School of Chemical Technology
Kalinga Institute of Industrial Technology (KIIT)
Deemed to be University U/S 3 of UGC Act, 1956

Curriculum and Syllabi

for

Integrated Dual Degree Programme (BTech and MTech in Chemical Technology)
and
BTech in Chemical Technology

Integrated Dual Degree Programme Structure of BTech and MTech in Chemical Technology

Detailed Curriculum							
First Year							
Semester-1				**Semester-2**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
MA1003	Mathematics-I	3-1-0	4	MA1004	Mathematics-II	3-1-0	4
PH1007	Physics	3-1-0	4	CH1007	Chemistry	3-0-0	3
EE1003	Basic Electrical Engineering	3-0-0	3	HS1005	Professional Communication	2-0-0	2
ME1003	Engineering Mechanics	3-0-0	3	LS1001	Biology	2-0-0	2
PH1097	Physics Lab	0-0-3	1.5	CS1093	Computer Programming	0-2-6	4
EE1093	Basic Electrical Engineering Lab	0-0-4	2	CH1097	Chemistry Lab	0-0-3	1.5
ME1083	Basic Manufacturing Systems	0-1-2	2	HS1085	Language Lab	0-0-2	1
CH1081	Environmental Science	0-0-2	1	CE1083	Engineering Graphics	0-1-2	2
Total credit			20.5	Total Credit			19.5
Second Year							
Semester-3				**Semester-4**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
MA2001	Mathematics-III	3-1-0	4	CL2002	Materials Science and Engineering	3-0-2	4
CL2003	Chemical Engineering Thermodynamics	3-0-2	4	CL2004	Numerical Methods in Chemical Engineering	3-1-0	4
CL2005	Chemical Process Calculation	3-1-0	4	CL2006	Process Heat Transfer	3-0-2	4
CL2007	Transport Phenomena	3-0-2	4	CL2008	Chemical Fluid Mechanics	3-0-2	4
CL2009	Basics of Solid Mechanics	3-1-0	4	CL2012	Principles of Management	3-0-0	3
	Humanities Elective-I	3-0-0	3		Humanities Elective-II	3-0-0	3
Total credit			23	Total credit			22
Summer Term (CL2081)			**Industry Practice**	**Credit 2**			
Third Year							
Semester-5				**Semester-6**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
CL3001	Mass Transfer Operations-I	3-0-2	4	CL3002	Mass Transfer Operations-II	3-0-2	4
CL3003	Chemical Reaction Engineering	3-1-0	4	CL3004	Process Dynamics and Control	3-0-2	4
CL3005	Chemical Process Technology and Economics	3-1-0	4	CL3006	Chemical Reactor Design	3-1-0	4
CL3007	Process Equipment Design-I	2-0-2	3	CL3008	Chemical Process Modelling and Simulation	3-0-2	4
	Discipline Elective-I	3-0-0	3	CL3012	Process Equipment Design-II	2-0-2	3
	Humanities Elective-III	3-0-0	3		Discipline Elective-II	3-0-0	3
Total credit			21	Total credit			22
Fourth Year							
Semester-7				**Semester-8**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
	Discipline Elective -III	3-0-0	3	CL4002	Computational Fluid Dynamics	3-0-2	4
	Discipline Elective -IV	3-0-0	3	CL4004	Biochemical Engineering	3-0-2	4
	Discipline Elective -V	3-0-0	3	CL4006	Fuel Engineering	3-0-2	4
	Open Elective -I	3-0-0	3	CL4008	Piping Engineering	3-0-2	4
	Open Elective -II	3-0-0	3	CL4012	Petroleum Refinery Engineering	3-0-2	4
	Open Elective -III	3-0-0	3				
Total credit			18	Total credit			20
Fifth Year							
Semester-9				**Semester-10**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
CL5081	Industry Project-I / Internship-I Or Major Project-I		20	CL5082	Industry Project-II / Internship-II Or Major Project-II		20
Total credit				Total credit			

Credit Structure

S.No	Category of Courses	Credits
1	Science Foundation	13
2	Mathematics Foundation	12
3	Engineering Science	28
4	Humanities, Social Sciences and Management	15
5	Discipline Core	54
6	Discipline Electives	15
7	Dual Core	20
8	Open Electives	09
9	Capstone Project • Industry Project / Major Project	40
	Total Credits	206

Science Foundation

Course Code	Course	L-T-P	Credits
PH 1003	Physics	3-1-0	4
PH 1097	Physics Lab	0-0-3	1.5
CH 1081	Environmental Science	0-0-2	1
CH 1007	Chemistry	3-0-0	3
CH 1097	Chemistry Lab	0-0-3	1.5
LS 1001	Biology	2-0-0	2
Total Credits		13	

Mathematics Foundation

Course Code	Course	L-T-P	Credits
MA 1003	Mathematics-I	3-1-0	4
MA 1004	Mathematics-II	3-1-0	4
MA 2001	Mathematics-III	3-1-0	4
Total Credits		12	

Engineering Science

Course Code	Course	L-T-P	Credits
EE 1003	Basic Electrical Engineering	3-0-0	3
EE 1093	Basic Electrical Engineering Lab	0-0-2	1
ME 1003	Engineering Mechanics	3-0-0	3
ME 1083	Basic Manufacturing Systems	0-1-2	2
CS 1093	Computer Programming	0-2-4	3
CE 1083	Engineering Graphics	0-1-2	2
CL2009	Mechanics of Solids	3-1-0	4
CL2002	Material Science and Engineering	3-0-2	4
CL2004	Numerical Methods in Chemical Engineering	3-1-0	4
CL2081	Industry Practice		2
Total Credits		28	

Humanities, Social Sciences and Management

Course Code	Course	L-T-P	Credits
HS 1005	Professional Communication	2-0-0	2
HS 1085	Language Lab	0-0-2	1
CL2082	Principles of Management	3-0-0	3
	Humanities Elective I	3-0-0	3
	Humanities Elective II	3-0-0	3
	Humanities Elective II	3-0-0	3
Total Credits		15	

Programme Structure of BTech in Chemical Technology

Detailed Curriculum							
First Year							
Semester-1				**Semester-2**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
MA1003	Mathematics-I	3-1-0	4	MA1004	Mathematics-II	3-1-0	4
PH1007	Physics	3-1-0	4	CH1007	Chemistry	3-0-0	3
EE1003	Basic Electrical Engineering	3-0-0	3	HS1005	Professional Communication	2-0-0	2
ME1003	Engineering Mechanics	3-0-0	3	LS1001	Biology	2-0-0	2
PH1097	Physics Lab	0-0-3	1.5	CS1093	Computer Programming	0-2-6	4
EE1093	Basic Electrical Engineering Lab	0-0-4	2	CH1097	Chemistry Lab	0-0-3	1.5
ME1083	Basic Manufacturing Systems	0-1-2	2	HS1085	Language Lab	0-0-2	1
CH1081	Environmental Science	0-0-2	1	CE1083	Engineering Graphics	0-1-2	2
Total credit			20.5	Total Credit			19.5
Second Year							
Semester-3				**Semester-4**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
MA2001	Mathematics-III	3-1-0	4	CL2002	Materials Science and Engineering	3-0-2	4
CL2003	Chemical Engineering Thermodynamics	3-0-2	4	CL2004	Numerical Methods in Chemical Engineering	3-1-0	4
CL2005	Chemical Process Calculation	3-1-0	4	CL2006	Process Heat Transfer	3-0-2	4
CL2007	Transport Phenomena	3-0-2	4	CL2008	Chemical Fluid Mechanics	3-0-2	4
CL2009	Basics of Solid Mechanics	3-1-0	4	CL2012	Principles of Management	3-0-0	3
	Humanities Elective-I	3-0-0	3		Humanities Elective-II	3-0-0	3
Total credit			23	Total credit			22
Summer Term (CL2081)			**Industry Practice**		**Credit 2**		
Third Year							
Semester-5				**Semester-6**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
CL3001	Mass Transfer Operations-I	3-0-2	4	CL3002	Mass Transfer Operations-II	3-0-2	4
CL3003	Chemical Reaction Engineering	3-1-0	4	CL3004	Process Dynamics and Control	3-0-2	4
CL3005	Chemical Process Technology and Economics	3-1-0	4	CL3006	Chemical Reactor Design	3-1-0	4
CL3007	Process Equipment Design-I	2-0-2	3	CL3008	Chemical Process Modelling and Simulation	3-0-2	4
	Discipline Elective-I	3-0-0	3	CL3012	Process Equipment Design-II	2-0-2	3
	Humanities Elective-III	3-0-0	3		Discipline Elective-II	3-0-0	3
Total credit			21	Total credit			22
Fourth Year							
Semester-7				**Semester-8**			
Course Code	**Course**	**L-T-P**	**Credit**	**Course Code**	**Course**	**L-T-P**	**Credit**
	Discipline Elective -III	3-0-0	3		Discipline Elective -III	3-0-0	3
	Discipline Elective -IV	3-0-0	3		Discipline Elective -IV	3-0-0	3
	Discipline Elective -V	3-0-0	3		Discipline Elective -V	3-0-0	3
	Open Elective -I	3-0-0	3		Open Elective -I	3-0-0	3
	Open Elective -II	3-0-0	3		Open Elective -II	3-0-0	3
	Open Elective -III	3-0-0	3		Open Elective -III	3-0-0	3
CL4081	Or Industry Project / Internship OR Major Project		20	CL4082	Or Industry Project / Internship OR Major Project		20
Total credit			18 / 20	Total credit			18 / 20

Credit Structure

S.No	Category of Courses	Credits
1	Science Foundation	13
2	Mathematics Foundation	12
3	Engineering Science	28
4	Humanities, Social Sciences and Management	15
5	Discipline Core	54
6	Discipline Electives	15
8	Open Electives	09
9	Capstone Project • Industry Project / Major Project	20
	Total Credits	166

Science Foundation

Course Code	Course	L-T-P	Credits
PH 1003	Physics	3-1-0	4
PH 1097	Physics Lab	0-0-3	1.5
CH 1081	Environmental Science	0-0-2	1
CH 1007	Chemistry	3-0-0	3
CH 1097	Chemistry Lab	0-0-3	1.5
LS 1001	Biology	2-0-0	2
Total Credits		13	

Mathematics Foundation

Course Code	Course	L-T-P	Credits
MA 1003	Mathematics-I	3-1-0	4
MA 1004	Mathematics-II	3-1-0	4
MA 2001	Mathematics-III	3-1-0	4
Total Credits		12	

Engineering Science

Course Code	Course	L-T-P	Credits
EE 1003	Basic Electrical Engineering	3-0-0	3
EE 1093	Basic Electrical Engineering Lab	0-0-2	1
ME 1003	Engineering Mechanics	3-0-0	3
ME 1083	Basic Manufacturing Systems	0-1-2	2
CS 1093	Computer Programming	0-2-4	3
CE 1083	Engineering Graphics	0-1-2	2
CL2009	Mechanics of Solids	3-1-0	4
CL2002	Material Science and Engineering	3-0-2	4
CL2004	Numerical Methods in Chemical Engineering	3-1-0	4
CL2081	Industry Practice		2
Total Credits		28	

Humanities, Social Sciences and Management

Course Code	Course	L-T-P	Credits
HS 1005	Professional Communication	2-0-0	2
HS 1085	Language Lab	0-0-2	1
CL2082	Principles of Management	3-0-0	3
	Humanities Elective I	3-0-0	3
	Humanities Elective II	3-0-0	3
	Humanities Elective II	3-0-0	3
Total Credits		15	

Discipline Core

Course Code	Course	L-T-P	Credits
CL2003	Chemical Engineering Thermodynamics	3-0-2	4
CL2005	Chemical Process Calculations	3-1-0	4
CL2007	Transport Phenomena	3-0-2	4
CL2006	Heat Transfer	3-0-2	4
CL2008	Fluid Mechanics	3-0-2	4
CL3001	Mass Transfer Operations-I	3-0-2	4
CL3003	Chemical Reaction Engineering	3-1-0	4
CL3005	Chemical Process Technology and Economics	3-1-0	4

CL3007	Process Equipment Design-I	2-0-2	3
CL3002	Mass Transfer Operations-II	3-0-2	4
CL3004	Process Dynamics and Control	3-0-2	4
CL3006	Chemical Reactor Design	3-1-0	4
CL3008	Chemical Process Modelling and Simulation	3-0-2	4
CL3012	Process Equipment Design-II	2-0-2	3
Total Credits		54	

Discipline Electives

Course Code	Course	L-T-P	Credits
CL3011	Basics of Polymer Science	3-0-0	3
CL3013	Interfacial Engineering	3-0-0	3
CL3015	Chemical Product Development	3-0-0	3
CL3017	Process Plant Safety	3-0-0	3
CL3022	Polymer Processing Technology	3-0-0	3
CL3024	Petroleum Reservoir Engineering	3-0-0	3
CL3026	Corrosion Engineering	3-0-0	3
CL3028	Materials Processing Technology	3-0-0	3
CL4011	Paint and Surface Coating Technology	3-0-0	3
CL4013	Instrumental Techniques of Chemical Analysis	3-0-0	3
CL4015	Petroleum Product Characterization	3-0-0	3
CL4017	Extractive Metallurgy	3-0-0	3
CL4018	Petrochemicals Technology	3-0-0	3
CL4019	Special Project		3
CL4020	Lab Project-I		3
CL4022	Design Project		3
CL4024	Computer Project		3
CL4026	Study Project		3
CL4028	Reading Course		3

Open Electives

Course Code	Course	L-T-P	Credits
CL4071	Pharmaceutical Technology	3-0-0	3
CL4073	Nanotechnology	3-0-0	3
CL4075	Ceramic Technology	3-0-0	3
CL4077	Catalysis	3-0-0	3
CL4079	Environmental Pollution Control	3-0-0	3
CL4081	Mineral Processing Technology	3-0-0	3
CL4083	IPR	3-0-0	3
CL4085	Lab Project-II		3

Humanities Electives

Course Code	Course	L-T-P	Credits
HM2001	Environmental Studies	3-0-0	3
HM2003	Srimad Bhagavad Gita	3-0-0	3
HM2005	Sankara's Thoughts	3-0-0	3
HM2007	Gandhian Thoughts	3-0-0	3
HM2009	Public Administration	3-0-0	3
HM3002	Dynamics of Social Change	3-0-0	3
HS2002	Engineering Economics	3-0-0	3
HM3004	Anthropology	3-0-0	3
HM3006	Principles of Economics	3-0-0	3
HM3008	Professional Ethics	3-0-0	3
HM4001	Reading Course		3

Dual Core

Course Code	Course	L-T-P	Credits
CL4002	Computational Fluid Dynamics	3-0-2	4
CL4004	Biochemical Engineering	3-0-2	4
CL4006	Fuel Engineering	3-0-2	4
CL4008	Piping Engineering	3-0-2	4
CL4012	Petroleum Refinery Engineering	3-0-2	4

Syllabus for BTech in Chemical Technology / Integrated Dual Degree (BTech and MTech in Chemical Technology)

Semester-I

Mathematics-I

Course Objective(s):

The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Course Contents:

Module 1: Calculus Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Module 2: Sequences and Series Convergence of sequences and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithmic functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Module 3: Multivariable Calculus (Differentiation) Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Module 4: Matrices Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Textbooks/References:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Reena Garg, Engineering Mathematics – I, Khanna Book Publishing Co., 2018.
3. Reena Garg & Chandrika Prasad, Advanced Engineering Mathematics, Khanna Book Publishing Co., 2018.25
4. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
7. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
8. N.P. Bali and Manish Goyal, A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Outcomes:

1) To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
2) The fallouts of Rolle's Theorem that is fundamental to the application of analysis to Engineering problems.
3) The tool of power series and Fourier series for learning advanced Engineering Mathematics.
4) To deal with functions of several variables those are essential in most branches of engineering.
5) The essential tool of matrices and linear algebra in a comprehensive manner.

Programming in C

Course Contents:

Unit 1: Introduction to Programming; Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Unit 2: Arithmetic expressions and precedence

Unit 3: Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

Unit 4: Arrays, Arrays (1-D, 2-D), Character arrays and Strings

Unit 5: Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Unit 6: Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Unit 7: Recursion, Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Unit 8: Structures, Defining structures and Array of Structures

Unit 9: Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Unit 10: File handling (only if time is available, otherwise should be done as part of the lab).

Text/Reference books:

1. R.S. Salaria, Problem Solving & Programming in C, Khanna Book Publishing Co.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
5. R.S. Salaria, Computer Concepts and Programming in C, Khanna Publishing House.

Course Outcomes: The student will learn following through lectures:

● To formulate simple algorithms for arithmetic and logical problems.
● To translate the algorithms to programs (in the C language).
● To test and execute the programs and correct syntax and logical errors.
● To implement conditional branching, iteration and recursion.
● To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
● To use arrays, pointers and structures to formulate algorithms and programs.
● To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
● To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

Physics

Course Objectives: To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

Course Contents:

Module 1: Electrostatics in vacuum Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Faraday's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Module 2: Electrostatics in a linear dielectric medium Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge

at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Module 3: Magnetostatics Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Module 4: Magnetostatics in a linear magnetic medium Magnetization and associated bound currents; auxiliary magnetic field H; Boundary conditions on B and H. Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Module 5: Faraday's law Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Module 6: Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time dependent electric field; calculating magnetic field due to changing electric fields in quasistatic approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Pointing vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Module 7: Electromagnetic waves The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

TEXTBOOKS/REFERENCES:

i. David Griffiths, Introduction to Electrodynamics

ii. Halliday and Resnick, Physics

iii. W. Saslow, Electricity, magnetism and light.

Engineering Mechanics

Course Contents:

Module 1 Transformation of scalars and vectors under Rotation transformation; Forces in Nature; Newton's laws and its completeness in describing particle motion; Form invariance of Newton's Second Law; Solving Newton's equations of motion in polar coordinates; Problems including constraints and friction; Extension to cylindrical and spherical coordinates**.**

Module 2 Potential energy function; F = - Grad V, equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, curl of a force field; Central forces;

Conservation of Angular Momentum; Energy equation and energy diagrams; Elliptical, parabolic and hyperbolic orbits; Kepler problem; Application: Satellite manoeuvres;
Module 3 Non-inertial frames of reference; Rotating coordinate system: Five-term acceleration formula. Centripetal and Coriolis accelerations; Applications: Weather systems, Foucault pendulum;
Module 4 Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly-damped oscillators; Forced oscillations and resonance.
Module 5 Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion; Euler's laws of motion, their independence from Newton's laws, and their necessity in describing rigid body motion; Examples.
Module 6 Introduction to three-dimensional rigid body motion — only need to highlight the distinction from two-dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor; Three-dimensional motion of a rigid body wherein all points move in a coplanar manner: e.g. Rod executing conical motion with center of mass fixed — only need to show that this motion looks two-dimensional but is three-dimensional, and two-dimensional formulation fails.
TEXTBOOKS/REFERENCES:
1. Engineering Mechanics, 2nd Ed. — MK Harbola
2. Introduction to Mechanics — MK Verma
3. Engineering Mechanics, 2nd Ed. – D.S. Bedi & M.P. Poonia
4. An Introduction to Mechanics — D Kleppner & R Kolenkow
5. Principles of Mechanics — JL Synge & BA Griffiths
6. Mechanics — JP Den Hartog
7. Engineering Mechanics - Dynamics, 7th ed. - JL Meriam
8. Mechanical Vibrations — JP Den Hartog
9. Theory of Vibrations with Applications — WT Thomson

Biology

Course Objective(s): To provide students the knowledge about cellular content, organization, structures, and functions. To impart a basic understanding of the developmental biology of plants and animals.

Course Content: Microscopy- Visualizing cells and tissues; Integrating cells into tissues (animals and plants); Structure of cell and cell organelles, Details of the cell cycle, cell division and regulation; Cell-Cell junctions; Mitosis and Meiosis. Gametogenesis (plants and animals), fertilization and embryogenesis, morphogen gradients, differentiation, asymmetric cell division, cell fate and lineage determination; Developmental embryonic stages, zygotic division, incomplete division and consequences; Ecto, meso and endodermal development, neural plate and tube formation; Early asymmetric division and generation of symmetry in developing

embryo in animals and plants; organogenesis and morphogenesis, metamorphosis, animal life cycle, sex determination and role of apoptosis in organ development; Role of morphogens and their gradient in axis patterning and determination. Concept of anteroposterior, dorso-ventral, and medio-lateral axis formation. Stem cells, pluripotency, and iPS cells. Introduction to plant fertilization, ovule and egg, and support cells; Root and shoot development, seed formation (monocot/dicot) and germination; flowering and nonflowering plants; Cellular differentiation and senescence; Meristematic tissue, development of root and leaf and floral tissues Model organisms like Drosophila melangoster, C. elegans, G. gallus, Xenopus. Arabidoposis, etc.

Practicals

1. Understanding components of different kinds of microscopes.
2. Visualization of mitochondria, plastids, and other intracellular structures.
3. Study of the life cycle of Drosophila melanogaster.
4. Study of different stages of chick embryos.
5. In situ hybridization of Drosophila embryos to study the cellularization process.
6. Observation of developmental mutants in Drosophila and C. elegans
7. Study of mitosis in onion root tips
8. Totipotency: Analysis of Growth and Subculture

Text Books/References:

1. Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walte; 6th edition New York: Garland Science; 2008.
2. Cell and Molecular Biology-Concepts and Experiments; Gerald Karp et al. John Wiley; 8th edition; 2015.
3. Plant Development: The Cellular Basis (1990 edition) by R. F. Lyndon (PublisherSpringer)
4. Topics in Plant Physiology 3. Series editors M. Black and J. Chapman; Unwin Hyman Ltd, 1990.
5. Plant growth and Development: a molecular approach: DE. Fosket; Academic Press 1994.
6. Developmental Biology (12th Edition) by Michael J.F. Barresi and Scott F. Gilbert (Publisher-Sinauer Associates Inc; 2019).
7. Molecular Cell Biology. 4th edition. Lodish H, Berk A, Zipursky SL, et al. New York: W. H. Freeman; 2000.

Course Outcomes: After completion of the course, students will have a basic understanding of the developmental biology of plants and animals.

Programming in C Lab

Course Contents:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions

3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

Course Outcomes:
The student will learn following through Practicals:
● To formulate the algorithms for simple problems.
● To translate given algorithms to a working and correct program.
● To be able to correct syntax errors as reported by the compilers.
● To be able to identify and correct logical errors encountered at run time.
● To be able to write iterative as well as recursive programs.
● To be able to represent data in arrays, strings and structures and manipulate them through a program. ● To be able to declare pointers of different types and use them in defining self referential structures.
● To be able to create, read and write to and from simple text files.

Text/Reference books:
1. R.S. Salaria, Problem Solving & Programming in C, Khanna Book Publishing Co.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
5. R.S. Salaria, Computer Concepts and Programming in C, Khanna Publishing House.

Physics Lab

List of experiments

● Experiments on electromagnetic induction and electromagnetic braking;
● LC circuit and LCR circuit;
● Resonance phenomena in LCR circuits;
● Magnetic field from Helmholtz coil;
● Measurement of Lorentz force in a vacuum tube.

TEXTBOOKS/REFERENCES:

i. David Griffiths, Introduction to Electrodynamics

ii. Halliday and Resnick, Physics

iii. W. Saslow, Electricity, magnetism and light.

Engineering Graphics

Course Objective(s):

The objective of this Course is to provide the basic knowledge about Engineering Drawing. Detailed concepts are given in projections, technical drawing, dimensioning and specifications, so useful for a student in preparing for an engineering career.

Course Contents:

Traditional Engineering Graphics: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance. Computer Graphics: Engineering Graphics Software; - Spatial Transformations; Orthographic Projections; Model Viewing; Coordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM). (Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

Module 1: Introduction to Engineering Drawing Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Module 2: Orthographic Projections Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Module 3: Projections of Regular Solids Covering those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module 4: Sections and Sectional Views of Right Angular Solids Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only).

Module 5: Isometric Projections Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Module 6: Overview of Computer Graphics Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects; Isometric Views of lines, Planes, Simple and compound Solids];

Module 7: Customization & CAD Drawing Consisting of set up of the drawing page and the printer, including scale settings, setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Module 8: Annotations, layering & other functions Covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;

Module 9: Demonstration of a simple team design project that illustrates Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerance; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Text/Reference Books:

1. Jain Pradeep, Gautam A.P. & Maheshwari Ankita (2018), Engineering Graphics & Design, Khanna Publishing House.
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education.
4. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.
6. (Corresponding set of) CAD Software Theory and User Manuals.

Course Outcomes: All phases of manufacturing or construction require the conversion of new ideas and design concepts into the basic line language of graphics. Therefore, there are many areas (civil, mechanical, electrical, architectural and industrial) in which the skills of the CAD technicians play major roles in the design and development of new products or construction. Students prepare for actual work situations through practical training in a new state-of-the-art computer designed CAD laboratory using engineering software. This course is designed to address:

● to prepare you to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

● to prepare you to communicate effectively

● to prepare you to use the techniques, skills, and modern engineering tools necessary for engineering practice

The student will learn:

● Introduction to engineering design and its place in society.
● Exposure to the visual aspects of engineering design.
● Exposure to engineering graphics standards.
● Exposure to solid modelling.
● Exposure to computer-aided geometric design.
● Exposure to creating working drawings.
● Exposure to engineering communication

Yoga and Sports

Course Objective(s):

● To make the students understand the importance of sound health and fitness principles as they relate to better health.

● To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.

● To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.
● To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Course Contents:

● Introduction to Physical Education
  o Meaning & definition of Physical Education
  o Aims & Objectives of Physical Education
  o Changing trends in Physical Education
● Olympic Movement o Ancient & Modern Olympics (Summer & Winter)
  o Olympic Symbols, Ideals, Objectives & Values
  o Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)
● Physical Fitness, Wellness & Lifestyle
  o Meaning & Importance of Physical Fitness & Wellness
  o Components of Physical fitness o Components of Health related fitness
  o Components of wellness
  o Preventing Health Threats through Lifestyle Change
  o Concept of Positive Lifestyle
● Fundamentals of Anatomy & Physiology in Physical Education, Sports and Yoga
  o Define Anatomy, Physiology & Its Importance
  o Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)
● Kinesiology, Biomechanics & Sports
  o Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports
  o Newton's Law of Motion & its application in sports.
    Friction and its effects in Sports.
● Postures o Meaning and Concept of Postures.
  o Causes of Bad Posture.
  o Advantages & disadvantages of weight training.
  o Concept & advantages of Correct Posture.
  o Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis.
  o Corrective Measures for Postural Deformities
● Yoga
  o Meaning & Importance of Yoga o Elements of Yoga
  o Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas
  o Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana & Shashankasana)

o Relaxation Techniques for improving concentration - Yog-nidra

● Yoga & Lifestyle

o Asanas as preventive measures.

o Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.

o Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.

o Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana.

o Diabetes: Procedure, Benefits & contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana.

o Asthema: Procedure, Benefits & contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.

● Training and Planning in Sports

o Meaning of Training o Warming up and limbering down

o Skill, Technique & Style

o Meaning and Objectives of Planning.

o Tournament – Knock-Out, League/Round Robin & Combination.

● Psychology & Sports

o Definition & Importance of Psychology in Physical Edu. & Sports

o Define & Differentiate Between Growth & Development

o Adolescent Problems & Their Management o Emotion: Concept, Type & Controlling of emotions

o Meaning, Concept & Types of Aggressions in Sports.

o Psychological benefits of exercise.

o Anxiety & Fear and its effects on Sports Performance.

o Motivation, its type & techniques.

o Understanding Stress & Coping Strategies.

● Doping

o Meaning and Concept of Doping

o Prohibited Substances & Methods

o Side Effects of Prohibited Substances

● Sports Medicine

o First Aid – Definition, Aims & Objectives.

o Sports injuries: Classification, Causes & Prevention.

o Management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries

● Sports / Games Following subtopics related to any one Game/Sport of choice of student out of: Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, Yoga etc.

o History of the Game/Sport.

o Latest General Rules of the Game/Sport.

o Specifications of Play Fields and Related Sports Equipment.
o Important Tournaments and Venues. o Sports Personalities.
o Proper Sports Gear and its Importance.

Text Books/References:

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light On Yoga by B.K.S. Iyengar.
3. Health and Physical Education – NCERT (11th and 12th Classes)

Course Outcomes: On successful completion of the course the students will be able to:

1. Practice Physical activities and Hatha Yoga focusing on yoga for strength, flexibility, and relaxation.
2. Learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.
3. Learn breathing exercises and healthy fitness activities
4. Understand basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination.
5. Perform yoga movements in various combination and forms.
6. Assess current personal fitness levels.
7. Identify opportunities for participation in yoga and sports activities.
8. Develop understanding of health-related fitness components: cardiorespiratory endurance, flexibility and body composition etc.
9. Improve personal fitness through participation in sports and yogic activities.
10. Develop understanding of psychological problems associated with the age and lifestyle.
11. Demonstrate an understanding of sound nutritional practices as related to health and physical performance.
12. Assess yoga activities in terms of fitness value.
13. Identify and apply injury prevention principles related to yoga and physical fitness activities.
14. Understand and correctly apply biomechanical and physiological principles elated to exercise and training.

Semester-II

Mathematics-II

Course Contents:

Module 1: Multivariable Calculus (Integration) Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Module 2: First order ordinary differential equations Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 3: Ordinary differential equations of higher orders Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation;

Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Module 4: Complex Variable – Differentiation Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Module 5: Complex Variable – Integration Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Text Books/References:

1. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 2018. 2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

3. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

4. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.

5. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.

6. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.

7. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.

8. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.

9. N.P. Bali and Manish Goyal, A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

10. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Outcomes: The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

● The mathematical tools needed in evaluating multiple integrals and their usage.

● The effective mathematical tools for the solutions of differential equations that model physical processes.

● The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

Workshop/Manufacturing Practices

Course Contents:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
2. CNC machining, Additive manufacturing.
3. Fitting operations & power tools.
4. Electrical & Electronics.
5. Carpentry.
6. Plastic moulding, glass cutting.
7. Metal casting. 8. Welding (arc welding & gas welding), brazing.

Practicals:
1. Machine shop (10 hours)
2. Fitting shop (8 hours)
3. Carpentry (6 hours)
4. Electrical & Electronics (8 hours)
5. Welding shop (8 hours: Arc welding 4 hrs + Gas welding 4 hrs)
6. Casting (8 hours)
7. Smithy (6 hours)
8. Plastic moulding & Glass Cutting (6 hours) Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Text Books/References:
1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Course Outcomes: Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.
Laboratory Outcomes: ● Upon completion of this laboratory course, students will be able to fabricate components with their own hands. ● They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes. ● By assembling different components, they will be able to produce small devices of their interest.

Chemistry

Course Objective(s):

The objective of the Chemistry I is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during the course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will be able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with new technologies.

Course Contents:

(i) Atomic and Molecular Structure Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

(ii)Spectroscopic techniques and applications Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.

(iii) Intermolecular forces and potential energy surfaces Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

(iv) Use of free energy in chemical equilibria (6 lectures) Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

(v)Periodic properties 34 Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic

sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard and soft acids and bases, molecular geometries.

(vi) Stereochemistry Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transition metal compounds.

(vii) Organic reactions and synthesis of a drug molecule Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Text/Reference books:

1. University chemistry, by B. H. Mahan
2. Engineering Chemistry, by Satyaprakash & Manisha Agarwal
3. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
4. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
5. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
6. Physical Chemistry, by P. W. Atkins
7. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Course Outcomes: The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at the molecular levels. The course will enable the student to:

- Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
- Rationalise bulk properties and processes using thermodynamic considerations.
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
- List major chemical reactions that are used in the synthesis of molecules.

Basic Electrical Engineering

Course Objective(s):

The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering.

Course Contents:

Module 1: D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faraday's Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

Module 2: Single Phase A.C. Circuits covering, Generation of sinusoidal voltagedefinition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; Three Phase A.C. Circuits covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

Module 3: Transformers covering, Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation;

Module 4: DC Machines covering, working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

Module 5: Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Module 6: Sources of Electrical Power covering, Introduction to Wind, Solar, Fuel cell, Tidal, Geo-thermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation;

Text/Reference Books:

1. Nagrath I.J. and D. P. Kothari (2001), Basic Electrical Engineering, Tata McGraw Hill.

2. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
3. Kulshreshtha D.C. (2009), Basic Electrical Engineering, Tata McGraw Hill.
4. Rajendra Prasad (2009), Fundamentals of Electrical Engineering, Prentice Hall, India
5. Sahdev Ritu (2018), Basic Electrical Engineering, Khanna Book Publishing Co.

Course Outcomes:

1. Students will learn strong basics of Electrical Engineering and practical implementation of Electrical fundamentals.
2. Students will learn different applications of commonly used electrical machinery.

Professional Communication

Course Objective(s):

The students will acquire knowledge on various types of listening techniques, barriers and benefits of listening recognize the speech sounds and learn the intonation patterns, learn various vocabulary patterns, develop the ability to structure and punctuate the sentences, learn different reading techniques learn different writing skills.

Course Contents:

Module 1: Information Design and Development- Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and online media.

Module 2: Technical Writing, Grammar and Editing- Technical writing process, forms of discourse, writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Human factors, Managing technical communication projects, time estimation, Single sourcing, Localization.

Module 3: Self Development and Assessment- Self assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time; Personal memory, Rapid reading, taking notes; Complex problem solving; Creativity.

Module 4: Communication and Technical Writing- Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.

Module 5: Ethics- Business ethics, Etiquettes in social and office settings, Email etiquettes, Telephone Etiquettes, Engineering ethics, managing time, Role and responsibility of engineer, Work culture in jobs, Personal memory, Rapid reading, taking notes, Complex problem solving, Creativity.

Text Books/References:

1. Effective Communication Skills. Kulbhushan Kumar. Khanna Publishing House. 2018.
2. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004.
3. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843).
4. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.
5. Raman Sharma, Technical Communications, Oxford Publication, London, 2004.
6. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4)
7. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH. 2002.
8. Xebec, Presentation Book, TMH New Delhi, 2000.

Environmental Science

Course Objective(s):

People working in industries or elsewhere essentially require the knowledge of environmental science to enable them to work and produce the most efficient, economical and eco-friendly finished products.

• Solve various engineering problems applying ecosystem to produce eco – friendly products. • Use relevant air and noise control method to solve domestic and industrial problems.
• Use relevant water and soil control method to solve domestic and industrial problems.
• To recognize relevant energy sources required for domestic and industrial applications.
• Solve local solid and e-waste problems.

Course Content:

Unit-1: Ecosystem • Structure of ecosystem, Biotic & Abiotic components. • Food chain and food web. • Aquatic (Lentic and Lotic) and terrestrial ecosystem. • Carbon, Nitrogen, Sulphur, Phosphorus cycle. • Global warming -Causes, effects, process, Green House Effect, Ozone depletion.

Unit–2: Air and Noise Pollution • Definition of pollution and pollutant, Natural and man-made sources of air pollution (Refrigerants, I.C., Boiler). • Air Pollutants: Types, Particulate Pollutants: Effects and control (Bag filter, Cyclone separator, Electrostatic Precipitator). • Gaseous Pollution Control: Absorber, Catalytic Converter, Effects of air pollution due to Refrigerants, I.C., Boiler. • Noise pollution: sources of pollution, measurement of pollution level, Effects of Noise pollution, Noise pollution (Regulation and Control) Rules, 2000.

Unit-3: Water and Soil Pollution • Sources of water pollution, Types of water pollutants, Characteristics of water pollutants Turbidity, pH, total suspended solids, total solids BOD and COD: Definition, calculation. • Wastewater Treatment: Primary methods: sedimentation, froth floatation, Secondary methods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane separation technology, RO (reverse osmosis). • Causes, Effects and

Preventive measures of Soil Pollution: Causes-Excessive use of Fertilizers, Pesticides and Insecticides, Irrigation, E-Waste.

Unit– 4: Renewable sources of Energy • Solar Energy: Basics of Solar energy. Flat plate collector (Liquid & Air). Theory of flat plate collector. Importance of coating. Advanced collector. Solar pond. Solar water heater, solar dryer. Solar stills. • Biomass: Overview of biomass as an energy source. Thermal characteristics of biomass as fuel. Anaerobic digestion. Biogas production mechanism. Utilization and storage of biogas. • Wind energy: Current status and future prospects of wind energy. Wind energy in India. Environmental benefits and problem of wind energy. • New Energy Sources: Need of new sources. Different types of new energy sources. Applications of (Hydrogen energy, Ocean energy resources, Tidal energy conversion.) Concept, origin and power plants of geothermal energy.

Unit-5: Solid Waste Management, ISO 14000 & Environmental Management • Solid waste generation- Sources and characteristics of: Municipal solid waste, Ewaste, biomedical waste. • Metallic wastes and Non-Metallic wastes (lubricants, plastics, rubber) from industries. Collection and disposal: MSW (3R, principles, energy recovery, sanitary landfill), Hazardous waste. • Air quality act 2004, air pollution control act 1981 and water pollution and control act1996. Structure and role of Central and state pollution control board. • Concept of Carbon Credit, Carbon Footprint. • Environmental management in fabrication industry. • ISO14000: Implementation in industries, Benefits.

Text Books/References:

1. S.C. Sharma & M.P. Poonia, Environmental Studies, Khanna Publishing House, New Delhi.
2. C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.
3. Arceivala, Soli Asolekar, Shyam, Waste Water Treatment for Pollution Control and Reuse, Mc-Graw Hill Education India Pvt. Ltd., New York, 2007, ISBN:978-07-062099-
4. Nazaroff, William, Cohen, Lisa, Environmental Engineering Science, Willy, New York, 2000, ISBN 10: 0471144940.
5. O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House, New Delhi
6. Rao, C. S., Environmental Pollution Control and Engineering, New Age International Publication, 2007, ISBN: 81-224-1835-X.
7. Rao, M. N.Rao, H.V.N, Air Pollution, Tata Mc-Graw Hill Publication, New delhi, 1988, ISBN: 0-07- 451871-8.
8. Frank Kreith, Jan F. Kreider, Principles of Solar Engineering, McGraw-Hill, New York; 1978, ISBN: 9780070354760.
9. Aldo Vieira, Da Rosa, Fundamentals of renewable energy processes, Academic Press Oxford, UK; 2013. ISBN: 9780123978257.
10. Patvardhan, A.D, Industrial Solid Waste, Teri Press, New Delhi, 2013, ISBN:978-81- 7993-502-6 69

11. Metcalf & Eddy, Waste Water Engineering, Mc-Graw Hill, New York, 2013, ISBN: 077441206.
12. Keshav Kant & Rajni Kant, Air Pollution & Control, Khanna Publishing House, New Delhi (Edition 2018)

Teachers should use the following strategies to achieve the various outcomes of the course. ● Different methods of teaching and media to be used to attain classroom attention. ● Massive open online courses (MOOCs) may be used to teach various topics/subtopics. ● 15-20% of the topics which are relatively simpler of descriptive in nature should be given to the students for self-learning and assess the development of competency through classroom presentations. ● Micro-projects may be given to a group of students for hands-on experiences. ● Encouraging students to visit sites such as Railway station and research establishment around the institution.

Course Outcomes: At the end of the course student will be able to
1. Understand the ecosystem and terminology and solve various engineering problems applying ecosystem knowledge to produce eco – friendly products.
2. Understand the suitable air, extent of noise pollution, and control measures and acts.
3. Understand the water and soil pollution, and control measures and acts.
4. Understand different renewable energy resources and efficient process of harvesting.
5. Understand solid Waste Management, ISO 14000 & Environmental Management.

Chemistry Lab

Laboratory: Choice of 10-12 experiments from the following:
1. Determination of surface tension and viscosity.
2. Thin layer chromatography.
3. Ion exchange column for removal of hardness of water.
4. Determination of chloride content of water.
5. Colligative properties using freezing point depression.
6. Determination of the rate constant of a reaction.
7. Determination of cell constant and conductance of solutions.
8. Potentiometry - determination of redox potentials and emfs.
9. Synthesis of a polymer/drug.
10. Saponification/acid value of an oil.
11. Chemical analysis of a salt.
12. Lattice structures and packing of spheres.
13. Models of potential energy surfaces.
14. Chemical oscillations- Iodine clock reaction.
15. Determination of the partition coefficient of a substance between two immiscible liquids.
16. Adsorption of acetic acid by charcoal.
17. Use of the capillary viscometers to demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of the egg.

Text/Reference books:

1. University chemistry, by B. H. Mahan
2. Engineering Chemistry, by Satyaprakash & Manisha Agarwal
3. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
4. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
5. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
6. Physical Chemistry, by P. W. Atkins
7. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Laboratory Outcomes: The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering. The students will learn to:

● Estimate rate constants of reactions from concentration of reactants/products as a function of time.

● Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.

● Synthesize a small drug molecule and analyze a salt sample

Language Lab

Course Contents:

1. Vocabulary Building
   1.1. The concept of Word Formation
   1.2. Root words from foreign languages and their use in English
   1.3. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
   1.4. Synonyms, antonyms, and standard abbreviations.
2. Basic Writing Skills
   2.1. Sentence Structures
   2.2. Use of phrases and clauses in sentences
   2.3. Importance of proper punctuation
   2.4. Creating coherence
   2.5. Organizing principles of paragraphs in documents
   2.6. Techniques for writing precisely
3. Identifying Common Errors in Writing
   3.1. Subject-verb agreement
   3.2. Noun-pronoun agreement
   3.3. Misplaced modifiers

3.4. Articles
3.5. Prepositions
3.6. Redundancies
3.7. Clichés

4. Nature and Style of sensible Writing
4.1. Describing
4.2. Defining
4.3. Classifying
4.4. Providing examples or evidence
4.5. Writing introduction and conclusion

5. Writing Practices
5.1. Comprehension
5.2. Précis Writing
5.3. Essay Writing

6. Oral Communication (This unit involves interactive practice sessions in Language Lab) ● Listening Comprehension ● Pronunciation, Intonation, Stress and Rhythm ● Common Everyday Situations: Conversations and Dialogues ● Communication at Workplace ● Interviews ● Formal Presentations

Suggested Readings:

1. Practical English Usage. Michael Swan. OUP. 1995.
2. Remedial English Grammar. F.T. Wood. Macmillan.2007
3. On Writing Well. William Zinsser. Harper Resource Book. 2001
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
6. Effective Communication Skills. Kulbhushan Kumar. Khanna Publishing House. 2018.
7. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

Course Outcomes: The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

Semester-III

Subject: Engineering Principles (include thermodynamics)

Course Category: ESC

Course objectives:

Enhance the basic knowledge and intuitive understanding of thermodynamics on the physical and chemical system. Introduce the concepts of partial molar properties, fugacity, activity, vapour-liquid equilibrium for ideal and real substances existing in more than one phases under equilibrium. Generalize the design thinking skills on property estimation to chemical industries.

Course Contents:

Module: 1

Introduction - Definition and Basic Concepts - classical and statistical thermodynamics - Concept of Continuum - Thermodynamic steady state - equilibrium state process , Volumetric properties of pure fluids: PVT Relations - Ideal gas- Real gas- Law of corresponding states

Module: 2

First law analysis – Closed non-flow system - Steady state flow systems and their analysis; Second law of thermodynamics - change in internal energy - enthalpy - entropy calculation for process - phase change; Heat effects - standard heat of reaction

Module: 3

Gibbs free energy- Helmholtz free energy- exact differential equation - thermodynamic property relations- Maxwell's relations and applications - fugacity -activity of pure substancesdetermination of fugacity of pure gases, solids and liquids

Module: 4

Mixture of pure fluids - Partial molar properties - Chemical potential - fugacities in solution; Ideal solutions - Lewis Randal rule - Raoult' s law - Henry's law; Gibbs- Duhem equation; Residual properties - Property changes of mixing for ideal - non-ideal solutions - Excess properties relations and Gibbs free energy calculation

Text Books/References:

1.Narayanan K.V., A Textbook of Chemical Engineering Thermodynamics, 2nd ed., Prentice Hall India, New Delhi, 2012

2. Ahuja P, Chemical Engineering Thermodynamics, 2nd ed., PHI Learning Pvt. Ltd., New Delhi, 2012.

3. Smith J.M., Van Ness H.C., Abbott M.M., Introduction to Chemical Engineering Thermodynamics, 8th ed., McGraw-Hill, New York, 2018.

4. Rao Y.V.C., Chemical Engineering Thermodynamics, 1st ed., University Press, New Delhi, 2005.

Course Outcomes:

1. Define and illustrate thermodynamic equilibrium state system, ideal and non-ideal relations

2. Relate properties such as change in enthalpy, entropy, free energy, heat and work requirement for any batch and flow process happens in chemical industries

3. Make use of thermodynamic relations to interpret the partial molar properties of pure gases and liquids, and their mixtures

4. Construct and analysis the phase equilibrium data, P-x-y, T-x-y diagram for ideal binary miscible vapour-liquid systems

5. Device methodologies for qualitative and quantitative analysis of VLE for non-ideal binary miscible systems using van Laar, Margules, property estimation models

6. Estimate the feasibilities of any reaction, and to determine the equilibrium rate constant for chemical reactions

Subject: Biochemistry

Course Category: BS

Course Objective(s):

The course provides the students with a conceptual and experimental background in the broad discipline of microbiology. The students will be introduced to the major groups of microorganisms and their diversity in structure and functions and microbial interactions.

Emphasis has been laid on bacterial growth, nutrition, control, metabolism, and genetics. The course also introduces the students to the scope and relevance of microbes in the field of medicine, agriculture, and industry

Course Contents:

Module: 1

Introduction to biological buffers and its importance in biochemistry, pH, water, basics of amino acids

Module: 2

pK and pI values of amino acids, pK values of the ionizable groups of proteins, peptide bond, peptide, protein structures, protein stability and folding, native structure of protein, protein methodology, enzymes and kinetics,

Module: 3

Nucleotide, biochemistry of nucleic acids, lipids and membrane, carbohydrates, introduction to metabolism, Glucose metabolism, citric acid cycle

Module: 4

Electron transport chain, amino acid and lipid metabolism, haemoglobins, regulation and integration of metabolic pathways and the biochemical basis of human diseases (e.g. diabetes), Biochemical techniques.

Text Books/References:

1. Principles of Biochemistry by David L. Nelson and Michael M. Cox

2. Biochemistry by Geoffrey Zubey49

3. Biochemistry. 5th edition. Berg JM, Tymoczko JL, Stryer L. New York: W H Freeman; 2002.

4. Essentials of Glycobiology [Internet]. 3rd edition. Varki A, Cummings RD, Esko JD, et al., editors. Cold Spring Harbor (NY): Cold Spring Harbor Laboratory Press; 2015- 2017.

5. Basic Neurochemistry: Molecular, Cellular and Medical Aspects. 6th edition. Siegel GJ, Agranoff BW, Albers RW, et al, editors. Philadelphia: Lippincott-Raven; 1999.

Course Outcomes:

1. Biological buffers and its importance in biochemistry

2. Biochemical basis of cellular functions

3. Biochemical basis of organism physiology

4. Introduction to bio-metabolism

5. Metabolic pathways

6. Biochemical basis of human diseases

Subject: Microbiology

Course Category: BS

Course Objective(s):

It is intended to impart basic undergraduate-level knowledge in the area of general Biochemistry. Students would be able to understand the biochemical basis of cellular functions and organism physiology. They would also be able to assimilate recent research findings, advancement and development in the relevant subject.

Course Contents:

Module: 1

Introduction to Microbiology (History and Scope- Role of Microbes in agriculture, public health, medicine and industry). Organization of Prokaryotic and Eukaryotic Cell Structure and Function. Diversity of the Microbial World- (Microbial Evolution, Taxonomy, Microbial Diversity). The Viruses.

Module: 2

Microbial Nutrition and Growth (Types of growth media, growth phases, culture methods). Microbial Metabolism (Aerobic & anaerobic respiration, fermentation, Entner Duodruffs pathway, photosynthesis, nitrogen fixation).

Module: 3

Microbial Molecular Biology and Genetics (Genome and gene structure, Replication,

Expression, Regulation of gene expression (operon system), transformation conjugation and transduction). Microbial Ecology (Microbes from Marine, Freshwater and Terrestrial Environments), Microbial Interactions (Symbiotic, non-symbiotic)).

Module: 4

Pathogenic Microbes. Control of microbial growth – (Effect of heat, Sterilization, disinfectants, therapeutic agents, antimicrobial resistance). Applications in Food and Industrial Microbiology

Text Books/References:

1. Prescott's Microbiology by Willey, Sherwood and Woolverton.

2. Brock Biology of Microorganisms by Madigan, Martinko, Stahl and Clark.
3. General Microbiology by Stanier, Ingraham, Wheelis and Painter.
4. Microbiology, M. Pelczar, E. Chan, N. Kreig, 5th ed, MGH.

Course Outcomes:

7. Presence of microbes in the environment and their influence in our daily lives as part of the food, soil, air environment, and disease development.
8. Immense diversity in the microbial world, their varied inter or intra community interactions and contribution to the biotech industry
9. Microbial Nutrition and Growth and Microbial Metabolism
10. Microbial Molecular Biology and Genetics
11. Microbial Ecology and Microbial Interactions
12. Applications in Food and Industrial Microbiology

Subject: Genetics & Evolutionary Biology

Course Category: BS

Course Objective(s):

To provide students the knowledge about gene organization, genetic materials,molecular heritance, gene transfer, and their regulations.

Course Contents:

Module: 1

Chemistry of Genetic Material: Discovery of DNA as genetic material, Experiments of Griffith; Avery, McCleod and; McCarthy, and Harshey and Chase. RNA as genetic materialExperiment of Fraenkel and Singer; Nucleic acids: structure of DNA, RNA, and Proteins, DNA Replication in prokaryotes and eukaryotes.

Module: 2

Genome organization: Organization of Prokaryotic and Eukaryotic genome; Fine structure of the Gene: Cistron, muton, and recon; Transformation; Transduction and Conjugation: F factor-mediated, Hfr and F-duction; Introduction to Genomics and Proteomics.

Module: 3

Transposable elements: Transposable elements Maize and Drosophila; Introduction and Types of Gene mutations- Base substitution and Frameshift mutations; Mutagens - Physical and chemical; Reverse mutation in bacteria; DNA repair mechanism (Mismatch 51 repair photo reactivation, excision and SOS repair); Beneficial and harmful effects of mutations.

Module: 4

Gene Expression and Gene regulation: Genetic code: Brief account. Gene regulation in prokaryotes and eukaryotes, positive regulation, negative regulation, attenuation, gene regulation in lambda phage life cycle, RNA processing and post-transcriptional regulation; regulatory RNA; Eukaryotic transcription factors, enhancers, silencers, insulators, chromatin structure and gene regulation, Translational regulation in prokaryotes and eukaryotes, Post-translational modification and protein stability.

Text Books/References:

1. Lewin's GENES XII by Jocelyn E. Krebs Elliott S. Goldstein and Stephen T.Kilpatrick
2. 2. Molecular Biology of the Gene by James D. Watson, A. Baker Tania, P. Bell Stephen, Gann Alexander, Levine Michael, and Losick Richard
3. The Biophysical Chemistry of Nucleic Acids and Proteins: Thomas E. Creighton; Helvetian Press; 2010.
4. Molecular Cell Biology, 8th edition (2016) by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon and Kelsey C. Martin
5. Textbook on Molecular Genetics by D. N. Bharadwaj (2009); Kalyani Publisher
6. Latest/classic research articles and reviews relevant to various topics

Course Outcomes:

1. Chemistry of Genetic Material
2. Genome organization and Transposable elements:
3. Gene organization
4. genetic materials,
5. molecular heritance and gene transfer
6. Gene Expression and Gene regulation

Subject: Plant Biology

Course Category: BS

Course Objective(s):

To understand plant metabolism, plant development and their interaction with other organisms.

Course Contents:

Module: 1

Origin of land plants: Earth, Cells and Photosynthesis; Evolution of eukaryotic cells, land plants, seed plants and Angiosperms. Plant cell structure, the nuclear genome and genome sequencing efforts in model and crop plants. Organelle genomes and gene regulation in the organelles.

Module: 2

Plant Metabolism: Control of metabolic pathways. Carbon assimilation: photosynthesis, photorespiration and sucrose transport; Non-photosynthetic generation of energy and precursors. Storage of carbon. Metabolism in plastids. Nitrogen, phosphorus, sulfur and iron assimilation; Movement of water and minerals.

Module: 3

Plant Development: Embryo and seed development. Root and shoot development. Transition from vegetative to reproductive phase and from sporophyte to gametophyte. Seed germination. Response of plants to light and role of photoreceptors. Response of plants to gravity and root and shoot growth. Signaling during seedling development and flowering. Plant response to environmental biotic and abiotic stress

Module: 4

Interactions of plants with other organisms: Microbial pathogens, pests, parasites, viruses and viroid. Defense mechanism in plants. Useful interactions between plants and organisms. The history of plant domestication with specific examples. Scientific plant breeding and role of markers in plant breeding.

Text Books/References:

1. Plant Biology. Allison Smith et al. Garland Science, 2010.
2. Botany: An Introduction to Plant Biology, James D. Mauseth
4. Molecular Cell Biology, 8th edition (2016) by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon and Kelsey C. Martin
5. Textbook on Molecular Genetics by D. N. Bharadwaj (2009); Kalyani Publisher
6. Latest/classic research articles and reviews relevant to various topics

Course Outcomes:

1. Origin of land plants and Plant cells and genomes:
2. Plant Metabolism
3. Plant Development
4. Plant response to environmental signals
5. Interactions of plants with other organisms
6. Plant domestication and agriculture:

Subject: Principle of Economics

Course Category: HS

Course Objective(s):

This course aims at providing the student with advanced concepts of engineering economic analysis and its role in engineering decision making. Additionally, thecourse also covers topics such as depreciation, after tax analysis, replacement analysis, uncertainty, inflation, deflation, and estimation of future events.

Course Contents:

Module: 1

Introduction: Definition – Nature – Scope and Significance of Economics for Engineers. Demand and Supply: Demand – Types – Determinants – Law of Demand – Elasticity of Demand – Types – Significance – Supply – Market price determination – Case Study in Demand Forecasting –- Meaning – Methods – Consumer Survey – Trend Projections – Moving average.

Module: 2

Cost and Revenue: Concepts – Classifications – Short run and long run cost curves –
Revenue – Concepts – Measurement of Profit (Case Study). Market Structure: Perfect Competition – Characteristics – Price and output determination in short run and long run – Monopoly – Price Discrimination – Monopolistic Competition – Product Differentiation – Oligopoly and Duopoly.

Module: 3

Market Failure: Causes – Type of Goods – Rivalrous and Non-rivalrous goods – Excludable and Non-excludable goods – Solutions – Government Intervention. Money and Banking: Money – Functions – Quantity theory of money – Banking – Commercial Banks – Functions – Central Bank (RBI) – Functions – Role of Banks in
Economic Development.

Module: 4

Foreign Exchange: Balance of Payments – Exchange rate determination – Methods

of foreign payments – International Institutions – IMF, IBRD. Business Cycle and National Income: Meaning –Phases of business cycle - Inflation – Causes – Control measures - Deflation - National Income – Concepts – Methods of calculating national income – Problems in calculating national income.

Text Books/References:

1. Premvir Kapoor, "Sociology & Economics for Engineers", Khanna Publishing House, 2018.

2. Dewett. K.K., Navalur M. H., "Modern Economic Theory", S. Chand and Company Ltd, New Delhi, 24thEdn., 2014.

3. Lipsey& Chrystal, "Economics", Oxford University Press, 2010.

Course Outcomes:

1. Describe the role of economics in the decision making process and perform calculations in regard to interest formulas.
2. Estimate the Present, annual and future worth comparisons for cash flows.
3. Calculate the rate of return, depreciation charges and income taxes.
4. Enumerate different cost entities in estimation and costing.
5. Explain the importance of finance functions, financial ratios and solve related problems.
6. Explain the elements of budgeting and benchmarking

Semester-IV

Subject: Biophysics

Course Category: BS

Course Objective(s):

It is intending to impart basic undergraduate-level knowledge in the area of general Biophysics. The student would be able to understand the molecular and mechanistic basis of the cellular functions, organism physiology, and pathophysiology. They would also be able to assimilate recent research findings, advancement and development in the relevant subject.

Course Contents:

Module: 1

Biomolecules, Chemical Bonds in Biochemistry, Conformational Changes in DNA Molecules, From DNA to RNA, The Biophysics of RNA, Protein Function,Hierarchical Structure of Proteins, torsional angles in proteins and nucleic acids,

Module: 2

Characterization of secondary structure using CD, Protein stability and folding, Thermodynamics of bimolecular structures, Protein folding: thermodynamics and kinetics, Functional Design of Proteins, Electrical Phenomena in Excitable Cells, Electrically Excitable Cells, Electrical Signals of Nerve Cells,

Module: 3

The Ionic Hypothesis and Rules of Ionic Electricity, Membrane proteins, Channels and Transporters in Biological system, Functional Properties of Voltage-Gated Ion Channels, Ion pumping and Ion Channel rhodopsins and their use,

Module: 4

Cilia and Flagella: Structure and Movement, Molecular Motors: Kinesin, Dynein and Myosin, and intracellular movement, Microtubule structure. Mechanobiology and its importance in human health.

Text Books/References:

1. Biochemistry. 5th edition. Berg JM, Tymoczko JL, StryerL.New York: W H Freeman; 2002.
2. Basic Neurochemistry: Molecular, Cellular and Medical Aspects. 6th edition. Siegel GJ, Agranoff BW, Albers RW, et al., editors. Philadelphia: Lippincott-Raven; 1999.
3. Molecular Biology of the Cell. 4th edition. Alberts B, Johnson A, Lewis J, et al. New York: Garland Science; 2002.
4. Molecular Cell Biology. 4th edition. Lodish H, Berk A, Zipursky SL, et al. New York: W. H. Freeman; 2000.
5. Neuroscience. 2nd edition.Purves D, Augustine GJ, Fitzpatrick D, et al., editors. Sunderland (MA): Sinauer Associates; 2001.
6. The Biophysics of RNA. ACS Chem. Biol.200727440-444

Course Outcomes:

1. Molecular and mechanistic basis of the cellular functions, organism physiology,and pathophysiology.
2. Biomolecules, Chemical Bonds in Biochemistry
3. Protein folding: thermodynamics and kinetics, Functional Design of Proteins
4. The Ionic Hypothesis and Rules of Ionic Electricity

5. Cilia and Flagella: Structure and Movement, Molecular Motors: Kinesin, Dynein and Myosin, and intracellular movement

6. Mechanobiology and its importance in human health.

Subject: Cell and Molecular Biology

Course Category: BS

Course Objective(s):

To provide students the knowledge about cellular content, organization, structures, and functions. To impart a basic understanding of the developmental biology of plants and animals

Course Contents:

Module: 1

Microscopy- Visualizing cells and tissues; Integrating cells into tissues (animals and plants); Structure of cell and cell organelles, Details of the cell cycle, cell division and regulation; Cell-Cell junctions; Mitosis and Meiosis.

Module: 2

Gametogenesis (plants and animals), fertilization and embryogenesis, morphogen gradients, differentiation, asymmetric cell division, cell fate and lineage determination; Developmental embryonic stages, zygotic division, incomplete division and consequences; Ecto, meso and endodermal development, neural plate and tube formation

Module: 3

Early asymmetric division and generation of symmetry in developing embryo in animals and plants; organogenesis and morphogenesis, metamorphosis, animal life cycle, sex determination and role of apoptosis in organ development; Role of morphogens and their gradient in axis patterning and determination. Concept of anteroposterior, dorso-ventral, and medio-lateral axis formation. Stem cells, pluripotency, and iPS cells.

Module: 4

Introduction to plant fertilization, ovule and egg, and support cells; Root and shoot development, seed formation (monocot/dicot) and germination; flowering and nonflowering plants; Cellular differentiation and senescence; Meristematic tissue, development of root and leaf and floral tissues Model organisms like *Drosophila melangoster, C. elegans, G. gallus, Xenopus. Arabidoposis*, etc.;

Text Books/References:

1. Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walte; 6th edition New York: Garland Science; 2008.
2. Cell and Molecular Biology-Concepts and Experiments; Gerald Karp et al. John Wiley; 8th edition; 2015.
3. Plant Development: The Cellular Basis (1990 edition) by R. F. Lyndon (PublisherSpringer)
4. Topics in Plant Physiology 3. Series editors M. Black and J. Chapman; Unwin Hyman Ltd, 1990.
5. Plant growth and Development: a molecular approach: DE. Fosket; Academic Press 1994.
6. Developmental Biology (12th Edition) by Michael J.F. Barresi and Scott F. Gilbert (Publisher- Sinauer Associates Inc; 2019)
7. Molecular Cell Biology. 4th edition. Lodish H, Berk A, Zipursky SL, et al. New York: W. H. Freeman; 2000.

Course Outcomes:

1. Basic understanding of the developmental biology of plants and animals.
2. Microscopy- Visualizing cells and tissues;
3. Gametogenesis (plants and animals), fertilization and embryogenesis,
4. Developmental embryonic stages, zygotic division, incomplete division and consequences
5. Introduction to plant fertilization, ovule and egg, and support cells
6. Model organisms like *Drosophila melangoster, C. elegans, G. gallus, Xenopus. Arabidoposis,* etc

Subject: Biostatistics

Course Category: BSC

Course Objective(s):

Biostatistics (also known as biometry) are the development and application of statistical methods to a wide range of topics in biology. It encompasses the design of biological experiments, the collection and analysis of data from those experiments and the interpretation of the results.

Course Contents:

Module: 1

Collection, Classification and Tabulation of data, Bar diagrams and Pie diagrams, Histogram, Frequency curve and frequency polygon, Ogives. Mean, median, mode, Standard deviation.

Module: 2

Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations, curve fitting, principles of least squares, Two regression lines, Karl Pearson's coefficient of correlation, Rank correlation, Tied ranks.

Module: 3

Probability theory: Random experiments, sample space, probability theory, conditional probability. Baye's theorem.

Module: 4

Random variable,(.discrete and continuous), Probability density function(discrete and continuous), Distribution function for discrete random variable. Distribution function for continuous random variable, Joint probability distribution, Conditional and marginal distribution. Mathematical expectations: Introduction, The expected value of a random variable, moments, Moment generating functions, Product moments, Conditional expectations. Standard distributions -: Uniform distribution. (Discrete and continuous).Exponential distribution Gamma distribution, Beta distribution. Binomial distribution, Poisson distribution, Normal distributions. Standard normal distributions.

Text Books/References:

1. Fundamentals of Biostatistics. by Irfan A Khan.
2. An introduction to Biostatistics. by PSS Sunder Rao.
3. Introduction to the Practice of Statistics by Moore and McCabe
4. Principles of Biostatistics. Marcello Pagano.

Course Outcomes:

1. Collection, Classification and Tabulation of data
2. Correlation and Regression analysis
3. Probability theory
4. Concept of Random variable,(.discrete and continuous),
5. Concept of Probability density function

Semester-3

MA2001 Mathematics-III

Partial Differential Equations: Basic concepts, Solution of PDE by Variable Separable method, Mathematical Modeling of one dimensional Wave equation and its solution, Classification of PDE and transformation into its Normal form, D'Alembert's solution of Wave equation, Solution of one dimensional Heat equation, Steady state flow of heat in a rectangular bar, Solution of one dimensional heat equation by Fourier Integral, Solution of two dimensional wave equation, Laplace Equation in Polar, Cylindrical and Spherical coordinates and applications. Solution of PDE by use of Laplace Transform

Complex Analysis: Complex Numbers and Functions: Basic concept, Complex functions, Derivatives, Analyticity, Cauchy Riemman equations, Exponential, Trigonometric, hyperbolic, Logarithmic functions, general powers, Complex integration: Line integral, Line Integral of independent path, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic function. Taylor's series, Maclaurin's series, Laurent's series, Expansion of functions, singularities, Residues, Residue Integration method, Evaluation of Real Integrals

Mapping: Conformal mapping and linear fractional transformation (LFT)

Text Book

1. Erwin Kryeszig, *Advanced Engineering Mathematics*, Wiley, INC, 9th Edition.

B. V. Ramanna, *Higher Engineering Mathematics*, TMH

CL2003 Chemical Engineering Thermodynamics

Introduction and Basic Concepts, First Law of Thermodynamics, P-V-T Behaviour and Heat Effects, Second Law of Thermodynamics, Some Applications of the Laws Thermodynamics, Thermodynamic Properties of Pure Fluids, Properties of Solutions, Phase Equilibria, Chemical Reaction Equilibria

Text Book

2. K. V. Narayanan, *A Textbook of Chemical Engineering Thermodynamics*, PHI
3. J. M. Smith, *Introduction to Chemical Engineering Thermodynamics*, TMH

CL2005 Chemical Process Calculation

The chemical equation & stoichiomentry, concept of limiting & excess reactants, conversion, degree of conversion, yield etc, Ideal gas laws, equation of state, Vapor pressure, Clausius-Clapeyron equation, humidity-relative saturation & percentage saturation, concept of wet & dry bulbs thermometer, use of humidity Chart, Material balances &unit operation-drying, crystallization dissolution, combustion, Solving material balance with Chemical reaction, recycle, bypass & purge Calculations, Energy balance concepts & units, Heat capacity,

Calculation of enthalpy changes without change of phase, Energy balance with Chemical reaction, Standard heat of reaction at constant, pressure & constant volume, effect of temperature, on heat of reaction, Adiabatic reaction of temperature, heat of solution & mixing

Text Book

1. B I Bhatt, M Vora, *Stoichiometry*, TMH
2. D. M. Himmelblau, *Basic Principles and Calculations in Chemical Engineering*, 6th Ed., PHI

CL2007 Transport Phenomena

Introduction to transport phenomena; molecular transport mechanisms and general properties; analogies amongst momentum, heat, and mass transport; boundary layer analysis for momentum, heat, & mass transfer; estimation of transport coefficient, non-Newtonian fluids, rheological characteristics of materials, agitation of non-Newtonian fluids. Heat & mass transfer with chemical reaction; Diffusion and chemical reaction inside a porous catalyst

Text Book

1. B. R. Bird, E. W. Stewart, N. E. Lightfoot, *Transport Phenomena*, 2nd Ed., John Wiley & Sons
2. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, 6th Ed., TMH

CL2009 Basic Solid Mechanics

Simple Stresses and Strains, Principal Stresses and Strains, Bending Moments and Shearing Forces, Bending Stresses in Beams, Combined Direct and Bending Stresses, Shearing Stresses, Fixed and Continuous Beams, Thin Shells, Torsion of Circular and Non-circular Shafts, Springs, Strain Energy and Deflection Due to Shear and Bending, Theories of Failure, Stresses Due to Rotation, Centroid and Moment of Inertia, Unsymmetrical Bending and Shear Centre

Text Book

1. S. S. Rattan, *Strength of Material*, TMH
2. R. K. Rajput, *Strength of Material*, S. Chand and Co.

Semester-4

CL2002 Materials Science and Engineering

Atomic structure and interatomic bonding; structure of crystalline solids; imperfections; diffusion; Mechanical properties of metals; dislocation; strengthening; failure; phase diagram; structure, properties, applications, processing of ceramics and polymers; composites; corrosion degradation of materials; corrosion protection; electrical, thermal, magnetic and optical properties; property requirements and material selection.

Text Book

1. V. Raghavan, *Materials Science and Engineering: A First Course*, PHI
2. William D. Callister Jr, *Materials Science and Engineering*, Wiley India (P) Ltd

CL2004 Numerical Methods in Chemical Engineering

Introduction to numerical methods: Understanding sources of errors; round-off errors, truncation errors, floating point arithmetic, Convergence, Solution of linear systems: Gauss elimination, Gauss Jordan elimination, Gauss-Seidel method, Diagonal dominance, Banded matrices, storage schemes for banded matrices, skyline solver, Solution of non-linear systems: Newton Raphson method, Local and global minimum, rates of convergence, convergence criteria, conjugate gradient method, Ordinary Differential Equations: Taylor series, Euler method, Runge-Kutta method, Finite Difference Method, Partial Differential Equations: Finite Difference Method – Laplace equation, Poison equation, 1-D heat equation, 1-D wave equation.

Text Book

1. S. C. Chapra and R. P. Canale, *Numerical Methods for Engineers*, TMH
2. P. Ahuja, Introduction to Numerical Methods in Chemical Engineering, PHI

CL2006 Process Heat Transfer

Basic modes of heat transfer. Conduction: basic equations of one-dimensional, two-dimensional and three-dimensional conduction; steady conduction in slabs, cylinders and spheres; critical thickness of insulation; transient conduction: analytical solution for slabs; use of transient temperature charts for slabs, cylinders, and spheres; lumped system of analysis. Convection: equation of motion; equation of energy; hydrodynamic and thermal boundary layers; forced convection inside tubes, over cylinders and spheres; natural convection, Empirical equations for free and forced convection; boiling and condensation heat transfer; basic types of heat exchangers; overall heat transfer coefficient; LMTD method, effectiveness-NTU method. Radiation: black body and gray body radiation; shape factor; Kirchhoff's law; Radiation shields; radiation from gases. Evaporation: evaporator capacity, economy and types; single and multiple effect evaporators, forward and backward feed evaporation, evaporator calculations.

Text Book

1. D.Q. Kern, *Process Heat Transfer*, 2nd Ed., TMH
2. B. K. Dutta, *Heat Transfer*, PHI
3. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, TMH

CL2008 Chemical Fluid Mechanics

Properties and classification of fluids; fluid statics; velocity field; stream function; irrotational flow; integral and differential analysis for fluid motion: Reynolds' transport theorem; Navier-Stoke's equation; Euler & Bernoulli's equation; dimensional analysis and similitude; internal and external fluid flow: friction factor; energy losses in fittings, valves etc.; flow measuring devices;

fluid machinery: pump, blower; agitation; introduction to non-Newtonian fluid; introduction to compressible flow.

Text Book

1. R. W. Fox and A. T. McDonald, *Introduction to Fluid Mechanics*, John Wiley & Sons
2. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, TMH
3. B. R. Bird, E. W. Stewart, and N. E. Lightfoot, *Transport Phenomena*, John Wiley & Sons

CL2012 Principles of Management

Management: Science, Theory, and Practice, Management and Society: The External Environment, Social Responsibility, and Ethics, Global, Comparative, and Quality Management Essentials of Planning and Managing by Objectives, Strategies, Policies, and Planning Premises, Decision Making, The Nature of Organizing, Entrepreneuring, and Reengineering

Text Book

1. Harold Koontz and Heinz Weihrich, *Essentials of Management*, TMH

Semester-5

CL3001 Mass Transfer Operations-I

Concepts of molecular diffusion and mass transfer coefficient; interphase mass transfer; the equilibrium stage approximation; conservation relations; reflux; constant molal overflow; batch distillation; Ponchon-Savarit and McCabe- Thiele analysis of binary distillation; introduction to multi-component distillation; equilibrium solubility of gases in liquids; counter-current multi-stage absorption; continuous contact equipment; multi-component systems; absorption with chemical reaction.

Text Book

1. R. E. Treybal, *Mass Transfer Operations*, 3rd Ed., TMH
2. B. K. Dutta, *Principles of Mass Transfer and Separation Processes*, PHI

CL3003 Chemical Reaction Engineering

Classification of chemical reactions; single, multiple, elementary and nonelementary homogeneous reactions; order and molecularity; temperature dependency; constant and variable volume batch reactor; reaction rate; rate constant; collection and interpretation of kinetic data; parallel and series reaction; batch, ideal plug flow and CSTR; temperature and pressure effects; Residence Time Distribution.

Text Book

1. O. Levenspiel, *Chemical Reaction Engineering*, 2nd Ed., Wiley Eastern
2. S. C. Roy, C. Guha, *A Text Book of Chemical Reaction Engineering*, Dhanpat Rai & Co.

Reference:

1. J. M. Smith, *Chemical Engineering Kinetics*, TMH

2. H. S. Fogler, *Elements of Chemical Reaction Engineering*, Prentice Hall

CL3005 Chemical Process Technology and Economics

Raw materials and principles of production of olefins and aromatics; typical intermediates from olefins and aromatics such as ethylene glycol, ethyl benzene, phenol, cumene and DMT, dyes, and pharmaceuticals; chemical processes based on raw materials sugar, starch, alcohol, cellulose, paper, glyceride, oils, soaps, detergents; industrial processes for the production of inorganic heavy chemicals such as acids, alkalis, salts, and fertilizers such as sulphuric, nitric, and phosphoric acids, soda ash, ammonia, etc.

Text Book

1. C. L. Dryden, *Outlines of Chemical Technology*, Affiliated East West, New Delhi
2. T. G. Austin and S. Shreve, *Chemical Process Industries*, TMH

CL3007 Process Equipment Design-I

Design of pressure vessel and vessel accessories like heads, nozzles, flanges, openings and supports; computer aided design (CAD) of heat exchanger; mechanical and fabrication aspects; Design of condenser, reboiler, and evaporator.

Text Book

1. B. C. Bhattacharyya, *Introduction to Chemical Equipment Design*, CBS Publishers & Distributors, New Delhi, 2003.
2. J. M. Coulson, J. F.Richardson and R. K. Sinnot, *Coulson and Richardson's Chemical Engineering: Chemical Engineering Design (Vol. 6)*, 3rd Ed.(Indian Print), Butterworth-Heinemann, 2004.

Semester-6

CL3002 Mass Transfer Operations-II

Simultaneous Heat and Mass Transfer; Drying: rate of drying for batch and continuous dryers; Humidification and Dehumidification: design of cooling towers; Adsorption: types and nature of adsorption, isotherm, stage wise and continuous adsorption; fixed, fluidized and moving beds; ion-exchange; Extraction: triangular diagram; Leaching: single and multistage operation, equipment for leaching; Crystallization: Millers theory, yield calculations, crystallizers; Membrane processes: liquid & gas separation processes, microfiltration, ultra-filtration, nanofiltration, reverse osmosis.

Text Book

1. R. E. Treybal, *Mass Transfer Operations*, 3rd Ed., TMH
2. B.K. Dutta, *Principles of Mass Transfer and Separation Processes*, PHI

CL3004 Process Dynamics and Control

First Principles model development; dynamics of first, second and higher order linear systems, open loop and closed loop systems; linearisation; feed back control; stability; root locus diagram; frequency response analysis; Bode stability criterion; Nyquist stability criterion; design of controller; dynamics of some complex processes; control valves and introduction to real time computer control of process equipment; cascade, feed forward, adaptive control; SISO; MIMO; A/D conversion, PLC architecture; Multi-variable control strategies.

Text Book

1. G. Stephanopoulos, *Chemical Process Control: An Introduction to Theory and Practice*, Prentice Hall of India.

References:

1. S. S. Bhagade, G. D. Nageshwar, *Process Dynamics and Control*, Prentice Hall of India.
2. D. R. Coughanowr, and L. B. Koppel, *Process systems Analysis and Control*, 2nd Ed., Mc-Graw-Hill, 1991.

CL3006 Chemical Reactor Design

Heterogeneous reaction kinetics; selectivity; heterogeneous reactors: fluid-solid catalytic fixed bed reactor design principles; isothermal, adiabatic and non-isothermal operations; gas-solid non-catalytic reactor design; fluidized bed reactors; thermal stability in reactor operation

Text Book

1. O. Levenspiel, *Chemical Reaction Engineering*, 2nd Ed., Wiley Eastern
2. S.C. Roy, S.C. Guha, *A Text Book of Chemical Reaction Engineering*, Dhanpat Rai & Co.

Reference:

1. J. M. Smith, *Chemical Engineering Kinetics*, TMH
2. H. S. Fogler, *Elements of Chemical Reaction Engineering*, Prentice Hall

CL3008 Chemical Process Modeling and Simulations

Principle of formulations, Mathematical consistency of model, Continuity equations, Componentcontinuity equations, Energy equations, Equations of motion, Transport equations, Equilibrium, Chemical Kinetics with examples, Modeling of chemical kinetics and reactor designs, Solve above developed modeling equations using polymath/matlab/c++

Text Book

1. Mickley H. S., Sherwood T. S., Reed C. E., Application of Mathematical Modeling in Chemical Engineering, Tata-McGraw-Hill
2. Lubyen W. L., Process Modeling, Simulation and Control for Chemical Engineers, McGraw-Hill, New York, 1989.
3. Kayode Coker, Modelling of Chemical Kinetics and Reactor Design, Gulf professional publication

CL3012 Process Equipment Design-II

Mechanical operations in chemical engineering, properties and storage of solids, size reduction of solids, solid-solid separation, solid-liquid separation, solid-gas separation, transportation of solids, mixing of solids, design of equipments and operational significance

Text Book

1. W. L. McCabe, J. Smith and P. Harriot, *Unit Operations of Chemical Engineering*, 6th Ed., Mc-Graw Hill
2. A. K. Swain, H. Patra, G. K. Roy, *Mechanical Operations*, Mc-Graw Hill

References:

1. Richard G. Holdich, *Fundamentals of Particle Technology*, Midland Information Technology and Publishing, 2002.
2. Martin J. Rhodes, Introduction to Particle Technology, John Wiley & Sons 2008.

Semester-8

CL4002 Computational Fluid Dynamics

Introduction to floating point arithmetic. Introduction to numerical methods for Euler and Navier-Stokes equations with emphasis on error analysis, consistency, accuracy and stability, Modified equation nalysis (dispersion vs. dissipation) and Von Neumann stability analysis, Finite difference methods, finite volume and spectral element methods, Explicit vs implicit time stepping methods, Solution of systems of linear algebraic systems, Higher-order vs higher resolution methods.Computation of turbulent flows, Compressible flows with highresolution shock-capturing methods (e.g. PPM, MUSCL, WENO), Theory of Riemann problems and weak solutions for hyperbolic equations

Text Book

1. Ferziger, J. H., Peric, M., Computational Methods for Fluid Dynamics, 3rd ed., Springer
2. Pletcher, R. H., Tannehill, J. C., Anderson, D., Computational Fluid Mechanics and Heat Tranfer, CRC Press

CL4004 Biochemical Engineering

Introduction. Microbiology: Cell structure, characterization, classification of microorganisms; environmental and industrial microbiology; cell nutrients and growth media. Chemicals of Life: Repetitive and non repetitive biological polymers, lipids, fatty acids and other related lipids, carbohydrates, mono-, di- and polysaccharides, amino acids and proteins, structure of proteins, protein denaturation and renaturation, antibodies, nucleic acids, nucleotides to RNA and DNA, DNA double helix model. Kinetics of Enzyme-Catalyzed Reactions: Chemical kinetics fundamentals, introduction to enzymes, classification of enzymes, enzymes of industrial importance, enzyme catalyzed reactions and kinetics, determination of kinetic parameters, inhibitors and inhibition kinetics, enzyme deactivation, immobilized enzyme technology.

Metabolism and Bioenergetics: Thermodynamic principles, metabolic pathways for carbohydrates, lipids and proteins; ATP, TCA cycles etc. Cell Growth and Product Formation: Growth patterns and kinetics in batch culture, models with growth inhibitors, the ideal chemostat; Stochiometry of microbial growth, theoretical prediction of yield coefficients. Bioprocess Systems: Transport phenomena in bioprocesses, mass transfer in bioreactors, solid-liquid mass transfer, power requirement, heat transfer; Various types of bioreactors, Scale-up and its difficulties; Downstream Processing: Strategies to recover and purify products Control of microorganism: Control fundamentals, antimicrobial action, control of microorganisms by physical and chemical method

Text Book

1. P. M. Duran, *Principles of Bioprocess Engineering*, Academic Press
2. M. L. Schuler and F. Kargi, *Bioprocess Engineering: Basic Concepts*, PHI

References

1. James Bailey & David Ollis, *Biochemical Engineering Fundamentals*, TMH

CL4006 Fuel Engineering

Conventional and non-conventional energy sources; solar energy; wind energy; energy from biomass; energy survey in India, Solid fuels: origin and composition of coal; analysis and properties of coal; coal classification; properties and storage of coal; coal carbonization, gasification and liquefaction. Liquid fuels: origin and composition of petroleum; petroleum processing; petroleum refining in India. Combustion process: combustion stoichiometry and combustion thermodynamics; gas burners; oil burners; coal burning equipment

Text Book

1. S. Sarkar, *Fuel & combustion*, 2nd Ed., Orient Longman
2. J. G. Speight, *Fuel Science & Technology Handbook*, Dekker

CL4008 Piping Engineering

Basics of fluid mechanics, dynamics of inviscid flows, flows with a free surface, flows through pipes, compressible flow, basics of pipe designing, applications

Text Book

1. S K Som, Gautam Biswas and S Chakraborty, *Introduction To Fluid Mechanics & Fluid Machines*, TMH
2. B. R. Bird, E. W. Stewart, and N. E. Lightfoot, *Transport Phenomena*, John Wiley & Sons

CL4012 Petroleum Refinery Engineering

Origin and occurrence, composition, classification and physico-chemical properties of petroleum; testing and uses of petroleum products; refining Processes such as distillation,

cracking, reforming; conversion of petroleum gases into motor fuel, aviation fuel; lubricating oils and petroleum waxes; chemicals and clay treatment of petroleum products, desulfurization; refining operations -Dehydration, Desalting, Gas separation, Natural gas production and gas sweetening; tube still heater design; product profile of petrochemicals; petrochemical feed stocks; olefin and aromatic hydrocarbons production; Treatment and upgrading of olefinic C4 and C5 cuts; chemicals from C1 compounds, ethylene and its derivatives, propylene and its derivatives, butadiene and butene; BTX chemicals

Text Book

1. W.L. Nelson, *Petroleum Refinery Engineering*, McGraw Hill,
2. J. H. Gary and G. E. Handwork, *Petroleum Refining Technology and Economics*, Dekker

Discipline Electives

CL3011 Basics of Polymer Science

Polymerization, Step-Reaction (Condensation) Polymerization, Radical Chain (Addition) Polymerization, Ionic and Coordination Chain (Addition) Polymerization, Copolymerization, Polymerization Conditions and Polymer Reactions, Characterization, Polymer Solutions, Measurement of Molecular Weight and Size, Analysis and Testing of Polymers, Structure and Properties, Morphology and Order in Crystalline Polymers, Rheology and the Mechanical Properties of Polymers, Polymer Structure and Physical Properties

Text Book

1. Fred W. Billmeyer, *Textbook of Polymer Science*, Weiley
2. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, *Polymer Science*, New Age International

CL3013 Interfacial Engineering

Phenomenology of colloidal materials; Brownian diffusion; long range van der Waals forces; double layer forces and short range forces; DLVO theory of stability of lyphobic colloids; electrokinetic phenomena; association colloids; interfacial tension; wetting and contact angle; capillary hydrostatics; interfacial rheology and stability; some selected applications of principles of colloid and interface science in detergents, personal products, pharmaceuticals, food, textile, paint and petroleum industries

Text Book

1. P. C. Hiemenz and R. Rajgopalan, *Principles of Colloid and Surface Chemistry*, Dekker
2. P. Ghosh, *Colloid and Interface Science*, PHI
3. Shaw Duncan J., *Introduction to Colloid and Surface Chemistry*, Butterworth-Heinemann Ltd

CL3022 Polymer Processing Technology

Properties of Commerical Polymers, Hydrocarbon Plastics and Elastomers, Other Carbon-Chain Polymers, Heterochain Thermoplastics, Thermosetting Resins, Polymer Processing, Plastics Technology, Fiber Technology, Elastomer Technology

Text Book

1. Fred W. Billmeyer, *Textbook of Polymer Science*, Weiley
2. Vasant R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, *Polymer Science*, New Age International

CL4011 Paint and Surface Coating Technology

Unit-1: Surface Chemistry and Surface Engineering

Application of surface chemistry, Interfacial tension, Free energy changes, wetting & emulsification; Chemistry & Technology of Surfactants, Introduction; Electroplating; Thermal Spray Coating; Cold Gas Dynamic Coating; Diffusion Coating; CVD & PVD; Plasma Immersion Ion implantation; DLC thin film; Sol Gel Coating; Laser Assisted Surface Engineering; Micro Arc Oxidation; Electro Spark Coating etc.

Unit-2: Chemistry & Technology of pigments

Concept of Dyes & Pigments: Lakes, Tonner, Resinated pigments, Flushed Colors, Dispersed Colors; Chemistry and Technology of Organic Pigments: Azo Pigments, Benzimidazolone dioxazines, Naphthol AS Pigments, perylenes, Phthalocyanines, Quinacridones etc. Technology & Applications of High Performance Pigments & Special Effect Pigments Types, preparation, and applications of Metallic Driers; Additives used in aqueous and non-aqueous paint systems for wetting and dispersion, Storage stability and application properties Solvents: Classification of Solvents, their characteristics, uses and application. Plasticizers: Classification, Characterization, Theory and application

Unit-3: Coating Properties & Analysis of Coating

Study of important characteristics of surface coating viz. Rheological properties, Optical Properties, Adhesion and Mechanical properties, Corrosion and Chemical resisting properties, Film thickness, Liquid Paint analysis according to ASTM, BIS and BS Standards, Characterization of Varnishes according to ASTM, BIS and BSS Standards.

Text Book

1. R. Lambourne & T.A. Stevens, Paints and surface coatings -Theory & Practice, 2nd ed., William Andrew Publishing, 1999.
2. WM Morgan, Outlines of Paint Technology, 3rd Ed, CBS Publishers & Distributors, 1996

Reference:

1. Swaraj Paul, Surface coating, 2nd ed., John Wiley & Sons Ltd, 1996
2. Surface Coatings – Raw Materials & Their Usage, OCCA-VOI I “Chapman and Hall”, NY, 1993

CL4013 Instrumental Techniques of Chemical Analysis

Unit-1: General Introduction to Spectroscopy

Define Spectroscopy, Types of spectroscopy, Absorption spectrum, Emission spectra, Wave length and Wave number, Electromagnetic radiation, visible spectrum, Stokes's shift, Hypochromicity, transmittance

Unit-2: Introduction, basic principles and instrumentation of spectroscopy

UV/visible and Infrared Spectroscopy, Flame Photometry, Atomic Absorption Spectroscopy, Raman spectroscopy and Mass Spectrometry

Unit-3: Introduction to Chromatography

Classification – Theory – distribution coefficient, rate of travel, retention time, retention volume, adjusted retention volume, specific retention volume, column capacity, separation number, peak capacity, shapes of chromatic peak, column efficiency, resolution, optimization of column performance, Chromatogram, Void volume, TLC, GC, HPLC

Texts:

1. R.M. Silverstein and W.P. Webster, spectrometric Identification of organic compounds, 6th Edition, Wiley & Sons, 1999
2. K. Sharma, Instrumental Methods of Chemical Analysis, Goel Publishing House
3. Chatwal Anand, Instrumental Methods of Chemical Analysis, 3rd Edition, Himalaya Publishing House
4. G.W. Ewing, Instrumental methods of Chemical Analysis, 5th Edition, McGraw-Hill

References:

1. Instrumental Methods of Analysis, H.H.Willard, L.L. Merritt and J.A. Dean and F. A. Settle, CBS Publishers, 7th Edition, 1988

CL4017 Extractive Metallurgy

General principles of extraction of metals from oxides and sulphides; Mineral resources of non – ferrous metals in India; their production, consumption and demand; Future of non – ferrous metal industries in India; Kinetics of leaching of ores and the effects of operation variables, Aluminium: Bayer's process and factors affecting its operation; Hall – Heroult process: principle & practices, use of electrodes, anode effect; Refining of Aluminium; Alternative methods of Alumina and Aluminium production, Copper: Roasting of sulphides; Matte smelting; Converting; Refining; By – products recovery; Recent developments; Continues copper production processes, hydrometallurgy of copper, Zinc: Pyrometallurgy of zinc; principles and practices of roasting, sintering and smelting; Hydrometallurgy of zinc.

Lead: Roasting and agglomeration of galena concentrate; Blast furnace smelting, Refining of lead bullion. Uranium: Processes for the digestion of Uranium ores; Purification of crude salts; Production of reactor grade UO2, Titanium: Methods for upgrading ilmenite; Chlorination of titania; Kroll & Hunter processes; Consolidation and refining. Other Metals: Simplified flow sheets and relevant chemical principles of extraction of Ni, Mg, Au, Be, etc.

Text Book

1. Principles of Extractive Metallurgy, H S Ray & A Ghosh, New Age International

2. Chemical Metallurgy, Chiranjib Kumar Gupta, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim

Open Electives

CL4071 Pharmaceutical Technology

Unit-1: Principles of Pharmaceutical Processing

Mixing, milling, drying, compression and consolidation of powdered solids, emulsion and suspension dosage forms, pharmaceutical rheology, clarification and filtration

Unit-2: Pharmaceutical Dosage Forms

Preformulation, tablets and tablet coatings, capsules, sustained release dosage forms, pharmaceutical suspensions, emulsions, pharmaceutical aerosols

Unit-3: Product Processing, Packaging, Evaluation, and Regulations

Pilot plant scale-up techniques, packaging materials science, kinetic principles and stability testing, drug regulatory affairs

Text Book

1. The Theory and Practise of Industrial Pharmacy by Lachman, Lieberman and Kanig

References:

1. Modern Pharmaceutics, Marcel Dekker by Banker,G.S. and C.T. Rhodes

CL4073 Nanotechnology

Unit-1: The Science of Nanotechnology Nanotechnology: Definition of nano scale with reference to biosystems, Scope (Overview of current industry applications) and future prospects (Engineering principles for nanotechnology materials and applications). Physics of nano-structure - Quantum Size effect - optical properties, Semiconductor (magnetic, organic, and doped nanoparticles), Synthesis of bio-metric materials (Quantum dot, thin film etc) – Characterization techniques - Role of surfaces in nanotechnology devices – Nano fabrication nanotubes, nano-probes – biosensor, Brownian motions and Particle diffusion, Dispersion stability, Tuning intiparticle interaction forces to generate different types of nano-structured materials, Principle of Bragg diffraction, Rheology, the science of flow (understanding mechanical properties of materials).

Unit-2: Techniques in Nanotechnology Nanomaterials: Polymers, Carbon Nanotubes, Nanowires, Nanocrystals, and Quantum Dots, Synthesis of nanomaterials, Top-down and bottom-up approach, Analytical Techniques used in nanotechnology for Particle Size characterization of nanomaterials: SEM (scanning electron microscopy), Dynamic Light Scattering (DLS), Transmission Electron Microscopy (TEM), XRay Diffraction (XRD), Atomic Force Microscopy (AFM), Spectroscopic characterization (UVVisible).

Unit-3: Properties of nanomaterials Introduction, nanochemistry including self-assembly of materials; nanoparticles, carbon nanotubes, nanocomposites; synthesis and characterization of

such materials Unit -4 Nanobiology: Introduction to nanobiology, bionanotechnology, nanobiochemistry, molecular nanotechnology, Nanosomes, Benefits of molecular nanotechnology)

Text Book

1. Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005

References:

1. C. N. R. Rao, A. Muller, A. K. Cheetham (Eds), The chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh & Co, Weinheim, 2004
2. G. Cao, Naostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.

CL4083 IPR

Unit-1: Definition of Property and various types of property: Historical development of property rights. Conceptual understanding of discovery enabled science and innovation. Basic Concepts of intellectual Property: Introduction to intellectual property rights, Intellectual property Law,

Unit-2 Various forms of IPR: Patent, Copyright, trademark, Industrial Design, Geographical indication Trade Secret General Agreement on Tariffs and Trade (GATT), Trade Related Aspects of Intellectual Property rights (TRIPS), Importance of IPR in the field of Science and Technology.

Unit -3 IPR Laws: Rights of Patent; Patent Infringement, remedies for infringement for patent rights; Indian Patent Act 1970 and TRIPS; Major changes in Indian Patent system as post TRIPS effect; Draft of National Intellectual Property Policy; 2003 and 2005 amendments Content of Patent specification and procedure for patent; (a) Obtaining patent, (b) Geographical Indication, (c) WTO, Detailed Information on Patenting Biological Products, Cartagena Protocol.

Text Book

1. Intellectual property Rights and the law .Gogia Law agency

HM4001 Personality Development

The concept of Personality: significance of personality development, Dimensions of theories of Freud & Erickson- personality, The concept of success and failure, Attitude & Motivation: importance of Positive attitude & Self-motivation; self-esteem and character-building, Time Management, Decision making skills, Promoting Creative & Critical Thinking, Employability quotient: Participating in GD & Facing Mock interviews, Psychometric Test and Analysis,

Text Books

1. Alex, K. Soft Skills: Know yourself and Know the World. S.Chand.
2. Onkar, R. M. Personality Development and Career Management. S.Chand.
3. Rizvi, A. Effective Technical Communication. TMGH.