Chemical and Biochemical Engineering

Semester II						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	MA 102	Linear Algebra	3	1	0	4
2	BB 201	Biomolecules	2	1	0	6
3	ME 111	Engineering Graphics Lab	1	0	3	5
4	ME 201	Engineering Mechanics	2	1	0	6
5	CS 201	Data Structures and Algorithms	3	0	0	6
6	CS 211	Data Structures and Algorithms Laboratory	0	0	3	3
7	ME 113	Hands on Engineering Lab	0	0	3	3
8	CL 101	Introduction to Chemical Engineering	3	0	0	6
9	NO 105/ NO 107	National Sports Organization (NSO)/National Service Scheme (NSS)	0	0	2	2
		Total Credits				39

Chemical and Biochemical Engineering

1	**Title of the course (L-T-P-C)**	**Linear Algebra (3-1-0-4)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Vectors in R^n, notion of linear independence and dependence, linear span of a set of vectors, vector subspaces of R^n, basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix in terms of determinants. Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product spaces, Gram-Schmidt process, orthonormal bases, projections and least squares approximation. Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, Hermitian, symmetric, skew-symmetric, normal). Algebraic and geometric multiplicity, diagonalization by similarity transformations, spectral theorem for real symmetric matrices, application to quadratic-forms.
4	**Texts/References**	**1.** H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995). **2.** G. Strang, Linear algebra and its applications (4th Edition), Thomson (2006) **3.** S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000) **4.** E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999)

1	**Title of the course (L-T-P-C)**	**Biomolecules (2-1-0-6)**
2	**Pre-requisite courses(s)**	**None**
3	**Course content**	**Major classes of biological molecules:** Comparison of the alphabets and sources of structural diversity of proteins, nucleic acids, carbohydrates, and lipids. **Proteins:** Ramachandran plot, evolution of protein structure, structure-function **relationships:** myoglobin and adaptations in myoglobin structure in deep diving mammals; allostery in hemoglobin; Bohr effect (for pH and carbon dioxide); adult and foetal hemoglobin. **Post-translational modifications:** special types of covalent bonds found in proteins. **Protein folding:** Natively folded and natively disordered proteins; miniproteins and peptide toxins; Anfinsen's observations, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, diseases associated with protein folding. **Carbohydrates:** Sources of structural diversity; structure-function relationship in glycogen and cellulose, Difficulty associated with sequencing of glycans. **Lipids:** Structure and properties of storage and membrane lipids. **Self-assembly of lipids:** packing parameter; Biomembrane organization - sidedness and function; membrane bound proteins-structure, properties and function; transport phenomena. **Nucleic acids:** Historical perspective leading up to the proposition of DNA double helical structure with emphasis on the innovativeness of experimental design; Secondary structure of RNA; chromatin organization. **Enzymes:** General principles of catalysis; quantitation of enzyme activity and efficiency; Henri-Michaelis-Menten and Briggs-Haldane relationships. **Transition state:** definition Pauling's intuition and proposal, catalytic antibodies; Catalytic strategies. **Isozymes:** Haldane relationship between kinetic constants and equilibrium constants; Zymogens. **Bioenergetics:** basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels, recurring motifs in metabolism. Relevant metabolic pathways may be included to discuss relevant concepts.
4	**Texts/References**	**1.** Rodney F Boyer, Concepts in Biochemistry. John Wiley & Sons; 3rd Ed (2 December 2005). **2.** Thomas Miilar, Biochemistry Explained: A Practical Guide to Learning Biochemistry CRC Press; 1 edition (30 May 2002. **3.** Lubert Stryer et al., Biochemistry.W. H. Freeman; 6th Edition edition (14 July 2006) **4.** David L Nelson, and Michael M Cox et al., Lehninger principles of biochemistry WH Freeman; 7th ed. 2017 edition (1 January 2017)

1	**Title of the course (L-T-P-C)**	**Engineering Graphics Lab (1-0-3-5)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Engineering Graphics with mini drafter: Around half a semester and bit more with following topics to be covered. • Introduction to Engineering Graphics • Curves • Projections of Points • Projection of Lines • Projection of Planes • Projections on Auxiliary Planes • Projections of Solids • Sections of Solids • Intersections of Solids Engineering Graphics with 2D Drafting Software: 5 weekly computer laboratory sessions covering above using AutoCAD® as a drafting software, 5th session on Isometric Projections.
4	**Texts/References**	**1.** N. D. Bhatt, revised and enlarged by V. M. Panchal and P. R. Ingle, Engineering Drawing, 53rd Edition, 2014, Charotar Publishers, Anand. **2.** Warren J. Luzadder and Jon M. Duff, Fundamentals of Engineering Drawing, Prentice-Hall of India. **3.** Gopalakrishna K. R., Engineering Drawing Vol. I & II Combined., Subhas Stores, 25th Edition, 2017. **4.** Narayana. K. L., and Kannaiah, P. E., Textbook on Engineering Drawing, 2nd Edition, 2013, Scitech Publications, Chennai. **5.** Venugopal K. and Prabhu Raja V., Engineering Drawing + AutoCAD, New Age International Publishers, 5th Edition, 2011.

1	**Title of the course** (L-T-P-C)	**Engineering Mechanics** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Module 1:** Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar ConcurrentForces, 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 covering, 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 Structures and Algorithms (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Exposure to Computer Programming**
3	**Course content**	Introduction: data structures, abstract data types,analysis of algorithms. Creation and manipulation of data structures: arrays,lists, stacks, queues, trees, heaps, hash tables, balanced trees, tries, graphs. Algorithms for sorting and searching, order statistics, depth-first and breadth-first search, shortest paths and minimum spanning tree.
4	**Texts/References**	**1.** Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Pressand McGraw-Hill, 2009. **2.** Data structures and algorithms in C++, by MichaelT. Goodrich, Roberto Tamassia, and David M. Mount,Wiley, 2004.

1	**Title of the course (L-T-P-C)**	**Data Structures and Algorithms Laboratory (0-0-3-3)**
2	**Pre-requisite courses(s)**	**Exposure to Computer Programming (CS 102)**
3	**Course content**	Laboratory course for CS 211 is based on creatingand manipulating various data structures and implementation of algorithms.
4	**Texts/References**	1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Pressand McGraw-Hill, 2009. 2. Data structures and algorithms in C++, by Michael T.Goodrich, Roberto Tamassia, and David M. Mount, Wiley, 2004.

1	**Title of the course** (L-T-P-C)	**Hands on Engineering Lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**List of Experiments (Mechanical Workshop)** • To make a Square-fit from the given mid steel pieces (Fitting) • To make a V-fit from the given mid steel pieces (Fitting) • To make a rectangular tray as per required dimensions (Sheet Metal) • To build a transition piece (Sheet Metal) • To make a Butt joint using the given two M.S pieces (Arc welding) • To make a lap joint using the given two M.S pieces (Arc welding) • To build a pipeline using fittings for given flow circuit (Plumbing) **List of Experiments (Electrical Workshop)** • To control one lamp by a one switch with provision for plug socket with switch control (Electrical wiring) • To do stair case wiring (i.e. control of one lamp by two switches fixed at two different places) (Electrical wiring) • Measurement of hot and cold resistance of filament • Improvement of Power Factor • Calibration of Energy meter • Measurement of Power using three ammeter/voltmeter method **List of Experiments (Electronics)** • Understanding breadboard, One-way traffic • Introduction to Arduino and Buzzer • Using Arduino speed measurement of motor/ glowing of LED • Control of water level using Arduino Line follower using Arduino
4	**Texts/References**	1. Elements of Workshop Technology Vol. 1 (2015), S. K. Hajra Choudhary, A. K. Hajra Choudhary and Nirjhar Roy, Media Promoters and Publishers Pvt. Ltd. 2. W. A. J. Chapman, Workshop Technology, Vol. 1 (2006), Vol 2 (2007), and (1995), CBS Publishers.

1	**Title of the course (L-T-P-C)**	**Introduction to Chemical Engineering (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	Historical overview of Chemical Engineering: Concepts of unit operations and unit processes, and more recent developments, Features of organized chemical processing- from chemistry to chemical engineering. The Chemical Industry-scope, features & characteristics. and scope. Principles of balancing with examples to illustrate differential and integral balances, lumped and distributed balances. Material balances in simple systems involving physical changes and chemical reactions; systems involving recycle, purge. and bypass. Properties of substances: single component & multicomponent, single and multiphase systems. Use of Compressibility charts, vapour pressure correlations/charts & Psychometric charts. Ideal liquid and gaseous mixtures. Energy balance calculations in simple systems. Introduction to Computer aided calculations-steady state material and energy balances.
4	**Texts/References**	**1.** R. M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd ed., John Wiley, New York, 2004. **2.** D. M. Himmelblau and J. B. Riggs, Basic Principles and Calculations in Chemical Engineering. 7th ed., Prentice Hall, 2003. **3.** B. I. Bhatt and S. M. Vora, Stoichiometry. 4th ed., McGraw Hill, 2004.