simulation", Oxford University Press, 2004.

REFERENECE BOOKS:

1. R.W. Gaikwad & Dr. Dhirendra, " Process Modelling and Simulation", Denett & Co., 2006
2. Amiya K. Jana, "Chemical Process Modelling and Computer Simulation" , PHI Learning Pvt. Ltd., 2011.
3. Pradeep Ahuja, "Introduction to Numerical Methods in Chemical Engineering", PHI Learning Pvt. Ltd., 2010.

E BOOKS

1. Chemical Process Technology and Simulation by Srikumar Koyikkal, ISBN-13: 978-8120347090
2. Enes Kadic, Theodore J. Heindel, "An Introduction to Bioreactor Hydrodynamics and Gas-Liquid Mass Transfer", Willey, April 2014.

MOOC's &ONLINE COURSES:

1. http://nptel.ac.in/courses/103107096/
2. http://www.myopencourses.com/subject/process-modelling-and-simulation-1

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, III, V and two questions each from Unit II and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Comprehend the fundamental laws and Thermodynamic principles required for formulating a mathematical model.	PO2
CO2	Apply the fundamental laws using engineering concepts to identify steps in building mathematical models for chemical processes.	PO3
CO3	Analyze and pursue suitable shell balance approach to build models for complex chemical processes	PO4
CO4	Apply the simulation principles to solve built-in models for chemical processes individually or in a team and interpret the result.	PO6
CO5	Conduct simulation experiments individually using UNISIM.	PO5
CO6	Recognize the need for learning simulation tools in the context of technological change.	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Laboratory Component		50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Laboratory Work	Laboratory Test	Total Marks
Max. Marks	20	20	10	30	20	100
Reduced CIE	10	10	5	15	10	50

Course Title	CHEMICAL REACTION ENGINEERING-II													
Course Code	1	9	C	H	6	D	C	C	R	2	Credits	04	L – T – P	3 – 0 – 1
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Chemical Reaction Engineering-1 and Engineering Mathematics

SYLLABUS:

UNIT - I

BASICS of NON-IDEAL FLOW: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation, Dispersion model. Tanks in series model, Conversion in non- ideal flow reactors for simple systems. **06 Hrs**

UNIT – II

NON-CATALYTIC SYSTEMS: Introduction to Fluid-Fluid reactions, Kinetics for straight mass transfer without reaction, Kinetics for direct mass transfer with the reaction for all types of reactions, the significance of Hatta Number and related problems on fluid-fluid reactions.

FLUID PARTICLE REACTIONS: Introduction to Fluid-Particle reactions, selection of suitable model, Kinetics for different rate-controlling steps for spherical particles of unchanging size and shrinking spherical particles, limitation of the shrinking core model, rate-determining steps with a combination of resistances and related problems. **10 Hrs**

UNIT- III

CATALYSIS: Introduction to catalysis, Properties of catalysts, Estimation methods for catalytic properties, Promoters, Inhibitors etc., Mechanism of catalysis, Rate equations for different rate controlling steps. **06 Hrs**

UNIT- IV

DEACTIVATION: Deactivating catalyst, Mechanism, rate & performance equation

SOLID CATALYZED REACTIONS: Rate equation for surface kinetics, heterogeneous systems, Pore diffusion resistance combined with surface kinetics, Thiele modulus and enhancement factor. **10 Hrs**

UNIT -V

PERFORMANCE EQUATION FOR DIFFERENT REACTION SYSTEMS: Performance equations for reactors containing porous catalyst particles, Experimental methods for finding rates, Packed bed catalytic reactor & reactors with suspended solid catalyst.

GAS-LIQUID REACTORS: Trickle Bed, Slurry reactors. Three phase fluidized bed. **07 Hrs**

LABORATORY COMPONENT

1. Kinetic studies using batch reactor for an equimolar bimolecular reaction
2. Kinetic studies using batch reactor for a non-equimolar bimolecular reaction
3. Isothermal plug flow reactor
4. Mixed flow reactor
5. Semi batch reactor
6. RTD studies in packed bed reactor
7. RTD studies in a tubular reactor
8. RTD studies in a mixed flow reactor
9. Effect of temperature on the kinetics of the reaction
10. Determination of percentage of iron in the given rust solution by external indicator method

TEXTBOOKS:

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

REFERENCE BOOKS:

1. J.M. Smith, Chemical Engineering Kinetics -3rd Edition, McGraw Hill., 1984
2. K.A. Gavhane, Chemical Reaction Engineering-I, series Volume-1, Nirali Prakashan., ISBN-13: 9788185790879, 2011.

E BOOKS

1. Fundamentals of Chemical Reaction Engineering by M E Davis: http://authors.library.caltech.edu/25070/1/FundChemReaxEng.pdf
2. Chemical Reaction Engineering: Beyond the Fundamentals by *Dora Swamy*: https://www.crcpress.com/Chemical-Reaction-Engineering-Beyond-the-Fundamentals/Doraiswamy-Uner/9781439831229
3. Fundamentals of Chemical Reaction Engineering, Mark E. E. Davis, Robert J. J. Davis http://www.e-booksdirectory.com/details.php?ebook=2512

MOOC's &ONLINE COURSES:

1. http://ocw.mit.edu/courses/chemistry/5-68j-kinetics-of-chemical-reactions-spring-2003/index.htm
2. https://nptel.ac.in/courses/103/101/103101141/#

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, III, V and two questions each from Unit II and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Apply knowledge of material balance to formulate the design equations for non-ideal systems	PO3
CO2	Analyze/interpret the performance of non-ideal systems in comparison with ideal systems.	PO4
CO3	Develop rate expression for different reaction mechanisms using suitable models for catalytic, non-catalytic and catalytic deactivation reactions with an understanding of their limitations	PO3
CO4	Formulate the design equation for heterogeneous reaction systems and porous catalytic reactions in combination with diffusion mechanisms.	PO3
CO5	Analyze the experimental data from different reactor configurations used for heterogeneous catalytic reactions	PO4
CO6	Conduct experiments in teams to collect kinetic data from both ideal and non-ideal reactors.	PO9

ASSESSMENT:

Continuous Internal Assessments		**Marks 100% (Weightage 50%)**	**Assessment**
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Laboratory Component	Laboratory Component	50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Laboratory Work**	**Laboratory Test**	**Total Marks**
Max. Marks	20	20	10	30	20	100
Reduced CIE	10	10	5	15	10	50

Course Title	ECONOMICS IN ENGINEERING													
Course Code	1	9	C	H	6	H	S	E	I	E	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Basic Accounting and Mathematical calculation skills.
SYLLABUS:

UNIT - I

INTRODUCTION: Engineering Economics – An overview, Relationship between Engineering and Economics, Scope of Engineering Economics, Engineering Design and Process Economics.
PROCESS DESIGN DEVELOPMENT: Economics in the Overall Plant, Plant location and layout – Factors affecting plant design and layout, Economics of Plant Location and Layout, Conduction of feasibility survey and studies. **06 Hrs**

UNIT - II

COST ANALYSIS: Factors involved in project cost estimation, methods employed for estimation of the capital investment, Estimation of fixed and working capital, Calculation using Cost Indices, estimating equipment cost by scaling, Component of total product cost and Estimation of Total Sale Value and Numerical. **06 Hrs**

UNIT - III

INTEREST: Simple and compound interest, Nominal and effective interest, Continuous Interest, interest formulae and their application, Time value of money and Numerical. **10 Hrs**

UNIT- IV

DEPRECIATION: Depreciation – Introduction, Meaning, causes of depreciation, Methods of Depreciation - Straight Line method, Unit of Production Method, Double Declining Balance Method, Sum of Years Digits Method /Sinking Fund Method and Numerical.
TAXES: Relationship between Depreciation and Taxes, Types of Taxes, Equivalence after Taxes, Cost comparison after taxes and Numerical. **10 Hrs**

UNIT - V

FINANCIAL STATEMENTS: Importance of Financial Statements, Compilation of Financial Statements including Balance Sheet, Income statement and Profit and loss statement.
BREAKEVEN ANALYSIS: Meaning, Determination of Break Even Point, BEP in terms of quantity, BEP in terms of Sales Value, BEP as a percentage of Capacity, Break Even Chart, Limitations of Break-Even Analysis and Numericals. **07 Hrs**

TEXT BOOKS:

1. Plant Design and Economics for Chemical Engineers, M.S. Peters and K.D.Timmerhaus, 4th Edition, McGraw Hill, 1991.
2. Engineering Economy, Thuesen, Fabrycky and Thuesen, 9th Edition, Prentice-Hall,2000.

REFERENCE BOOKS:

1. Engineering Economics and Costing, Sasmita Mishra, PHI Learning Pvt. Ltd., 2nd Edition, 2011.
2. Principles of Engineering Economy; by Grant and Ireson, Ronald Press, 2019.

E BOOKS

1. Engineering Economics, R Paneerselvam, ISBN: 978-81203-48370

MOOC's &ONLINE COURSES:

1. https://www.coursera.org/lecture/faecalsludge/4-7-engineering-economics-KoVa9
2. https://online.stanford.edu/courses/cee146s-engineering-economics-and-sustainability

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question each from Unit I, II, V and two questions each from Unit IIII and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Acquainted with the application of the principles of Economics to Chemical Engineering	PO1
CO2	Understand the basics of fixed and working capital in an industrial set up and the cost accounting principles of product costing.	PO10
CO3	Distinguish between various types of interests and their application in Engineering Economics.	PO2
CO4	Identify the appropriate method of depreciation under various circumstances. Comprehend the interrelationship between depreciation and taxes.	PO2
CO5	Comprehend the different Financial Statements as applied to any Chemical company and learn the principles of Break Even Analysis.	PO4
CO6	Infer on a macroscopic level the minute economics of Process Engineering Design and Plant Technology.	PO11

ASSESSMENT:

Continuous Internal Assessments		**Marks 100% (Weightage 50%)**	**Assessment**
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	NUMERICAL TECHNIQUES IN CHEMICAL ENGINEERING													
Course Code	1	9	C	H	6	D	E	L	D	1	Credits	03	L – T – P	3– 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Heat Transfer**,** Chemical Reaction Engineering-1, Chemical Reaction Engineering 2, and Engineering Mathematics

SYLLABUS:

UNIT - I

MATHEMATICAL FORMULATION OF THE PHYSICAL PROBLEMS: Applications of the law of conservation of mass in mixing tank system, equilibrium batch still and single stage extraction. Applications of the law of conservation of energy: Gas compression system, and Flow of heat from a fin and related numerical problems for all the above physical systems. **07Hrs**

UNIT - II

MATHEMATICAL FORMULATION OF COMPLEX PROBLEMS: Mass transfer with the reaction for gas-liquid contact, heat transfer through multiwall cylinders and spheres, heat transfer in a jacketed vessel, rate expression for series and parallel homogenous reactions and related numerical problems. **06Hrs**

UNIT – III

APPLICATION OF NON LINEAR ALGEBRAIC EQUATION: Pressure drop in pipe, Minimum fluidization velocity – Use of Newton – Raphson method.

APPLICATION OF INITIAL VALUE PROBLEMS: Stirred tank with coil heater, Series of stirred tanks with coil heaters, Batch reactors, Plug flow reactors and unsteady state stirred tank reactors – Use of RK method.

APPLICATION OF FINAL VALUE PROBLEMS: One dimensional steady state heat conduction, Chemical reaction and diffusion in a pore – Use of discretization technique. **10Hrs**

UNIT- IV

FORMULATIONS OF PARTIAL DIFFERENTIAL EQUATIONS: Formulations of partial Differential equations for the continuity equation, Fick's second law of diffusion and heat conduction in rectangular coordinates.

SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS: Solution for heat conduction equation, solution for Laplace's equation using finite difference method.

FINITE DIFFERENCES METHOD FOR STAGE PROCESSES: Analysis of stage-wise Processes like multistage counter-current extraction, stirred-tank reactor system. **10Hrs**

UNIT –V

APPLICATIONS OF LAPLACE TRANSFORMS: Applications to chemical engineering like level/temperature in a single tank system, mixing tank, CSTR with first order reaction, interacting system and non-interacting system. **06Hrs**

TEXTBOOKS:

1. Mickley H.S., Sherwood T.K. and Reed C.E., Applied Mathematics in Chemical Engineering - 3rd Edition, Tata McGraw Hill, 1999.
2. Jenson V.G. &Jeggreys G.V., Mathematical Methods in Chemical Engineering, 1977.

REFERENCE BOOKS:

1. Rose L.M. Applications of Mathematical Modeling to Process Development and Design, Publishers Ltd., London, 1998.
2. William. L Luyben, Process Modeling Simulation and Control for Chemical Engineering, 2nd Edition, McGraw Hill, 1990.

E BOOKS

1. http://www.amazon.in/Applied-Mathematics-Modeling-Chemical-Engineers-ebook/ dp/B009I06RKU
2. http://www.worldcat.org/title/applied-mathematics-in-chemical-engineering/oclc/557742198

MOOC's & ONLINE COURSES:

1. https://www.mooc-list.com/categories/mathematics?static=true
2. http://www.moocs.co/Higher_Education_MOOCs.html

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, II, V and two questions each from Unit III and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Apply the principles of conversation laws to formulate chemical engineering problems.	PO2
CO2	Develop and solve ordinary differential equations for chemical engineering problems for reaching substantiated conclusions	PO3
CO3	Develop and solve partial differential equations to solve chemical engineering problems	PO3
CO4	Apply the finite difference method to predict and model various unit operations and processes by understanding the limitations.	PO4
CO5	Use knowledge of numerical techniques to solve the developed differential and algebraic equations to analyze and interpret the behaviour of different processes.	PO2
CO6	Use knowledge of Laplace transforms to solve complex engineering problems.	PO4

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	INTERFACIAL PHENOMENA													
Course Code	1	9	C	H	6	D	E	L	D	2	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Chemical Reaction Engineering-1 and Engineering Mathematics

SYLLABUS:

UNIT - I

INTRODUCTION: Concept of Colloids and Interface, Surface Tension, Equivalence in the concepts of surface energy and surface tension, Measurement of Interfacial Tension. **10Hrs**

UNIT - II

EXCESS PRESSURE: Generalized equation for excess pressure across a curved surface-the equation of Young and Laplace and its application, Kelvin's equation and its implications: Capillary condensation, Super Saturation, Nucleation. **07Hrs**

UNIT- III

WETTING, FLOATING AND DETERGENCY: Work of adhesion, cohesion, criteria for spreading of liquids, kinetics of spreading, Young's equation

EMULSIONS: General Properties, Factors determining emulsion stability, Aging and inversions of emulsions, Hydrophobic-Lipophilic Balance **10Hrs**

UNIT- IV

CHARGED INTERFACES AND ADSORPTION AT INTERFACES: The concept of electrical double layer, Electro kinetic Phenomena: Electrophoresis, Electro-Osmosis, and its Industrial applications.

06Hrs

UNIT -V

SURFACTANTS: Introduction, classification & its Properties of surfactants, and Surfactant self-assembly, and Thermodynamic aspects.

SURFACTANT BASED SEPARATIONS: Liquid membrane permeation, Foam separations, Micellar separations, Soil remediation. **06 Hrs**

TEXTBOOKS:

1. Pallab Ghosh, Colloids and Interface Science, 1st Edition, Prentice Hall Publications, 2009.
2. Clarence A. Miller, and P. Neogi, " Interfacial Phenomena: Equilibrium and Dynamic Effects", 2nd Edition, 2019.

REFERENCE BOOKS:

1. A.W. Adamson, Physical chemistry of surfaces, 6th Edition, John Wiley,1997.
2. Duncan J. Shaw, Butter worth Heinemann, Introduction to colloid and surface chemistry,4th Edition.

EBOOKS

1. **http://www.freebookcentre.net/chemistry-books-download/An-Introduction-to-Surface-Chemistry.html**

2. https://archive.org/details/introductiontosu017148mbp

MOOC's & ONLINE COURSES:

1. http://www.rsc.org/eic/2015/03/mooc-massive-open-online-course

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit II, IV, V and two questions each from Unit I and III

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Understand the concepts of surface and interfacial phenomena	PO2
CO2	Collate the practical implications of the surface concepts	PO 3
CO3	Accustomed with real-world applications of colloids and its stability for Societal needs	PO 6
CO4	Apprehend the principles and Options available for the measurement of surface Properties	PO2
CO5	Get entranced with the updated research in the topic to bridge the gap between societal needs and development in the area of Interfacial Science and Technology.	PO12
CO6	Recognize the factors affecting Industrial separation processes based on interfacial/surface phenomena for sustainability	PO 6

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	COMPOSITE MATERIALS													
Course Code	1	9	C	H	6	O	E	C	O	M	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Material Science and biomaterials, Nanomaterial & Technology & polymer technology

SYLLABUS:

UNIT -I

INTRODUCTION: Introduction to ceramics & advanced ceramics materials, superior structural, optical and electrical properties of ceramic composites, classification & application of advanced ceramics based on their functions.

CERAMIC FABRICATION METHODS: Gas phase reactions methods: direct metal oxidation & reaction bounding. Liquid precursor methods: Polymer pyrolysis. Fabrication from powders: melt casting and firing of compacted powders. All three methods for the preparation of ultra-fine powders of metal-oxides, metal-nitrides and metal-carbides. **07Hrs**

UNIT- II

SINTERING OF CERAMICS: Fundamental concepts in sintering, driving forces for sintering and Fick's Law of Diffusion in crystalline solids.

FORMING OF CERAMICS COMPOSITE MATERIALS: Hot pressing, iso-static pressing, slip casting, tape-casting and pressure casting, sol-gel processes for the formation of monolithic ceramics.

PROCESSING TECHNIQUES BASED ON REACTION METHODS: Chemical vapour deposition (CVD), plasma-enhanced chemical vapour deposition (PECVD), processing methods for synthesis of fibers (Boron, Aramaid, Carbon and glass fibers) and whiskers. **10Hrs**

UNIT -III

SYNTHESIS OF MIXED CERAMIC OXIDES: Mechanical methods: Consolidation, mechano-chemical synthesis, Evaporation of liquid methods: Spray drying and Spray pyrolysis.

NON-CONVECTIONAL COMPOSITES: Polymer Clay Nanocomposites, Self-Healing Composites, Biocomposites, Laminates, Ceramic Laminates and Hybrid Composites. **06Hrs**

UNIT -IV

REINFORCEMENT: Mechanism of reinforcement, master bath & compounding equipment used for reinforcement. **REINFORCED METAL MATRIX:** Methods for preparation of powdered metal matrix, fiber reinforced metal matrix. Types and Properties of matrix materials and its industrial application

CERAMIC REINFORCED MATRIX: Cold pressing & sintering method, liquid silicon infiltration technique for synthesis of ceramic reinforced matrix, Types and properties of ceramic Matrix and its industrial applications. **10Hrs**

UNIT V

POLYMER COMPOSITES: Stress-Strain modulus relationship for fibre reinforced polymer composites, manufacturing methods: Hand layouts, filament winding, pultrusion, SMC and DMC. Applications of polymer reinforced composites in marie, aerospace, automobile, building & computer industry. **06Hrs**

TEXTBOOKS:

1. M.N. Rahaman, "Ceramic processing and sintering", 2nd Edition, Marcel Dekker, Inc, New York.
2. David Segal, "Chemical synthesis of advanced ceramic materials", Cambridge university press, Cambridge, New York.

REFERENCE BOOKS:

1. Krishan K. Chawla, "Composite Materials Science and Engineering", 2nd Edition, Springer New York Heidelberg Dordrecht London.

EBOOKS

1. Composite Materials by Dr. H. K. Shivanand and B. V. Babu Kiran, ISBN: 9788184121452
2. Composite Materials by S. C. Sharma, ISBN: 9788173192579

MOOC's &ONLINE COURSES:

1. http://nptel.ac.in/courses/101104010/
2. https://www.coursebuffet.com/sub/material-science/320/composite-materials

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, III, V and two questions each from Unit II and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Classify composite materials based on the Industrials applications	PO2
CO2	Apprehend and select a suitable fabrication technique for the processing of ceramic materials.	PO6
CO3	Distinguish between mechanical and chemical techniques for the fabrication of composite materials	PO3
CO4	Identify suitable instruments to measure the properties of the ceramics and other composites	PO2
CO5	Custom the synthesized metal- matrix and ceramic-matrix composite materials to use in different engineering disciplines.	PO12
CO6	Comprehend the fabrication techniques for reinforced polymer materials to demonstrate the knowledge of sustainable development.	PO7

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Laboratory Component	Laboratory Component	50%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	CHEMICAL PLANT DESIGN PROJECT													
Course Code	1	9	C	H	6	D	C	P	W	2	Credits	03	L – T – P	0 – 0 – 3
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITE: Core subjects from the preceding semesters.

SYLLABUS:

This course is teamwork where a student is expected to work in a group with a maximum of four students. The group is expected to select a chemical engineering process project, which is oriented in solving an industrial problem or beneficial for society. The project group should complete the preliminary literature survey, identify suitable products, equipment/utility complete with all the accessories required & execution plan for the project in the first phase. A synopsis needs to be submitted at the end of the first phase. In the second phase, students are expected to submit detailed material & energy balances for all unit operations, safety aspects, a summary of economic aspects, and finally submit the feasible project report for the process. The project work should be completed at the end of the sixth semester, which is evaluated by a committee constituted by the HoD for internal assessment.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Select or identify the industrial/societal engineering challenge and find a viable option	PO2
CO2	Develop/Design a process flow diagram and estimate the requirement of materials and energy	PO3
CO3	Optimization of the process/plant system using available software	PO5
CO4	Analyze the impact of process inventories on environment and society	PO7
CO5	Showcase the ethics in design and development of the process	PO8
CO6	Possess enhanced psychomotor, cognitive and affective skills	PO9

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Practical Component	Presentation 1	40%	Committee constituted by HOD
	Presentation 2	40%	Committee constituted by HOD
	Report	20%	Course Instructor/ Guide
Semester End Examination – Presentation and write up (Weightage 50%)			

ASSESSMENT PATTERN:

Component	Presentation 1	Presentation 2	Report	Total Marks
Max. Marks	40	40	20	100
Reduced CIE	20	20	10	50

Course Title	SEMINAR-1: BASED ON CERTIFIED MOOC COURSE ON NPTEL/SWAYAM													
Course Code	1	9	C	H	6	D	C	S	R	1	Credits	02	L – T – P	0 – 0 – 2
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

The students are expected to obtain a certificate in $3^{rd}/4^{th}/5^{th}$ Semester in any one of the MOOCS (NPTEL/SWAYAM) courses enlisted in the syllabus or courses related to Chemical Engineering and allied areas. If the student selects any course other than that enlisted, should get prior approval from the Department. The student should submit a report and present the same during the sixth semester. The course will be evaluated by a committee constituted by the HoD for internal assessment.

LIST OF THE MOOC COURSES

S No	Course Title	Offered Institute and Portal
1.	Chemical Process Intensification	Prof. Subrata Kumar, IIT Guwahati
2.	Chemical Process Safety	Prof. Shishir Sinha, IIT Roorkee
3.	Colloids and Surfaces	Prof. Basavaraju, IIT Madras
4.	Infrared spectroscopy for pollution monitoring	Prof. J. R. Mudakavi , IISc Bangalore
5.	Introduction to Polymer Physics	Prof. Amit Kumar, IIT Guwahati
6.	Natural Gas Engineering	Prof. Pankaj Tiwari, IIT Guwahati
7.	Phase equilibrium thermodynamics	Prof. Gargi Das, IIT Kharagpur
8.	Polymers: concepts, properties, uses and sustainability	Prof. Abhijit P Deshpande, IIT Madras
9.	Technologies for Clean and Renewable Energy Production	By Prof. P. Mondal, IIT Roorkee
10.	Unit operations of particulate matter	Prof. Shabina Khanam, IIT Roorkee
11.	Electrochemical Technology in Pollution Control	Prof. J. R. Mudakavi , IISc Bangalore
12.	Environmental Quality Monitoring & Analysis	Dr. R. Ravi Krishna, IIT Madras
13.	Flow through porous media	Dr. Somnath Ganguly IIT Kharagpur
14.	Rheology of Complex Materials	Dr. Abhijit P. Deshpande, IIT Madras
15.	Soft Nano Technology	Dr. R. Mukherjee, IIT Kharagpur
16.	MATLAB Programming for Numerical Computation	Dr. Niket S.Kaisare, IIT Madras
17.	Catalyst Science and Technology	Dr. Mahuya De, IIT Guwahati
18.	Computational Fluid Dynamics	Prof. Sreenivas Jayanti IIT Madras
19.	Entrepreneurship and IP strategy	Prof. Gouri Gargate | IIT Kharagpur
20.	Ethics in Engineering Practice	Prof. Susmita Mukhopadhyay, IIT Kharagpur
21.	Industrial Safety Engineering	Prof. Jhareswar Maiti, IIT Kharagpur
22.	Innovation and Start-up Policy	Prof. Rahul K. Mishra, IILM Institute

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Enhance the knowledge in chemical engineering and allied domains.	PO1
CO2	Extent the knowledge to utilize modern tools to upgrade the soft skills.	PO5
CO3	Utilize the gained knowledge for interdisciplinary applications	PO6
CO4	Report the apercu of the MOOCS course.	PO10
CO5	Communicate effectively with peers regarding the significance of the course selected.	PO10
CO6	Select a topic of interest and demonstrate its significance in life-long learning.	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Practical Component	Presentation 1	40%	Committee constituted by HOD
	Presentation 2	40%	Committee constituted by HOD
	Report	20%	Course Instructor/ Guide
Semester End Examination – Presentation and write up (Weightage 50%)			

ASSESSMENT PATTERN:

Component	Presentation 1	Presentation 2	Report	Total Marks
Max. Marks	40	40	20	100
Reduced CIE	20	20	10	50

SEVENTH SEMESTER

Course Title	BIOLOGY FOR ENGINEERS													
Course Code	1	9	C	H	7	B	S	B	F	E	Credits	02	L – T – P	2– 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

SYLLABUS:

UNIT-I

INTRODUCTION TO LIFE: Characteristics of living organisms, structure of prokaryotic and eukaryotic cell; Introduction to biomolecules: definition, general classification and important functions of carbohydrates, lipids, proteins, nucleic acids, vitamins, and enzymes; concept of genes and chromosome. **06 Hrs**

UNIT-II

CONCEPTS OF ENZYMOLOGY: Basic concepts in enzyme structure and function, cofactors, enzyme kinetics, modes of inhibition. **04 Hrs**

UNIT-III

IMMUNOLOGICAL SCIENCE: Immune system and its types; Functional properties of antibodies; Helper T cells and T cell activation, Importance of Microbiology. **05 Hrs**

UNIT-IV

IMPLEMENTATION OF BIO-NANO SCIENCE: Nano Biomolecules and its various types; Principles and Application of Biosensor; Basics of Biochips, Bioinformatics, and its applications **06 Hrs**

UNIT-V

ADVANCES IN BIOLOGICAL SCIENCE: Fundamentals of Biomechanics, Neural Network, Stem Cell, Introduction to Genetics, Genetic Engineering, and its Application **05 Hrs**

TEXTBOOKS:

1. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
2. Dr. Sohini Singh and Dr. Tanu Allen, "Biology for Engineers", Vayu Education of India, New Delhi, 2014.
3. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox, 7th Edition, W. H. Freeman and Company, New York.

REFERENCE BOOKS:

1. Molecular Biology of the cell. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Garland Science; 5th edition.
2. Simon O. Haykin, Neural Networks and Learning Machines (3rd Edition), Prentice Hall; 3 edition (November 28, 2008).

E-BOOKS

1. www.bio12.com/ch3/RaycroftNotes.pdf
2. www.engineering.uiowa.edu/bme050/cvb-solids.pdf
3. www.biologyjunction.com/mendelian_genetics.html

MOOC's & ONLINE COURSES:

1) Biology for engineers and other non-biologists: https://onlinecourses.nptel.ac.in/noc19_ge31/preview
2) Biology & Life Sciences: https://www.edx.org/course/subject/biology-life-sciences

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit II, III, V and two questions each from Unit II and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Understand the biological living organisms concepts from an engineering perspective.	
CO2	Integrate biological principles for developing next generation technologies for development of artificial systems mimicking human action.	
CO3	To understand the cellular make up and structure and functions of biomolecules	
CO4	To understand basic concepts in enzyme function, kinetics and modes of inhibition	
CO5	To comprehend importance of microbiology and immunological science	
CO6	To comprehend the biological science related to the different disciplinary areas	

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals (Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	BIOCHEMICAL ENGINEERING													
Course Code	1	9	C	H	7	D	C	B	C	E	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Mechanical Operations and Reaction Engineering

SYLLABUS:

UNIT-I

INTRODUCTION: Bioprocess engineering and technology. Role of Chemical engineer in bioprocess industry, Classification of micro-organisms based on structure, reproduction cycle and engineering applications, Nucleic Acids-Structure, Biological function, and Importance for life.

06Hrs

UNIT-II

PROTEINS AND ENZYMES: Enzyme commission's nomenclature of enzymes, Structure and functions of proteins, Methods of enzyme production and purification, Effect of temperature, and pH on the rates of enzyme catalyzed reactions.

KINETIC MODELS AND EQUATIONS OF ENZYME ACTION: Michaelis-Menten rate Equation-Steady state and equilibrium state, Experimental determination of rate parameters: Lineweaver-Burk, Eadie-Hofstee and Hanes-Woolf Plots. **10Hrs**

UNIT-III

ENZYME INHIBITION: Kinetics of inhibition reactions- Competitive, non-competitive, uncompetitive, substrate and product inhibitions, Determination of kinetic parameters for various types of inhibitions. Evaluation of inhibition Constant-Dixon method, Enzyme Immobilization-Methods of enzyme immobilization and various applications. **10Hrs**

UNIT-IV

GROWTH KINETICS OF MICROORGANISMS: Transient growth kinetics, Quantification of growth kinetics, Substrate limited growth, Models with growth inhibitors, Logistic equation, Continuous culture: Optimum Dilution rate in ideal chemostat. **07Hrs**

UNIT-V

FERMENTATION TECHNOLOGY: Operation and maintenance of typical aseptic aerobic fermentation processes, Sterilization of bioprocess equipment, Sources of nutrients to formulate the medium, alternate bioreactor configurations

DOWNSTREAM PROCESSING: Cell disruption, Affinity chromatography, Freeze drying.

06Hrs

TEXTBOOKS:

1. Bailey and Ollis, Biochemical Engineering Fundamentals, 2nd edition, McGraw Hill, 1976.

2. Shuler M. L. and Kargi. F, Bioprocess Engineering, 2nd edition, Prentice Hall, 2002.

REFERENCE BOOKS:

1. Biochemical Engineering by James Lee, Prentice Hall, University of Michigan, 1992.
2. Microbiology Concept and Application by Pelczer, 5th edition, McGraw Hill, 2001.

E BOOKS

1. Biochemical Engineering and Biotechnology by Ghasem Najafpour Ghasem Najafpour, eBook ISBN: 9780080468020.

2. Biochemical Engineering by Shigeo Katoh, ISBN: 978-3-527-33804-7.

MOOC's & ONLINE COURSES:

1) https://ocw.mit.edu/courses/biological-engineering

2) http://www.online.colostate.edu/degrees/biomedical-engineering

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units
2. Five questions to be answered.
3. One question each from Unit I, IV, V and two questions each from Unit II and III.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Apply biology in bioprocess engineering	PO2
CO2	Understand functioning of molecules of life	PO2
CO3	Infer features of bioreactors to decide various processes	PO4
CO4	Identify enzymes for catalysed processes	PO2
CO5	Explain the kinetics of enzyme catalysed reaction	PO4
CO6	Perform the basis analytical techniques in downstream processing	PO7

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	CHEMICAL TECHNOLOGY													
Course Code	1	9	C	H	7	D	C	C	T	N	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

PREREQUISITES: Mechanical operations, Process Thermodynamics-I, Process Thermodynamics-II

SYLLABUS:

UNIT-I

CHEMICAL PROCESS INDUSTRIES AND FUELS: Introduction- Components of flow sheet: Unit operations, unit processes, mass and material balance equations.

FUELS AND INDUSTRIAL GASES- Coking of coal, LPG, LNG, Petroleum technology- Constituents, distillation of crude petroleum.

CRYOGENIC INDUSTRY-Nitrogen and Oxygen by Linde –Frankl's process. **10 Hrs**

UNIT-II

INORGANIC CHEMICALS: Sulphuric acid - DCDA Process; Alkali industry- Soda Ash, Caustic soda; Nitrogen Industries- Ammonia and Nitric Acid; and Phosphoric acid –Hydrochloric acid leaching method. **07 Hrs**

UNIT-III

NATURAL INDUSTRIES: Sugar Industry; Oil industry: Vegetable oil extraction; Refining and hydrogenation and Surfactant industry: Manufacture of soaps and detergents. **06 Hrs**

UNIT-IV

COMMERCIAL INDUSTRIES: Fermentation Industry-Manufacture of ethyl alcohol, penicillin; Polymer industry - LDPE, PVC; Rubber Industry-Natural rubber and SBR; Paper industry- Pulp from sulfate process, paper from pulp, treatment of effluent from sulfate process. **10 Hrs**

UNIT-V

MISCELLANEOUS INDUSTRIES: Paints- Zinc oxide, Titanium dioxide; Cement Industry-Limestone beneficiation and Cement Fertilizers- Urea, NPK, bio fertilizers. **06 Hrs**

TEXTBOOKS:

1. George T.A. and Shreve's, Chemical process industries, 5th edition, McGraw Hill International Ltd., 1984.

2. Gopal Rao, M. and Marshall Sitting, Dryden's Outlines of Chemical Technology, 3rd Edition, Affiliated East West Press Pvt. Ltd., New Delhi, 1997.

REFERENCE BOOKS:

1. Shukla S. D. and Pandey G. N., Textbook of chemical technology, Volume 2, Vikas Publishing House Pvt. Ltd., New Delhi, 1979.
2. Chemical Process Technology, O.P. Gupta, 1st edition, Khanna Publishing House, 2018.

E BOOKS:

1. Handbook of Chemical Technology and Pollution Control (Third Edition): http://www.sciencedirect.com/science/book/9780120887965
2. Chemical Technology: An Integral Textbook: https://www.wiley.com/en-in/Chemical+Technology:+An+Integral+Textbook-p-9783527670611

MOOC's and ONLINE COURSES:

1) http://nptel.ac.in/courses/103103029/
2) http://www.vlab.co.in/ba-nptel-labs-chemical-engineering

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit II, III, and V and two questions each from Unit I and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Acquainted with sources, methods, and thermodynamics for the synthesis of chemicals	PO2
CO2	Comprehend the construction and working details of equipment used for upstream operations	PO3
CO3	Analyse and describe the unit operations/processes adopted for the synthesis	PO2
CO4	Demonstrate the conventional and modern separation technology adopted in downstream processing	PO3
CO5	Write the mass and material balance and energy balance equations across each unit operation/unit process	PO2
CO6	Identify the economics and engineering problems associated with the process and apply broad cognitive to assess the social issues	PO6

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

DEPARTMENT OF CHEMICAL ENGINEERING
B. M. S. COLLEGE OF ENGINEERING, BENGALURU
Autonomous College under VTU

Course Title	RISK AND SAFETY MANAGEMENT IN PROCESS INDUSTRIES													
Course Code	1	9	C	H	7	D	C	R	S	M	Credits	02	L – T – P	1 – 0 – 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

SYLLABUS:

UNIT I

RISK BASED PROCESS SAFETY: Four Pillars and 20 Elements of Risk based Process safety. Process Safety Information, Hazard Identification and Risk Analysis, Compliance with standards, operating procedures, Training and Performance Assurance, Operational readiness, Document Control, Management of Change, Prestart up safety review, Asset Integrity and reliability, Safe work practices, Incident Investigation, Measurement Metrics,

AUDITS: Workforce Involvement and Conduct of Operation

EMERGENCY MANAGEMENT: Management review and Continuous Improvement-Implementation and the Future. **07Hrs**

UNIT II

RISK IDENTIFICATION METHODS: Quantitative and Qualitative risk assessment techniques, Hazard Identification (HAZID), Hazard and Operability studies, Failure mode risk analysis, Fault tree Analysis, Event tree Analysis.

HAZARDOUS AREA CLASSIFICATION AND DESIGN PRINCIPLES (DUST, GAS AND VAPORS): Hazardous zones: Classification of hazardous zones -intrinsically safe and explosion proof equipment's (IS, API and OSHA standard) -increase safe equipment-their selection for different zones- temperature classification-grouping of gases-use of barriers and isolators. **07Hrs**

UNIT III

MANAGING CHANGE AND SAFE WORK PRACTICES IN FACTORY: CASE LESSON: Elucidate the Changes that has been made in the process Industry citing examples of the entire risk identification, management, and treatment.

Share the experience on How Non routine work activity of High-risk category is managed without any untoward incident or Loss? **04Hrs**

UNIT IV

MECHANICAL INTEGRITY: CASE LESSON: Identification of Critical safety process equipment's and controls that safeguard in case of any Malfunction or Human Error.

Chemical Storage tanks, Fuel Storage Tanks. (Focus towards Bhopal Gas Tragedy)- Learnings from the Event. **04Hrs**

UNIT V

PROCESS SAFETY INFORMATION: CASE LESSON: Share the learnings on Basis of Safety adopted in Process Industries, citing Minimum two key aspects:

- Piping and Instrument diagram
- Material of construction of Pressure pipelines and Vessels.
- Reaction based controls. (Example: Quenching Runaway reaction)
- Process controls and Critical cutoffs. **04Hrs.**

TEXTBOOKS:

1. Lees F.P, Loss Prevention in Process Industries, 2nd edition, Butterworth Heinemann, 1996
2. Trevor Kletz, What Went Wrong? 5th edition, Butterworth Heinemann, 2009

REFERENCE BOOKS:

1. Sam Mannan, Lee's Loss Prevention in the Process Industries Hazard Identification, Assessment and Control Volume 1, 3rd edition, Elsevier, 2004.

E BOOKS

1. Guidelines for Risk Based Process Safety, American Institute of Chemical Engineers, Wiley, https://onlinelibrary.wiley.com/doi/book/10.1002/9780470925119

MOOC's & ONLINE COURSES:

1) Process Safety Management Overview, eLearning (online) Courses, https://www.aiche.org/academy/courses/els105/process-safety-management-overview

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Interpret and apply legislative requirements, industry standards, and best practices in the workplace	PO6
CO2	Apply risk management principles to anticipate, identify, evaluate and control industrial hazards	PO7
CO3	Practice due diligence and employ ethical standards in all aspects of professional conduct.	PO8
CO4	Work in a team to review and interpret the Industrial safety case studies	PO9
CO5	Communicate and report the industrial risk & safety management practices through technical presentations	PO10
CO6	Affect/manage change by advancing safety principles within the work environment.	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Practical Component	Presentation 1	40%	Committee constituted by HOD
	Presentation 2	40%	Committee constituted by HOD
	Report	20%	Course Instructor/ Guide
Semester End Examination – Presentation and write up (Weightage 50%)			

ASSESSMENT PATTERN:

Component	Presentation 1	Presentation 2	Report	Total Marks
Max. Marks	40	40	20	100
Reduced CIE	20	20	10	50

Course Title	ADVANCES IN ENERGY TECHNOLOGY													
Course Code	1	9	C	H	7	O	E	A	E	T	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Environmental Science and pollution control, Environmental Science

SYLLABUS:

UNIT I

INTRODUCTION: Man, and energy, worlds and India's production and reserves of energy, present and future power position, need for alternate energy, energy alternatives.

06 Hrs

UNIT II

SOLAR ENERGY: Introduction: Extra-terrestrial solar radiation, radiation at ground level, collectors. Solar cells, applications of solar energy

06 Hrs

UNIT III

BIOMASS & GEOTHERMAL: Biomass energy, introduction, biomass conversion, biogas production, ethanol production, pyrolysis and gasification, direct combustion, applications of biomass energy.

RECOVERY OF THERMAL CONVERSION PRODUCTS: Combustion of waste materials & related calculations, waste incineration with heat recovery and use of refused derived fuels (RDF).

GEOTHERMAL ENERGY: Introduction, resource types, resource base, applications for heating and electricity generation.

10 Hrs

UNIT IV

WIND ENERGY SOURCES: Introduction: Basic theory, types of turbines, applications.

HYDROPOWER ENERGY SOURCES: Introduction, basic concepts, site selection, types of turbines, small scale hydropower.

10 Hrs

UNIT V

FUEL CELLS: Introduction Principle and operation of fuel cells, classification and types of fuel cells and application of fuel cells.

07 Hrs

TEXTBOOKS:

1. G. D. Rai, Non-conventional energy resources, 1st Edition, Khanna Publishers, New Delhi, 2011.

2. B. H Khan, Non-conventional energy resources, Tata McGraw Hill, New Delhi.

REFERENCE BOOKS:

1. Harker and Back Hurst, Fuel and energy science and engineering, Academic press, London 1981.

2. Howard S. Peavy, Donald R Rowe & George Tchobanoglous, Environmental Engineering, MeG Engineering Thermodynamics raw Hill International Editions

E BOOKS

1. Non-Conventional Energy Resources (Second Edition) by B.H. Khan, https://www.abebooks.com/Non-Conventional-Energy-Resources-Second-Edition-B.H/4877611079/bd

MOOC's &ONLINE COURSES:

1) http://nptel.ac.in/courses/Webcourse-contents/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question each from Unit I, II, and V and two questions each from Unit III and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Acquaint with the various forms of available and alternative energy resources	PO2
CO2	Demonstrate the global scenario of energy recourses and its need for sustainable development.	PO7
CO3	Comprehend the principles behind different non-conventional energy systems.	PO2
CO4	Analyse economic and environmental aspects to establish non-conventional energy harvesting units.	PO6
CO5	Design and Develop the energy generating devices using renewable energy sources.	PO3
CO6	Understand the applications of various non -conventional energy systems.	PO2

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	ADVANCES IN SEPARATION TECHNIQUES													
Course Code	1	9	C	H	7	D	E	L	E	1	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Mass Transfer 1, Mass Transfer II, and Interfacial Phenomena

SYLLABUS:

UNIT I

FUNDAMENTAL CONCEPTS: Basic Separation Techniques, Separations by Phase Addition or Creation, Separations by Barriers, Separations by Solid Agents, Separations by External Field or Gradient, Separation Factor, Selection of Feasible Separations. **06 Hrs**

UNIT II

MEMBRANE SEPARATIONS: Membrane Materials, Different Membrane Shapes like flat, asymmetric or thin-film composite sheet, tubular, hollow-fibre and monolithic; Membrane Modules like plate-and-frame, spiral-wound, four-leaf, spiral-wound, hollow-fibre, tubular and monolithic; Transport in Porous Membranes, Module Flow Patterns like perfect mixing, counter-current flow, co-current flow and crossflow.

INDUSTRIAL MEMBRANE SEPARATION PROCESSES: Reverse Osmosis, Nano filtration, Ultrafiltration, Microfiltration and Dialysis: Physio chemical principles, Process Description and Applications. **10 Hrs**

UNIT III

SEPARATIONS BY SOLID AGENTS: Adsorption: Industrial Applications, Adsorbents, Equilibrium Considerations, Kinetic and Transport Considerations, Equipment; Chromatography: Industrial Applications, Sorbents for Chromatography, Equilibrium considerations, Equipment. **10 Hrs**

UNIT IV

Ionic Separations: Electro dialysis, Electrophoresis, Ion exchange chromatography: Physio chemical principles, Process Description and Industrial Applications. **07 Hrs**

UNIT V

Other Techniques: Gas Permeation, Pervaporation, Supercritical fluid extraction, Zone Melting: Physio chemical principles, Process Description and Applications. **06 Hrs**

TEXT BOOKS:

1. Separation Process Principles; J. D. Seader, Ernest J. Henley, D. Keith Roper, Third Edition, John Wiley & Sons, Inc.
2. Separation Processes, C. J. King, Second Edition, Mc Graw Hill Chemical Engineering Series

REFERENCE BOOKS:

1. Handbook of Separation Process Technology, R.W. Rousseau, John Wiley and Sons
2. Encyclopaedia of Chemical Technology, Kirk-Othmer, Fifth Edition, John Wiley and Sons

E BOOKS

1) Separation Process Engineering, Wankat Phillip C, Second Edition, Prentice Hall.

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question each from Unit I, IV, and V and two questions each from Unit II and III.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Apply the knowledge of engineering fundamentals to utilize separation operations in chemical industries.	PO1
CO2	Identify membrane processes in terms of materials, modules, mechanisms of transport and industrial applications.	PO2
CO3	Apply contextual knowledge for the industrial application of Adsorption and Chromatography techniques.	PO6
CO4	Demonstrate the pursuance of sustainable development through Electro dialysis, Electrophoresis and Ion exchange chromatography techniques.	PO7
CO5	Illustrate Gas Permeation, Pervaporation, Supercritical fluid extraction and Zone Melting in terms of Physio chemical principles, Process Description and Applications.	PO7
CO6	Differentiate the separation techniques in terms of their relative advantages, disadvantages and applicability in the context of technological changes.	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

Assessment Pattern:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PILOT PLANT AND SCALE UP STUDIES													
Course Code	1	9	C	H	7	D	E	L	E	2	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Chemical equipment design, Process Equipment Design**,** Chemical Reaction Engineering-II, Fluid Mechanics, and Heat Transfer

SYLLABUS:

UNIT I

INTRODUCTION: Evolution of process system, Role of pilot plants, Major Factors in Scale –Up, Concept of prototypes, models, scale ratios, element. **06 Hrs**

UNIT II

SIMILARITY: Principles of Similarity: Geometric similarity. Distorted similarity. Static, dynamic, kinematics, thermal and chemical similarity with examples, Dimensional Analysis.

06 Hrs

UNIT III

REGIME CONCEPT: Static regime. Dynamic regime. Mixed regime concepts. Criteria to decide the regimes. Equations for scale criteria of static, dynamic processes, Extrapolation. Boundary effects.

07 Hrs

UNIT IV

SCALE UP OF MIXING PROCESS AND CHEMICAL REACTORS: Mixing Processes: Scale-up relationships, Scale-up of polymerization units, Continuous stages gas liquid slurry processes.
FLUID-FLUID REACTORS: Scale-up considerations in packed bed absorbers and bubble columns, Applicability of models to scale-up. **10 Hrs**

UNIT V

SCALE UP OF MASS AND HEAT TRANSFER PROCESSES: Continuous Mass Transfer Process: Fundamental considerations scale-up procedure for distillation, Absorption, Stripping and extraction units.
Scale up of momentum and heat transfer systems. **10 Hrs**

TEXT BOOKS

1. Attilio Bisio, Robert L. Kabel, Scale up of Chemical Processes, L. Kabel, John Wiley & Sons, 1985.
2. Johnstone and Thring, Pilot Plants Models and scale up method in Chemical Engineering, McGraw Hill, 1957.

REFERENCE BOOKS

1. Marko Zlokarnik, Scale-up in chemical engineering, Wiley-VCH, 2006
2. Colin Divall, Sean Johnston, Scaling up: The Institution of Chemical Engineers and the rise of a new profession, Springer (2000)

E BOOKS

1. P. E. Burke, H. M. S. Patel, Pilot Plants and Scale-up of Chemical Processes, Volume 1, Royal Society of Chemistry, Information Services, 1997

MOOC's &ONLINE COURSES:

1) Scale up Process Operations: https://www.icheme.org/career/training/online-training/scale-up/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question each from Unit I, II, and III and two questions each from Unit IV and V.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Comprehend the concept of Pilot Plant Scale up.	PO2
CO2	Recognise the importance of principles of Similarity in scale up process.	PO2
CO3	Develop the correlation between various physical quantities involved.	PO4
CO4	Scale up Mixing Processes ,fluid-fluid reactors and separation processes	PO3
CO5	Scale up momentum and heat transfer systems	PO3
CO6	Identify and conclude engineering limitations allied with the scale up process.	PO6

ASSESSMENT:

Continuous Internal Assessments		Marks 100 (Weightage 50%)	Assessment
Theory Component	Three Internals(Best of Two)	80%	Course instructor
	Quiz (Two Quizzes or AAT)	20%	Course instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	PRE-PROJECT WORK													
Course Code	1	9	C	H	7	D	C	P	P	W	Credits	02	L – T – P	0 – 0 – 2
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

A project is assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester with a literature survey and plan for the experimental work to be performed with all parameters.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Perform extensive literature survey to understand the changes in the technological trends	**PO4**
CO2	Identify a feasible method to carry out the project work by considering professional ethics of engineering practice	**PO8**
CO3	To formulate one or more methodological approach to carry out the experiments to find a feasible solution for societal and environmental problems.	**PO6**
CO4	Communicate and present/publish effectively the methodological planned to carry out the project work.	**PO10**
CO5	Develop multidisciplinary skills to work as an individual and as a member or leader in diverse team	**PO9**
CO6	Relate the outcomes of the project where the knowledge on developed understanding will help in lifelong learning so as to suit the current technological trends	**PO12**

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Practical Component	Presentation Based on the Topics/problem taken up by the project group under the guidance by a faculty from the department /external guide from industries/other research organisation	Presentation 1 50% Presentation 2 50%	Committee constituted by HOD
Semester End Examination (Presentation)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Presentation 1	Presentation 2	Report	Total Marks
Max. Marks	40	40	20	100
Reduced CIE	20	20	10	50

Course Title	**SEMINAR-2: BASED ON REVIEW OF RESEARCH PUBLICATION/PATENTS**													
Course Code	**1**	**9**	**C**	**H**	**7**	**D**	**C**	**S**	**R**	**2**	**Credits**	**01**	**L – T – P**	**0 – 0 – 1**
CIE	**100 marks (50% weightage)**										**SEE**		**100 marks (50% weightage)**	

The students are expected to obtain a certificate in 3rd/4th/5th/6th Semester in any one of the MOOCS (NPTEL/SWAYAM) courses enlisted in the syllabus or courses related to Chemical Engineering and allied areas. If the student selects any course other than that enlisted, should get prior approval from the Department. The student should submit a report and present the same during the sixth semester. The course will be evaluated by a committee constituted by the HoD for internal assessment.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		**PROGRAMME OUTCOMES**
CO1		
CO2		
CO3		
CO4		
CO5		
CO6		

ASSESSMENT:

Continuous Internal Assessments		**Marks 100% (Weightage 50%)**	**Assessment**
Practical Component	Presentation 1	40%	Committee constituted by HOD
	Presentation 2	40%	Committee constituted by HOD
	Report	20%	Course Instructor/ Guide
Semester End Examination – Presentation and write up (Weightage 50%)			

ASSESSMENT PATTERN:

Component	**Presentation 1**	**Presentation 2**	**Report**	**Total Marks**
Max. Marks	40	40	20	100
Reduced CIE	20	20	10	50

EIGHTH SEMESTER

Course Title	PROJECT MANAGEMENT AND FINANCE													
Course Code	1	9	C	H	8	D	C	P	M	F	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

PREREQUISITES: Economics in Engineering, Statistics and Probability

Syllabus:

UNIT I

PROJECT PLANNING: Overview of project planning, Resource Allocation strategies, generation and screening of project ideas and plans. **06 Hrs**

UNIT II

PROJECT ANALYSIS: Analysis, Market and demand analysis, Technical analysis, Financial requirements and estimation **06 Hrs**

UNIT III

PROJECT SELECTION: Time value of money, Investment criteria, Cash flows, Cost of capital, Risk factors and analysis and Analysis of rate of return **07 Hrs**

UNIT IV

FINANCING OF PROJECTS: Raising capital methods and means, Venture capital, Credit risk rating, Case studies and corporate examples in brief **10 Hrs**

UNIT V

PROJECT SCHEDULING & EXECUTION: CPM and PERT (Critical Path, Float, Total Float, AON, AOA Diagram), GANTT charts, LOB, Resource Allocation, ABC analysis, VED analysis, EOQ, CAT & RAT (Numerical problems included) **10 Hrs**

TEXTBOOKS

1. Prassanna Chandra, “Projects”, Tata McGraw Hill, 8th edition., 2014.

2. Sadhan Choudhury, “Project Management”: Tata McGraw-Hill Education, 1988.

REFERENCE BOOKS

1. J. K. Sharma, “Operation Research” MacMillan, 4th edition., 2009.

2. Entrepreneurship Development, Colombo Plan Staff College for Technical Education, Tata Mc Graw Hill, 1998.

E BOOKS

1. Principles of Project Finance by E.R. Yescombe, 1st Edition: https://www.amazon.com/Principles-Project-Finance-R-Yescombe-ebook/dp/B0027IS4WE

2. Project Management by K.Nagarajan : http://www.bookadda.com/books/project-management-k-nagarajan-8122428037-9788122428032

MOOC's & ONLINE COURSES:

1) https://alison.com/courses/Diploma-in-Project-Management
2) https://www.coursera.org/learn/project-management-basics

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question each from Unit I, II, and III and two questions each from Unit IV and V.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	To make the student understand the concept of a project with relevance to industry and chemical industry in particular.	PO11
CO2	Recognize the effective functions of an individual, a member or leader in diverse teams, and in multidisciplinary settings.	PO9
CO3	Communicate effectively about the need of industrial or societal project.	PO10
CO4	Demonstrate the knowledge and understanding of project planning and its implementation.	PO11
CO5	Demonstrate the knowledge and understanding of project finance	PO11
CO6	Learn different methods to analyse project duration.	PO4

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Theory Component	Three Internals (Best of Two)	60%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Self-Study Component	Term Papers/Modelling/Seminar/Mini projects.	40%	Committee constituted by HOD
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Test 1	Test 2	Quiz 1/AAT	Quiz 2 /AAT	Total Marks
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	INDUSTRIAL SAFETY AND OCCUPATIONAL HEALTH													
Course Code	1	9	C	H	8	O	E	I	S	O	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

SYLLABUS:

UNIT-I

ISO45001: Scope, Normative references, terms and Definitions, Context of the organization, Leadership and Worker participation, Planning, Support, Operation, Performance evaluation and Improvement. Safety Management System and Regulations Complimenting Safety of People and Loss prevention in Factories. **07 Hrs**

UNIT-II

INDIAN LAWS GOVERNING INDUSTRIAL SAFETY: Factories act, State rules there under building and other construction workers acts and rules, Gas cylinders' rules, Explosives acts, Petroleum act, Static and Mobile pressure vessels (Unfired) rules, Indian Boiler acts and rules.
EMPLOYEE SAFETY: Concept of Man-Machine system, Applications of human factors engineering, Human behaviour, Individual difference, Unsafe Action Factors, Personal Factors, Psychological and Psychosocial Factors, Motivation, Frustration and Conflicts, Attitudes and Learning concepts. **Personal Protective Equipment:** Types, specifications, standards, testing procedures, maintenance. **Principles of Ergonomics**: Application of ergonomics in a work system. **10 Hrs**

UNIT-III

PRINCIPLES OF MACHINE GUARDING: Machine Safety risk assessment, Physical guard assessment and allied Controls.
Guarding during maintenance, Zero Mechanical State (ZMS), Definition.

POLICY FOR ZMS: Guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing, guard construction, guard opening. Selection and suitability to ensure controls.
06 Hrs

UNIT-IV

INCIDENT REPORTING INVESTIGATION AND ANALYSIS: Accidents classification and analysis-fatal, serious, minor, and reportable accidents, safety audits, recent development of safety engineering approaches for industrial activity, frequency rates, accident occurrence, investigation, measures for improving safety in factories, cost of accident.
CORRECTIVE ACTION MANAGEMENT: Emergency preparedness, disaster management. Periodic Inspection of workplace to validate the operability and availability of Controls designed, initiating actions after conducting root cause analysis. **06 Hrs**

UNIT-V

ELECTRICAL SAFETY CONCEPTS AND STATUTORY REQUIREMENTS: Introduction – electrostatics, electromagnetism, stored energy, energy radiation and electromagnetic interference – Working principles of electrical Equipment-Indian electricity act and rules-statutory requirements from electrical inspectorate-international standards on electrical safety – first aid-cardiopulmonary resuscitation (CPR).

ELECTRICAL HAZARDS: Primary and secondary hazards– Energy leakage – Clearance and insulation – Excess energy – Current surges – Electrical causes of fire and explosion -ionization, spark and arc-ignition energy – National electrical Safety code - Safety in handling equipment's-over current and short circuit current-heating effects of current-electromagnetic forces-corona effect-static electricity – definition, sources, hazardous conditions, control.
Protection systems: fuse, circuit breakers and Personal protective equipment – safety in handling handheld electrical appliances tools and medical equipment's. Lightning, hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance. **10 Hrs**

TEXT BOOKS

1. ISO 45001:2018 BSI Standards Publication, 2018.
2. K.U. Mistry, Fundamentals of Industrial Safety and Health, 1st Edition, Siddharth Prakashan, 2008

REFERENCE BOOKS

1. Lees F.P, Loss Prevention in Process Industries, 2nd edition, Butterworth Heinemann, 1996
2. Trevor Kletz, What Went Wrong? 5th edition, Butterworth Heinemann, 2009

E BOOKS

1. Charles D. Reese, Occupational Health and Safety Management, https://www.routledge.com/Occupational-Health-and-Safety-Management-A-Practical-Approach-Third-Edition/Reese/p/book/9781138749573

MOOC's & ONLINE COURSES:

1) Health & Safety Training Courses, https://www.britsafe.org/training-and-learning/find-the-right-course-for-you/all-health-safety-and-environmental-training-courses/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question each from Unit I, III, and IV and two questions each from Unit II and V.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		Programme Outcomes
CO1	Interpret and apply legislative requirements, industry standards, and best practices in the workplace	PO6
CO2	Apply risk management principles to anticipate, identify, evaluate and control occupational hazards	PO7
CO3	Practice due diligence and employ ethical standards in all aspects of professional conduct.	PO8
CO4	Work in a team to achieve Industrial safety engineering goals	PO9

CO5	Communicate effectively the incidents, their investigation and analysis	PO10
CO6	Affect/manage change by advancing safety and health principles within the work environment.	PO12

ASSESSMENT:

Continuous Internal Assessments		**Marks 100% (Weightage 50%)**	**Assessment**
Theory Component	Three Internals (Best of Two)	80%	Course Instructor
	Quiz (Two Quizzes)	20%	Course Instructor
Semester End Examination (Written Examination for Three Hours)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	FINAL PROJECT WORK													
Course Code	1	9	C	H	8	D	C	F	P	W	Credits	09	L – T – P	0 – 0 – 9
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

The students in a group will be assigned an experimental, design, a case study or an analytical problem, to be carried out under the supervision of a guide. The project has to be assigned at the beginning of the seventh semester. The project group should complete the preliminary literature survey & plan of project and submit the synopsis at the end of seventh semester. The project work should be carried out and completed at the end of eighth semester, which is evaluated by a committee constituted by the HoD for assessment. Students are encouraged to submit one technical paper at the end of the semester in reputed National/International journals for publications/present the paper in any national or international conference at the end of the semester.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Design and carry out the experiments/design/theoretical design/ simulations work in team in the predetermined methodology.	PO4
CO2	Analyze and interpret the obtained data for optimum solution using suitable Engineering and IT tools.	PO5
CO3	Elucidate the short comings and identify the scope for future work	PO12
CO4	Communicate effectively the project the results/write effective reports to publicize the deduce solutions.	PO10
CO5	Develop ability to function and to work as an individual/ as a member/leader in diverse team	PO9
CO6	Understand the essence and need of professional ethics during project documentation	PO8

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Practical Component	The students will take-up the project assigned in the previous semester and will start carry out experiments/design/theoretical interpretation/simulations studies. The students will present and write reports of the findings. The evaluation will be based on the rubrics framed.	Presentation 1 50% Presentation 2 50%	Two members Committee constituted by HOD
Semester End Examination (Presentation)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Presentation 1	Presentation 2	Report	Total Marks
Max. Marks	40	40	20	100
Reduced CIE	20	20	10	50

DEPARTMENT OF CHEMICAL ENGINEERING
B. M. S. COLLEGE OF ENGINEERING, BENGALURU
Autonomous College under VTU

Course Title	SEMINAR 3: BASED ON SUMMER/WINTER INTERNSHIP													
Course Code	1	9	C	H	8	D	C	S	R	3	Credits	01	L – T – P	0 – 0- 1
CIE	100 marks (50% weightage)										SEE	100 marks (50% weightage)		

The students are expected to undergo in-plant training in any chemical industry or in a reputed research laboratory with pilot plant facility. This shall be for a minimum period of two weeks before end of the eight semesters. The student should submit a report separately, at the beginning of the eighth semester which is evaluated by a committee constituted by the HoD for internal assessment.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Communicate & report the industrial practices through technical presentations	PO10
CO2	Develop interpersonal relationship and work as a member in diversified areas	PO9
CO3	Understand the need of engineering solutions for sustainability and environmental conservation	PO7
CO4	Understand the essence and need of industrial ethics	PO8
CO5	Get to know the role of economics and management principles in the success of industrial operation	PO11
CO6	Recognize the changes in the industrial practices due to technological changes and engage in lifelong learning	PO12

ASSESSMENT:

Continuous Internal Assessments		Marks 100% (Weightage 50%)	Assessment
Presentation	The Students will present the internship taken up in the semester vacation and submit the certificate issued by the industry along with the report.	100%	Committee constituted by HOD
Semester End Examination (Presentation)		**Marks 100 (Weightage 50%)**	

ASSESSMENT PATTERN:

Component	Presentation 1	Presentation 2	Report	Total Marks
Max. Marks	40	40	20	100
Reduced CIE	20	20	10	50