Chemical and Biochemical Engineering

Semester IV						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	
1	CL201L	Chemical Engineering lab -1 (Thermodynamics and fluid mechanics)	3	0	0	6
2	CL206T	Materials Science for Chemical Engineers	3	0	0	6
3	MA103T	Differential Equations -I	3	1	0	4
4	BB 404	Biophysics	3	0	0	3
5	CE301T	Environmental Studies	3	0	0	6
6	CL 202T	Reaction engineering	3	0	0	6
7	CH 201T	Organic chemistry	3	0	0	3
8	CL 202T	Mass transfer	3	0	0	6
		Total Credits				**38**

Chemical and Biochemical Engineering

1	**Title of the course** (L-T-P-C)	**Chemical Engineering lab -1 (Thermodynamics and fluid mechanics) (0-0-3-3)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Thermoynamics: Determination of partial molar enthalpies, vapour pressures, infinite dilution activity coefficient, vapour-liquid equilibrium, adiabatic calorimetry. Fluid mechanics: Flow visualization, Flow rate, velocity and pressure measurements, calibration of flow-meters, flow-through pipes and piping elements including Bernouli's principle, Impact of fluid-jets on substrates.
4	**Texts/References**	

1	**Title of the course** (L-T-P-C)	**Materials Science for Chemical Engineers** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Introduction:** Introduction to materials and their principle properties, Atomic bonding, crystal structure and defects, Basic principles in their selection for fabrication and erection of the chemical plant. **Deformation:** Plastic deformation - Mechanism of plastic deformation, slip, work hardening, deformation in polycrystalline materials, Effect of cold working and annealing, hot working. Elastic deformation, Anelastic deformation, Viscoelastic deformation – models for viscoelastic behavior. **Fracture:** Types of fracture, cleavage, brittle, ductile, Griffith crack theory, Theories of crack initiation, ductile-brittle transition. **Testing of materials**: Destructive tests - Tensile testing, stress-strain curves, condition for necking, compression testing, Hardness testing. Creep-testing method, creep curve, requirements for creep resistance materials. Fatigue – testing method fatigue prevention. Non-destructive tests. Thermal properties: Heat capacity and specific heat, Thermal expansion, thermal conductivity, thermal shock. Heat treatment: Annealing, quenching, normalizing, hardening, martempering, Aus tempering, case hardening, cyaniding, nitriding, flame hardening, induction hardening, diffusion coating, furnaces, and temperatures. Phase diagram: Basic terms, Hume - Rothery rules of solid solubility, Gibb's phase rule, polymorphism, solidification of pure metal. Types of cooling curves, plotting of equilibrium diagram, lever rule, common types of phase diagram, other transformations in alloy system; Non-equilibrium cooling.
4	**Texts/References**	**1.** William D. Callister Jr., David G. Rethwisch. "Materials Science and Engineering: An Introduction", Wiley, 10th Edition, January 2018 ISBN: 978-1-119-40549-8, **2.** James F. Shackelford. "Introduction to Materials Science for Engineers", Pearson College Div; 8th edition, 2 April 2014, ISBN-10 :0133826651 **3.** Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright. "The Science and Engineering of Materials". Cl-Engineering; 6th edition (21 June 2010), ISBN-10 : 0495296023 **4.** V. Raghavan. "Materials Science and Engineering: A First Course". Prentice Hall India Learning Private Limited; 6th edition (1 January 2015), ISBN-10 9788120350922: **5.** Hajra Choudhury S. K, "Material science and processes", Imprint unknown (1 March 1978), ISBN-10: 0906216001.

1	**Title of the course (L-T-P-C)**	**Environmental studies (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	**Module A:** Natural Resources, Ecosystems, Biodiversity and its conservation: Natural resources and ecosystems, Forest, grassland, desert and aquatic ecosystems, biodiversity at global, national and local levels, conservation of biodiversity **Module B:** Air Pollution Introduction to understanding air quality management, fundamental processes of meteorology, Air Pollutants – Gaseous and particulate, Criteria for pollutants, ambient and source standards, Aerosols: Characterisation of aerosols, size distributions, measurement methods; Transport behaviour: diffusion, sedimentation, inertia; Visibility; principles of particulate control systems. **Module C:** Water Treatment Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment processes. **Module D:** Solid Waste Management and Climate Change Different aspects of solid and hazardous waste management. Climate change and greenhouse gas emissions, technologies would reduce the greenhouse gas emissions. Climate change and its possible causes. **Module E:** Sociology/Environmentalism Description: Environmentalism in sociological tradition, Sustainability, North-South divide, Political economy approaches in environmental studies, Debates over environmental issues. **Module F:** Economics Energy economics and financial markets, Market dynamics, Energy derivatives, Energy Efficiency; Sustainable Development: Concept, Measurement & Strategies, Interaction between Economic Development and the Environment **Module G:** Philosophy Environmental ethics, Deep ecology, Practical ecology, Religion and attitude towards environmental ethics, Ecofeminism and its evolution. **Module H**: Field work and project: visit to a local area to document environmental assets, case studies of a simple ecosystem and group discussions on current environmental issues.
4	**Texts/References**	**1.** Cunningham W.P. and Cunningham M.A. (2002), Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi. **2.** Dasgupta, P. and Maler, G. (eds.), (1997), The Environment and Emerging Development Issues, Vol. I, Oxford University Press, New Delhi. **3.** Jackson, A.R.W. and Jackson, J.M. (1996), Environmental Sciences: The Environment and Human Impact, Longman Publishers. **4.** Nathanson, J.A., (2002), Basic Environmental Technology, Prentice Hall of India, New Delhi **5.** Redclift, M. and Woodgate, G. (eds.), (1997), International Handbook of Environmental Sociology. **6.** Srivastava, K.P. (2002), An Introduction to Environmental Study, Kalyani Publishers, Ludhiana. **7.** Review articles from literature.

1	**Title of the course (L-T-P-C)**	**Differential Equations -I (3-1-0-4)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	Exact equations, integrating factors and Bernoulli equations. Orthogonal trajectories. Lipschitz condition, Picard's theorem, examples on non-uniqueness. Linear differential equations generalities. Linear dependence and Wronskians. Dimensionality of space of solutions, Abel-Liouville formula. Linear ODEs with constant coefficients, the characteristic equations. Cauchy-Euler equations. Method of undetermined coefficients. Method of variation of parameters. Laplace transforms generalities. Shifting theorems. Convolution theorem.
4	**Texts/References**	**1.** E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999) **2.** W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005)

1	**Title of the course (L-T-P-C)**	**Biophysics (3-0-0-3)**
2	**Pre-requisite courses(s)**	

3	**Course content**	• Diffusion and Brownian motion and biological applications.
		• Electrostatic interactions
		• Chemical potential and Chemical reactions
		• Self-assembly, micelles, cell membranes
		• Helix coil transition
		• Stretching of macromolecules
		• Protein folding
		• Unzipping of DNA
		• Machines in membranes
		  ○ Electro-osmotic effects
		  ○ Ion pumping
		• Nerve Impulses
		  ○ Action Potentials
		  ○ Ion Channels
		• Physical Techniques and related biology
		  ○ X-ray diffraction, light and neutron scattering
		  ○ Nuclear magnetic Resonance
		  ○ Fluorescence
		  ○ DNA Microarrays
		  ○ Manipulation of biomolecules using optical tweezers.
		  ○ Tomography
		  ○ Patch clamps

4	**Texts/References**	1. Physical biology of the cell, second edition by rob phillips, jane kondev, julie theriot, and hernan garcia (garland science, 2012). 2. Biological Physics: energy, information, life student edition by philip nelson. (chiliagon science)

1	**Title of the course** (L-T-P-C)	**Reaction engineering** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Kinetics Reaction rate, order, rate constant; Batch reactors Design + basics; Kinetic constants from batch reactor data; Ideal flow reactors Mass and Energy balances; Isothermal, adiabatic and non-isothermal operation; Catalysts, Catalytic rates, Reaction mechanisms; Internal/External transport in catalysts; Non-catalytic solid-gas reactions; Reactor design for ideal flow reactors; Yield and Selectivity; Concept of RTD; Segregation and Maximum Mixedness models
4	**Texts/References**	1. H.S.Fogler, Elements of Chemical Reaction Engineering, 2nd ed., Prentice Hall, New Jersey, 1992. 2. 2. O.Levenspiel, Chemical Reaction Engineering, 2nd ed., Wiley Eastern,1992 3. 3. J.M.Smith, Chemical Engineering Kinetics, 3rd ed., McGraw Hill, 1980.

1	**Title of the course (L-T-P-C)**	**Organic chemistry (3-0-0-3)**
2	**Pre-requisite courses(s)**	Fundamental concepts and applications of chemistry (CH101)
3	**Course content**	**Reactive Intermediates**: An overview of the chemistry of carbenes, nitrenes, radicals, carbocations, carbanions and benzynes. Introduction to substitution, elimination, addition, oxidation, reduction, rearrangement types of reactions **Epoxidation named reactions**: Jacobsen and Sharpless. **Olefination named reactions**: Wittig, Julia, Wharton, Peterson, Tebbe. **Cross-Coupling named reactions**: Buchwald-Hartwig, Negishi, Sonogashira, Suzuki, Wurtz, Ullmann, McMurry, Heck, Stille. **Pericyclic reactions**: Diels-alder cycloaddition, Ene reaction, Cope rearrangement, Claisen rearrangement (Johnson, Ireland and Eschenmoser). **Organic chemistry in industry**: Pharmaceuticals, dye, and agrochemicals
4	**Texts/References**	1. Jerry March and Michael Smith, "Advanced Organic Chemistry", 7th Ed., Wiley, 2015. 2. F. A. Carey and R. J. Sundberg, "Advanced Organic Chemistry, Part A and B", 5th Ed., Springer, 2008. 3. J. Clayden, N. Greeves, and S. Warren, "Organic Chemistry", 2nd Ed., Oxford University Press, 2014. 4 W. Carruthers and I. Coldham, "Modern Methods of Organic Synthesis", 4th Ed., Cambridge University Press, 2015. 5. Laszlo Kurti and Barbara Czako, "Strategic applications of named reactions in organic synthesis", 1st Ed., Elsevier, 2005. 6. R. B. Grossman, "Art of writing reasonable organic reaction mechanisms", 2nd Ed., Springer, 2010. 7. P. Bruice, "Organic Chemistry" 7th Ed., Pearson, 2013. 8. Penny Chaloner, "Organic chemistry: A mechanistic approach, CRC Press; 1st edition, 2014

1	**Title of the course (L-T-P-C)**	**Mass transfer (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	Principles of Mass transfer: Constitutive laws of diffusion; unsteady state diffusion; Convective mass transfer. Interphase mass transfer and mass transfer coefficients; Mass transfer theories/models; Equilibrium stages and transfer units: number and height of transfer units; stage efficiency. Gas absorption: plate and packed column design. Distillation: batch distillation, continuous fractionation, other types of distillation (e.g., azeotropic), solvent extraction, drying, cooling towers.
4	**Texts/References**	1. R.E.Treybal, Mass Transfer Operations, 3rd Edition, McGraw Hill, New Delhi, 1983. 2. E.D. Cussler, Di usion - Mass Transfer in Fluid Systems, Cambridge University Press, Cambridge 1984. 3. A. S. Foust, Principles of Unit Operations, 2nd Edition, Wiley, New York, 1980. 4. C.J. Geankoplis, Transport Processes and Unit Operations, 3rd Edition, Prentice Hall, India, 1993.