Semester IV						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	ME 220	Heat Transfer	2	1	0	6
2	EE 101	Introduction to Electrical Systems and Electronics	3	0	0	6
3	MA 407	Introduction to Numerical Linear Algebra	3	1	0	4
4	MA 103	Differential Equations -I	3	1	0	4
5	BB 404	Biophysics	3	0	0	3
6	CL 202	Reaction engineering	3	0	0	6
7	CH 201	Organic chemistry	3	0	0	3
8	CL 203	Mass transfer	3	0	0	6
		Total Credits				38

1	**Title of the course (L-T-P-C)**	**Heat Transfer (2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• **Introduction:** Typical heat transfer situations, Modes of heat transfer, Introduction to laws, some heat transfer parameters • **Conduction:** Fourier's law and thermal conductivity, Differential equation of heat conduction, boundary conditions and initial conditions, Simple one-dimensional steady state situations – plane wall, cylinder, sphere (simple and complex situations), concept of thermal resistance, concept of U, critical radius. variable thermal conductivity (exercise), Special one-dimensional steady state situations: heat generation, pin fins, other fin configurations (exercise), Two-dimensional steady state situations, Transient conduction, Lumped capacitance model, One dimensional transient problem: analytical solutions, 1D Heisler charts, Product solutions, Numerical methods in conduction, Steady state 1D and 2D problems, 1D transient problems: Explicit and implicit • **Radiation:** Basic ideas, spectrum, basic definitions, Laws of radiation, black body radiation, Planck's law, Stefan Boltzmann law, Wien's Displacement law, Lambert cosine law, Radiation exchange between black surfaces, shape factor, Radiation exchange between Gray surfaces – Radiosity-Irradiation method, Parallel plates, Enclosures (non-participating gas), Gas radiation Forced Convection: Concepts of fluid mechanics, Differential equation of heat convection, Laminar flow heat transfer in circular pipe: constant heat flux and constant wall temperature, thermal entrance region, Turbulent flow heat transfer in circular pipe, pipes of other cross sections, Heat transfer in laminar flow and turbulent flow over a flat plate, Reynolds analogy, Flow across a cylinder and sphere, flow across banks of tubes, impinging jets • **Natural Convection:** Introduction, governing equations, Vertical plate Pohlhausen solution, horizontal cylinder, horizontal plate, enclosed spaces Heat Exchangers: Types of heat exchangers, LMTD approach – parallel, counter-flow, multi-pass and cross flow heat exchanger, NTU approach: parallel, counter- flow, shell and tube, cross flow heat exchanger Condensation and Boiling: Dimensionless parameters, boiling modes, correlations, forced convection boiling, laminar film condensation on a vertical plate, turbulent film condensation • **Mass Transfer:** Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy.
4	**Texts/References**	**1.** In crop era FP and Dewitt DP, Fundamentals of Heat and Mass Transfer, 5th e, John Wiley & Sons, 2010. **2.** Cengel YA, Heat and Mass Transfer - A Practical Approach, Third edition, McGraw-Hill, 2010. **3.** Holman JP, Heat Transfer, McGraw-Hill, 1997.

1	**Title of the course** (L-T-P-C)	**Introduction to Electrical Systems and Electronics** **(3-0-1-7)**
2	**Pre-requisite courses(s)**	Exposure to Calculus
3	**Course content**	**From Physics to Electrical Engineering** (a) Lumped matter discipline (b) Batteries, resistors, current sources and basic laws (c) I-V characteristics and modeling physical systems **Basic Circuit Analysis Methods** (a) KCL and KVL, voltage and current dividers (b) Parallel and serial resistive circuits (c) More complicated circuits (d) Dependent sources, and the node method (e) Superposition principle (f) Thevenin and Norton method of solving linear circuits (g) Circuits involving diode. **Analysis of Non-linear Circuits** (a) Toy example of non-linear circuit and its analysis (b) Incremental analysis (c) Introduction to MOSFET Amplifiers (d) Large and small signal analysis of MOSFETs (e) MOSFET as a switch **Introduction to the Digital World** (a) Voltage level and static discipline (b) Boolean logic and combinational gates (c) MOSFET devices and the S Model (d) MOSFET as a switch; revisited (e) The SR model of MOSFETs (f) Non-linearities: A snapshot **Capacitors and Inductors** (a) Behavior of capacitors, inductors and its linearity (b) Basic RC and RLC circuits (c) Modeling MOSFET anomalies using capacitors (d) RLC circuit and its analysis (e) Sinusoidal steady state analysis (f) Introduction to passive filters **Operational Amplifier Abstraction** (a) Introduction to Operational Amplifier (b) Analysis of Operational amplifier circuits (c) Op-Amp as active filters (d) Introduction to active filter design **Transformers and Motors** (a) AC Power circuit analysis (b) Polyphase circuits (c) Introduction to transformers (d) Introduction to motors

4	**Texts/References**	2. Anant Agarwal and Jefferey H. Lang, "Foundations of Analog and Digital Electronics Circuits," Morgan Kaufmann publishers, 2005. 3. Wlilliam H. Hayt, Jr., Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis," Tata McGraw-Hill. 4. Theodore Wildi, "Electrical Machines, Drives and Power Systems," Pearson, 6-th edition. 5. V. Del. Toro, "Electrical Engineering Fundamentals," Pearson publications, 2nd edition.

Chemical and Biochemical Engineering

1	**Title of the course** (L-T-P-C)	**Introduction to Numerical Linear Algebra** **(3-1-0-4)**
2	**Pre-requisite courses(s)**	Calculus, MA 101 & Linear Algebra, MA 106
3	**Course content**	Floating point number system, Big O notation Matrix and vector norms, ill conditioned problems Solution of a system of linear equations, Gauss elimination, LU factorization, Cholesky method, Classical iterative methods: Jacobi and Gauss-Seidel Eigenvalue problems, Power method, QR method, Gershgorin theorem. Exposure to MATLAB
4	**Texts/References**	S. D. Conte and Carl de Boor, Elementary Numerical Analysis- An Algorithmic Approach (3rd Edition), McGraw-Hill, 1980.

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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)

Chemical and Biochemical Engineering

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.