Semester III						
Sr No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CL 201	Introduction to Transport Phenomena	3	0	0	6
2	CL 204	Thermodynamics for chemical engineers	3	0	0	6
3	ME 203	Fluid Mechanics	2	1	0	6
4	ME 201	Engineering Mechanics	2	1	0	6
5	EE 221	Introduction to Probability	3	0	0	3
6	EE 227	Data Analysis	3	0	0	3
7	BB 301	Basics of Cell Biology and Genetics	3	0	0	6
8	CL 207	Chemical Engineering lab -1 (**Thermodynamics and fluid mechanics)**	0	0	3	3
		Total Credits				39

1	**Title of the course (L-T-P-C)**	**Introduction to Transport Phenomena (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	Introduction: Vectors/Tensors, Viscosity, Shell balance: Falling film, Circular tube. Equations of Change for isothermal systems: Continuity, Motion, Energy, Substantial derivatives. Unidirectional flows: Pipe flow, Variable viscosity falling film, Couette viscometer, Rotating Sphere. Unsteady flows: Startup Plate flow, Parallel plates, Oscillating plate; Thermal conductivity and mechanism of energy transport; Shell energy balances and temperature distributions in solids and laminar flow; The equations of change for non-isothermal systems; Diffusivity and the mechanisms of mass transport; Concentration distributions in solids and laminar flow; Equations of change for multicomponent systems; Introduction to the concept of heat and mass transfer-coefficients.
4	**Texts/References**	R.B.Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena, 2nd ed., Wiley, 2006

1	**Title of the course (L-T-P-C)**	**Thermodynamics for chemical engineers (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	Thermodynamics introduction and basic definitions; Importance of PVT relation and equation of state; First law of thermodynamics, applications and limitations; Second law of thermodynamics and its applications; Irreversibility and availability; Thermodynamic potentials & property relations; Thermodynamic property estimation for ideal gas, real gas, and multicomponent mixtures; Solution thermodynamics: ideal and real solutions and the concept of excess properties; Phase equilibrium including vapor-liquid, liquid-liquid, and solid-liquid equilibrium; Chemical reaction equilibrium
4	**Texts/References**	1. Y V C Rao; "Chemical Engineering Thermodynamics" 2. Stanley I. Sandler "Chemical, Biochemical, and Engineering Thermodynamics 4th Edition" 3. J.M. Smith, H.C. Van Ness, M.M. Abott, M.T. Swihart “Introduction to Chemical Engineering Thermodynamics 8th Edition"

1	**Title of the course (L-T-P-C)**	**Fluid Mechanics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	Introduction: Scope, definition of fluid as continuum, fluid properties. (2hr) Fluid Statics: Pressure at a point, basic equation for pressure field, pressure variation (fluid at rest): standard atmosphere, Measurement of pressure manometer, Hydrostatics force on a plane and curve surface, Buoyancy, flotation and stability, pressure variation in a fluid with rigid body motion linear motion, rigid body rotation(4hr) Elementary Fluid Dynamics: Statics, stagnation pressure, Bernoulli Equation assumptions(4hr) Fluid Kinematics The velocity filed: Eulerian and Largrangian flow descriptions, steady and deformation, Acceleration field: material derivative, unsteady and convective effects. Control volume and system representation: Reynolds' Transport Theorem, physical interpretation, steady, unsteady effects, moving control volume, potential function(6Hr) Integral approach Conservation of mass derivation of continuity, fixed, non-deforming control volume, moving non-deforming control volume, deforming control volume. Conservation of momentum: linear momentum and moment of momentum equation and their application., comparison of energy equation with Bernoulli's equation(6hr) Differential approach: linear motion and angular motion with deformation, Conservation of mass: differential form of continuity equation, stream function, Conservation of linear momentum, Inviscid flows, Irrotational flow(6hr) Viscous flow: Stress relationships, NS Equations, Simple solutions for viscous flows(4hr) Dimensional analysis Buckingham's II-theorem, Dimensionless groups & their importance (3hr) Viscous Flow in Pipes: General characteristics of pipe flow, fully developed laminar and turbulent flow, turbulent shear stress, turbulent velocity profile, Pipe Flow rate measurement. (4hr) Boundary layer: Boundary layer characteristics boundary layer structure and thickness on a plate, Blasius boundary layer, momentum integral boundary layer equation for a flat plate(4hr)
4	**Texts/References**	1. Yunus A. Cengel, John M. Cimbala, Fluid Mechanics, Tata McGraw Hill Education,2011 2. F.M.White Fluid Mechanics, Seventh Edition, Tata McGraw Hill Education,2011. 3. Kundu,Pijush K., and Ira M.Cohen.Fluid Mechanic, Elsevier,2001

1 1	~~Title of the course~~ Title of the course (L-T-P-C) (L-T-P-C)	~~Introduction to Probability~~ Engineering Mechanics (3-0-0-3) (2-1-0-6)
2 2	~~Pre-requisite~~ Pre-requisite courses(s) courses(s)	Basic calculus --
3	Course content	**Introduction**: Motivation for studying the course, revision of basic math required, connection between probability and length on subsets of the real line, probability-formal definition, events and σ-algebra, independence of events, and conditional probability, sequence of events, and Borel-Cantell Lemma. **Random Variables**: Definition of random variables, and types of random variables, CDF, PDF and its properties, random vectors and independence, brief introduction to transformation of random variables, introduction to Gaussian random vectors. **Mathematical Expectations**: Importance of averages through examples, definition of expectation, moments and conditional expectation, use of MGF, PGF and characteristic functions, variance and k-th moment, MMSE estimation. **Inequalities and Notions of convergence**: Markov, Chebychev, Chernoff and Mcdiarmid inequalities, convergence in probability, mean, and almost sure, law of large numbers and central limit theorem. **A short introduction to Random Process:** Example and formal definition, stationarity, autocorrelation, and cross correlation function, definition of ergodicity.
4	Texts/References	1. **Robert B. Ash**, ``Basic Probability Theory," Reprint of the John Wiley & Sons, Inc., New York, 1970 edition. 2. **Sheldon Ross**, ``A first course in probability," Pearson Education India, 2002. 3. **Bruce Hayek**, ``An Exploration of Random Processes for Engineers," Lecture notes, 2012. 4. D. P. Bertsekas and J. Tsitisklis, “Introduction to Probability” MIT Lecture notes, 2000 (*link*:https://www.vfu.bg/en/e-Learning/Math--Bertsekas_Tsitsiklis_Introduction_to_probability.pdf)

3	**Course content**	**Module 1:** Introduction to Engineering Mechanics covering, Force SystemsBasic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy **Module 2:** Friction overing, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack. **Module 3:** Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines. **Module 4:** Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook. **Module 5:** Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium. **Module 6:** Particles dynamics- Kinematics of Particles: Rectilinear motion, Plane curvilinear motion - rectangular coordinates, normal and tangential coordinates, polar coordinates, Space curvilinear - cylindrical, spherical (coordinates), Relative and Constrained motion. Kinetics of Particles: Force, mass and acceleration – rectilinear and curvilinear motion, work and energy, impulse and momentum – linear and angular; Impact – Direct and Oblique. Kinetics of System of Particles: Generalized Newton's Second Law, Work-Energy, Impulse-Momentum, Conservation of Energy and Momentum **Module 7:** Introduction to Rigid body dynamics Kinematics of Planar Rigid Bodies: Equations for rotation of a rigid body about a fixed axis, General plane motion,

		Instantaneous Center of Rotation in Plane Motion Plane Motion of a Particle Relative to a Rotating Frame. Coriolis Acceleration Kinetics of Planar Rigid Bodies: Equations of Motion for a Rigid Body, Angular Momentum of a Rigid Body in Plane Motion, Plane Motion of a Rigid Body and D'Alembert's Principle, Systems of Rigid Bodies, Constrained Plane Motion; Energy and Work of Forces Acting on a Rigid Body, Kinetic Energy of a Rigid Body in Plane Motion, Systems of Rigid Bodies, Conservation of Energy, Plane Motion of a Rigid Body - Impulse and Momentum, Systems of Rigid Bodies, Conservation of Angular Momentum. **Module 8:** Mechanical Vibrations covering, Basic terminology, free and forced vibrations, resonance, and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulums, use of simple, compound and torsion pendulums.
4	**Texts/References**	**Textbooks:** 1. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II – Dynamics, 6th Ed, John Wiley, 2008. 2. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II – Dynamics, 9th Ed, Tata McGraw Hill, 2011. 3. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press, 2006. **References:** 1. S. P. Timoshenko and D. H. Young, Engineering Mechanics. Fourth Edition. McGraw-Hill, New York, 1956. 2. I. H. Shames, Engineering Mechanics: Statics and dynamics, 4th Ed, PHI, 2002 3. Robert W. Soutas-Little; Daniel J. Inman; Daniel Balint, Engineering Mechanics: Dynamics – Computational Edition, 1st Ed., Cengage Learning, 2007 **4**. Robert W. Soutas-Little; Daniel J. Inman; Daniel Balint, Engineering Mechanics: Statics-Computational Edition, 1st Ed.,, Cengage Learning, 2007

1	**Title of the course (L-T-P-C)**	**Data Analysis** **(3-0-0-3)**
2	**Pre-requisite courses(s)**	**Introduction to Probability**
3	**Course content**	The role of statistics. Graphical and numerical methods for describing and summarizing data. Sampling variability and sampling distributions, Estimation using a single sample, Hypothesis testing using a single sample, Comparing two populations or treatments, Simple linear regression and correlation, and Case studies.
4	**Texts/References**	Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists," Elsevier, New Delhi, 3rd edition (Indian), 1987. Papoulis and Pillai, "Probability, Random Variables and Stochastic processes," 4th Edition, Tata McGraw Hill, 1991. William Feller , "An Introduction to Probability Theory and Its Applications," Vol. 1, 3rd edition, John Wiley International, 1968.

1	**Title of the course (L-T-P-C)**	**Basics of Cell Biology and Genetics (3-0-0-6)**
2	**Pre-requisite courses(s)**	None
3	**Course content**	1. Quantity Introduction to genetics 2. Mendelian genetics: Mendel's law and examples, Monohybrid and di-hybrid cross, recessive, and dominant mutation, concept of allele 3. Non-Mendelian genetics: incomplete dominance, semi- dominance, and introduction to epigenetics, Cytoplasmic inheritance, infection heredity. 4. Genetic interactions: approach towards generating a network (epistasis, redundancy, synthetic lethality, lethal interactions) 5. Model organisms and studies on molecular and genetic interactions. 6. Structure of prokaryotic and eukaryotic cells 7. Introduction of cell biology, classification of living organisms, Prokaryotic cells, eukaryotic cells. 8. Membrane structure and function. 9. Structure and Composition of the Cell Membrane, Membrane Proteins, Transport across the Cell Membrane 10. Structural organization and function of intracellular organelles Structure and function of cytoplasm, Cytoskeletal elements and architecture, Structure and Function of mitochondria, Ribosomes, Endoplasmic reticulum, Rough endoplasmic reticulum and protein secretion, Lysosomes, The Golgi Complex, Peroxisomes, Vacuoles, plant cell organelles, Cell locomotion.
4	**Texts/References**	1. Anthony JF Griffiths et al., An Introduction to Genetic Analysis W.H. Freeman and Co 7th Edition 2000 2. Watson et. al., Molecular Biology of the Gene, Pearson, 7th Edition 2013 3. Jocelyn E. Krebs et al., Lewin's Gene Jones & Bartlett Learning; 11 edition (December 31, 2012) 4. Richard Kowles, Solving Problems in Genetics Springer; 2001 edition (June 21, 2001) 4. Gerald Karp, Cell Biology, WILEY (Feb. 4th, 2013) 5. Bruce Alberts et al., Essential Cell Biology; Richard Goldsby and Thomas J, &F/Garland, 4th Edition, (2014). 6. Alberts, Bruce.; Molecular Biology of the Cell, Garland Science; 5th edition (2 January 2008)

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**	**Thermodynamics:** 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 flowmeters, flow-through pipes and piping elements including Bernouli's principle, Impact of fluid-jets on substrates.
4	**Texts/References**	--