Heritage Institute of Technology

DEPARTMENT OF CHEMICAL ENGINEERING

B.TECH. PROGRAMME IN CHEMICAL ENGINEERING

July, 2019

CURRICULUM

1st Year 1st Semester (Semester 1)

THEORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	PHYS 1001	Physics I	3	1	0	4	4
02	MATH 1101	Mathematics - I	3	1	0	4	4
03	CSEN 1001	Programming for Problem Solving	3	0	0	3	3
	Total Theory						**11**
LABORATORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	PHYS 1051	Physics I Laboratory	0	0	3	3	1.5
02	MECH 1051	Workshop/Manufacturing Practices	1	0	4	5	3
03	CSEN 1051	Programming for Problem Solving Laboratory	0	0	4	4	2
	Total Practical						**6.5**
	Semester Total						**17.5**
HONOURS							
01	ECEN 1011	Basic Electronics	3	0	0	3	3
02	ECEN 1061	Basic Electronics Engineering Laboratory	0	0	2	2	1
	Honours Total						**4**

1st Year 2nd Semester (Semester 2)

THEORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	MATH 1201	Mathematics-II	3	1	0	4	4
02	CHEM 1001	Chemistry - I	3	1	0	4	4
03	ELEC 1001	Basic Electrical Engineering	3	1	0	4	4
04	HMTS 1202	Business English	2	0	0	2	2
	Total Theory						**14**
LABORATORY/SESSIONAL							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEM 1051	Chemistry Laboratory	0	0	3	3	1.5
02	HMTS 1252	Language Laboratory	0	0	2	2	1
03	MECH 1052	Engineering Drawing & Design	1	0	4	5	3
04	ELEC 1051	Basic Electrical Engineering Laboratory	0	0	2	2	1
	Total Practical						**6.5**
	Semester Total						**20.5**
HONOURS							
01	HMTS1011	Communication for Professionals	3	0	0	3	3
02	HMTS1061	Professional Communication Laboratory	0	0	2	2	1
	Honours Total						**4**

2nd Year 1st Semester (Semester 3)

THEORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 2101	Particle & Fluid Particle Processing	3	0	0	3	3
02	CHEN 2102	Chemical Engineering Fluid Mechanics	3	0	0	3	3
03	CHEN 2103	Basics of Material & Energy Balance	3	0	0	3	3
04	MECH 2106	Mechanics for Engineers	3	0	0	3	3
05	CHEN 2104	Thermodynamics - I	3	0	0	3	3
06	BIOT 2105	Biology	2	0	0	2	2
	Total Theory						**17**
LABORATORY/SESSIONAL							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 2151	Fluid Mechanics (ChE) Laboratory	0	0	3	3	1.5
02	CHEN 2152	Particle & Fluid Particle Processing Laboratory	0	0	2	2	1
03	CHEN 2153	Instrumental Methods of Analysis Laboratory	0	0	3	3	1.5
	Total Practical						**4**
	Semester Total						**21**
HONOURS							
01	PHYS2111	Physics II	3	1	0	4	4
	Honours Total						**4**

2nd Year 2nd Semester (Semester 4)

THEORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 2201	Heat Transfer	3	0	0	3	3
02	CHEN 2202	Transport Phenomena	3	0	0	3	3
03	CHEN 2203	Thermodynamics II	3	0	0	3	3
04	CHEM 2201	Chemistry II	3	0	0	3	3
05	MECH 2201	Material Science	3	0	0	3	3
06	HMTS-2001	Human Values And Professional Ethics	3	0	0	3	3
07	EVSC 2016	Environmental Science	2	0	0	2	0
	Total Theory						**18**
LABORATORY/SESSIONAL							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 2251	Heat Transfer Laboratory	0	0	3	3	1.5
02	CHEN 2252	Programming Basics for Numerical Computation	0	0	3	3	1.5
03	CHEN 2253	Engineering Drawing Laboratory	0	0	2	2	1
	Total Practical						**4**
	Semester Total						**22**

3rd Year 1st Semester (Semester 5)

THEORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 3101	Chemical Process Technology	3	0	0	3	3
02	CHEN 3102	Chemical Reaction Engineering - I	3	0	0	3	3
03	CHEN 3103	Mass Transfer I	3	0	0	3	3
04	CHEN 3104	Numerical Methods in Chemical Engineering	3	0	0	3	3
05	CHEN 3141- 3143	Professional Elective-I	3	0	0	3	3
06	CHEN 3144- 3146	Professional Elective-II	3	0	0	3	3
	Total Theory						**18**
LABORATORY/SESSIONAL							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 3252	Numerical Computation Laboratory	0	0	3	3	1.5
02	CHEN 3152	Chemical Reaction Engineering Laboratory	0	0	3	3	1.5
03	CHEN 3153	Energy Engineering Laboratory	0	0	2	2	1
	Total Practical						**4**
	Semester Total						**22**
HONOURS							
01	CHEN 3111	Process Simulation	3	1	0	4	4
	Honours Total						**4**

Professional Elective- I	**CHEN 3141**	**CHEN 3142**	**CHEN 3143**
Subject name	Petrochemical Technology	Polymer Science	Energy Engineering
Professional Elective – II	**CHEN 3144**	**CHEN 3145**	**CHEN 3146**
Subject name	Bioprocess Engineering	Industrial Safety and Hazards Analysis	Mathematical Modeling in Chemical Engineering

3rd Year 2nd Semester (Semester 6)

THEORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 3201	Process Control and Instrumentation	3	0	0	3	3
02	CHEN 3202	Mass Transfer II	3	0	0	3	3
03	CHEN 3241- 3243	Professional Elective-III	3	0	0	3	3
04		Open Elective I	3	0	0	3	3
05	HMTS 3201	Economics for Engineers	3	0	0	3	3
06	INCO 3016	Indian Constitution	2	0	0	2	0
	Total Theory						**15**
LABORATORY/SESSIONAL							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 3251	Process Control Laboratory	0	0	2	2	1
02	CHEN 3151	Mass Transfer Laboratory	0	0	3	3	1.5
03	CHEN 3253	Process Equipment Design & Drawing Laboratory	0	0	3	3	1.5
04	CHEN 3293	Term Paper & Technical Seminar	0	0	4	4	2
	Total Practical						**6**
	Semester Total						**21**

Professional Elective – III	**CHEN 3241**	**CHEN 3242**	**CHEN 3243**
Subject name	Computational Fluid Dynamics	Reactor Design	Nanotechnology

4th Year 1st Semester (Semester 7)

THEORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 4131- 4133	Professional Elective IV	3	0	0	3	3
02	HMTS 4101	Principles of Management	3	0	0	3	3
03		Open Elective-II	3	0	0	3	3
04		Open Elective-III	3	0	0	3	3
	Total Theory						**12**
LABORATORY/SESSIONAL							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 4151	Design & Simulation Laboratory I	0	0	3	3	1.5
02	CHEN 4195	Project –I	0	0	0	7	3.5
03	CHEN 4191	Industrial Training					2
	Total Practical						**7**
	Semester Total						**19**
HONOURS							
01	CHEN4111	Industrial Process Control & Instrumentation	3	1	0	4	4
	Honours Total						**4**

Professional Elective – IV	**CHEN 4131**	**CHEN 4132**	**CHEN 4133**
Subject name	Chemical Reaction Engineering –II	Petroleum Refinery Engineering	Environmental Engineering

4th Year 2nd Semester (Semester 8)

THEORY							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 4231-4233	Professional Elective V	3	0	0	3	3
02		Open Elective-IV	3	0	0	3	3
	Total Theory						**6**
LABORATORY/SESSIONAL							
S.No	**Code**	**Course Title**	**L**	**T**	**P**	**H**	**Credit**
01	CHEN 4295	Project –II	0	0	0	17	8.5
02	CHEN 4251	Design & Simulation Laboratory II	0	0	3	3	1.5
03	CHEN 4297	Grand Viva					1
	Total Practical						**11**
	Semester Total						**17**

Professional Elective – V	**CHEN 4231**	**CHEN 4232**	**CHEN 4233**
Subject name	Project Engineering	Statistical Design of Experiments	Optimization in Chemical Engineering

Open Electives to be offered by Chemical Engineering Department for Non-departmental Students		
Semester VI Open Elective I	Materials for Engineering Applications (CHEN 3221)	Industrial Safety and Hazards (CHEN 3222)
Semester VII Open Elective II	Industrial Total Quality Management (CHEN 4121)	Industrial Pollution Control (CHEN 4122)
Semester VII Open Elective III	Statistical Methods in Design of Experiments (CHEN 4123)	Reactor Design (CHEN 4124)
Semester VIII Open Elective IV	Nanotechnology(CHEN 4221)	Introduction to Solar and Wind Technology(CHEN 4222)

Honours Courses for B.Tech Chemical Engineering Students			**Contact Hours / Week**			
Sem. No.	**Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1st	ECEN 1011	Basic Electronics	3	0	0	3
	ECEN 1061	Basic Electronics Engineering Laboratory	0	0	2	1
2nd	HMTS 1011	Communication For Professionals	3	0	0	3
	HMTS 1061	Professional Communication Laboratory	0	0	2	1
3rd	PHYS 2111	Physics II	3	1	0	4
5th	CHEN 3111	Chemical Reaction Engineering II	3	1	0	4
7th	CHEN 4111	Industrial Process Control & Instrumentation	3	1	0	4
Total Honors Credit						20

Division of Credits according to Categories	**AICTE Recommended**	**HIT CHE Credit**
Basic Sciences	27	24
Engineering Sciences	27	25
Humanities	12	12
Professional Core	55	55
Professional Elective	12	15
Open Elective	12	12
Seminar, Project, Internship etc.	12	17
Total	**157**	**160**

Division of Credits according to Categories from 3rd semester – 8th semester	**HIT CHE Credit**
Basic Sciences	5
Engineering Sciences	9
Humanities	9
Professional Core	55
Professional Elective	15
Open Elective	12
Seminar, Project, Internship etc.	17
Total	**122**

Definition of Credit (as per AICTE):

- 1 Hour Lecture (L) per Week = 1 Credit
- 1 Hour Tutorial (T) per Week = 1 Credit
- 1 Hour Practical (P) per Week = 0.5 Credits
- 2 Hours Practical (Lab) per Week = 1 Credit

Range of Credits (as per AICTE): -

- A total of 160 credits will be necessary for a student to be eligible to get B Tech degree.
- A student will be eligible to get B Tech degree with Honours if he/she completes an additional 20 credits. These could be acquired through various Honours Courses offered by the respective departments.
- A part or all of the above additional credits may also be acquired through MOOCs. Any student completing any course through MOOCs will have to submit an appropriate certificate to earn the corresponding credit.
- For any additional information, the student may contact the concerned HODs.

PART II: DETAILED SYLLABUS

Subject Name: Physics I					
Paper Code: PHYS1001					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Course Outcomes:

1. Interpret oscillations under different conditions, with the understanding of Resonance phenomena followed by calculation of Q factor.
2. Analyze the Quantum phenomenon like Black body radiation , Compton effect and origin of X-ray spectrum.
3. Understand the wave character of light through the phenomenon of interference, diffraction and polarization.
4. Study of various crystal structures and classification of different crystal planes.
5. Explain the working principle of LASER, and apply the knowledge in different lasing system and their engineering applications in holography
6. Understand the dual nature of matter, Heisenberg's uncertainty relation and it's various application.

Module I [12L]

Mechanics:

Elementary concepts of grad, divergence and curl. 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 orbit; Kepler Problem; Application : Satellite manoeuvres .
Non-inertial frames of reference; rotating coordinate system; five term acceleration formula-centripetal and coriolis accelerations; applications: Weather system, Foucault pendulum.

Module II [12 L]
Optics:
Oscillatory Motion:
Damped harmonic motion – Over damped, critically damped and lightly damped oscillators; Forced oscillation and resonance. Electrical equivalent of mechanical oscillator, Wave equation, plane wave solution.
Optics:
Elementary features of polarization of light waves. Double refraction, Production and analysis of linearly, elliptic and Circularly polarized light, Polaroid and application of polarizations.: Polarimeter.
Laser & Fiber Optics:
Characteristics of Lasers, Spontaneous and Stimulated Emission of Radiation, Meta-stable State, Population Inversion, Lasing Action, Einstein's Coefficients and Relation between them, Ruby Laser, Helium-Neon Laser, Semiconductor Diode Laser, Applications of Lasers.
Fiber optics - principle of operation, numerical aperture, acceptance angle, Single mode , graded indexed fiber.

Module III [12 L]

Electrostatics:

Electrostatics in free space

Calculation of electric field and electrostatic potential for a charge distribution, Divergence and curl of electrostatic field, Laplace's and Poisson's equation for electrostatic potential. Boundary conditions of electric field and electrostatic potential. Method of images , energy of a charge distribution and its expression in terms of electric field.

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 electrostatic problem in presence of dielectric – point charge at the centre of a dielectric sphere, charge in front of dielectric slab, Dielectric slab and dielectric sphere in uniform electric field.

Module IV [12L]

Magnetostatics :

Biot-Savart law, divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; equation for vector potential and it's solutions for given current densities .

Magnetostatics in a linear magnetic medium:

Magnetization and associated bound currents; Auxiliary magnetic field $\vec{H}$; boundary conditions on $\vec{B}$ and $\vec{H}$. Solving for magnetic field due to simple magnet like a bar magnet; Magnetic susceptibility ; ferromagnetic , paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Faraday's Law:

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.

Books of reference :

1. Optics , Eugene Hecht Pearson Education India Private Limited.
2. David J. Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited.
3. N.K. Bajaj , Waves and Oscillations .
4. David Halliday, Robert Resnick Jearl Walker , Principles of Physics, 10ed, Wiley.
5. Wayne M. Saslow, Electricity, Magnetism, and Light, Academic Press.
6. Narayan Rana, Pramod Joag, Classical mechanics, McGraw Hill Education.
7. R Takwale, P Puranik, Introduction to Classical Mechanics, McGraw Hill Education.
8. Ghatak, Optics, McGraw Hill Education India Private Limited.
9. C.L.Arora , Refresher Course in B.Sc. Physics ,Vol1 and Vol 2.

Subject Name: Mathematics I					
Paper Code: MATH 1101					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**1**	**0**	**4**	**4**

Course Outcomes:

After successfully completing this course the students will be able to:

1. Apply the concept of rank of matrices to find the solution of a system of linear simultaneous equations.
2. Develop the concept of eigen values and eigen vectors.
3. Combine the concepts of gradient, curl, divergence, directional derivatives, line integrals, surface integrals and volume integrals.
4. Analyze the nature of sequence and infinite series.
5. Choose proper method for finding solution of a specific differential equation.
6. Describe the concept of differentiation and integration for functions of several variables with their applications in vector calculus.

Module I [10L]

Matrix:

Inverse and rank of a matrix; Elementary row and column operations over a matrix; System of linear equations and its consistency; Symmetric, skew symmetric and orthogonal matrices; Determinants; Eigen values and eigen vectors; Diagonalization of matrices; Cayley Hamilton theorem; Orthogonal transformation.

Module II [10 L]

Vector Calculus:

Vector function of a scalar variable, Differentiation of a vector function, Scalar and vector point functions, Gradient of a scalar point function, divergence and curl of a vector point function, Directional derivative, Related problems on these topics.

Infinite Series:

Convergence of sequence and series; Tests for convergence: Comparison test, Cauchy's Root test, D' Alembert's Ratio test(statements and related problems on these tests), Raabe's test; Alternating series; Leibnitz's Test (statement, definition); Absolute convergence and Conditional convergence.

Module III [10 L]

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.

Ordinary differential equations of higher orders:

General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods, Method of variation of parameters, Cauchy-Euler equations.

Module IV [10L]

Calculus of functions of several variables:

Introduction to functions of several variables with examples, Knowledge of limit and continuity, Determination of partial derivatives of higher orders with examples, Homogeneous functions and Euler's theorem and related problems up to three variables.

Multiple Integration:

Concept of line integrals, Double and triple integrals. Green's Theorem, Stokes Theorem and Gauss Divergence Theorem.

Books of reference :

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2000.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. K. F. Riley, M. P. Hobson, S. J. Bence. Mathematical Methods for Physics and Engineering, Cambridge University Press, 23-Mar-2006.
6. S. L. Ross, Differential Equations", Wiley India, 1984.
7. G.F. Simmons and S.G. Krantz, Differential Equations, McGraw Hill, 2007.
8. M.R. Spiegel, Seymour Lipschutz, Dennis Spellman ,Vector Analysis(Schaum's outline series), McGraw Hill Education.
9. S. S. Sastry , Engineering Mathematics, PHI.
10. M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP), Advanced Engineering Mathematics , Indian Edition.
11. Seymour Lipschutz, Marc Lipson ,Linear Algebra (Schaum's outline series), McGraw Hill Education.

Subject Name: Programming for Problem Solving					
Paper Code: CSEN 1001					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

On completion of this course, students are expected to be capable of solving problems using mathematics and generalize those solutions into flowcharts to form programs. This course is directed towards teaching the students, how to automate those solutions by implementing them in C programming language. It is expected that due to the use of C programming language, the students will learn the basics of how a high-level language works in tandem with memory. The students should be able to identify coding inefficiencies and errors in C code and turn those programs into efficient ones and rem ve programming bugs, primarily with manual inspection and later with the use of debuggers.. After completion of this course students will be able to:

1. Understand and remember functions of the different parts of a computer.
2. Understand and remember how a high-level language (C programming language, in this course) works, different stages a program goes through.
3. Understand and remember syntax and semantics of a high-level language (C programming language, in this course).
4. Understand how code can be optimized in high-level languages.
5. Apply high-level language to automate the solution to a problem.
6. Apply high-level language to implement different solutions for the same problem and analyze why one solution is better than the other.

Learning Objectives:

Introduction to the concept of computer and computation and solving of problems using C as a programming language. Coverage of C will include basic concepts, arithmetic and logic, flow control, and data handling using arrays, structures, pointers and files.

Module I [10L]

Fundamentals of Computer:

History of Computers, Generations of Computers, Classification of Computers.

Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. Basic Concepts of Assembly language, High level language, Compiler and Assembler.

Binary & Allied number systems (decimal, octal and hexadecimal) with signed and unsigned numbers (using 1’s and 2’s complement) - their representation, conversion and arithmetic operations. Packed and unpacked BCD system, ASCII. IEEE-754 floating point representation (half- 16 bit, full- 32 bit, double- 64 bit).

Basic concepts of operating systems like MS WINDOWS, LINUX

How to write algorithms & draw flow charts.

Module II [10L]
Basic Concepts of C:
C Fundamentals:
The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements.
Operators & Expressions:
Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Standard input and output, formatted output -- printf, formatted input scanf.
Flow of Control:
Statement and blocks, if-else, switch-case, loops (while, for, do-while), break and continue, go to and labels.

Module III [10L]
Program Structures in C:
Basic of functions, function prototypes, functions returning values, functions not returning values. Storage classes - auto, external, static and register variables – comparison between them. Scope, longevity and visibility of variables.
C preprocessor (macro, header files), command line arguments.
Arrays and Pointers:
One dimensional arrays, pointers and functions – call by value and call by reference, array of arrays. Dynamic memory usage– using malloc(), calloc(), free(), realloc(). Array pointer duality. String and character arrays; C library string functions and their use.

Module IV [9L]
Data Handling in C:
User defined data types and files:
Basic of structures; structures and functions; arrays of structures.
Files – text files only, modes of operation. File related functions – fopen(), fclose(), fscanf(), fprintf(), fgets(), fputs(), fseek(), ftell().

Text Books:

1. Byron Gottfried ,Schaum’s outline of Programming with C.
2. Herbert Schildt ,Teach Yourself C.
3. E Balagurusamy, Programming in ANSI C .

Books of reference:

1. Herbert Schildt , C: The Complete Reference .
2. D.M.Ritchie, B.W. Kernighan , The C Programming Language.

Subject Name: Basic Electronics					
Paper Code: ECEN 1011					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

1. Categorize different semiconductor materials based on their energy bands and analyze the characteristics of those materials for different doping concentrations based on previous knowledge on semiconductors acquired.
2. Describe energy band of P-N Junction devices and solve problems related to P-N Junction Diode both from device and circuit perspectives.
3. Design different application specific circuits associated with diodes operating both in forward and reverse bias.
4. Analyze various biasing configurations of Bipolar Junction Transistor and categorize different biasing circuits based on stability.
5. Categorize different field-effect transistors based on their constructions, physics and working principles and solve problems associated with analog circuits based on operational amplifiers.
6. Design and implement various practical purpose electronic circuits and systems meant for both special purpose and general purpose and anlayze their performance depending on the type of required output and subsequently the applied input.

Module I [10 L]

Basic Semiconductor Physics:

Crystalline materials, Energy band theory, Conductors, Semiconductors and Insulators, Concept of Fermi Energy level, intrinsic and extrinsic semiconductors, drift and diffusion currents in semiconductor.

Diodes and Diode Circuits:

Formation of p-n junction, Energy Band diagram, forward & reverse biased configurations, V-I characteristics, load line, breakdown mechanisms, Zener Diode and its Application.

Rectifier circuits: half wave & full wave rectifiers: ripple factor, rectification efficiency.

Module II [8 L]

Bipolar Junction Transistors (BJT):

PNP & NPN BJT structures, current components in BJT, CE, CB, CC configurations, V-I Characteristics of CB & CE modes, regions of operation, Base width modulation & Early effect, thermal runaway, Concept of Biasing: DC load line, Q-point, basics of BJT amplifier operation, current amplification factors, different biasing circuits: fixed bias, collector to base bias, voltage divider bias.

Module III [9 L]

Field Effect Transistors (FET):

hannel Junction Field Effect Transistor (JFET) structure & V-I characteristics.

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): enhancement & depletion type MOSFETs (for both n & p channel devices), drain & transfer characteristics.

MOSFET as a digital switch, CMOS inverter, voltage transfer characteristic (VTC), NAND & NOR gate realization using CMOS logic.
Moore's Law, evolution of process node, state of integration (SSI, MSI, LSI, VLSI, ULSI), Classification of Integrated circuits (IC) and their applications.

Module IV [9 L]
Feedback in amplifiers :
Concept of feedback, advantages of negative feedback (qualitative), Barkhausen criteria.
Operational Amplifier:
Ideal OPAMP characteristics, OPAMP circuits: inverting and non-inverting amplifiers, Adder, Subtractor, Integrator, Differentiator, Basic Comparator.
Special Semiconductor Devices:
Light Emitting Diode (LED), Silicon Controlled Rectifier (SCR), Photodiode: Operations, characteristics & applications.

Books of reference :

1. Boylestad & Nashelsky, Electronic Devices & Circuit Theory.
2. R.A Gayakwad, Op Amps and Linear IC's, PHI.
3. D. Chattopadhyay, P. C Rakshit , Electronics Fundamentals and Applications.
4. Adel S. Sedra, Kenneth Carless Smith, Microelectronics Engineering.
5. Millman & Halkias. Integrated Electronics.
6. Salivahanan, Electronics Devices & Circuits.
7. Albert Paul Malvino, Electronic Principle.

LABORATORY

Subject Name: Physics-I lab					
Paper Code: PHYS 1051					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**3**	**3**	**1.5**

Course Outcomes:

1. To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
2. To learn the usage of electrical and optical systems for various measurements.
3. Apply the analytical techniques and graphical analysis to the experimental data.
4. Understand measurement technology, usage of new instruments and real time applications in engineering studies.
5. To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

Minimum of six experiments taking at least one from each of the following four groups :

Group 1 : Experiments in General Properties of matter

1. Determination of Young's modulus by Flexure Method.
2. Determination of bending moment and shear force of a rectangular beam of uniform cross- section.
3. Determination of modulus of rigidity of the material of a rod by static method.
4. Determination of rigidity modulus of the material of a wire by dynamic method.
5. Determination of coefficient of viscosity by Poiseulle's capillary flow method.

Group 2: Experiments in Optics

1. Determination of dispersive power of the material of a prism.
2. Determination of wavelength of light by Newton's ring method.
3. Determination of wavelength of light by Fresnel's biprism method.
4. Determination of the wavelength of a given laser source by diffraction method.

Group 3: Electricity & Magnetism experiments

1. Determination of dielectric constant of a given dielectric material.
2. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
3. Determination of the thermo-electric power at a certain temperature of the given thermocouple.
4. Determination of specific charge (e/m) of electron.

Group 4: Quantum Physics Experiments

1. Determination of Planck's constant.
2. Determination of Stefan's radiation constant.
3. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
4. Determination of Rydberg constant by studying Hydrogen/ Helium spectrum.
5. Determination of Hall co-efficient of semiconductors.

6. Determination of band gap of semiconductors.
7. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells.

Books of reference :

1. Optics – Eugene Hecht Pearson Education India Private Limited.
2. David J. Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited.
3. N.K. Bajaj , Waves and Oscillations .
4. David Halliday, Robert Resnick Jearl Walker , Principles of Physics, 10ed, Wiley.
5. Wayne M. Saslow, Electricity, Magnetism, and Light, Academic Press.
6. Narayan Rana, Pramod Joag, Classical mechanics, McGraw Hill Education.
7. R Takwale, P Puranik, Introduction to Classical Mechanics, McGraw Hill Education.
8. Ghatak, Optics, McGraw Hill Education India Private Limited.
9. C.L.Arora , Refresher Course in B.Sc. Physics ,Vol1 and Vol 2 .

Subject Name: Workshop/Manufacturing Practices					
Paper Code: MECH 1051					
Contact	**L**	**T**	**P**	**Total**	**Credit Points**
Hours Per Week	**1**	**0**	**4**	**5**	**3**

Course Outcomes:

1. Upon completion of this course
2. The students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.
3. The students will be able to fabricate components with their own hands.
4. They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
5. By assembling different components, they will be able to produce small devices of their interest.
6. The students will be able to describe different components and processes of machine tools.
7. The students will be able to apply the knowledge of welding technology and they can perform arc and gas welding to join the material.

(i) Lectures & videos: (13 hours)

Detailed contents

1. Introduction on Workshop and Safety Precautions. **(1 lecture)**

2. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods **(3 lectures)**

3. CNC machining, Additive manufacturing **(1 lecture)**

4. Fitting operations & power tools **(1 lecture)**

5. Electrical & Electronics **(1 lecture)**

6. Carpentry **(1 lecture)**

7. Plastic moulding, glass cutting **(1 lecture)**

8. Metal casting **(1 lecture)**

9. Welding (arc welding & gas welding), brazing **(2 lecture)**

10. Viva-voce **(1 lecture)**

(ii) Workshop Practice :(52 hours)[L : 0; T:0 ; P : 4 (2 credits)]

1. Machine shop **(12 hours)**

2. Fitting shop **(8 hours)**

3. Carpentry **(4 hours)**

4. Electrical & Electronics **(4 hours)**

5. Welding shop **(Arc welding 4 hrs + gas welding 4 hrs)** **(8 hours)**

6. Casting **(4 hours)**

7. Smithy **(4 hours)**

8. Plastic moulding& Glass Cutting **(4 hours)**

9. Sheet metal Shop **(4 hours)**

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Books of reference :

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 McGrawHill House, 2017.

Subject Name: Programming for Problem Solving Lab					
Paper Code: CSEN 1051					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**4**	**4**	**2**

Course Outcomes:

After completion of this course the students should be able:

1. To write simple programs relating to arithmetic and logical problems.
2. To be able to interpret, understand and debug syntax errors reported by the compiler.
3. To implement conditional branching, iteration (loops) and recursion.
4. To decompose a problem into modules (functions) and amalgamating the modules to generate a complete program.
5. To use arrays, pointers and structures effectively in writing programs.
6. To be able to create, read from and write into simple text files.

Software to be used: GNU C Compiler (GCC) with LINUX
NB: Cygwin (Windows based) may be used in place of LINUX

Topic 1: LINUX commands and LINUX based editors
Topic 2: Basic Problem Solving
Topic 3: Control Statements (if, if-else, if-elseif-else, switch-case)
Topic 4: Loops - Part I (for, while, do-while)
Topic 5: Loops - Part II
Topic 6: One Dimensional Array
Topic 7: Array of Arrays
Topic 8: Character Arrays/ Strings
Topic 9: Basics of C Functions
Topic 10: Recursive Functions
Topic 11: Pointers
Topic 12: Structures
Topic 13: File Handling

Text Books:

1. Byron Gottfried , Schaum’s outline of Programming with C .
2. Herbert Schildt , Teach Yourself C.
3. E Balagurusamy , Programming in ANSI C .

Subject Name: Basic Electronics Engineering Lab					
Paper Code: ECEN 1061					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**2**	**2**	**1**

Course Outcomes:

1. The students will correlate theory with diode behavior.
2. They will design and check rectifier operation with regulation etc.
3. Students will design different modes with BJT and FET and check the operations.
4. They will design and study adder, integrator etc. with OP-AMPs.

List of Experiments (from)

1. Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multi-meters etc.
2. Familiarization with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs in CB mode
7. Study of I-V characteristics of BJTs in CE mode
8. Study of I-V characteristics of Field Effect Transistors.
9. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
10. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
11. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and Differentiators.

1st Year 2nd Semester (Semester 2)

THEORY

Subject Name: Mathematics- II					
Paper Code: MATH 1201					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**1**	**0**	**4**	**4**

Course Outcomes:

After successfully completing this course the students will be able to:

1. Demonstrate the knowledge of probabilistic approaches to solve wide range of engineering problem.
2. Recognize probability distribution for discrete and continuous variables to quantify physical and engineering phenomenon.
3. Develop numerical techniques to obtain approximate solutions to mathematical problems where analytical solutions are not possible to evaluate.
4. Analyze certain physical problems that can be transformed in terms of graphs and trees and solving problems involving searching, sorting and such other algorithms.
5. Apply techniques of Laplace Transform and its inverse in various advanced engineering problems.
6. Interpret differential equations and reduce them to mere algebraic equations using Laplace Transform to solve easily.

Module I [10 L]

Basic Probability:

Random experiment, Sample space and events, Classical and Axiomatic definition of probability, Addition and Multiplication law of probability, Conditional probability, Bayes' Theorem, Random variables, General discussion on discrete and continuous distributions, Expectation and Variance, Examples of special distribution: Binomial and Normal Distribution.

Module II [10L]

Basic Numerical Methods:

Solution of non-linear algebraic and transcendental equations: Bisection Method, Newton-Raphson Method, Regula-Falsi Method. Solution of linear system of equations: Gauss Elimination Method, Gauss-Seidel Method, LU Factorization Method, Matrix Inversion Method. Solution of Ordinary differential equations: Euler's Method, Modified Euler's Method, Runge-Kutta Method of 4th order.

Module III [10L]

Basic Graph Theory:

Graph, Digraph, Weighted graph, Connected and disconnected graphs, Complement of a graph, Regular graph, Complete graph, Sub-graph, Walk, Path, Circuit, Euler Graph, Cut sets and cut vertices, Matrix representation of a graph, Adjacency and incidence matrices of a graph, Graph isomorphism, Bipartite graph, Dijkstra's Algorithm for shortest path problem. Definition and properties of a Tree, Binary tree and its properties, Spanning tree of a graph, Minimal spanning tree, Determination of spanning trees using BFS and DFS algorithms, Determination of minimal spanning tree using Kruskal's and Prim's algorithms.

Module IV [10L]

Laplace Transformation:

Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations. Introduction to integral transformation, Functions of exponential order, Definition and existence of Laplace Transform(LT) (statement of initial and final value theorem only), LT of elementary functions, Properties of Laplace Transformations , Evaluation of sine , cosine and exponential integrals using LT, LT of periodic and step functions, Definition and properties of inverse LT, Convolution Theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODEs with constant coefficients (initial value problem) using LT

Books of reference :

1. E.Kreyszig, Advanced Engineering Mathematics , Wiley Publications.
2. S.Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier.
3. S.S. Sastry, Introductory methods of Numerical Analysis, PHI learning.
4. D. B. West, Introduction to Graph Theory, Prentice-Hall of India.
5. B.S. Grewal, Engineering Mathematics, S. Chand & Co.

Subject Name: Chemistry 1					
Paper Code: CHEM 1001					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**1**	**0**	**4**	**4**

Course Outcomes:

The subject code CHEM1001 corresponds to chemistry theory classes for the first year B. Tech students, which is offered as Engineering Chemistry and is common for all branches of engineering subjects. The course provides basic knowledge of theory based subjects like quantum mechanics, thermodynamics, reaction dynamics, electrochemistry, structure and reactivity of molecules. The course outcomes of the subject are

1. Knowledge of understanding the operating principles and reaction involved in batteries and fuel cells and their application in automobiles as well as other sectors to reduce environmental pollution.
2. An ability to analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.for engineering applications.
3. Have knowledge of synthesizing nano materials and their applications in industry, carbon nano tube technology is used in every industry now-a-days.
4. Understanding of bulk properties and processes using thermodynamic considerations.
5. Elementary knowledge of IR, UV, NMR and X-ray spectroscopy is usable in structure elucidation and characterisation of various molecules.
6. Knowledge of electronic effect and stereochemistry for understanding mechanism of the major chemical reactions involved in synthesis of various drug molecules.

Module 1 [10L]

Atomic structure and Wave Mechanics:

Brief outline of the atomic structure, Duel character of electron, De Broglies's equation, the Heisenberg uncertainty principle, brief introduction of quantum mechanics, the Schrodinger wave equation, Hermitian operator, solution of the Schrodinger equation for particle in a one dimensional box, interpretation of the wave function Ψ, concept of atomic orbital.

Thermodynamics:

Carnot cycle, 2nd law of thermodynamics, entropy, Clausius inequality, free energy and work function, Clausius Clapeyron Equation, Chemical Potential, Activity and Activity coefficient. Gibbs Duhem Relation.

Spectroscopic Techniques & Application:

Electromagnetic spectrum: EMR interaction with matter - absorption and emission of radiation.
Principle and application of UV- visible and IR spectroscopy
Principles of NMR Spectroscopy and X-ray diffraction technique.

Module II [10L]

Chemical Bonding:

Covalent bond, VSEPR Theory, hybridization, molecular geometries, Dipole moment, Intermolecular forces, V.B. and M.O. Theory and its application in Homo and Heteronuclear diatomic molecules, Band theory of solids, Pi-molecular orbitals of ethylene and butadiene.

Periodicity:
Effective nuclear charge, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, inert pair effect.
Ionic Equilibria:
Acid Base Equilibria, Salt Hydrolysis and Henderson Equation, Buffer solutions, pH indicator, Common ion Effect, Solubility product, Fractional Precipitation .

Module III [10L]
Conductance:
Conductance of electrolytic solutions, Strong and Weak electrolytes, effect of temperature and concentration. Kohlrausch's law of independent migration of ions, transport numbers and hydration of ions. Application of conductance Acid-base and precipitation titration.
Electrochemical Cell:
Thermodynamic derivation of Nernst equation, Electrode potential and its application to predict redox reaction; Standard Hydrogen Electrode, Reference electrode, cell configuration, half cell reactions, evaluation of thermodynamic functions; Reversible and Irreversible cells; Electrochemical corrosion.
Electrochemical Energy Conversion: Primary & Secondary batteries, Fuel Cells.
Reaction dynamics:
Rate Laws, Order & Molecularity; zero, first and second order kinetics. Pseudo-unimolecular reaction, Arrhenius equation.
Mechanism and theories of reaction rates (Transition state theory, Collison theory).
Catalysis: Homogeneous catalysis (Definition, example, mechanism, kinetics).

Module IV [10L]
Stereochemistry:
Representations of 3- dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.
Structure and reactivity of Organic molecule:
Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion, free radicals, aromaticity.
Organic reactions and synthesis of drug molecule:
Introduction to reaction mechanisms involving substitution, addition, elimination and oxidation-reduction reactions. Synthesis of commonly used drug molecules.

Text Books:

1. P.W. Atkins ,Atkins' Physical Chemistry, 10th Edition.
2. I. L. Finar, Organic Chemistry, Vol-1, 6th Edition.
3. Jain & Jain, Engineering Chemistry, 16th Edition.
4. A. K. Das, Fundamental Concepts of Inorganic Chemistry, 2nd Edition.
5. Gourkrishna Dasmohapatra, Engineering Chemistry -I, 3rd Edition.

Books of reference:

1. R. P. Sarkar , General & Inorganic Chemistry.
2. P. C. Rakshit, Physical Chemistry, 7th Edition.
3. Morrison & Boyd , Organic Chemistry, 7th Edition.
4. C.N. Banwell, Fundamentals of Molecular Spectroscopy, 4th Edition.
5. G. W. Castellan, Physical Chemistry , 3rd Edition.
6. Subrata Sen Gupta, Basic Stereo chemistry of Organic Molecules, 1st Edition.

Subject Name: Basic Electrical Engineering					
Paper Code: ELEC 1001					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**1**	**0**	**4**	**4**

Course Outcomes:

After attending the course, the students will be able to

1. Analyse DC electrical circuits using KCL, KVL and network theorems like Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.
2. Analyse DC Machines; Starters and speed control of DC motors.
3. Analyse magnetic circuits.
4. Analyse single and three phase AC circuits.
5. Analyse the operation of single phase transformers.
6. Analyse the operation of three phase induction motors.

Module-I [11L]

DC Network Theorem:

Kirchhoff's laws, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Star-Delta conversion.

Electromagnetism:

Review of magnetic flux, Force on current carrying conductors, Magnetic circuit analysis, Self and Mutual inductance, B-H loop, Hysteresis and Eddy current loss, Lifting power of magnet.

Module II [10L]

AC single phase system:

Generation of alternating emf, Average value, RMS value, Form factor, Peak factor, representation of an alternating quantity by a phasor, phasor diagram, AC series, parallel and series-parallel circuits, Active power, Reactive power, Apparent power, power factor, Resonance in RLC series and parallel circuit.

Module III [11L]

Three phase system:

Generation of three-phase AC power, Balanced three phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams, power measurement by two wattmeter method.

DC Machines:

Construction, EMF equation, Principle of operation of DC generator, Open circuit characteristics, External characteristics, Principle of operation of DC motor, speed-torque characteristics of shunt and series machine, starting of DC motor, speed control of DC motor.

Module IV [10L]

Transformer:

Construction, EMF equation, no load and on load operation and their phasor diagrams, Equivalent circuit, Regulation, losses of a transformer, Open and Short circuit tests, Efficiency, Introduction to three phase transformer.

Three-phase induction motor:

Concept of rotating magnetic field, Principle of operation, Construction, Equivalent circuit and phasor diagram, torque-speed/slip characteristics.

Text Books :

1. D.P Kothari & I.J Nagrath , Basic Electrical engineering, TMH, Second Edition.
2. V.N Mittle & Arvind Mittal, Basic Electrical Engineering, TMH, Second Edition.
3. Hughes , Basic Electrical Engineering.
4. Surinder Pal Bali, Electrical Technology, Pearson Publication, Vol-I,Vol-II,
5. B.L. Theraja, A.K. Theraj ,A Text Book of Electrical Technology, S.Chand & Company, Vol. I & II.

Books of reference :

1. Vincent Del Toro ,Electrical Engineering Fundamentals, Prentice-Hall.
2. H.Cotton ,Advance Electrical Technology, Reem Publication.
3. R.A. Natarajan, P.R. Babu ,Basic Electrical Engineering, Sictech Publishers.
4. N.K. Mondal, Dhanpat Rai , Basic Electrical Engineering.
5. Nath & Chakraborti, Basic Electrical Engineering.
6. Rajendra Prasad, Fundamental of Electrical Engineering, PHI, Edition 2005.

Subject Name: Business English					
Paper Code: HMTS 1202					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**2**	**0**	**0**	**2**	**2**

Course Outcomes:

The learner will

1. Acquire competence in using English language to communicate.
2. Be aware of the four essential skills of language usage-listening,speaking, reading and writing.
3. Be adept at using various modes of written communication at work.
4. Attain the skills to face formal interview sessions.
5. Write reports according to various specifications.
6. Acquire the skill to express with brevity and clarity.

Module I

Grammar (Identifying Common Errors in Writing)

- Subject-verb agreement.
- Noun-pronoun agreement.
- Misplaced Modifiers.
- Articles.
- Prepositions.
- Redundancies.

Module II

Basic Writing Strategies

Sentence Structures

- Use of phrases and clauses in sentences.
- Creating coherence.
- Organizing principles –accuracy, clarity, brevity.
- Techniques for writing precisely.
- Different styles of writing: descriptive,narrative, expository.
- Importance of proper punctuation.

Module III

Business Communication- Scope & Importance

Writing Formal Business Letters:Form and Structure-Parts ofa Business letter, Business Letter Formats, Style and Tone, Writing strategies.

Organizational Communication: Agenda & minutes of a meeting, Notice, Memo, Circular Organizing e-mail messages, E-mail etiquette.

Job Application Letter: Responding to Advertisements and Forced Applications, Qualities of well-written Application Letters: The You-Attitude, Length, Knowledge of Job Requirement, Reader-Benefit Information, Organization, Style, Mechanics – Letter Plan: Opening Section, Middle Section, Closing Section.

Resume and CV: Difference, Content of the Resume – Formulating Career Plans: Self Analysis, Career Analysis, Job Analysis, Matching Personal Needs with Job Profile – Planning your Resume – Structuring the Resume: Chronological Resume, The Functional Resume, Combination of Chronological and Functional Resume, Content of the Resume: Heading, Career Goal or Objectives, Education, Work Experience, Summary of Job Skills/Key Qualifications, Activities, Honors and Achievements, Personal Profile, Special Interests, References.

Module IV

Writing skills

- Comprehension: Identifying the central idea, inferring the lexical and contextual meaning, comprehension passage – practice.
- Paragraph Writing: Structure of a paragraph, Construction of a paragraph, Features of a paragraph, Writing techniques/developing a paragraph.
- Précis: The Art of Condensation-some working principles and strategies. Practice sessions of writing précis of given passages.
- Essay Writing:Characteristic features of an Essay, Stages in Essay writing, Components comprising an Essay, Types of Essays-Argumentative Essay, Analytical Essay, Descriptive Essays, Expository Essays, Reflective Essays.

Books of reference :

1. Armand Matterlart and Michele Matterlart, Theories of Communication: A Short Introduction , Sage Publications Ltd.
2. Chan, Janis Fisher and Diane Lutovich, Professional Writing Skills, San Anselmo, CA: Advanced Communication Designs.
3. Hauppauge, Geffner, Andrew P. Business English, New York: Barron's Educational Series.
4. Kalia, S. & Agarwal,S. Business Communication, Wiley India Pvt. Ltd., New Delhi, 2015.
5. Mukherjee, H.S., Business Communication- Connecting at work, Oxford University Press.2nd Edition.2015.
6. Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011.

Subject Name: Communication for Professionals					
Paper Code: HMTS 1011					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

Students will be able to

1. Write business letters and reports.
2. Communicate in an official and formal environment.
3. Effectively use the various channels of communication at work place.
4. Use language as a tool to build bridges and develop interpersonal relations in multi-cultural environment.
5. Learn to articulate opinions and views with clarity.
6. Use various techniques of communication for multiple requirements of globalized workplaces.

Module I

Introduction to Linguistics:

- Introduction to Linguistics.
- Phonetics- Vowel and Consonant Sounds (Identification & Articulation).
- Word- stress, stress in connected speech.
- Intonation (Falling and Rising Tone).
- Voice Modulation.
- Accent Training.
- Vocabulary Building.
- The concept of Word Formation.
- Root words from foreign languages and their use in English.
- Acquaintance with prefixes and suffixes from foreign languages in Englishto formderivatives.
- Synonyms, Antonyms and standard abbreviations.

Module II

Communication Skills:

- Definition, nature & attributes of Communication.
- Process of Communication.
- Models or Theories of Communication.
- Types of Communication.
- Levels or Channels of Communication.
- Barriers to Communication.

Module III

Professional Writing Skills:

- Letter Writing : Importance, Types , Process, Form and Structure, Style and Tone.
- Proposal Writing: Purpose,Types of Proposals, Structure of Formal Proposals.

- Report Writing: Importance and Purpose, Types of Reports, Report Formats, Structure of Formal Reports, Writing Strategies.

Module IV

Communication skills at Workplace:

- Communication and its role in the workplace.
- Benefits of effective communication in the workplace.
- Common obstacles to effective communication.
- Approaches and Communication techniques for multiple needs at workplace: persuading, convincing, responding, resolving conflict, delivering bad news, making positive connections.
- Identify common audiences and design techniques for communicating with each audience.

Books of reference :

1 Kumar,S. &Lata, P. Communication Skills, OUP, New Delhi, 2011.

2 Rizvi,Ashraf,M. Effective Technical Communication, Mc Graw Hill Education(India) Pvt. Ltd..Chennai, 2018.

3 Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011.

LABORATORY

Subject Name: Chemistry I Lab					
Paper Code: CHEM 1051					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**3**	**3**	**1.5**

Course Outcomes:

The subject code CHEM1051 corresponds to chemistry laboratory classes for the first year B. Tech students. This course enhances the students' experience regarding handling of various chemicals along with various laboratory equipments. Hands on experiments increase the depth of knowledge that is taught in the theory classes as well as it increases research aptitude in students because they can see the direct application of theoretical knowledge in practical field. The course outcomes of the subject are

1. Knowledge to estimate the hardness of water which is required to determine the usability of water used in industries.
2. Estimation of ions like Fe^{2+}, Cu^{2+} and Cl^- present in water sample to know the composition of industrial water.
3. Study of reaction dynamics to control the speed and yield of various manufactured goods produced in polymer, metallurgical and pharmaceutical industries.
4. Handling physico-chemical instruments like viscometer, stalagmometer, pH-meter, potentiometer and conductometer.
5. Understanding the miscibility of solutes in various solvents required in paint, emulsion, biochemical and material industries.
6. Knowledge of sampling water can be employed for water treatment to prepare pollution free water.

List of Experiments:

1. Estimation of iron using $KMnO_4$: self indicator.
2. Iodometric estimation of Cu^{2+}.
3. Determination of Viscosity.
4. Determination of surface tension.
5. Adsorption of acetic acid by charcoal.
6. Potentiometric determination of redox potentials.
7. Determination of total hardness and amount of calcium and magnesium separately in a given water sample.
8. Determination of the rate constant for acid catalyzed hydrolysis of ethyl acetate.
9. Heterogeneous equilibrium (determination of partition coefficient of acetic acid in n-butanol and water mixture).
10. Conductometric titration for the determination of strength of a given HCl solution against a standard NaOH solution.
11. pH-metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
12. Determination of chloride ion in a given water sample by Argentometric method (using chromate indicator solution).

Books of reference :

1. G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis.
2. S. C. Das., Advanced Practical Chemistry.
3. P. S. Sindhu, Practicals in Physical Chemistry.

Subject Name: Language lab					
Paper Code: HMTS 1252					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**2**	**2**	**1**

Course Outcomes:

The learner will

1. Acquire the techniques to become an effective listener.
2. Acquire the skill to become an effortless speaker.
3. Organize and present information for specific audience.
4. Communicate to make a positive impact in professional and personal environment.
5. Engage in research and prepare authentic, formal, official documents.
6. Acquire reading skills for specific purpose.

Module I

Listening Skills

- Principles of Listening: Characteristics, Stages.
- Types of Listening: Passive listening, Marginal or superficiallistening, Projective Listening, Sensitive or Empathetic Listening, Active or Attentive listening.
- Guidelines for Effective Listening.
- Barriers to Effective Listening.
- Listening Comprehension.

Module II

- Interviewing
  Types of Interviews, Format for Job Interviews: One-to-one and Panel Interviews, Telephonic Interviews,Interview through video conferencing.
- Interview Preparation Techniques, Frequently Asked Questions, Answering Strategies, Dress Code, Etiquette, Questions for the Interviewer, Simulated Interviews.

Module III

- Public Speaking:TheSpeech Process: The Message, The Audience, The Speech Style, Encoding, Feedback.
- Characteristics of a good speech : content and delivery, structure of a speech
- Modes of delivery in public speaking: Impromptu, Extemporaneous, Prepared or Memorized, Manuscript.
- Conversation: Types of conversation: formal and informal, Strategies for effective conversation, Improving fluency.
- Situational conversation practice: Greetings and making introductions, Asking for information and giving instructions, agreeing and disagreeing.
- Conversational skills in the business scenario: One-to-one and Group communication, Gender and Culture Sensitivity, Etiquette, Sample Business Conversation, Telephonic Conversation.

Module IV

Presentation Skills

- Speaking from a Manuscript, Speaking from Memory, Impromptu Delivery, Extemporaneous Delivery, Analyzing the Audience, Nonverbal Dimensions of Presentation.
- Organizing the Presentation: The Message Statement, Organizing the Presentation: Organizing the Speech to Inform, The Conclusion, Supporting Your Ideas – Visual Aids: Designing and Presenting Visual Aids, Selecting the Right Medium.
- Project Team/Group Presentations.

Books of reference :

1. Carter, R. And Nunan, D. (Eds), The Cambridge guide to Teaching English to Speakers of Other Languages, CUP, 2001.
2. Edward P. Bailey, Writing and Speaking At Work: A Practical Guide for Business Communication, Prentice Hall, 3rd Ed., 2004.
3. Munter, M., Guide to Managerial Communication: Effective Business Writing and Speaking, Prentice Hall, 5th Ed., 1999.
4. Sen, S.,Mahendra,A. &Patnaik,P.,Communication and Language Skills, Cambridge University Press, 2015.
5. Locker,Kitty O. Business and Administrative Communication McGraw-Hill/ Irwin.
6. Chaney,L.andMartin,J., Intercultural Business Communication. Prentice Hall.

Subject Name: Engineering Drawing & Design					
Paper Code: MECH 1052					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**1**	**0**	**4**	**5**	**3**

Course Outcomes:

After going through the course, the students will be able

1. To understand the meaning of engineering drawing.
2. To have acquaintance with the various standards (like lines, dimensions, scale etc.) and symbols followed in engineering drawing.
3. To represent a 3-D object into 2-D drawing with the help of orthographic and isometric projections.
4. To read and understand projection drawings.
5. To draw the section view and true shape of a surface when a regular object is cut by a section plane.
6. To use engineering drawing software (CAD).

Lecture Plan [13 L]

1. Importance and principles of engineering drawing (1 L)
2. Concepts of Conic sections and Scale (1 L)
3. Introduction to concept of projection (Projections of points, lines and surfaces) (4 L)
4. Definitions of different solids and their projections (1 L)
5. Section of solids and sectional view (1 L)
6. Isometric projection (2 L)
7. Introduction to CAD (2 L)
8. Viva Voce (1 L)

Module I

Introduction to Engineering Drawing covering:

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lines, lettering & dimensioning, Conic section like Ellipse (General method only); Involute; Scales – Plain, Diagonal.

Module II

Orthographic Projections covering:

Principles of Orthographic Projections - Conventions - Projections of Points and lines inclined to both planes; Projections on Auxiliary Planes. Projection of lamina.

Module III

Projections of Regular Solids covering:

Those inclined to both the Planes- Auxiliary Views.

Module IV

Sections and Sectional Views of Right Angular Solids covering:

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**.**

Module V

Isometric Projections covering:

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 VI

Overview of Computer Graphics covering:

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 VII

Customisation & 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 VIII

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.

Module IX

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.

Books of reference:

1. Bhatt, N.D., Panchal V.M. & Ingle P.R., Elementary Engineering Drawing, Charotan Publishing House, 2014.
2. Narayana, K.L. and Kannaaiah P Engineering Graphics, TMH.
3. Lakshminarayanan, V. and Vaish Wanar, R.s Engineering Graphics , Jain Brothers.
4. Shah, M.B. & Rana B.C., Engineering Drawing and Computer Graphics, Pearson Edication, 2008.
5. Agarwal B. & Agarwal C. M., Engineering graphics, TMH Publications, 2012.

Subject Name: Basic Electrical Engineering Lab					
Paper Code: ELEC 1051					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**2**	**2**	**1**

Course Outcomes:

The students are expected to

1. Get an exposure to common electrical apparatus and their ratings.
2. Make electrical connections by wires of appropriate ratings.
3. Understand the application of common electrical measuring instruments.
4. Understand the basic characteristics of different electrical machines.

List of Experiments:

1. Characteristics of Fluorescent lamps.
2. Characteristics of Tungsten and Carbon filament lamps.
3. Verification of Thevenin's & Norton's theorem.
4. Verification of Superposition theorem.
5. Verification of Maximum Power Transfer theorem.
6. Calibration of ammeter and voltmeter.
7. Open circuit and Short circuit test of a single phase Transformer.
8. Study of R-L-C Series / Parallel circuit.
9. Starting and reversing of speed of a D.C. shunt Motor.
10. Speed control of DC shunt motor.
11. No load characteristics of D.C shunt Generators.
12. Measurement of power in a three phase circuit by two wattmeter method.

Subject Name: Professional Communication Lab					
Paper Code: HMTS 1061					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**2**	**2**	**1**

Course Outcomes:

Students will be skilled in the following areas

1. Communicate in an official and formal environment.
2. Effectively communicate in a group and engage in relevant discussion.
3. Engage in research and prepare presentations on selected topics.
4. Understand the dynamics of multicultural circumstances at workplace and act accordingly.
5. Organize content in an attempt to prepare official documents .
6. Appreciate the use of language to create beautiful expressions

Module I

Techniques for Effective Speaking.
Voice Modulation: Developing correct tone.
Using correct stress patterns: word stress, primary stress, secondary stress.
Rhythm in connected speech.

Module II

Effective Speaking and Social awareness
The Art of Speaking

- Encoding Meaning Using Nonverbal Symbols.
- How to Improve Body Language.
- Eye Communication, Facial Expression, Dress and Appearance.
- Posture and Movement, Gesture, Paralanguage.
- Encoding meaning using Verbal symbols: How words work and how to use words.
- Volume, Pace, Pitch and Pause.
- Cross-Cultural Communication : Multiple aspects/dimensions of culture.
- Challenges of cross-cultural communication.
- Improving cross-cultural communication skills at workplace.

Module III

Group Discussion: Nature and purpose

- Group Discussion:Nature and purpose.
- Characteristics of a successful Group Discussion.
- Group discussion Strategies: Getting the GD started, contributing systematically, moving the discussion along, promoting optimal participation, Handling conflict, Effecting closure.

Module IV

Professional Presentation Skills

Nature and Importance of Presentation skills.

Planning the Presentation: Define the purpose, analyze the Audience, Analyze the occasion and choose a suitable title.
Preparing the Presentation: The central idea, main ideas, collecting support material, plan visual aids, design the slides.
Organizing the Presentation: Introduction-Getting audience attention, introduce the subject, establish credibility, preview the main ideas, Body-develop the main idea, present information sequentially and logically, Conclusion-summaries, re-emphasize, focus on the purpose, provide closure.
Improving Delivery: Choosing Delivery methods, handling stage fright
Post-Presentation discussion: Handling Questions-opportunities and challenges.

Books of reference :

1. Carter, R. And Nunan, D. (Eds), The Cambridge guide to Teaching English to Speakers of Other Languages, CUP, 2001.
2. Edward P. Bailey, Writing and Speaking At Work: A Practical Guide for Business Communication, Prentice Hall, 3rd Ed., 2004.
3. Munter, M., Guide to Managerial Communication: Effective Business Writing and Speaking, Prentice Hall, 5th Ed., 1999.
4. R. Anand, Job Readiness For IT & ITES- A Placement and Career Companion, , McGraw Hill Education.2015.
5. Malhotra, A.,Campus Placements, McGraw Hill Education.2015.

2nd Year 1st Semester(Semester3)

THEORY

Subject Name: Particle and Fluid Particle Processing					
Paper Code: CHEN 2101					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

The objective of the course is to provide an elaborated concept of different unit operations that are required in an industry. After completion of the course students will be able to:

1. Calculate average particle diameters for a mixture of solid particles and select different screens according to specifications.
2. Select the type of crusher/grinder for a particular comminution operation and calculate the energy consumption.
3. Calculate drag force and terminal settling velocity for single particles.
4. Select the type of classifier required for a given operation and given a particular thickening operation, design the thickener required.
5. Calculate power consumption for an agitation operation and scale up the agitator as per the problem given.
6. Analyze filtration data and select filtration equipment based on requirements.

Module I [13 L]

Characterization of particulate solids:

particle size, shape and particle size distribution; concepts of mass-mean diameter, volume-surface-mean diameter, arithmetic-mean diameter and volume- mean diameter, specific surface area of a mixture of solid particles, measurement of specific surface area of a mixture of particles.

Screen analysis:

concept of mesh number, types of standard screens, differential and cumulative analysis, concept of cut diameter and screen efficiency; industrial screening equipment eg. stationary screens, vibratory screens, grizzlies and trammels.

Handling and storage of solids:

Operation and performance criteria of screw, belt, pipe, apron and flight conveyors, bucket elevators. Operation of pneumatic and hydraulic conveyors. Storage of solids in bins, silos and hoppers.

Module II [13 L]

Comminution (size reduction) of solids:

Different forces for comminution, laws of comminution - Rittinger's law, Kick's law, Bond's law and their validity limits, crushing efficiency and power consumption.

Primary crushing equipment: Blake jaw crusher, gyratory crusher, Taggart's law.

Secondary crushers:

Smooth and toothed roll crushers, concepts of nipping and angle of nip.

Grinders:

Operation of ball mill, critical speed of ball mil, operation of rod mill and hammer mill, applicability of these mills for different sizes of feed, vertical roller mill and attrition mill, concepts of dry and wet grinding.

Ultrafine grinders:
Colloid mill and fluid-energy mill, Close-circuit and Open-circuit size reduction.
Size enlargement:
Nucleation and growth of particles, Extrusion of solids.

Module III [13 L]
Flow of particles in fluids:
Concepts of drag, boundary layer separation, skin and form drag, drag correlations.
Gravitational settling of particles:
Concepts of terminal settling velocity, Stokes's law and Newton's law regimes of settling, free and hindered settling, Richardson-Zaki equation, use of gravitational settling for solid-fluid separation, settling tank and its design principles, spitzkasten, elutriator and rake classifier, clarification and thickening, operation of Lamelar clarifiers, Hirate thickeners, design of continuous thickener using Kynch theory.
Flow through packed bed:
Ergun and Kozeny Carman equation, Darcy's law and permeability, Blaine's apparatus.
Agitation and Mixing:
Agitation equipment, different types of agitators, flow patterns in agitation, calculation of power consumption in agitated vessels, scale up of agitated vessels using concepts of geometric, kinematic and dynamic similarity, Mixing effectiveness and mixing index, solid-solid mixing equipment.
Froth flotation:
Theory, operation, flotation agents.

Module IV [13 L]
Solid-liquid filtration:
Cake and clarifying filters, constant pressure and constant rate filtration, compressible and incompressible filter cakes, pressure drop through filter cake; Operation of plate and frame filter press, cake washing and filtration cycle; continuous filtration, operation of a rotary drum vacuum filter, filter aids and filter media; Centrifugal filtration.
Solid-gas filtration:
Bag filters and electrostatic filters - design principles.
Centrifugal separation:
Design and operation of cyclone separators and hydrocyclones.
Introduction to nanoparticles:
Properties, characterization, synthesis methods and applications.

Text Books:

1. McCabe W.L., Smith J.C. & Harriot P. Unit Operations of Chemical Engineering, McGraw-Hill, 7th edition, 2017.
2. Harker J.H., Backhurst J.R. & Richardson J.F. Coulson and Richardson’s Chemical Engineering (Volume 2), Butterworth-Heinemann, 5th edition, 2002.

Books of reference:

1. Kulkarni A.P. & Hiremath R.S. ,Mechanical Operations – Unit Operations of Chemical Engineering (Volume 1), Everest Publishing House.
2. Gavhane K.A. Unit Operations-I, Fluid Flow & Mechanical Operation, Nirali Prakashan, 2019.

Subject Name: Chemical Engineering Fluid Mechanics					
Paper Code: CHEN 2102					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

The objective of this course is to equip students with fundamental concept of fluid mechanics so that the students can develop understanding related to fluid statics as well as dynamics of fluid flow. The students will be capable to apply concepts of mass, momentum and energy conservation to various fluid flow encountered in industrial and other sectors. After completion of the course students will be able to:

1. Analyze the continuum concept of fluid and to categorize Newtonian and non-Newtonian fluids.
2. Determine force on submerged bodies and analyze working principle of manometric devices.
3. Apply continuity equation, momentum balance equation, Bernoulli's equation to solve engineering problems on fluid flow.
4. Categorize different flow measuring devices as well as fluid moving devices used in various engineering applications.
5. Determine terminal velocity and settling regime in case of motion of particles through fluids.
6. Estimate pressure drop in a packed bed and apply knowledge of fluidization in industrial applications.

Module I [13L]

Fundamental Concepts: Introduction to Fluid mechanics:

Definition of Fluid, Continuum concept of fluid, concept of Knudsen number. Shear stress field, Rheological properties of fluids.

Fluid Statics:

Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices– manometer, U-tube, inclined tube, force on submerged bodies (straight, inclined), centre of pressure.

Fluid kinematics:

Eulerian and Lagrangian approach, Streamline, pathline, timeline, streak line.

Fluid dynamics:

Velocity field, mass, volumetric flow rate, dimensionality of flow; stress field; Reynolds number —its significance, laminar, transition and turbulent flows, steady, unsteady and uniform, non-uniform flows.

Boundary layers:

Flow in boundary layers, transition length for laminar and turbulent flow, boundary layer separation.

Module II [13L]

Basic laws for a system; relation of system derivatives to the control volume ; conservation of mass; continuity equation.

Momentum balance equation:
Derivation of Equation of motion, Introduction to Navier - Stokes equation in rectangular, cylindrical coordinates and its applications, Couette flow, Introduction to rotational and irrotational flow.
Mechanical Energy equation:
Introduction to Bernoulli's equation, Euler's Equation, kinetic energy correction factor, momentum correction factor, pump work in Bernoulli's equation.
Internal incompressible viscous flow:
Velocity distribution of fluid flowing in a closed conduit – local, average, maximum velocity. Turbulent flow- universal velocity distribution laws, Reynolds stress, Prandtl's mixing length.
Head loss in different flow condition:
Hagen Poiseuille equation, Fanning's equation, friction factor, Moody's diagram, effect of roughness, friction from changes in velocity or direction.

Module III [13L]
Flow measurement:
Introduction; Orifice meter; Venturimeter;
concept of area meters:
rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flow meter.
Open channel flow:
Introduction, Flow classification, importance of Froude number, Chezy formula, Manning roughness correction, flow measurement by weirs.
Fluid moving machines:
Introduction;
Basic classification of pumps:
Non-Mechanical Pumps— acid egg, steam jet ejector, air lift pump,
Mechanical pump: Centrifugal pumps - cavitation , NPSH, basic characteristics curves for centrifugal pumps, positive displacement pumps (rotary, piston, plunger, diaphragm pumps); pump specification; parallel operation of Centrifugal pumps; system resistance curves; fan, blower and compressor.
Valves and fittings:
Pipe fittings and valves, schedule no, equivalent diameter.

Module IV [13L]
Flow past immersed bodies:
Introduction; concept of drag and lift; variation of drag coefficient with Reynolds number; stream-lined body and bluff body.
Flow through beds of solids:
Concept of sphericity; Ergun equation, modified friction factor.
Motion of particles through fluids:
Terminal velocity, criteria for settling regime.
Fluidization:
Introduction; different types of fluidization; minimum fluidization velocity; governing equation; advantages and disadvantage, industrial applications.
Introduction to compressible flow:

Concept of speed of sound, Mach number, subsonic, sonic, supersonic flow.

Text books:

1. Pritchard P.J., Fox and McDonald's Introduction to Fluid Mechanics, , John Wiley & Sons Inc., 8th edition, 2011.
2. McCabe W.L., Smith J.C. & Harriot P. Unit Operations of Chemical Engineering, McGraw-Hill, 7th edition, 2017.

Books of reference:

1. Jain A.K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, 1998.
2. Bird R.B., Stewart W.E. & Lightfoot E.N. Transport Phenomena, John Wiley & Sons, 2nd Edition, 2010.
3. Karassik I.J., Messina J. P., Cooper P. & Heald C. C. Pump Handbook, McGraw Hill, 4th Edition.
4. Singh S. Fluid Mechanics, Khanna Book Publishing, 1st Edition, 2016.
5. Som S.K., Biswas G. & Chakraborty S. Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill, 3rd Edition, 2017.

Subject Name: Basics of Material and Energy Balance					
Paper Code: CHEN 2103					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

The objective of the course will to be served as a basis for all further chemical engineering courses that are part of the curriculum. After completion of the course students will be able to:

1. Apply knowledge base to identify dimensionless numbers given a system of correlated variables.
2. Generate ability to handle elementary flow-sheeting given a specific process.
3. Identify skills to develop equations for energy and mass balance given a specific process.
4. Illustrate material and energy balance calculations without and with chemical reactions.
5. Identify recycle, bypass and purge points in a chemical process and perform calculations with them.
6. Describe equations of state and properties of gases and liquids, including phase transition.

Module I [13 L]

Introductory concepts of units, physical quantities in chemical engineering, dimensionless numbers, dimensionless groups, “basis” of calculations.

Material Balance:

Introduction, solving material balance problems without chemical reaction for industrially relevant unit operations like Evaporation, Drying, Distillation, Crystallization, Absorption, Extraction.

Module II [13 L]

Material Balance:

With chemical reaction, Concept of stoichiometry and mole balance, examples, including combustion,Material Balances with recycle, bypass and purge – examples.

Module III [13 L]

Gases,

Vapours and Liquids:

Equations of state, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring’s plot, Raoult’s law.

Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use.

Linear regression analysis of linear and nonlinear data, log and semilog plotting for nonlinear data.

Module IV [13 L]

Energy balance:

Open and closed system, heat capacity, calculation of enthalpy changes, adiabatic and isothermal process, non-adiabatic and non-isothermal process.

Energy balances with chemical reaction:

Heat of reaction, Heat of combustion, calorific value of fuel, adiabatic flame temperature.

Text Books:

1. Felder R. M. & Rousseau R. W. Elementary Principles of Chemical Processes, , John Wiley & Sons, 3rd edition, 2000.
2. Himmelblau D. M. & Riggs J. B. Basic Principles and Calculations in Chemical Engineering, , Pearson India Education Services, 8th edition, 2015.

Books of reference:

1. Bhatt B. I. & Vora S.M. Stoichiometry, , Tata McGraw Hill Publishing Company Ltd, 4th edition, 2004.
2. Hougen O. A., Watson K. M. & Ragatz R. A. Chemical Process Principles, Part-I Material & Energy Balances, , CBS Publishers & Distributors, 2nd edition, 2004.
3. Venkataramani V., Anantharaman N., Begum K.M. & Sheriffa M. Process Calculations, Prentice Hall of India, 2nd Edition, 2011.
4. Sikdar D. C. Chemical Process Calculations, Prentice Hall of India, 2013.
5. Narayanan K.V. & Lakshmikutty B. Stoichiometry and Process Calculations, PHI, 2010.

Subject Name: Mechanics for Engineers					
Paper Code: MECH 2106					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

1. After going through the course, the students will be able.
2. Understand basic concepts of vector algebra as applied to engineering mechanics.
3. Draw free body diagram of a system under equilibrium.
4. Understand friction phenomenon and calculate friction loss.
5. Understand and quantify elastic behavior of deformable bodies.
6. Know how to calculate the CG location required for design of structures.
7. Apply the principles of work-energy for analysis of dynamic systems.

Module I [10 L]

Importance of Mechanics in Engineering ; Definition of Mechanics; Concepts of particles & rigid bodies;

Vector and scalar quantities; vector algebra –definition and notation; Types of vectors – equal , equivalent , free , bound , sliding ; Addition , subtraction of vectors ; Parallelogram law , triangle law , vector polygon ; scalar multiplication of vectors ; Resolution of vectors in Cartesian co–ordinate system ; unit vector, unit co–ordinate vectors $(\hat{i}, \hat{j}, \hat{k})$; Direction cosines ; Addition/ subtraction of vectors in components form.

dot product , cross product and the application ; important vector quantities (position vector , displacement vector, velocity vector, acceleration vector, force vector);

Force, moment of a force about a point and about an axis , moment of a couple ; representation of force and moments in items of $\hat{i}, \hat{j}, \hat{k}$.Principle of transmissibility of force (sliding vector); Varignon's theorem for a system of concurrent forces with proof; Resolution of a force by its equivalent force-couple system; resultant of forces.

Module II [10 L]

Type of forces – collinear, concurrent, parallel, concentrated, distributed; active and reactive forces, different types of reaction forces; free body concept and diagram; concept and equilibrium of forces in two dimensions; equations of equilibrium; equilibrium of three concurrent forces -- lami's theorem.

concept of friction: laws of coulomb's friction; angle of friction, angle of repose, coefficient of friction -- static and kinetic.

Module III [10 L]

Distributed force system; centre of gravity; centre of mass & centroid; centroid of an arc; centroid of plane areas – triangle, circular sector, quadrilateral and composite area consisting of above figures.

Concept of simple stress and strain ; normal stress , shear stress , normal strain, shear strain; hooke's law; poisson's ratio; stress- strain diagram of ductile and brittle material; proportional

limit, elastics limit, yield point , ultimate stress, breaking point,; modulus of elasticity. Factor of safety for design calculations.

Module IV [10 L]

Introduction to dynamics: kinematics & kinetics; newton's laws of motion; law of gravitation and acceleration due to gravity; rectilinear motion of particles with uniform & non – uniform acceleration.

Plane curvilinear motion of particles: Rectangular components (projectile motion).

Principle of work & energy; principle of conservation of energy.

Text/ Books of reference:

1. Meriam J.L. & Kreige L.G. Engineering mechanics:- Statics and Dynamics, Wiley India,1998
2. Shames I.H. & Rao G.K.M. Engineering mechanics:- Statics and Dynamics, PHI, 4th Edition, 2005.
3. Timoshenko S., Young D.H., Sukumar P. & Rao J.V. Engineering mechanics, TMH, 2013.
4. Nag D. & Chanda A. Fundamentals of Engineering Mechanics, Chhaya Prakashani, 2018.

Subject Name: Thermodynamics – I					
Paper Code: CHEN 2104					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

The objective of this course is to elaborate principles and application of first and second law of thermodynamics, and phase equilibrium. After completion of the course students will be able to:

1. Apply mass and energy balances to closed and open systems.
2. Evaluate the properties of non-ideal gases.
3. Solve problems involving liquefaction, refrigeration and different power cycles.
4. Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
5. Calculate thermodynamic efficiency of a process.
6. Quantify the deviation from ideal behaviour of a system.

Module I [13 L]

Basic concept of thermodynamics:

Definition and classification of thermodynamic systems, Temperature, Pressure, Work, Energy, Heat.

Energy conservation & first law of thermodynamics; State functions; Thermodynamic Properties; Equilibrium; Phase Rule; Reversible and Irreversible process.

Energy balance for open & closed system:

Energy relation for steady flow process; Application of Steady Flow Energy Equation (SFEE) in Turbine, Compressor, Pump, Heat Exchangers, Condenser, Boilers; Isenthalpic process and Joule-Thompson Coefficient.

Module II [13 L]

Thermodynamic properties of pure substance,

P-V-T behaviour of pure substance:

diagram and P-V diagram, Critical Properties (Pc, Tc & Vc) of pure substance.

Equation of State:

Ideal gas equation of state; Virial equation of state; Virial equation of state at low to moderate pressure;

Cubic equation of state:

Two parameter cubic equation of state (Van-der-waals equation of state, Redlich-Kwong equation of state), Compressibility factor; Cubic equation in reduced form; Laws of corresponding state; Compressibility factor chart; Definition of Acentric factor and its application.

Module III [13 L]

Limitations of first law of thermodynamics; Statements of the second law; Concept of Heat engines and Heat pump; Carnot Cycle; Carnot's theorem; Concept of Entropy; Calculation of entropy change; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work; Clausius inequality.

Thermodynamic energy properties; Fundamental property relation; Maxwell relation.

Heat effects:

latent heat, sensible heat, standard heats of formation, reaction and combustion; Hess's law of constant heat summation; Effect of temperature on heat of reaction.

Module IV [13 L]

Temperature-Entropy diagram; Mollier diagram; Steam table.

Ideal Power cycle; Ideal Rankine cycle; Practical Rankine cycle; Reheat cycle; Internal combustion engine: Otto cycle; Diesel cycle.

Ideal Refrigeration cycle; Vapour Compression cycle; Absorption refrigeration cycle; Thermodynamic criteria of selecting refrigerant.

Gas Liquefaction process:

Linde and Claude liquefaction process.

Text Book:

1. Smith J.M., Van Ness H.C. & Abbott M.M., Introduction to Chemical Engineering Thermodynamics, McGraw-Hill International Edition, 7th edition, 2005.

Books of reference:

1. Nag P.K., Engineering Thermodynamics, McGraw-Hill Education (India) Private Limited, 5th edition, 2013.
2. Rao Y.V.C., Chemical Engineering Thermodynamics, University Press (India) Private limited, 1st edition, 2004.

Subject Name: Biology					
Paper Code: BIOT 2105					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**2**	**0**	**0**	**2**	**2**

Course Outcomes:

After completion of the course, the students will be able to:

1. Understand the basic structure and function of cells and cellular organelles.
2. Understand the fundamental concepts of DNA, RNA and central dogma of cells.
3. Characterize the different types of proteins, lipids and carbohydrates.
4. Analyze the mechanism of inheritance of characters through generations.
5. Understand and implement the working principles of enzymes and their applications in biological systems and industry.
6. Design and evaluate different environmental engineering projects with respect to background knowledge about bioresources, biosafety and bioremediation.

Module I [L]

Basic Cell Biology:

Prokaryotic and Eukaryotic cells, Cell theory; Cell structure and function, Cell organelles, Structure and function of DNA and RNA, Central Dogma; Genetic code and protein synthesis.

Module II [L]

Biochemistry and Cellular Aspects of Life:

Biochemistry of carbohydrates, proteins and lipids; Fermentation; Cell cycle; Basics of Mendelian Genetics.

Module III [L]

Enzymes and Industrial Applications:

Enzymes – significance, co-factors and co-enzymes, classification of enzymes; models for enzyme action; Restriction enzymes; industrial applications of enzymes.

Module IV [L]

Biodiversity and Bioengineering Innovations:

Basic concepts of environmental biosafety, bioresources, biodiversity, bioprospecting, bioremediation, biosensors; recent advances in engineering designs inspired by examples in biology.

Text Books:

1. Wiley Editorial, Biology for Engineers: As per Latest AICTE Curriculum, Wiley-India, 2018.
2. ThyagaRajan S., Selvamurugan N., Rajesh M. P., Nazeer R. A., Thilagaraj R.W., Barathi S. & Jaganathan M. K. Biology for Engineers, Tata McGraw-Hill, 2012.

Books of reference:

1. Berg J.M., Tymoczko J.L. & Stryer L. Biochemistry, W.H. Freeman and Co. Ltd., 6th Ed., 2006.
2. Weaver R. Molecular Biology, McGraw-Hill, 5th Edition, 2012.
3. Cooper J. Biosensors A Practical Approach, Bellwether Books**,** 2004.
4. Alexander M. Biodegradation and Bioremediation, Academic Press, 1994.
5. Murphy K. Janeway's Immunobiology, Garland Science, 8th edition, 2011.

Subject Name: Physics -II					
Paper Code: PHYS 2111					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**1**	**0**	**4**	**4**

Course Outcomes:

1. To understand the concept of mechanics of Quantum Particles and hence their strange behavior which ultimately imparting the knowledge of nano – science and its applications in nano technology.
2. To understand magnetic properties and magnetic behaviour of materials which will enrich the industrial use of different materials for various purposes.
3. To understand the physics behind the superconducting properties of materials and their industrial and medical usefulness.
4. understand the physics behind X-ray diffraction in crystalline structure of a material, and the different imperfection in it.
5. To understand the basic difference between the atomic structure of an isolated atom and atoms in solids differ and accordingly assures the electrical and thermal properties of solids.
6. To study the energy band formation in solids and the behavior of electron and hole in the bands.

Module I [12L]

Quantum Mechanics:

Group velocity and Phase Velocity, Heisenberg's Uncertainty Relation and its application, Wave function and its physical interpretation, Postulates of Quantum Mechanics, Schrodinger time dependent and time independent equation , Operator formalism, commutation ,expectation value.

Application of Quantum Mechanics:

Concept of free state and bound state, finite and infinite potential , step potential, Rectangular barrier potential, Square well, One dimensional potential well of finite and infinite depth. Quantum confinement.

Module II [12L]

Magnetic Properties of Solids:

Magnetic Properties of Atoms: Para- and Dia-Magnetism, Basic Definitions of types of Magnetism, Hund's Rules, Coupling of Electrons in Atoms to an External Field, Free Spin (Curie or Langevin) Paramagnetism, Larmor Diamagnetism, Spontaneous Order: Antiferro-, Ferri-, and Ferro-Magnetism Macroscopic Effects in Ferromagnets: Domains, Hysteresis in Ferromagnets,

Super Conductivity:

Introduction (experimental survey). General properties of super conductivity. Effect of magnetic field. Meissner effect . Explanation in view of wave mechanical property. Hard and soft superconductors. Thermal properties of superconductor. London equations and penetration depth.

Module III [12L]

Crystal Physics:

Review of Symmetries in solid, Two dimensional and three dimensional Bravias lattices, Millers indices; X-ray Diffraction: Brags law, Laue's equation. Reciprocal lattice, Concept of Brillion Zone, Ewald construction, Structure factor, Imperfections due to point defects, Energy of formation of vacancy, number of vacancies at any temperature, equilibrium concentration of of Schottky and Frenkel defects in ionic crystal , Colour center, Exciton.

Module IV [12L]

Physics of Solids:

Bonding energy of ionic crystal, Vibrations of monoatomic linear lattice, One dimensional diatomic lattice, Concept of phonons, Inelastic scattering of photons and phonons, Einstein and Debye theory of specific heat.

Band Theory of Solids:

Fermi Dirac distribution and its application in metal and semiconductor. Bloch theorem. Kronig-Penny model (qualitative treatment). Origin of energy band formation in solids. Classification of materials into conductors, Semi conductors & Insulators. Concept of effective mass of an electron and hole.

Text/ Books of reference:

1. Ghoshal S.N. Atomic Physics (Volume 1), S Chand & Company, 2010.
2. Ashcroft N.W. & Mermin N. Solid State Physics, Brooks/Cole, 1976.
3. Kittel C. Introduction to Solid State Physics, Wiley, 2019.
4. Dekker A.J. Solid State Physics, Macmillan, 1969.

LABORATORY

Subject Name: Fluid Mechanics (ChE) Laboratory					
Paper Code: CHEN 2151					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**3**	**3**	**1.5**

Course Outcomes:

The objective of this course is to impart working knowledge and develop skills of the students in fluid mechanics through bridging between the theoretical concepts and working practices for attaining the competency in practical applications or for working in the industry and conducting research & development activities. After completion of the course students will be able to:

1. Predict the energy losses, economic factors and maintenance aspects in the design, installation and operations of fluid flow systems for efficient transportation of mass & energy by studying the flow characteristics namely, turbulent, laminar and transition flow of different fluids.
2. Identify the requirements of various types of devices for quantitative measurement of fluid flow in open channel (rivers,/dams etc) and in closed channel(pipe flow etc) efficiently and economically.
3. Analyze the pump characteristics relating to best efficiency of the pump, power consumption, head developed by the pump for a given flow rate.
4. Design and install pumping system to demonstrate occurrence of cavitation in the system and also to take a practical measure to avoid cavitation during fluid flow and ultimately develop skills and expertise in designing the most efficient fluid transportation system including pump & the piping.
5. Construct and design packed bed and fluidized bed chemical reactors for various types of chemical processes and unit operations with a given pressure drop and various flow rates of the fluid or vice-versa.
6. Describe the concept of packed bed or fluidized bed operations practically for physical processes such as coating granular metal surfaces with various other desirable materials by normal fluidisation technique and separation of oil from water by reverse fluidisation technique etc.

Experiments to be performed:

1. Determination of coefficient of discharge at various Reynolds number during fully developed fluid flow through orificemeter.
2. Determination of coefficient of discharge at various Reynolds number during fully developed fluid flow through venturimeter.
3. Determination of loss coefficient of pitot tube and construction of fully developed velocity profile through pipe in laminar and turbulent flow regime.
4. Measurement of open channel flow and determination of coefficient of discharge V-notch and rectangular notch.
5. Determination of pressure drop for flow through packed bed and verification of Ergun equation.
6. Determination of characteristic curve of a centrifugal pump.
7. Experiments on Reynolds apparatus for determination of flow regime and construction of fanning’s friction factor vs Reynolds number plot.

8. Determination of pressure drop and bed height profile with varying modified Reynolds number during flow through a fluidized bed & determination of incipient fluidization.
9. Calibration of rotameter.
10. Assembling of pipe line and fitting according to a given layout.

Text Books:

1. P Pritchard P.J. Fox and McDonald's Introduction to Fluid Mechanics, John Wiley & Sons Inc., 8th edition, 2011.
2. McCabe W.L., Smith J.C. & Harriot P. Unit Operations of Chemical Engineering, McGraw-Hill, 7th edition, 2017.
3. Harker J.H., Backhurst J.R. & Richardson J.F. Coulson and Richardson's Chemical Engineering (Volume 2), Butterworth-Heinemann, 5th edition, 2002.

Books of reference:

1. Jain A.K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, 1998.
2. Bird R.B., Stewart W.E. & Lightfoot E.N. Transport Phenomena, John Wiley & Sons, 2nd Edition, 2010.

Subject Name: Particle & Fluid-Particle Processing Laboratory					
Paper Code: CHEN 2152					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**2**	**2**	**1**

Course Outcomes:

The objective of this course is to provide a hands-on idea on the mechanical devices that are essential in handling the material and it's processing in different chemical engineering related downstream applications. After completion of this course students will be able to:

1. Identify mechanical instruments required for particles processing before downstream applications.
2. Describe the working principle of the mechanical instruments required for particles processing.
3. Solve the experimental problems related to particles' processing applications.
4. Generate real life data from the experiments.
5. Analyze the outcome of the experiment on the basis of theoretical knowledge they had acquired.
6. Conclude on the troubleshooting required after analyzing the experimental outcomes.

Experiments to be performed:

1. Sieve Analysis: To analyze a given powder for its particle size distribution. / Cumulative and Differential methods of particle size distributions.
2. Overall Screen Effectiveness: To find out screen efficiency through a suitable material balance with respect to a single screen.
3. Jaw Crusher: To find out the reduction ratio and capacity and to verify Rittinger's law.
4. Ball Mill: To determine the reduction ratio, capacity and the critical speed of the ball mill.
5. Rod Mill: To determine the reduction ratio and capacity and compare the reduction ratio for the same feed sample to that in a ball mill.
6. Hammer Mill: To find out the reduction ratio and capacity.
7. Batch sedimentation: To determine the settling and sedimentation characteristics of given slurry.
8. Filtration: To determine the specific cake resistance and filter medium resistance in the given plate and frame filtration.
9. Elutriator: To study the sorting of a given mixture in an elutriator.
10. Cyclone Separator: Demonstration of the operation of a cyclone separator and determination of its overall collection efficiency.

Text Books:

1. McCabe W.L., Smith J.C. & Harriot P. Unit Operations in Chemical Engineering, McGraw-Hill, 7th Edition, 2004.
2. Harker J.H., Backhurst J.R. & Richardson J.F. Chemical Engineering - Volume 2, Butterworth-Heinemann, 5th Edition, 2002.

Books of reference:

1. Badger W.L., Banchero J.T. & Bancheo J.T. Introduction to Chemical Engineering, McGraw Hill, 1955.
2. Narayanan C.M. & Bhattacharya B.C. Mechanical Operations for Chemical Engineers, Khanna Publications, 2014.

Subject Name: Instrumental Methods of Analysis Laboratory					
Paper Code: CHEN 2152					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**3**	**3**	**1.5**

Course Outcomes:

1. Given a sample of turbid water, students will be able to plot calibration curve (NTU vs. concentration) from samples of known turbidity and determine the turbidity of the unknown sample using Nephelo Turbidimeter.
2. Given a sample of pure protein, students will be able to plot calibration curve (Absorbance vs. concentration) using a spectrophotometer by Folin's Method.
3. Given a sample of ferric ion solution, students will be able to plot calibration curve (Absorbance vs. concentration) from samples of known Fe^{3+} concentration and determine the Fe^{3+} concentration of the unknown sample using a Colorimeter.
4. Given a sample of water, students will be able to determine he dissolved Oxygen concentration using a DO meter.
5. Given a sample of ethanol-water mixture, students will be able to plot calibration curve (RI vs. concentration) from samples of known ethanol concentration and determine the Ethanol concentration of the unknown sample using Abbe Refractometer
6. Given a sample of dextrose-water solution, students will be able to plot calibration curve (Specific Rotation vs. concentration) from samples of known dextrose concentration and determine the dextrose concentration of the unknown sample using a Polarimeter.

Experiments to be performed:

1. Determination of Turbidity of Water using Nephelo Turbidimeter.
2. Construction of standard curve (Absorbance vs. concentration) of a pure protein by Folin's Method using Spectrophotometer.
3. Determination of Fe^{3+} in a solution by Colorimeter Method.
4. Determination of Dissolved Oxygen in water by DO Meter.
5. Estimation of Ethanol concentration in a mixture of Ethanol & Water by Abbe Refractometer.
6. Determination of concentration of any optically active substance in presence of nonactive species by a Polarimeter.
7. Determination of TDS of water sample by Conductivity Meter.
8. Demonstration of analysis of gas mixtures by Gas Chromatography.

Text/ Book of reference:

1. Dash D.C. Analytical Chemistry, PHI, 2nd Edition, 2017

2nd Year 2nd Semester(Semester4)

THEORY

Subject Name: Heat Transfer					
Paper Code: CHEN 2201					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

The objective of this course is to understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries. After completion of the course students will be able to:

1. Describe basic knowledge of the heat transfer.
2. Justify the practical importance and relevance of energy transfer and its conservation in chemical industry.
3. Categorize the technological methods related to heat transfer in process plant.
4. Identify a detailed overview of heat transfer equipment and problems associated at preliminary stage of design.
5. Construct a bridge between theoretical and practical concept used in industry.
6. Analyze basic heat transfer processes and identify modes.

Module I [13L]

Introduction to basic modes of heat transfer and their application in chemical process,

Heat transfer by conduction:

Fourier law, thermal conductivity, thermal resistance; general heat conduction equation, thermal diffusivity; steady state heat conduction with heat generation for plane wall, cylindrical body and spherical body;

Conduction-convection system:

Critical insulation thickness of curved surface, steady state heat conduction through fin, fin efficiency, unsteady state heat conduction in solid with large thermal conductivity, significance of Biot no and Fourier no, transient heat conduction in solid.

Module II [13L]

Convective heat transfer without phase change:

Newton-Rikhman law, local and average heat transfer coefficient, Reynold-Colburn analogy, concept of individual heat transfer coefficient and overall heat transfer coefficient, LMTD, empirical correlation for heat transfer coefficient in forced convection; elementary concept of thermal boundary layer, temperature distribution in laminar flow, analysis of free convection and correlation of free convection, Grashof number.

Module III [13L]

Heat transfer with phase change:

Film-wise and drop-wise condensation, laminar film condensation on vertical plate, Nusselt equation; analysis of heat transfer during boiling, different boiling regimes during pool boiling. Characteristics of radiation, properties of radiating surface,

Black body radiation:

Plank’s distribution law,

Total emissive power:

Stefan-Boltzman law, use of radiation function table; Wien's displacement law; Kirchoff's law; emissivity of black body, gray body and real body;

Radiation between surfaces:

View factor, Electrical network approach for radiation heat exchange, radiation shields and their application, radiation heat exchange for three radiating surfaces; radiation heat transfer through absorbing emitting medium.

Module IV [13l]

Heat exchangers and their classification,

Performance analysis of heat exchanger:

Fouling factor, LMTD correction factor, effectiveness and NTU of heat exchangers, sizing and rating problems of heat exchangers, construction details of shell and tube heat exchanger, Shell and Tube heat exchanger design, elementary note on heat exchanger network.

Evaporators and their classification, capacity and steam economy, Boiling Point Elevation (BPE), material and energy balance of single effect evaporator, classification of multiple effect evaporator, design of single effect and multiple effect evaporator.

Text Books:

1. Kern D. Q. Process Heat Transfer, Tata McGraw-Hill, 1997.
2. Dutta B. K. Heat Transfer Principles and Application, PHI Learning Pvt. Ltd., 2015.
3. McCabe W.L., Smith J.C. & Harriot P. Unit Operations of Chemical Engineering, McGraw-Hill, 7th edition, 2017.

Books of reference:

1. Ozisik M. N. Heat Transfer: A Basic Approach, McGraw-Hill International Edition, Singapore, 1984.
2. Sikdar D.C. Process Heat Transfer & Chemical Equipment Design, Khanna Publishing House, 1st Edition, 2018.

Subject Name: Transport Phenomena					
Paper Code: CHEN 2202					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

The objective of this course is to provide an idea about the unified approach on the analysis of momentum, mass and energy transport process across the boundary of the system. The students will learn:

1. The students will be able to identify the inherent analogy between different property transport processes.
2. The students will be able to describe the concept of momentum transport for different flow geometry.
3. The students will be able to describe the concept of mass transport for different flow geometry.
4. The students will be able to describe the concept of energy transport for different flow geometry.
5. The students will be able to solve the flow problems relating all three different transport processes.
6. The students will be able to describe the concept of boundary layer and analyze the flow problem based on the comparative survey on the boundary layer thickness.

Module I [13 L]

Understanding of unified approach in transport phenomena for momentum, mass and energy transport; Fundamental variables and units used in describing a transport process; Concept of closed and open system; Concept of nondimensional form of the basic transport equation and dimensionless number; Concept of diffusion and convection mechanism; Idea on tensor and vector approach in describing a transport process; Understanding of thermodynamic equilibrium and transport process; Concept of different steady state condition (steady state and quasi-steady state condition) and its importance in analyzing transport process; Role of intermolecular forces (and potential) in quantification of system intrinsic properties for transport process.

Module II [13L]

Description of Newtonian and Non-Newtonian fluid; Newton's law of motion; Concept of momentum diffusivity; Basic idea on Lennard-Jones potential (from collision theory) to understand viscosity of gas with low density; Pressure and temperature dependence of viscosity; Tensor form for momentum transport; Shell momentum balance and boundary condition; Equation of Continuity in rectangular (Cartesian) coordinate system; Development of Navier-Stokes equation in rectangular (Cartesian) coordinate system; Concept of Euler's equation of motion; Concept of laminar and turbulent flow; Velocity profile prediction for (a) falling film (b) flow in a circular tube (c) flow through annulus (d) flow of two adjacent immiscible fluids; Coutte flow; Creeping flow and Drag force; Boundary Layer over a flat plate; Determination of boundary layer thickness and average flow velocity determination.

Module III [13L]

Fourier law of heat conduction; Temperature and pressure dependence of thermal conductivity; Shell energy balance and boundary condition; Development of convection-diffusion energy equation; Concept of thermal diffusivity; Heat conduction through laminar flow when (a) heat conduction with an electrical heat source (b) heat conduction with a nuclear heat source (c) heat conduction with a viscous heat source (d) heat conduction with a viscous heat source (e) heat conduction through composite wall (f) heat conduction in cooling fin; Unsteady heat conduction for semi-infinite and finite slab – Solution for temperature profile using similarity solution; Concept of thermal boundary layer; Relation establishment between thermal and momentum boundary layer thickness using Von-Karman integral method; Forced convective heating of a fluid flowing through a circular tube at laminar condition; Laminar free convection of fluid flowing between two parallel plates at two different temperatures.

Module IV [13L]

Fick's law of diffusion; Temperature and pressure dependence of diffusivity; Shell energy balance and boundary condition; Development of convection-diffusion equation for mass transport; Equation of continuity for a multicomponent mixture in rectangular (Cartesian) coordinate system; Evaluation of concentration profile for diffusion (a) through a stagnant gas film (b) with heterogeneous chemical reaction (c) with homogeneous chemical reaction (d) during gas absorption in a falling liquid film (e) during solid dissolution in a falling liquid film; Unsteady heat conduction for semi-infinite and finite slab – Solution for concentration profile using similarity solution; Concept of thermal boundary layer; Relation establishment between thermal and momentum boundary layer thickness using Von-Karman integral method; Concept of analogy between momentum, heat and mass transport; Derivation of Reynold's analogy; Coulburn Analogy and its benefits over Reynold's analogy.

Text Book:

1. Bird R.B., Stewart W.E. & Lightfoot E.N. Transport Phenomena, Wiley, 2nd Edition, 2006.

Books of reference:

1. Brodkey R.S. & Herskey H.C. Transport Phenomena, McGraw- Hill, 1988.
2. Geankoplis C.J. Transport Processes and Unit Operations, Prentice Hall of India, 3rd Edition, 1993.
3. Roy S.C. & Guha C. Introduction to Transport Phenomenon, Dhanpat Rai & Co., 2014.

Subject Name: Thermodynamics II					
Paper Code: CHEN 2203					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

To introduce the concepts of fugacity, activity coefficient, vapour -liquid equilibrium, reaction equilibrium, and introduction to molecular thermodynamics. After completion of the course students will be able to:

1. Ability to understand the basic knowledge that allows the students to solve problems relating fugacity of pure components as well as in mixture.
2. Ability to utilize the concept of chemical potential as criterion of phase equilibrium.
3. Ability to use concept of partial molar properties in solution thermodynamics.
4. Ability to understand the basic knowledge that allows the students to solve problems on equilibria of different phases involving no chemical reaction.
5. Ability to understand the basic knowledge that allows the students to solve problems on chemical reaction equilibrium.
6. Ability to differentiate the basic thermodynamics approach to irreversible and reversible processes in chemical engineering practice.

Module I [13L]

Review of first and second law of thermodynamics:

First law for closed and open systems (steady and unsteady), entropy and second law, principle of maximum entropy.

Thermodynamic property of pure substances and mixture:

Residual properties, fugacity and fugacity coefficient/in solution, relation between fugacity coefficient and compressibility factor , chemical potential, chemical potential as criterion of phase equilibrium, free energy and chemical potential, excess properties, numerical problems.

Module II [13L]

Solution thermodynamics:

Concept of partial molar properties, Gibbs- Duhem equation, fundamental excess property relation, evaluation of partial properties, property change on mixing,

Vapour –liquid equilibrium:

Phase rule, simple models for VLE, VLE by modified Raoult's law, VLE from K- value correlations, Numerical problems.

Module III [13L]

Application of Solution thermodynamics:

liquid phase properties from VLE data,

Non-ideal VLE:

Models for excess Gibbs free energy, UNIFAC and UNIQUAC models, property changes of mixing, heat effect of mixing processes, liquid- liquids equilibrium, solid liquid equilibrium, vapour-liquid-liquid equilibrium, solid-vapour equilibrium, numerical problems.

Module IV [13L]

Chemical reaction equilibrium:

Reaction coordinate, equilibrium criterion, equilibrium constant, effect of temperature on equilibrium constant, evaluation of equilibrium constant, equilibrium conversion of single reaction, multi reaction equilibria, numerical problems.

Introduction to molecular thermodynamic:

Postulates; microcanonical, canonical and grand canonical ensembles; non-interacting examples. Partition function, second virial coefficients from potential functions, internal energy of ideal gases- microscopic view, thermodynamic and statistical mechanics.

Text Book:

1. Smith J.M., Van Ness H.C. & Abbott M.M. Introduction to Chemical Engineering Thermodynamics, McGraw-Hill International Edition, 7th. Edition, 2005.

Books of reference:

1. Sandler S. Chemical, Biochemical and Engineering Thermodynamics, Wiley, 5th. Edition, 2017.
2. Kyle B.G. Chemical Process Thermodynamics, Prentice Hall of India Pvt.Ltd., New Delhi, 2nd Edition., 2000.
3. Narayanan K.V. A Text Book Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd, 2013.
4. Rao Y.V.C. Chemical Engineering Thermodynamics, University Press (India) Ltd. Reprint, 2004.

Subject Name: Chemistry II					
Paper Code: CHEM 2201					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

1. Students will have a firm knowledge in the advances of inorganic, organic and physical chemistry. They will get an understanding of the theoretical principles underlying molecular structure, bonding and properties.
2. Knowledge of understanding the quantum mechanics makes students to learn illustrative case studies that organize molecular modeling for designing of reactors and derivation of thermo-chemical functions.
3. Ability to identify and formulate different types of complexes can be of further use in dye and pigment industry. Organometallic chemistry will provide clear idea on transition metal catalysis which has wide industrial and biological applications.
4. Understanding of the role of transition metal in living cell will be introduced through the knowledge of bioinorganic chemistry has tremendous scope in future research.
5. Knowledge in the fundamental concepts of structure and reactivity of alicyclic and acyclic organic molecules has important applications in pharmaceuticals industries and natural product synthesis.
6. Studies on adsorption isotherms can develop the concept of heterogeneous catalysis widely applied in oil refinery and petroleum industry.

Module I [9L]

Introduction to Quantum Theory for Chemical Systems:

Schrodinger equation, applications to Hydrogen atom, atomic orbitals, many electron atoms.

Kinetic Theory of Gases:

Maxwell distribution law, kinetic energy distribution, equipartition principle.

Colloids:

Introduction, classification of colloids, size and shape, preparation of sols, origin of charge in colloidal particles, stability of colloids, kinetic, optical & electrical properties, electrokinetic phenomena, electrical double layer, applications of colloids.

Module II [9L]

Basic Idea of Coordination Chemistry:

IUPAC nomenclature of coordination complexes (up to two metal centres), idea of coordination number and isomerism in coordination compounds.

Properties of Coordination Compounds:

Effective atomic number, elementary crystal field theory: splitting of d^n configurations in octahedral, and tetrahedral fields, crystal field stabilization energy (CFSE) in weak and strong fields; pairing energy. spectrochemical series. Jahn-Teller distortion, magnetism and colour: orbital and spin magnetic moments, d-d transitions, charge transfer spectra.

Organometallic Chemistry:

Definition and classification of organometallic compounds on the basis of bond type, 18-electron Rule, applications of 18-electron rule to metal carbonyls, nitrosyls, cyanides. Zeise's salt: Preparation, structure, evidences of synergic effect.

Module III [9L]

Acyclic System:

Conformation of alkanes, halogeno-alkanes, stability, intra-molecular hydrogen bonding, optical activity, racemic mixture and their resolution.

Alicyclic Compounds:

Concept of I-strain, ring-size and ease of cyclisation, characteristics of chair conformation, conformation of cyclohexane, mono and di substituted cyclohexane, considering steric and stereoelectronic requirements reactivity of cyclohexane towards elimination, nucleophilic substitution, rearrangements.

Strategies for Synthesis of Organic Compounds:

(a) Substitution at sp^3 centre: mechanisms, relative rates & stereochemical features, role of crown ethers and phase transfer catalysts, (b) Elimination reactions: formation of alkenes and alkynes.

Module IV [9L]

Bio-inorganic Chemistry:

(a) Elements of life, essential trace and ultra trace elements in biological systems, role of metal ions in biological systems. (b) Toxic effects of metal ions and detoxification by chelation therapy (BAL, Unithiol, D-penicillamine, triethylene tetramene, ferrichrome, desferrioxamine B, EDTA), (c) Active site structure and basic function of O_2 uptake proteins-haemoglobin and myoglobin and electron transport proteins-Ferredoxins.

Adsorption:

Introduction, Gibb's adsorption equation, Surface Excess, adsorption isotherms-Langmuir, BET adsorption equations, surface Films, Langmuir Balance, two dimensional equation of state.

Reactivity of organic molecules:

(a) Kinetic vs. thermodynamic control of organic reactions, (b) Reactions involving molecular rearrangement, mechanism with evidence and stereochemical features for rearrangement to electron-deficient carbon, aromatic rearrangements, and rearrangement reactions by green approach.

Text Books:

1. Castellan G.W. Physical Chemistry, Narosa, 2004.
2. Finar I.L. Organic Chemistry, Vol I & II, Pearson Education, 6th Edition, 2002.
3. Morrison R.T., Boyd R.N. & Bhattacharjee S.K. Organic Chemistry , PHI/Pearson Education, 7th Edition, 2010.
4. Rakshit P. C. Physical Chemistry, Sarat Book House, 7th Edition, 2014.
5. Nasipuri D. Stereochemistry of Organic Compounds, New age international (P) limited, 3rd Edition, 2018.
6. Gupta S.S. Basic Stereochemistry of Organic Molecules, Oxford Higher Education, 1st Edition, 2014.

7. Huheey J. E., Keiter E. A. & Keiter R. L. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education, 4th Edition, 1997.
8. Cotton F.A., Wilkinson G. & Gaus P.L. Basic Inorganic Chemistry, Wiley, 3rd Edition, 1994.

Books of reference:

1. Atkins P. W. Physical Chemistry, Oxford, 9th Edition, 2009.
2. Kapoor K. L. A Text book of Physical Chemistry, Macmillan, 1999.
3. Sykes P. A guide Book to Mechanism in Organic Chemistry, Pearson Education, 6th Edition, 2003.
4. Loudon G.M. Organic Chemistry, Oxford University Press, 4th Edition, 2008.
5. Sarkar R. General Inorganic Chemistry (Vol-II), New Central Book Agency, 3rd edition 2011.

Subject Name: Material Science					
Paper Code: MECH 2201					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

The objective of this course is to impart basic knowledge and provide strong foundation to the learners on the processing, structural aspects, properties and functional applications of traditional and advance materials of the modern day. After completion of this course students will be able to:

1. Construct materials into numerous valuable products/devices.
2. Design research and development works for futuristic smart materials.
3. Solve industrial problems and inspire for achieving success in higher studies and employment in industries.
4. Identify different metal extraction processes from their ores.
5. Describe solid phase behavior from phase equilibrium study.
6. Construct ideas on the crystalline and optoelectronic properties of material.

Module I [13L]

Structure of materials:

Various types of bonds; Crystalline Structure of Solids- concepts of unit cell and space lattice, packing factor; Classification of materials, Selection of materials.

Mechanism of plastic deformation, slip and twinning,

Structural imperfections:

Elementary concepts of point, line, surface & volume imperfections; Influence of dislocations/Line imperfections on the mechanical properties of materials**;** Strain hardening and recrystallisation; Elementary aspects of creep, fatigue fracture.

Module II [13 L]

X-ray diffraction for determining crystal structure;

Mechanical properties:

Strength, hardness, toughness, ductility, brittleness of Engineering Materials**;** Elastic, Anelastic and visco-elastic behaviour of materials; Electrical, Electronic, Magnetic, Optical & Optoelectronic properties of material; Inorganic & organic amorphous materials and their structural & property characteristics; Optical fibers.

Phase Diagrams:

Solidification and structure of metals, Grain boundaries; Phase equilibrium and phase diagrams of binary alloys; Phase diagram of ternary systems; Iron-Carbon diagram;

Heat Treatment:

Introduction and purposes of heat treatment; T-T-T diagram; Corrosion-Concepts and forms of corrosion; Corrosion Mechanism and prevention; Protective materials and coating.

Module III [13 L]

Basic principles of metal extraction:

Pyrometallurgy: Smelting, calcinations, roasting— oxidizing, predominance area diagrams, multiple hearth, flash and fluo-solid, sintering, smelting, slag and its classification.

Iron making in Blast furnace,

Steelmaking process flow diagram:

Steel making (oxygen blown converter –LD) – Secondary steel making / refining (ladle processing, vacuum degassing, ladle furnace processing) – Continuous casting – with emphasis on application of the concepts of physicochemical principles involved, moving/packed bed reactor, gas-liquid two-phase flow, heat transfer with phase change (solidification).

Module IV [13 L]

Principles of Hydrometallurgy and Electrometallurgy,

Extraction of Aluminum:

Hall-Heroult process, Electrolytic refining, Pyro & Hydro metallurgical extraction of copper & Zinc; Extraction of Lead, Nickel, Titanium, Recent advances on nanomaterials.

Text Books:

1. Raghavan V. Material Science and Engineering, Prentice-Hall of India Pvt. Ltd., 5th Edition, 2004.
2. Ray H.S., Sridhar R. & Abraham K.P. Extraction of nonferrous metal, Affiliated East-West Press Pvt. Limited, 2008.
3. Callister W.D. Jr & Rethwisch D.G. Material Science and Engineering: An Introduction, John Wiley & Sons, 8th Edition, 2010.
4. Smith W.F., Hashemi J. & Prakash R. Material Science and Engineering, McGraw Hill Education, 5th Edition, 2017.

Books of reference:

1. Vlack L.H.V. Elements of Material Science and Engineering, Addison-Wesley Educational Publishers Inc., 1980.
2. Lakhtin Y. & Weinstein N. Engineering Physical Metallurgy, MIR Publishers, Moscow, 1975.
3. Bogdandy L.V. & Engell H.J. The Reduction of Iron Ores, Springer-Verlag, New York, 1971.
4. Guthrie R.I.L. Engineering in Process Metallurgy, Oxford University Press, 1992.

Subject Name: Human Values And Professional Ethics					
Paper Code: HMTS 2001					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**3**	**0**	**0**	**3**	**3**

Course Outcomes:

The student will

1. be aware of the value system and the importance of following such values at workplace.
2. learn to apply ethical theories in the decision making process.
3. follow the ethical code of conduct as formulated by institutions and organizations.
4. Implement the principles governing work ethics.
5. Develop strategies to implement the principles of sustainable model of development.
6. Implement ecological ethics wherever relevant and also develop eco-friendly technology.

Module I [9L]

Human society and the Value System**,**

Values: Definition, Importance and application.

Formation of Values:

The process of Socialization, Self and the integrated personality,Morality, courage, integrity .

Types of Values:

Social Values:

Justice, Rule of Law, Democracy, Indian Constitution, Secularism .

Aesthetic Values:

Perception and appreciation of beauty.

Organizational Values:

Employee:

Employer- rights, relationships, obligations .

Psychological Values:

Integrated personality and mental health.

Spiritual Values &their role in our everyday life, Value Spectrum for a Good Life, meaning of Good Life ,Value Crisis in Contemporary Society;Value crisis at - Individual Level , Societal Level, Cultural Level; Value Crisis management - Strategies and Case Studies.

Module II [9L]

Ethics and Ethical Values, Principles and theories of ethics, Consequential and non-consequential ethics, Egotism, Utilitarianism, Kant's theory and other non-consequential perspectives, Ethics of care, justice and fairness, rights and duties, Ethics-Standardization, Codification, Acceptance, Application .

Types of Ethics:

Ethics of rights and Duties, Ethics of Responsibility, Ethics and Moral judgment, Ethics of care, Ethics of justice and fairness, Work ethics and quality of life at work, Professional Ethics.

Ethics in Engineering Profession:

Moral issues and dilemmas, moral autonomy(types of inquiry), Kohlberg's theory, Giligan's theory(consensus and controversy), Code of Professional Ethics Sample Code of ethics like

ASME, ASCE. IEEE,Institute of Engineers,Indian Institute of materials management, Institute of Electronics and telecommunication engineers.
Violation of Code of Ethics-conflict, causes and consequences.
Engineering as social experimentation, engineers as responsible experimenters (computer ethics, weapons development).
Engineers as managers, consulting engineers, engineers as experts, witnesses and advisors, moral leadership.
Conflict between business demands and professional ideals, social and ethical responsibilities of technologies.

Whistle Blowing:

Facts, contexts, justifications and case studies, Ethics and Industrial Law.

Institutionalizing Ethics:

Relevance, Application, Digression and Consequences.

Module III [9L]

Science, Technology and Engineering.
Science, Technology and Engineering as knowledge and profession-Definition, Nature, Social function and Practical application of science, Rapid Industrial Growth and its Consequences.

Renewable and Non- renewable Resources:

Definition and varieties, Energy Crisis, Industry and Industrialization, Man and Machine interaction, Impact of assembly line and automation ,Technology assessment and Impact analysis Industrial hazards and safety, Safety regulations and safety engineering, Safety responsibilities and rights, Safety and risk, risk benefit analysis and reducing risk.

Technology Transfer:

Definition and Types, The Indian Context.

Module IV [9L]

Environment and Eco- friendly Technology , Human Development and Environment, Ecological Ethics/Environment ethics.

Depletion of Natural Resources:

Environmental degradation, Pollution and Pollution Control.

Eco-friendly Technology:

Implementation, impact and assessment.

Sustainable Development:

Definition and Concept, Strategies for sustainable development, **Sustainable Development:**
The Modern Trends, Appropriate technology movement by Schumacher and later development , Reports of Club of Rome.

Text/ Books of reference:

1. Tripathi A.N. Human Values, New Age International, 2006.
2. Ritzer G. Classical Sociological Theory, The McGraw Hill Companies, 6th Edition, 2010.
3. Doshi S.L. Postmodern Perspectives on Indian Society, Rawat Publications, 2008.
4. Bhatnagar, D.K. Sustainable Development, Cyber Tech Publications, 2008.
5. Kurzwell R. The age of Spiritual Machines, Penguin Books, 1999.

6. Weinberg S.K. Social Problems in Modern Urban Society, Prentice Hall,Inc., 2nd Edition, 1970.
7. Giddens A. Sociology, Polity Press, 6th Edition, 2009.

Subject Name: Environmental Science					
Paper Code: EVSC 2016					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**2**	**0**	**0**	**2**	**0**

Course Outcomes:

The subject code EVSC2016 corresponds to basic environmental chemistry for the 2nd year B.Tech students, which is offered as Environmental Sciences and is mandatory for all branches of engineering. The course provides basic knowledge of various environmental pollutions as well as its impact and ways to curb it. The course outcomes of the subject are

1. Understand the natural environment and its relationships with human activities.
2. Characterize and analyze human impacts on the environment.
3. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems.
4. Educate engineers who can work in a multi-disciplinary environment to anticipate and address evolving challenges of the 21st century.
5. Understand and implement scientific research strategies, including collection, management, evaluation, and interpretation of environmental data.
6. Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Module I [6L]

Socio Environmental Impact:

Basic ideas of environment and its component.

Population growth:

Exponential and logistic; resources; sustainable development.

Concept of green chemistry, green catalyst, green solvents.

Environmental disaster and social issue, environmental impact assessment, environmental audit, environmental laws and protection act of India.

Module II [6L]

Air Pollution:

Structures of the atmosphere, global temperature models.

Green house effect, global warming; acid rain: causes, effects and control.

Lapse rate and atmospheric stability; pollutants and contaminants; smog; depletion of ozone layer; standards and control measures of air pollution.

Module III [6L]

Water Pollution:

Hydrosphere;

Pollutants of water:

Origin and effects; oxygen demanding waste; thermal pollution; pesticides; salts. Biochemical effects of heavy metals; eutrophication: source, effect and control.

Water quality parameters:

DO, BOD, COD.

Water treatment:
Surface water and waste water.

Module IV [6L]
Land Pollution:
Sources and control;
Solid waste:
Classification, recovery, recycling, treatment and disposal.
Noise Pollution:
Noise: definition and classification; noise frequency, noise pressure, noise intensity, loudness of noise, noise threshold limit value; noise pollution effects and control.

Text Books:

1. Mahapatra G.K.D. Basic Environmental Engineering and Elementary Biology, Vikas Publishing House P. Ltd., 1st Edition, 2011.
2. De A.K. Environmental Chemistry, New Age International, 2003.
3. Das A.K. & Das M. Environmental Chemistry with Green Chemistry, Books and Allied P. Ltd.

Books of reference:

1. Santra S. C. Environmental Science, New Central Book Agency P. Ltd, 3rd Edition, 2011.
2. De D. & De D. Fundamentals of Environment & Ecology, S. Chand & Company Ltd., 2010.

LABORATORY

Subject Name: Heat Transfer Laboratory					
Paper Code: CHEN 2251					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**3**	**3**	**1.5**

Course Outcomes:

The objective of this course is to provide the practical exposure to the students regarding the application of various heat transfer phenomenon and correlations in various engineering processes. Hands on experience will enable them to analyze working principles of various heat transfer devices including heat exchangers, condensers. After completion of this course students will be able to:

1. Identify different modes of heat transfer and basic laws of heat transfer.
2. Analyze problems involving steady state heat conduction and develop solutions for transient heat conduction in simple geometries.
3. Identify the fundamentals of convective heat transfer process.
4. Evaluate the heat transfer coefficients for forced convection inside duct.
5. Analyze radiation heat transfer between black body surfaces.
6. Analyze heat exchanger/ condenser performance.

Experiments to be performed:

1. Determination of thermal conductivity of a metal bar using Fourier's heat conduction equation.
2. Estimation of heat loss through a lagged pipe and determination of thermal conductivity of insulating material.
3. Determination of heat transfer coefficient of air during heat transfer by forced convection and to study the effect of air velocities on heat transfer coefficient.
4. Determination of overall heat transfer coefficient in a counter current / parallel flow double pipe heat exchanger and to study the effect of fluid flow rate on overall heat transfer coefficient.
5. Determination of overall heat transfer coefficient and efficiency of a shell and tube heat exchanger and to study the effect of fluid flow rate on overall heat transfer coefficient.
6. Determination of Stefan Boltzmann constant experimentally.
7. Determination of Biot number for a conductive convective system and validation of lumped system assumption.
8. Determination of heat transfer co-efficient in film-wise & drop-wise condensation.
9. Determination of emissivity of a given radiating surface by applying Kirchhoff’s law of thermal radiation.

Text Books:

1. Kern D. Q. Process Heat Transfer, Tata McGraw-Hill, 1997.
2. Dutta B. K. Heat Transfer Principles and Application, PHI Learning Pvt. Ltd., 2015.
3. McCabe W.L., Smith J.C. & Harriot P. Unit Operations of Chemical Engineering, McGraw-Hill, 7th edition, 2017.

Book of reference:

1. Ozisik M. N. Heat Transfer: A Basic Approach, McGraw-Hill International Edition, Singapore, 1984.

Subject Name: Programming Basics for Numerical Computation					
Paper Code: CHEN 2252					
Contact Hours	**L**	**T**	**P**	**Total**	**Credit Points**
Per Week	**0**	**0**	**3**	**3**	**1.5**

Course Outcomes:

The objective of this course is to build up the basic knowledge on the programming skill with MATLAB/OCTAVE in order to solve mathematical model relating any chemical engineering process. After completion of the course students will be able to:

1. Generate the algorithm to solve a simple mathematical problem.
2. Formulate the logic required to solve the problem.
3. Generate code for the implementation of the algorithm with the knowledge of the logic required.
4. Read data from formatted input file for further processing of it through written code.
5. Execute loops, functions comparison operations.
6. Analyze the output of the program by representing the output in graphical format.

Programmes to be performed using MATLAB/OCTAVE:

1. Introduction to MATLAB/OCTAVE interface. Execution of statements from command lines, data input for scalars, 1D and 2D arrays, extract elements of arrays, evaluate array size.
2. Write and execute programs through .m file (editor file). Call in-built functions in MATLAB/OCTAVE.
3. Concept of loops (for, while and do-while), “break” and “continue” statement.
4. Usage of comparison operators and conditional statements (if, else and elseif).
5. Write a program to find out the adjoint and transpose of a 2D array.
6. Write a program to find out the determinant and inverse of a 2D array.
7. Write a program to check whether a matrix is diagonally dominant or not?
8. Write a program to plot the variation of y w.r.t. x for a differential equation $\frac{dy}{dx} = \exp(-x)$ using Euler’s method. Given at y(0)=1.

Text Books:

1. Pratap R. Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers, Oxford, 2010.
2. Nagar S. Introduction to Octave: For Engineers and Scientists, Apress, 1st Edition, 2017.

Books of reference:

1. Attaway S. Matlab: A Practical Introduction to Programming and Problem Solving, Butterworth-Heinemann, 3rd Edition, 2013.
2. Nakamura S. GNU Octave Primer for Beginners, Create space Independent Publishing Platform, 2nd Edition, 2016.

Subject Name: Engineering Drawing Laboratory					
Paper Code: CHEN 2253					
Contact Hours Per Week	**L**	**T**	**P**	**Total**	**Credit Points**
	0	**0**	**2**	**2**	**1**

Course Outcomes:

The objective of the course is to provide an elaborated concept of engineering drawing and idea on the relevant software for engineering drawing. After completion of the course students will be able to:

1. Student will be able to understand basics of engineering drawing.
2. Student will be able to draw different angular projection view of engineering equipment.
3. Students will be able to draw isometric projection view of engineering equipment.
4. Students will be able to draw cut-section view of engineering equipment.
5. Students will be able to use AutoCAD software for developing engineering drawing layouts.
6. Students will be able to prepare a virtual 3-D representation of an engineering equipment.

Problems to be solved:

1. Introduction to AUTOCAD software for drawing in 2D: Drawing and editing commands. Knowledge of setting up layers, dimensioning, hatching, making block, plotting and printing, working with external reference file.
2. Drawing any three of the following item using AUTOCAD software.
3. Flange coupling for shaft and vessel or pipe.
4. Pipe joints and fittings, single line and double line pipe line assembly.
5. Stuffing box.
6. Detailed cut section drawing of Globe valve and Stop valve.
7. Piping and instrumentation diagram of any given chemical process.

Assembly drawing of a single stirred jacketed pressure vessel with all its accessories using AUTOCAD software.4.Introduction to AUTOCAD software for drawing in 3D: Working in 3-dimensions, Drawing and editing commands, viewing 3D objects, basic solid and wireframe models, extruding, simple revolved objects. Generation of orthographic projections from 3D drawing.

Books of reference:

1. Venugopal K., Engineering Drawing and Graphics + AutoCAD, New Age International (P) Limited, Fourth edition, 2001.
2. Agarwal B. & Agarwal C.M., Engineering Drawing, McGraw Hill Education (India) Private Limited, 2nd Edition, 2014.
3. Lockhart S., Tutorial Guide to AutoCAD 2016, SDC Publication, 2016.