JNTUH COLLEGE OF ENGINEERING HYDERABAD
(AUTONOMOUS)
B.TECH. FOUR YEAR DEGREE COURSE
(METALLURGICAL ENGINEERING)
COURSE STRUCTURE

I YEAR **I SEMESTER**

Sl.No.	Course Code	Course Title	L	T	P	Credits
1	BSC	Matrix Algebra and Calculus	3	1	0	4
2	BSC	Engineering Physics	3	1	0	4
3	ESC	Programming for Problem Solving	3	0	0	3
4	ESC	Engineering Graphics	1	0	3	2.5
5	BSC -LC	Engineering Physics Lab	0	0	3	1.5
6	ESC -LC	Programming for Problem Solving Lab	0	0	3	1.5
7	MC	Induction program	2	0	0	0
		Total Credits				**16.5**

I YEAR **II SEMESTER**

Sl.No.	Course Code	Course Title	L	T	P	Credits
1	BSC	Applied and Multivariable Calculus	3	1	0	4
2	BSC	Engineering Chemistry	3	1	0	4
3	ESC	Classical Mechanics	3	1	0	4
4	HSMC	English	2	0	0	2
5	BSC -LC	Engineering Chemistry Lab	0	0	2	1
6	ESC-L	Engineering Work Shop Practice	0	0	3	1.5
7	HSMC-LC	English Language and Communication Skills Lab	0	0	2	1
8	ESC	Applied Python Programming Lab	0	1	2	2
		Total Credits				**19.5**

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II YEAR **I SEMESTER**

S.No.	Course Code	Course Title	L	T	P	Credits
1	BSC	Probability Distributions and Complex Variables	3	1	0	4
2	ESC	Basic Electrical Engineering	3	0	0	3
3	PCC - 1	Mineral Dressing	4	0	0	4
4	PCC - 2	Metallurgical Analysis	3	0	0	3
5	PCC - 3	Thermodynamics and Kinetics	3	1	0	4
6	ESC – Lab 3	Basic Electrical Engineering Lab	0	0	2	1
7	PCC - Lab 1	Mineral Dressing Lab	0	0	2	1
8	PCC - Lab 2	Metallurgical Analysis Lab	0	0	2	1
9	*MC	Environmental Science	2	0	0	0
		Total Credits				**21**

II YEAR **II SEMESTER**

S.No.	Course Code	Course Title	L	T	P	Credits
1	HSMC	Economics and Financial Analysis	3	0	0	3
2	PCC - 4	Physical Metallurgy	3	1	0	4
3	PCC - 5	Principles of Extractive Metallurgy	3	1	0	4
4	PCC - 6	Metallurgical Thermodynamics	3	1	0	4
5	PCC - 7	Fuels, Furnaces and Refractories	3	0	0	3
6	PCC- Lab 4	Physical Metallurgy Lab	0	0	2	1
7	PCC- Lab 5	Principles of Extractive Metallurgy Lab	0	0	2	1
8	PCC- Lab 6	Fuels, Furnaces and Refractories Lab	0	0	2	1
9	*MC	Constitution of India	2	0	0	0
		Total Credits				**21**

Note:* MC- Mandatory Course (Non credit course)

JNTUH COLLEGE OF ENGINEERING HYDERABAD

(AUTONOMOUS)

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(METALLURGICAL ENGINEERING)

COURSE STRUCTURE

III YEAR **I SEMESTER**

S.No.	Course Code	Course Title	L	T	P	Credits
1	HSMC	Management Fundamentals for Engineers	3	0	0	3
2	PCC - 8	Heat Treatment and Phase Transformations	3	1	0	4
3	PCC - 9	Mechanical Metallurgy	3	1	0	4
4	PCC -10	Metal Casting	3	1	0	4
5	PEC - 1	Professional Elective – I	3	0	0	3
6	PCC- Lab 7	Heat Treatment and Phase Transformations Lab	0	0	3	1.5
7	PCC- Lab 8	Mechanical Metallurgy lab	0	0	3	1.5
8	PCC- Lab 9	Metal Casting Lab	0	0	2	1
9	*MC	Introduction to Artificial Intelligence	2	0	0	0
		Total Credits				**22**

III YEAR **II SEMESTER**

S.No.	Course Code	Course Title	L	T	P	Credits
1	OEC - I	Open Elective - I	3	0	0	3
2	PCC – 11	Non Ferrous Extractive Metallurgy	4	0	0	4
3	PCC – 12	Metal Forming	3	1	0	4
4	PCC – 13	Iron Making and Steel Making Technology	4	0	0	4
5	PEC - 2	Professional Elective – II	3	0	0	3
6	HSMC Lab10	Advanced English Communication Skills Lab	0	0	2	1
7	PCC- Lab 11	Metal Forming Lab	0	0	3	1.5
8	PCC- Lab12	Metal Joining Lab	0	0	3	1.5
9	*MC	Introduction to Cyber security	2	0	0	0
		Total Credits				**22**

Note: * MC - Mandatory Course (Non credit course)

During Summer Vacation between III and IV Years: Industry Oriented Mini Project

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IV YEAR **I SEMESTER**

S.No.	Course Code	Course Title	L	T	P	Credits
1	ESC	Introduction to Instrumentation	2	0	0	2
2	OEC - II	Open Elective – II	3	0	0	3
3	PCC - 14	Environmental Degradation of Materials	3	0	0	3
4	PEC - 3	Professional Elective – III	3	0	0	3
5	PEC - 4	Professional Elective – IV	3	0	0	3
6	PCC- Lab 13	Environmental Degradation and Protection Lab	0	0	2	1
7		SEMINAR	0	0	2	1
8		MINI PROJECT	-	-	4	2
9	UG	Project Stage - I	0	0	6	3
		Total Credits				**21**

IV YEAR II SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1	OEC - III	Open Elective – III	3	0	0	3
2	PEC - 5	Professional Elective – V	3	0	0	3
3	PEC - 6	Professional Elective – VI	3	0	0	3
4	PROJ	Project Stage - II	0	0	16	8
		Total Credits				**17**

Professional Elective - I

1. Ceramics and Composite Materials
2. Computational Materials Engineering
3. Ferro Alloy technology

Professional Elective - II

1. Metal Joining
2. Non Metallic Materials
3. Electronic Materials

Professional Elective - III

1. Light Metals & Alloys
2. Fatigue and Fracture Mechanics
3. Failure Analysis

Professional Elective - IV

1. Surface Engineering
2. Nano Materials
3. Non Destructive Testing

Professional Elective - V

1. Materials Characterization Techniques
2. Nuclear Metallurgy
3. Functional Materials

Professional Elective - VI

1. Powder Metallurgy
2. Bio Materials
3. Transport Phenomena

Open Elective – I:

1. Metallurgy for Non Metallurgists

Open Elective – II:

1. Testing of Materials

Open Elective - III:

1. Alloy Steels

Matrix Algebra and Calculus

I Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-requisites: Mathematical Knowledge of 12th / Intermediate level

Course Objectives: To learn

1. Types of matrices and their properties.
2. Concept of a rank of the matrix and applying this concept to know the consistency and solving the system of linear equations.
3. Concept of Eigenvalues and Eigenvectors and to reduce the quadratic form to canonical form.
4. Methods of solving the differential equations of first and higher order.
5. Geometrical approach to the mean value theorems and their application to the mathematical problems.
6. Evaluation of surface areas and volumes of revolutions of curves.
7. Evaluation of improper integrals using Beta and Gamma functions.

UNIT-I: Matrices

Rank of a matrix: Echelon form, Normal form, system of linear equations: solving system of Homogeneous and Non-Homogeneous equations, Gauss-elimination method,
LU Decomposition method.

Linear Transformation and Orthogonal Transformation: Eigenvalues and Eigenvectors and their properties, Eigenvalues and Eigenvectors of Symmetric, Hermitian, Skew-Symmetric, Skew-Hermitian, Orthogonal and Unitary matrices.

UNIT-II: Diagonalization of a Matrix

Diagonalization of a matrix: Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem. Quadratic forms and Nature of the Quadratic Forms: Reduction of Quadratic form to canonical forms by Orthogonal Transformation.

UNIT-III: Mean value theorems and Beta, Gamma functions

Mean value theorems: Rolle's theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean value Theorem, Taylor's Series. (All theorems without proof).

Applications of definite integrals to evaluate surface areas and volumes of revolutions of curves (Only in Cartesian coordinates), Definition of Improper Integral: Beta and Gamma functions and their applications.

UNIT-IV: First Order ODE

Exact differential equations, converting non-exact equations to exact equations, Linear and Bernoulli's differential equations. Applications: Newton's law of cooling, Law of natural growth and decay, orthogonal trajectories and electrical circuits. First order equations with higher degree: solvable for the differential coefficient, dependent variable and Independent variable.

UNIT-V: Ordinary Linear Differential Equations of Higher Order

Second order linear differential equations with constant coefficients - Non-Homogeneous terms of the type $e^{ax}, \sin ax, \cos ax,$ polynomials in$x$, $e^{ax}V(x)$ and $x\,V(x)$ - method of variation of parameters, Equations reducible to linear ODE with constant coefficients, Legendre's equation, Cauchy-Euler equation. Applications: Bending of beams, Electrical circuits and simple harmonic motion.

Text Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

References

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition, Pearson, Reprint, 2002.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
3. RamanaB.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi,11thReprint, 2010.

Course outcomes:

After learning the contents of this paper the student must be able to

1. Write the matrix representation of a set of linear equations and to analyse the solution of the system of equations
2. Find the Eigenvalues and Eigenvectors
3. Reduce the quadratic form to canonical form using orthogonal transformations.
4. Identify whether the given differential equation of first order is exact or not
5. Solve higher differential equation and apply the concept of differential equation to real world problems
6. Solve the applications on the mean value theorems.
7. Evaluate the improper integrals using Beta and Gamma functions

ENGINEERING PHYSICS

I Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Course Objectives:

The course enables the students to understand:

1. Fundamental properties of free, damped and forced harmonic oscillators.
2. The concepts of wave optics for the exploration of inference, diffraction and polarization.
3. Lasing action and study various types of lasers and to learn fundamental principles of Optical fibres.
4. The concepts of various theories of solids and the classification of materials into three groups.
5. Principles, fabrication and characterization of nanomaterials.

UNIT-I: OSCILLATIONS & WAVES

Oscillations: Introduction, Oscillations-Simple harmonic oscillations, Simple harmonic motion–Energy function, Simple harmonic motion-Equation, Oscillations of a spring, Torsional pendulum, Projection of a uniform circular motion, Combination of simple harmonic motions, Damped harmonic motion, Forced oscillations, Resonance.

Waves: Mechanical waves and types of waves, Travelling wave equation, Wave speed – Dimensional method, Wave speed-Mechanical method, Power and intensity of a wave, Standing waves, Waves in string-Laws of transverse vibration, Verification of laws of transverse vibration-Sonometer, Melde's apparatus.

UNIT-II: OPTICS

Interference and Diffraction: Introduction, Huygen's principle, Superposition of waves, Interference of light by wave front splitting- Young's double slit experiment, Amplitude splitting- Newton's rings, Fresnel and Fraunhofer diffractions, Fraunhofer diffraction at a single slit and double slit, Diffraction grating.

Polarization: Introduction to polarization, Polarized and unpolarised light, Types of polarization: Plane polarized, Circularly polarized and Elliptically polarized light, Polarizer and Analyser: Production and Detection of linearly polarized light, Malus law.

UNIT-III: LASERS AND FIBRE OPTICS

Lasers: Introduction, Laser Beam Characteristics, Interaction of light with matter and the three Quantum Processes, Einstein Coefficients and their relations, Light Amplification, Components of Laser, Three requirements for Lasing Action, Pumping Methods, Types of Lasers: Ruby Laser, He-Ne Laser, Semiconductor Laser, Applications of laser.

Fibre Optics: Introduction to Optical Fibre, Total Internal Reflection, Construction of optical fibre, Acceptance angle - Numerical Aperture, Classification based on materials, Refractive index profile and mode propagation, Losses in Optical Fibre, Fibre Optic Communication System, Merits of Optical Fibres, Applications.

UNIT-IV: ELECTRON THEORY OF SOLIDS

Classical and Quantum theories: Introduction, Free electron theory of metals, Classical and quantum free electron theory, Estimation of Fermi energy, Dependence of Fermi level on temperature, Density of states

Band theory of solids: Bloch's theorem, Kronig – Penny model, E-K diagram, Effective mass of electron, Origin of energy bands, Classification of materials on the basis of energy bands.

UNIT-V: NANOMATERIALS

Introduction, nanoscale, Quantum confinement, Surface to volume ratio, Bottom-up Fabrication: Sol-Gel, Precipitation, Combustion Methods, Top-Down Fabrication: Chemical Vapor Deposition, Physical Vapor Deposition, Characterization Techniques: XRD, SEM & TEM, Applications of nanomaterials.

Text Books:

1. Principles of Physics, Jearl Walker, David Halliday and Robert Resnick - Wiley publications.
2. A textbook of Engineering Physics, Dr. M.N. Avadhanulu, Dr. P.G Kshirsagar – S. Chand.
3. Engineering Physics, R.K. Gaur - S.L.Gupta, Dhanpat Rai & Sons

References:

1. Introduction to Solid State Physics by Charles Kittel, Wiley student edition.
2. Ajoy Ghatak, "Optics", Mc Graw-Hill Education, 2012.
3. Applied Physics by P.K.Mittal, I.K. International.
4. Introduction to Nanotechnology, Charles P.Pode, Jr.Frank J.Owens, Wiley-India Edition.

Course Outcomes:

The student should be able to gain knowledge on:

1. Formulation of differential equations that describe the behaviour of oscillators under various conditions.
2. The principle of optical phenomenon like interference, diffraction and polarization of light.
3. Various types of lasers and transmission characteristics of fibre optics.
4. Classical, Quantum and band theories on electrical behavior of solids and their classifications.
5. Origin, fabrication and characterization of nanomaterials.

PROGRAMMING FOR PROBLEM SOLVING

I Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Course Objectives

1. To learn the fundamentals of computers.
2. To understand the various steps in Program development.
3. To learn the syntax and semantics of C Programming Language.
4. To learn the usage of structured programming approach in solving problems.

UNIT-I:

INTRODUCTION TO COMPUTERS – Computer Systems, Computing Environments, Computer Languages, Creating and running programs, Software Development Method, Algorithms, Pseudo code, flow charts, applying the software development method.

INTRODUCTION TO C LANGUAGE – Background, Simple C programs, Identifiers, Basic data types, Variables, Constants, Input / Output, Operators. Expressions, Precedence and Associatively, Expression Evaluation, Type conversions, Bit wise operators, Statements, Simple C Programming examples.

UNIT-II:

STATEMENTS – if and switch statements, Repetition statements – while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Simple C Programming examples.

DESIGNING STRUCTURED PROGRAMS- Functions, basics, user defined functions, inter function communication, Scope, Storage classes-auto, register, static, extern, scope rules, type qualifiers, recursion- recursive functions, Preprocessor commands, example C programs

UNIT-III:

ARRAYS AND STRINGS – Concepts, using arrays in C, inter function communication, array applications, two – dimensional arrays, multidimensional arrays, C program examples. Concepts, C Strings, String Input / Output functions, arrays of strings, string manipulation functions, string / data conversion, C program examples.

UNIT-IV:

POINTERS – Introduction (Basic Concepts), Pointers for inter function communication, pointers to pointers, compatibility, memory allocation functions, array of pointers, programming applications, pointers to void, pointers to functions, command –line arguments.

INPUT AND OUTPUT – Concept of a file, streams, standard input / output functions, formatted input / output functions, text files and binary files, file input / output operations, file status functions (error handling), C program examples.

UNIT-V:

DERIVED TYPES – Structures – Declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self referential structures, unions, typedef, bit fields, enumerated types, C programming examples.

SORTING AND SEARCHING – Selection sort, Bubble sort, Insertion sort, Linear search and Binary search methods.

Textbooks:

1. C Programming & Data Structures, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. Problem Solving and Program Design in C, J.R. Hanly and E.B. Koffman, Fifth Edition, Pearson Education.
3. The C Programming Language, B.W. Kernighan and Dennis M.Ritchie, PHI/Pearson Education

References:

1. C for Engineers and Scientists, H.Cheng, Mc.Graw-Hill International Edition
2. Data Structures using C – A. M.Tanenbaum, Y.Langsam, and M.J. Augenstein, Pearson Education / PHI
3. C Programming & Data Structures, P. Dey, M Ghosh R Thereja, Oxford University Press

Course Outcomes

1. Write algorithms and to draw flowcharts for solving problems.
2. Translate the algorithms/flowcharts to programs (in C language).
3. Code and test a given logic in C programming language.
4. Formulate simple algorithms for arithmetic and logical problems.
5. Decompose a problem into functions and to develop modular reusable code.
6. Use arrays, pointers, strings and structures to formulate algorithms and programs.
7. Searching and sorting problems.

ENGINEERING GRAPHICS

I Year B.Tech. I-Sem

L	T	P	C
1	0	3	2.5

Pre-requisites: Nil

Course objectives:

1. To provide basic concepts in engineering drawing
2. To impart knowledge about standard principles of orthographic projection of objects
3. To draw sectional views and pictorial views of solids

UNIT–I:

INTRODUCTION TO ENGINEERING DRAWING:

Principles of Engineering Graphics and their Significance, Conic Sections including the Rectangular Hyperbola – General method only. Cycloid, Epicycloid and Hypocycloid, Involute. Scales – Plain, Diagonal and Vernier Scales.

UNIT-II:

ORTHOGRAPHIC PROJECTIONS:

Principles of Orthographic Projections – Conventions – Projections of Points and Lines, Projections of Plane regular geometric figures. —Auxiliary Planes.

UNIT–III:

Projections of Regular Solids – Auxiliary Views.

UNIT–IV:

Sections or Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views – Sections of Sphere. Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid and Cone

UNIT–V:

ISOMETRIC PROJECTIONS:

Principles of Isometric Projection – Isometric Scale – Isometric Views – Conventions – Isometric Views of Lines, Plane Figures, Simple and Compound Solids – Isometric Projection of objects having non- isometric lines. Isometric Projection of Spherical Parts. Conversion of Isometric Views to Orthographic Views and Vice-versa – Conventions Auto CAD: Basic principles only

Text Books:

1. Engineering Drawing by N.D. Bhatt, Charotar
2. Engineering Drawing and Graphics by Rane and Shah, Pearson Edu.

Reference Books:

1. A Text Book of Engineering Drawing by Dhawan R K, S. Chand
2. Engineering Graphics with Auto CAD by James D Bethune, Pearson Edu.
3. Engineering Graphics by K R Mohan, Dhanpat Rai.
4. Text book on Engineering Drawing by KL Narayana, P Kannaih, Scitech

Course Outcomes:

At the end of the course, the student will be able to:

1. Prepare working drawings to communicate the ideas and information.
2. Read, understand and interpret engineering drawings.

ENGINEERING PHYSICS LAB

I Year B.Tech. I-Sem

L	T	P	C
0	0	3	1.5

Course Objectives:

The course enables the students to understand:

1. The concepts of mechanical waves and their resultant phenomena.
2. The phenomena of interference using Newton's rings and diffraction phenomena using diffraction grating.
3. The electrical resonance using LCR circuit.
4. The band concept of semiconductor diode and light phenomenon of Lasers and Optical fibres.

List of Experiments:

1. Melde's experiment: Determination of the frequency of a vibrating bar or turning fork using Melde's arrangement.
2. Torsional pendulum: Determination of the rigidity modulus of the material of the given wire using torsional pendulum.
3. Newton's rings: Determination of the radius of curvature of the lens by forming Newton's rings.
4. Diffraction grating: Determination of the number of lines per inch of the grating.
5. Dispersive power: Determination of the dispersive power of prism by using spectrometer.
6. Coupled Oscillator: Determination of the spring constant by single coupled oscillator.
7. LCR Circuit: Determination of quality factor and resonant frequency of LCR circuit.
8. LASER: The characteristics of LASER sources.
9. Optical fibre: Determination of the bending losses of Optical fibres.
10. Optical fibre: Determination of the Numerical aperture of a given fibre.
11. Sonometer: Determination of the AC frequency.
12. Energy gap of PN Junction diode: determination energy gap of a semiconductor diode

Note: Any 8 experiments are to be performed by each student

Course Outcomes:

By the end of the course students will be able to:

1. Understand the mechanical waves concepts and elastic properties.
2. Understand the light phenomena such as interference and diffraction.
3. Confirm the resonance produced by electrical waves.
4. Understand the band gap of semiconductor and certain characteristics of lasers and optical fibres.

PROGRAMMING FOR PROBLEM SOLVING LAB

I Year B.Tech. I-Semester

L	T	P	C
0	0	3	1.5

Course Objectives

1. To learn the fundamentals of computers.
2. To understand the various steps in Program development.
3. To learn the syntax and semantics of C Programming Language.
4. To learn the usage of structured programming approach in solving problems.

Week 1:

1. Write a C program to find the sum of individual digits of a positive integer.
2. Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence.
3. Write a C program to generate the first n terms of the sequence.
4. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.
5. Write a C program to find the roots of a quadratic equation.

Week 2:

6. Write a C program to find the factorial of a given integer.
7. Write a C program to find the GCD (greatest common divisor) of two given integers.
8. Write a C program to solve Towers of Hanoi problem.
9. Write a C program, which takes two integer operands and one operator from the user, performs the operation and then prints the result. (Consider the operators +,-,*, /, % and use Switch Statement)

Week 3:

10. Write a C program to find both the largest and smallest number in a list of integers.
11. Write a C program that uses functions to perform the following:
    i) Addition of Two Matrices ii) Multiplication of Two Matrices

Week 4:

12. Write a C program that uses functions to perform the following operations:
    i) To insert a sub-string in to a given main string from a given position.
    ii) To delete n Characters from a given position in a given string.
13. Write a C program to determine if the given string is a palindrome or not
14. Write a C program that displays the position or index in the string S where the string T begins, or – 1 if S doesn't contain T.
15. Write a C program to count the lines, words and characters in a given text.

Week 5:

16. Write a C program to generate Pascal's triangle.
17. Write a C program to construct a pyramid of numbers
18. Write a C program to read in two numbers, x and n, and then compute the sum of this geometric progression:
    $+x+x^2+x^3+\ldots\ldots\ldots\ldots+x^n$
    For example: if n is 3 and x is 5, then the program computes 1+5+25+125.
    Print x, n, the sum
    Perform error checking.
    For example, the formula does not make sense for negative exponents– if n is less than 0. Have your program print an error message if n<0, then go back and read in the next pair of numbers of without computing the sum. Are any values of x also illegal? If so, test for them too.

Week 6:

19. 2's complement of a number is obtained by scanning it from right to left and complementing all the bits after the first appearance of a 1. Thus 2's complement of 11100 is 00100. Write a C program to find the 2's complement of a binary number.
20. Write a C program to convert a Roman numeral to its decimal equivalent.

Week 7:

21. Write a C program that uses functions to perform the following operations:
    i) Reading a complex number
    ii) Writing a complex number
    iii) Addition of two complex numbers
    iv) Multiplication of two complex numbers
    (Note: represent complex number using a structure.)

Week 8:

22. . i) Write a C program which copies one file to another.
    ii) Write a C program to reverse the first n characters in a file.
    (Note: The file name and n are specified on the command line.)
23. . i) Write a C program to display the contents of a file.
    ii) Write a C program to merge two files into a third file (i.e., the contents of the first file followed by those of the second are put in the third file)

Week 9:

24. Write a C program that implements the following sorting methods to sort a given list of integers in ascending order
    i) Bubble sort ii) Selection sort iii) Insertion sort

Week 10:

25. Write C programs that use both recursive and non recursive functions to perform the following searching
    Operations for a Key value in a given list of integers:
    i) Linear search ii) Binary search

Textbooks:

1. C Programming & Data Structures, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. Problem Solving and Program Design in C, J.R. Hanly and E.B. Koffman, Fifth Edition, Pearson Education.
3. The C Programming Language, B.W. Kernighan and Dennis M.Ritchie, PHI/Pearson Education

References:

1. C for Engineers and Scientists, H.Cheng, Mc.Graw-Hill International Edition
2. Data Structures using C – A.M. Tanenbaum, Y. Langsam, and M.J. Augenstein, Pearson Education / PHI
3. C Programming & Data Structures, P. Dey, M Ghosh R Thereja, Oxford University Press

Course Outcomes

1. Write algorithms and to draw flowcharts for solving problems.
2. Translate the algorithms/flowcharts to programs (in C language).
3. Code and test a given logic in C programming language.
4. Formulate simple algorithms for arithmetic and logical problems.
5. Decompose a problem into functions and to develop modular reusable code.
6. Use arrays, pointers, strings and structures to formulate algorithms and programs.
7. Searching and sorting problems.

INDUCTION PROGRAM

I Year B.Tech. I-Semester

L	T	P	C
2	0	0	0

APPLIED AND MULTIVARIABLE CALCULUS

I Year B.Tech. II-Semester	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**

Pre-requisites: Mathematical Knowledge of 12^{th} / Intermediate level

Course Objectives: To learn

1. Concept, properties of Laplace transforms
2. Solving ordinary differential equations using Laplace transforms techniques.
3. Partial differentiation, concept of total derivative
4. Finding maxima and minima of function of two and three variables.
5. Evaluation of multiple integrals and their applications
6. The physical quantities involved in engineering field related to vector valued functions.
7. The basic properties of vector valued functions and their applications to line, surface and volume integrals.

UNIT-I: Laplace transforms

Laplace Transforms; Laplace Transform of standard functions, first shifting theorem, Laplace transforms of functions when they are multiplied and divided by 't', Laplace transforms of derivatives and integrals of function, Evaluation of integrals by Laplace transforms, Laplace transform of periodic functions, Inverse Laplace transform by different methods, convolution theorem (without proof), solving Initial value problems by Laplace Transform method.

UNIT-II: Partial Derivatives and applications

Definitions of Limit and continuity.

Partial Differentiation, Euler's Theorem, Total derivative, Jacobian, Functional dependence & independence, Maxima and minima of functions of two variables and three variables, method of Lagrange multipliers.

UNIT-III: Multiple Integration

Evaluation of Double Integrals (Cartesian and polar coordinates), change of order of integration (only Cartesian form). Evaluation of Triple Integrals, Change of variables (Cartesian to polar) for double and (Cartesian to Spherical and Cylindrical polar coordinates) for triple integrals.

Applications: Areas (by double integrals) and volumes (by double integrals and triple integrals), Centre of mass and Gravity (constant and variable densities) by double and triple integrals (applications involving cubes, sphere and rectangular parallel piped).

UNIT-IV: Vector Differentiation

Vector point functions and scalar point functions. Gradient, Divergence and Curl, Directional derivatives, Tangent plane and normal line, Vector Identities, Scalar potential functions, Solenoidal and Irrotational vectors.

UNIT-V: Vector Integration

Line, Surface and Volume Integrals, Theorems of Green, Gauss and Stokes (without proofs) and their applications.

Text Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010
2. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. M Apostol, Calculus vol-2, John Wiley & Sons

References

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002
2. Paras Ram, Engineering Mathematics, 2nd Edition, CBS Publishes
3. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.

Course outcomes:

After learning the contents of this paper the student must be able to

1. Use the Laplace transforms techniques for solving ODE's.
2. Find the extreme values of functions of two variables with/ without constraints.
3. Evaluate the multiple integrals and apply the concept to find areas, volumes, centre of mass and gravity for cubes, sphere and rectangular parallel piped
4. Evaluate the line, surface and volume integrals and converting them from one to another

ENGINEERING CHEMISTRY

I Year B.Tech. II-Semester

L	T	P	C
3	1	0	4

Course Objectives:

1. To bring adaptability to the concepts of chemistry and to acquire the required skills to become a perfect engineer.
2. To acquire the knowledge of water treatment, electrochemistry and corrosion which are essential for the Engineers and in industry.
3. To acquire the skills pertaining to Polymers and Energy sources to apply them for various engineering fields etc.
4. To impart then knowledge of Engineering materials and their aspects useful for understanding material chemistry.

Unit-1: Water and its treatment:

Introduction – hardness of water – Causes of hardness. Types of hardness: temporary and permanent. Expression and units of hardness. Estimation of hardness of water by complexometric method. Potable water and its specifications. Steps involved in treatment of water – Disinfection of water by chlorination, breakpoint chlorination, Ozonisation. Boiler troubles - Scale, Sludge, Priming, Foaming and Caustic embrittlement. Treatment of boiler feed water by Calgon conditioning, Phosphate conditioning and Colloidal conditioning. External treatment of water- Ion exchange process. Desalination of water – Reverse osmosis. Numerical problems based on Determination of hardness of water.

Unit-2: Electrochemistry and corrosion:

Electrochemistry: Electrochemical cells – Cell, Electrode, electrode potential, standard electrode potential, Nernst equation-derivation and significance- Electrochemical series and its applications. Construction and functioning of Calomel, Quinhydrone and glass electrode. Determination of pH of a solution by using quinhydrone and glass electrode. Numerical problems. Potentiometric titrations. Batteries – Primary (Lithium cell) and secondary batteries (Lead – acid storage battery and Lithium ion battery).

Corrosion: Causes and effects of corrosion – Theories of chemical and electrochemical corrosion – mechanism of electrochemical corrosion. Galvanic corrosion, Concentration cell corrosion- water-line and pitting corrosion. Factors affecting rate of corrosion, Corrosion control methods- Cathodic protection – Sacrificial anodic protection and impressed current cathodic methods. Surface coatings – metallic coatings – Methods of coatings - Hot dipping - galvanization, tinning. cementation, electroplating and electroless plating of copper.

Unit – 3: Polymeric materials:

Polymers: Definition, Monomer, functionality and degree of polymerisation. Classification – Types of Polymerisation - Addition & Condensation – Mechanisms of Polymerisation. Plastics: Definition, characteristics - Compounding and fabrication- Methods of Moulding - Thermoplastics and Thermosets – Preparation, properties and applications– PVC, Teflon and Bakelite. Fibres: Definition, Characteristics. Preparation, Properties and applications of Terylene, Nylon 6:6. Elastomers: Definition and characteristics. Natural rubber- structure,

processing of latex, Vulcanisation. Preparation, properties and applications of BuNa-S and Butyl rubber. Conducting Polymers- Definition, Classification. Mechanism of conduction in Polyacetylene, Polyaniline & Applications. Biodegradable polymers - Concept, Synthetic and Natural polymers, Polylactic acid, Poly Vinyl alcohol, Nylon-2 and Nylon – 6. Applications and advantages of biodegradable polymers.

Unit – 4: Energy sources:

Fuels: Definition, classification with examples. Calorific value. Determination of calorific value by Junker's gas Calorimeter. Characteristics of good fuel. Coal: Types- Analysis of coal- proximate analysis. Petroleum- Refining- Fractional distillation- composition, properties and uses of petrol, diesel and kerosene. Cracking-types, Moving bed catalytic cracking. Knocking - Octane and Cetane rating, Composition, characteristics and uses of LPG, CNG. Biodiesel-Transesterification. Advantages. Hydrogen fuel- Production, storage, advantages and limitations. Combustion - Definition, Calculation of air required for the combustion of fuel, numerical problems related to calorific value and combustion.

Unit-5: Engineering Materials:

Portland cement: Composition and constituents. Setting and hardening of cement, special cements- properties and uses of High alumina cement, White cement and water proof cement. RCC, Decay of Concrete. Refractories: Classification, Properties - Refractoriness, RUL, Chemical inertness and porosity. Characteristics of a good refractory. Engineering Applications. Failure of a refractory. Lubricants: functions of lubricants, Classification, Mechanism of Lubrication, Properties - Viscosity, Acid value, Flash & Fire point, Cloud & Pour point, Aniline point.

Text Book:

1. Engineering Chemistry – PC Jain and M Jain – Dhanpath Rai and Sons, New Delhi.

Reference Books:

1. Text book of Engineering Chemistry by Ramadevi, Venkata Ramana Reddy & Prashanth Rath, Cengage learning publications.
2. A text book of Engineering Chemistry by Thirumala Chary, Laxminarayana, Shashikala. Pearson Publications.

Course Outcomes:

The basic concepts included in this course will help the student to gain:

1. Differentiate hard and soft water; solve the related problems on water purification and its significance in industry and daily life.
2. Understand the principles, concepts of electrochemistry and causes of corrosion, its consequences and methods to minimize corrosion to improve industrial designs.
3. The required skills to get clear concepts on polymers and energy sources and their applications to various engineering fields etc.
4. The knowledge of engineering materials such as Portland cement, white cement, concrete and lubricants etc.

CLASSICAL MECHANICS

I Year B.Tech. II-Semester

L	T	P	C
3	1	0	4

Course Objectives:

1. To understand the resolving forces and moments for a given force system.
2. To analyze the types of friction for moving bodies and problems related to friction.
3. To determine the centroid and second moment of area.

UNIT-I:

Introduction to Mechanics: Basic Concepts, system of Forces Coplanar Concurrent Forces - Components in Space -Resultant -Moment of Forces and its Application - Couples and Resultant of Force Systems. Equilibrium of system of Forces: Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems.

UNIT-II:

Friction: Types of friction -Limiting friction -Laws of Friction -static and Dynamic Frictions - Motion of Bodies-Wedge Screw, Screw-jack and differential screw –jack

UNIT-III:

Centroid and Center of Gravity: Introduction – Centroids of lines – Centroids of area - Centroids of Composite figures - Theorem of Pappus -Centre of Gravity of Bodies – Centroids of Volumes – Center of gravity of composite bodies.

UNIT-IV:

Area moments of Inertia: Introduction – Definition of Moment of Inertia -Polar Moment of Inertia – Radius of gyration - Transfer Theorem for moment of inertia – Moments of inertia by integration - Moments of Inertia of Composite Figures, Product of Inertia, Transfer Formula for Product of Inertia.

UNIT-V:

Mass Moment of Inertia: Introduction - Moment of Inertia of Masses – Radius of gyration - Transfer Formula for Mass Moments of Inertia – Mass moments of inertia by integration - Mass moment of inertia of composite bodies.

Text Books:

1. Singer’s Engineering Mechanics Statics and Dynamics by K. Vijaya Kumar Reddy and J. Suresh Kumar, BS Publications, 3rd Edition (SI Units) Fifth impression 2013.
2. Engg. Mechanics by Irving Shames, G. Krishna Mohan Rao, Prentice Hall

Reference Books:

1. Engineering Mechanics by Timoshenko & Young
2. Engineering Mechanics by Umesh Regl, Tayal.
3. A text of Engineering Mechanics by YVD Rao, K. Govinda Rajulu, M. Manzoor Hussain, Academic Publishing Company
4. Text Book in Applied Mechanics by Malhotra, Subramanian, Gahlot and Rathore, New Age.
5. Engineering Mechanics by KL Kumar, Tata McGraw Hill.
6. Engineering. Mechanics by M.V. Seshagiri Rao & D Rama Durgaiah.
7. Engineering Mechanics by S.S. Bhavikati & K.G. Rajasekharappa

Course Outcomes:

At the end of the course, the student will be able to:

1. Resolve forces and moments for a given system.
2. Analyze the friction for moving bodies.
3. Determine centroid and second moment for a given area of a body.

ENGLISH

I Year B.Tech. II-Semester

L	T	P	C
2	0	0	2

INTRODUCTION

In view of the growing importance of English as a tool for global communication and the consequent emphasis on training students to acquire language skills, the syllabus of English has been designed to develop linguistic, and communicative competencies of Engineering students. In English classes, the focus would be on the skills development in the areas of vocabulary, grammar, reading and writing. For this, the teachers use the prescribed text for detailed study. The students are encouraged to read the texts leading to reading comprehension and different known/unknown passages may be given for practice in the class. The time is utilized for working out the exercises given after each excerpt. Authentic materials of a similar kind, for example, newspaper articles, advertisements, promotional material are used to supplement exercises. *The focus in this syllabus is on skill development in the areas of Vocabulary, Grammar, Reading and Writing Skills and practice of language skills in various contexts.*

LEARNING OBJECTIVES

The course will help students to:

a. Improve the language proficiency of students in English with an emphasis on Vocabulary, Grammar, Reading and Writing skills.
b. Develop study skills and communication skills in formal and informal situations.
c. Equip students to study engineering subjects more effectively and critically using the theoretical and practical components of the syllabus.

Reading Skills

Objectives

1. To develop an awareness in students about the significance of silent reading and comprehension.
2. To develop students' ability to guess meanings of words from the context and grasp the overall message of the text, draw inferences, etc.,
3. To facilitate the students practice the sub-skills of reading viz., Skimming and Scanning the text, Intensive and Extensive Reading, Reading for Pleasure, Identifying the topic sentence, Inferring lexical and contextual meaning, Recognizing Coherence/Sequencing of Sentences.

☛ **NOTE:** *The students will be trained in reading skills using the prescribed texts for detailed study. They will be tested in reading comprehension of different 'unseen' passages which may be taken from authentic texts, such as magazines/newspaper articles.*

Writing Skills

Objectives

1. To bring an awareness in the students about the difference between formal and informal writing
2. To make students understand sentence structures and variations in process writing
3. To develop students' creativity in different disciplines of academic writing.

SYLLABUS

The course content / study material is divided into **Five Units.**

Unit –I

Chapter entitled '***Presidential Address' by Dr. A.P.J. Kalam*** from ***"Fluency in English– A Coursebook for Engineering Students"*** published by Orient BlackSwan, Hyderabad

Vocabulary: The Concept of Word Formation -The Use of Prefixes and Suffixes- Collocations

Grammar: Punctuation - Identifying Common Errors in Writing with reference to Articles.

Reading: Reading and its Importance- Techniques for Effective Reading.

Writing: Sentence Structures -Use of Phrases and Clauses in Sentences- Paragraph Writing - Creating Coherence and Cohesiveness.

Unit –II

Chapter entitled ***Satya Nadella: Email to Employees on his First Day as CEO*** from ***"Fluency in English– A Coursebook for Engineering Students"*** Published by Orient BlackSwan, Hyderabad.

Vocabulary: Synonyms and Antonyms – Homonyms, Homophones and Homographs

Grammar: Identifying Common Errors in Writing with Reference to Noun-Pronoun Agreement – Words with appropriate Prepositions - Phrasal Verbs

Reading: Improving Comprehension Skills – Techniques for Good Comprehension

Writing: Writing Formal Letters **–** Format - Letter of Complaint and Reply - Letter of Requisition and Reply.

Unit –III

Vocabulary: Acquaintance with Phrases from Foreign Languages (Latin/French) with a focus on usage in English

Grammar: Tenses - Identifying Common Errors in Writing with Reference to Misplaced Modifiers and Tenses

Reading: Sub-skills of Reading- Skimming and Scanning.

Writing: Job Application with Resume- Writing Introduction and Conclusion - Essay Writing.

Unit –IV

Chapter entitled **'*Good Manners' by J.C. Hill*** from ***Fluency in English – A Coursebook for Engineering Students"*** published by Orient BlackSwan, Hyderabad

Vocabulary: Standard Abbreviations in English – Idioms – One Word Substitutes

Grammar: Subject-Verb Agreement - Redundancies and Clichés in Oral and Written Communication – Sequence of Tenses.

Reading: Comprehension- Intensive Reading and Extensive Reading- Reading Practice – *'If'* by Rudyard Kipling.

Writing: Writing Practices - Information Transfer -Précis Writing.

Unit –V

Chapter entitled ***'Father Dear Father'*** **by Raj Kinger** from ***Fluency in English – A Coursebook for Engineering Students"*** Published by Orient BlackSwan, Hyderabad

Vocabulary: Technical Vocabulary and their Usage – Indian Colloquial Terms

Grammar: Common Errors in English

Reading: Reading Comprehension-Exercises for Practice.

Writing: Technical Reports- Introduction – Characteristics of a Report – Categories of Reports Formats- Structure of Reports (Manuscript Format) -Types of Reports - Writing a Report.

Note: ***Listening and Speaking skills which are given under Unit-6 in AICTE Model Curriculum are covered in the syllabus of ELCS Lab Course.***

☞ (**Note**: As the syllabus of English given in AICTE *Model Curriculum-2018 for B.Tech First Year is* ***Open-ended***, besides following the prescribed textbook, it is required to prepare teaching/learning materials **by the teachers collectively** in the form of handouts based on the needs of the students in their respective colleges for effective teaching/learning in the class.)

PRESCRIBED TEXTBOOK:

1. ***"Fluency in English – A Coursebook for Engineering Students"*** by Board of Editors**:** Hyderabad: Orient BlackSwan Pvt. Ltd. 2016. Print.

Suggested Reading:

(i) *Practical English Usage.* Michael Swan. OUP. 1995.

(ii) *Remedial English Grammar.* F.T. Wood. Macmillan.2007

(iii) *Contemporary English Grammar Structures and Composition*. David Green. Macmillan. 2010.

(iv) *Communication Skills.* Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.

Course Outcomes: Students will be able to:

1. Choose appropriate vocabulary and sentence structures for their oral and written communication.
2. Demonstrate their understanding of the rules of functional grammar.
3. Develop comprehension skills from the known and unknown passages and respond appropriately.
4. Take an active part in drafting paragraphs, letters, essays, abstracts and reports in various contexts
5. Adapt basic proficiency in English

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ENGINEERING CHEMISTRY LAB

I Year B.Tech. II-Semester

L	T	P	C
0	0	2	1

I. Volumetric Analysis:

1. Estimation of Ferrous iron by Dichrometry method.
2. Estimation of Ferrous iron by Permanganometry method.
3. Estimation of Hardness of water by EDTA Complexometry method.

II. Conductometry:

1. Estimation of the concentration of an acid by Conductometry.

III. Potentiometry:

1. Estimation of the amount of Fe^{+2} by Potentiomentry.

IV. *p*H Metry:

1. Determination of an acid concentration using pH meter.

V. Preparations:

1. Preparation of Bakelite.
2. Preparation Nylon - 6.

VI. Lubricants:

1. Estimation of acid value of given lubricant oil.
2. Estimation Saponification value of a lubricant oil.
3. Estimation of Viscosity of lubricant oil using Ostwald's Viscometer.

VII. Corrosion:

1. Determination of rate of corrosion of mild steel in the presence and absence of inhibitor.

Recommended Books:

1. Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications.
2. Laboratory Manual of Engineering Chemistry by Y. Bharathi Kumari & Jyotsna C, VGS Booklinks, Vijayawada, 2009.
3. College Practical Chemistry by V.K. Ahluwalia, Narosa Publications Ltd. New Delhi (2007).
4. Engineering Chemistry Lab Manual by Cengage Publications.

ENGINEERING WORK SHOP PRACTICE

I Year B.Tech. II-Semester

L	T	P	C
0	0	3	1.5

Pre-requisites: Practical skill

Course Objectives: The objectives of this course is to acquire knowledge on the

1. To impart hands-on practice on Carpentry trade and skills.
2. To impart hands-on practice on Fitting trade and skills
3. To impart hands-on practice on Black Smithy trade and skills.
4. To impart hands-on practice on House Wiring trade and skills
5. To impart hands-on practice on Tin Smithy trade and skills
6. To impart hands-on practice on Plumbing trade and skills

Note: At least two exercises to be done from each trade.

A. Carpentry
   1. T-Lap Joint
   2. Cross Lap Joint
   3. Dovetail Joint

B. Fitting
   1. Vee Fit
   2. Square Fit
   3. Half Round Fit

C. Black Smithy
   1. Round rod to Square
   2. S-Hook
   3. Round Rod to Flat Ring

D. House Wiring
   1. Parallel / Series Connection of three bulbs
   2. Stair Case wiring
   3. Florescent Lamp Fitting

E. Tin Smithy
   1. Taper Tray
   2. Open Scoop
   3. Funnel

F. Plumbing
   1. Coupling Joint
   2. Elbow Joint
   3. T Joint

TEXT BOOKS:

1. Workshop Practice by B.L.Juneja Cengage Learning
2. Elements of Workshop Technology–S. K.Hajra Choudhury and A. K. Hajra Choudhury.

ENGLISH LANGUAGE AND COMMUNICATION SKILLS (ELCS) LAB

I Year B.Tech. II-Semester

L	T	P	C
0	0	2	1

The **English Language and Communication Skills (ELCS) Lab** focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations both in formal and informal contexts.

Objectives

- To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
- To sensitize the students to the nuances of English speech sounds, word accent, intonation and rhythm
- To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
- To improve the fluency of students in spoken English and neutralize their mother tongue influence
- To train students to use language appropriately for public speaking, group discussions and interviews

Syllabus: English Language and Communication Skills Lab (ELCS) shall have two parts:

a. Computer Assisted Language Learning (CALL) Lab
b. Interactive Communication Skills (ICS) Lab

Listening Skills:

Objectives

1. To enable students develop their listening skills so that they may appreciate the role in the LSRW skills approach to language and improve their pronunciation
2. To equip students with necessary training in listening, so that they can comprehend the speech of people of different backgrounds and regions

Students should be given practice in listening to the sounds of the language, to be able to recognize them and find the distinction between different sounds, to be able to mark stress and recognize and use the right intonation in sentences.

- Listening for general content
- Listening to fill up information
- Intensive listening
- Listening for specific information

Speaking Skills:

Objectives

1. To involve students in speaking activities in various contexts
2. To enable students express themselves fluently and appropriately in social and professional contexts

- Oral practice
- Describing objects/situations/people
- Role play – Individual/Group activities
- Just A Minute (JAM) Sessions

The following course content is prescribed for the **English Language and Communication Skills Lab**.

Exercise – I

CALL Lab:

Understand: Listening Skill- Its importance – Purpose- Process- Types- Barriers- Effective Listening.

Practice: Introduction to Phonetics – Speech Sounds – Vowels and Consonants – Minimal Pairs- Consonant Clusters- Past Tense Marker and Plural Marker- *Testing Exercises*

ICS Lab:

Understand: Spoken vs. Written language- Formal and Informal English.

Practice: Ice-Breaking Activity and JAM Session- Situational Dialogues – Greetings – Taking Leave – Introducing Oneself and Others.

Exercise – II

CALL Lab:

Understand: Structure of Syllables – Word Stress– Weak Forms and Strong Forms – Sentence Stress – Intonation.

Practice: Basic Rules of Word Accent - Stress Shift - Weak Forms and Strong Forms- Sentence Stress – Intonation - *Testing Exercises*

ICS Lab:

Understand: Features of Good Conversation – Strategies for Effective Communication.

Practice: Situational Dialogues – Role-Play- Expressions in Various Situations –Making Requests and Seeking Permissions - Telephone Etiquette.

Exercise - III

CALL Lab:

Understand: Errors in Pronunciation-the Interference of Mother Tongue (MTI).

Practice: Common Indian Variants in Pronunciation – Differences between British and American Pronunciation -*Testing Exercises*

ICS Lab:

Understand: Descriptions- Narrations- Giving Directions and Guidelines.

Practice: Giving Instructions – Seeking Clarifications – Asking for and Giving Directions – Thanking and Responding – Agreeing and Disagreeing – Seeking and Giving Advice – Making Suggestions.

Exercise – IV

CALL Lab:

Understand: Listening for General Details.

Practice: Listening Comprehension Tests - *Testing Exercises*

ICS Lab:

Understand: Public Speaking – Exposure to Structured Talks - Non-verbal Communication- Presentation Skills.
Practice: Making a Short Speech – Extempore- Making a Presentation.

Exercise – V
CALL Lab:
Understand: Listening for Specific Details.
Practice: Listening Comprehension Tests -*Testing Exercises*
ICS Lab:
Understand: Group Discussion
Practice: Group Discussion

Minimum Requirement of infrastructural facilities for ELCS Lab:

1. **Computer Assisted Language Learning (CALL) Lab:**

The Computer Assisted Language Learning Lab has to accommodate 40 students with 40 systems, with one Master Console, LAN facility and English language learning software for self- study by students.

System Requirement (Hardware component):
Computer network with LAN facility (minimum 40 systems with multimedia) with the following specifications:

i) Computers with Suitable Configuration
ii) High Fidelity Headphones

2. **Interactive Communication Skills (ICS) Lab :**

The Interactive Communication Skills Lab: A Spacious room with movable chairs and audio-visual aids with a Public Address System, a T. V. or LCD, a digital stereo – audio & video system and camcorder etc.

Suggested Software:

- Cambridge Advanced Learners' English Dictionary with CD.
- Grammar Made Easy by Darling Kindersley.
- Punctuation Made Easy by Darling Kindersley.
- Oxford Advanced Learner's Compass, 8th Edition.
- English in Mind (Series 1-4), Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge.
- English Pronunciation in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
- English Vocabulary in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
- TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS).

References:

1. Suzanna, R. *A Practical Course in English Pronunciation (with CD).* McGraw Hill Education. 2017. Print.
2. *Exercises in Spoken English*. Part 1, 2 and 3. CIEFL. Oxford University Press, 1997. Print.
3. Hancock, M. *English Pronunciation in Use. Intermediate Cambridge*: Cambridge University Press. 2009. Print.

Learning Outcomes

Students will be able to:

- Understand the nuances of English language through audio- visual experience and group activities
- Neutralise their accent for intelligibility
- Speak with clarity and confidence which in turn enhances their employability skills

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APPLIED PYTHON PROGRAMMING LAB

I Year B.Tech. II-Semester

L	T	P	C
0	1	2	2

LIST OF EXPERIMENTS

Cycle - 1

1. **Downloading and Installing Python and Modules**
   a) **Python 3 on Linux**
   Follow the instructions given in the URL https://docs.python-guide. org/starting / install3/linux/
   b) **Python 3 on Windows**
   Follow the instructions given in the URL https://docs.python.org/3/using/windows.html
   (Please remember that Windows installation of Python is harder!)
   c) **pip3 on Windows and Linux**
   Install the Python package installer by following the instructions given in the URL https://www.activestate.com/resources/quick-reads/how-to-install-and-use-pip3/
   d) **Installing numpy and scipy**
   You can install any python3 package using the command pip3 install <packagename>
   e) **Installing jupyterlab**
   Install from pip using the command pip install jupyterlab

2. **Introduction to Python3**
   a) Printing your biodata on the screen
   b) Printing all the primes less than a given number
   c) Finding all the factors of a number and show whether it is a *perfect* number, i.e., the sum of all its factors (excluding the number itself) is equal to the number itself

3. **Defining and Using Functions**
   a) Write a function to read data from a file and display it on the screen
   b) Define a boolean function *is palindrome*(<input>)
   c) Write a function *collatz(x)* which does the following: if x is odd, $x = 3x + 1$; if x is even, then $x = x/2$. Return the number of steps it takes for $x = 1$
   d) Write a function $N(m, s) = exp(-(x-m)^2/(2s^2))/sqrt(2\pi)s$ that computes the Normal distribution

4. **The package** numpy
   a) Creating a matrix of given order $m \times n$ containing *random numbers* in the range 1 to 99999
   b) Write a program that adds, subtracts and multiplies two matrices. Provide an interface such that, based on the prompt, the function (addition, subtraction, multiplication) should be performed
   c) Write a program to solve a system of n linear equations in n variables using matrix inverse

5. **The package** scipy **and** pyplot
   a) Finding if two sets of data have the same *mean* value
   b) Plotting data read from a file
   c) Fitting a function through a set a data points using *polyfit* function
   d) Plotting a histogram of a given data set

6. **The** strings **package**
   a) Read text from a file and print the number of lines, words and characters
   b) Read text from a file and return a list of all *n* letter words beginning with a vowel
   c) Finding a secret message hidden in a paragraph of text
   d) Plot a histogram of words according to their length from text read from a file

Cycle -2

7. Installing OS on Raspberry Pi
   a) Installation using PiImager
   b) Installation using image file
      - Downloading an Image
      - Writing the image to an SD card
        - using Linux
        - using Windows
      - Booting up

   Follow the instructions given in the URL
   https://www.raspberrypi.com/documentation/computers/getting-started.html

8. Accessing GPIO pins using Python
   a) Installing GPIO Zero library.
      First, update your repositories list:
      sudo apt update
      Then install the package for Python 3:
      sudo apt install python3-gpiozero
   b) Blinking an LED connected to one of the GPIO pin
   c) Adjusting the brightness of an LED
      Adjust the brightness of an LED (0 to 100, where 100 means maximum brightness) using the in-built PWM wavelength.
9. Collecting Sensor Data
   a) DHT Sensor interface
      - Connect the terminals of DHT GPIO pins of Raspberry Pi.
      - Import the DHT library using ***import Adafruit_DHT***
      - Read sensor data and display it on screen.

PROBABILITY DISTRIBUTIONS AND COMPLEX VARIABLES

II Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Mathematics courses of first year of study

Course Objectives: To learn

1. The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
2. The basic ideas of statistics including measures of central tendency, correlation and regression.
3. The statistical methods of studying data samples.
4. Differentiation and integration of complex valued functions.
5. Evaluation of integrals using Cauchy's integral formula and Cauchy's residue theorem.
6. Expansion of complex functions using Taylor's and Laurent's series.

UNIT-I: Basic Probability

Probability spaces, conditional probability, independent events, and Bayes' theorem.
Random variables: Discrete and continuous random variables, Expectation of Random Variables, Variance of random variables

UNIT-II: Probability distributions

Binomial, Poisson, evaluation of statistical parameters for these distributions, Poisson approximation to the binomial distribution, Continuous random variables and their properties, distribution functions and density functions,
Normal and exponential, evaluation of statistical parameters for these distributions

UNIT-III: Estimation & Tests of Hypotheses

Introduction, Statistical Inference, Classical Methods of Estimation.: Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Estimating a Proportion for single sample, Difference between Two Means, difference between two proportions for two Samples.
Statistical Hypotheses: General Concepts, Testing a Statistical Hypothesis, Tests Concerning a Single Mean, Tests on Two Means, Test on a Single Proportion, Two Samples: Tests on Two Proportions.

UNIT-IV: Complex Differentiation

Limit, Continuity and Differentiation of Complex functions, Analyticity, Cauchy-Riemann equations (without proof), finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties.

UNIT-V: Complex Integration

Line integral, Cauchy's theorem, Cauchy's Integral formula, Zeros of analytic functions, Singularities, Taylor's series, Laurent's series; Residues, Cauchy Residue theorem, Conformal mappings, Mobius transformations and their properties. (All theorems without Proof).

Text Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, keying Ye, Probability and statistics for engineers and scientists, 9th Edition, Pearson Publications.
3. A first course in complex analysis, D Zill,.

Reference Books

1. Fundamentals of Mathematical Statistics, Khanna Publications, S C Guptha and V.K. Kapoor.
2. Miller and Freund's, Probability and Statistics for Engineers, 8th Edition, Pearson Educations
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, LaxmiPublications, Reprint, 2010.
4. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.

Course Outcomes:

After learning the contents of this paper the student must be able to

1. Formulate and solve problems involving random variables and apply statistical methods for analysing experimental data.
2. Apply concept of estimation and testing of hypothesis to some case studies.
3. Analyse the complex function with reference to their analyticity, integration using Cauchy's integral and residue theorems.
4. Taylor's and Laurent's series expansions of complex function

BASIC ELECTRICAL ENGINEERING

II Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre- Requisites: Nil

Course Objectives:

1. To introduce the concepts of electrical circuits and its components.
2. To understand magnetic circuits, DC circuits and AC single phase & three phase circuits.
3. To study and understand the different types of DC/AC machines and Transformers.
4. To import the knowledge of various electrical installations.
5. To introduce the concept of power, power factor and its improvement.

UNIT-I

D.C. Circuits:

Electrical circuit elements (R, L and C), voltage and current sources, KVL & KCL, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.
Time-domain analysis of first-order RL and RC circuits.

UNIT-II

A.C. Circuits:

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance in series R-L-C circuit.
Three-phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III

Transformers:

Ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

UNIT-IV

Electrical Machines:

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor.
Construction and working of synchronous generators.

UNIT-V

Electrical Installations:

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Text Books:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.

Reference Books:

1. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
2. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
3. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Course Outcomes:

1. To analyze and solve electrical circuits using network laws and theorems.
2. To understand and analyze basic Electric and Magnetic circuits.
3. To study the working principles of Electrical Machines.
4. To introduce components of Low Voltage Electrical Installations.

MINERAL DRESSING

II Year B.Tech. I-Sem

L	T	P	C
4	0	0	4

Pre- Requisites: Nil

Course Objectives:

1. Introduce students to the principles of ore comminution, liberation and particle size analysis and the different equipments used in the processes.
2. Teach the students about various methods of concentration/ separation and the processes suitable to the liberated ore and equipments used.
3. Acquaint the students about quantifying concentration processes and selection of proper mineral dressing cycles for an ore/mineral.

UNIT–I

Scope, objectives and advantages of ore dressing. Sampling of ores by different methods. Theory of liberation of minerals. Crushers: - Jaw, Gyratory, Cone, Rolls and toothed roll crushers. Types of grinding operations- batch and continuous, dry and wet grinding and open circuit and closed circuit grinding. Grinding Mills: Ball mills, rod, tube mills and theory of ball mill operation. Comminution laws: - Rittinger's laws, Kick's law and Bond's law.

UNIT–II

Sizing Techniques: Laboratory and industry practices- Study of laboratory sizing techniques and reporting of sizing data. Types of screens, Movement of solids in fluids: Stokes and Newton's laws. Terminal velocity and its relation with size. Relation between time and velocity. Relation between distance traveled and velocity. Equal settling ratio, Free and hindered settling ratio. Quantifying concentrating operations: Ratio of concentration, recovery, selectivity index and economic recovery.

UNIT–III

Classification and types of classifiers**:** Study of settling cones, rake classifier, spiral classifier and cyclones. Heavy media separation: Principles, flow chart, different media used. Heavy media separation using heavy liquids and heavy suspensions. Washability curves of coal. Jigging: Theory of jigging and Jigging machines**:** Harz, Baum, Denver jig. Design considerations in a jig.

UNIT-IV

Tabling- Basic principle, study of stratification on a table, Wilfred Table. Humphrey's spiral classifier. Basic principles of Magnetic separation processes and electrostatic separation process. Brief description about the working of belt and drum magnetic separator, high tension separator.

UNIT–V

Floatation: Principles of floatation. Factors affecting floatation. Classification of collectors and frothers. Regulators, factors affecting their efficiency. Floatation machines: Pneumatic and mechanical floatation cells. Application of floatation process to Cu, Pb and Zn ores.

Text Books:

1. Mineral processing technology - A. Wills, Published by Butterworth-Heinemann, 2015.
2. Principles of Mineral Dressing by A.M. Gaudin, McGraw-Hill Inc., US, 1939.

References Books:

1. Text book of Mineral processing by D.V. Subba Rao, Scientific Publishers, 2007.
2. Ore dressing practices - S. K. Jain, Rotterdam: A.A. Balkema, 1987.
3. Elements of Ore Dressing by A.F. Taggart, John Wiley & Sons,1st Edition ,1951.

Course Outcomes:

At the end of the course the student will be able to:

1. Recognition of the need of the mineral dressing prior to extraction of metals.
2. Describe the working and construction details of various equipments used in mineral dressing.
3. Assess the efficiency of concentration processes.
4. Select and describe a particular concentration process suitable to the liberated ore.
5. To make a logical link between mineral processing and economics of metal production.
6. Apply the knowledge learned so as to being capable of understanding advance courses in mineral processing operations and modeling.

METALLURGICAL ANALYSIS

II Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To know the principles of qualitative and quantitative analysis of ores, metals, alloys, and refractory materials.
2. To know the principles and working of the various instruments utilized in instrumental analysis.
3. To know the importance of metallurgical analysis in the field of metallurgy.

UNIT-I

Importance of chemical analysis, scope of metallurgical analysis, classification of various methods used in metallurgical analysis. Solution preparations: Normality, Molarity, Molality, Equivalent weight. Dissolution of ores in general, metals and alloys.

UNIT-II

Chemical Analysis - Basic Principles - theory of indicators.
Estimation of C, S, Si, Mn and P in cast iron and steel.

UNIT-III

Estimation of Cr, Ni, Mo, W and V in alloy steels.
Determination of iron in iron ore, manganese in manganese ores, lime in limestone, fire-assay of precious metals.

UNIT-IV

Instrumental analysis: Importance of instrumental analysis – Comparison with standard wet chemical methods - Fundamental Physicochemical principles involved and equipment required in absorptiometry i.e, colorimetry and spectrophotometry.

UNIT-V

Spectroscopy, potentiometry, polarography conductometry, electro - analysis and flame photometry.

Text Books:

1. Metallurgical analysis - S.P. Jain, B.C. Agarwal, 8th Edition, 1996.
2. A Text Book of Metallurgical Analysis, Agarwal, B.C. and Jain S.P., Khanna Publishers, Delhi -1963.

Reference Books:

1. Metallurgical Analysis: Iyer, V. Gopalam, BHU Press, Varanasi. 2nd Edition, 1947.
2. Commercial methods of analysis : Snell Foster D and Frank M Biffen / Che. Publishing Co.,1964.
3. A Text Book of Quantitative Inorganic Analysis, Vogel Al., Longman ELBS 1962.
4. Instrumental Methods of analysis, Willard H.H, Merritt, Van Nostrand, 6th edition, 1989.

Course Outcomes:

At the end of the course the student will be able to:

1. Know the importance of chemical analysis and how it is related to metallurgical engineering.
2. Distinguish between qualitative and quantitative measurements and compare them. Can also suggest a method for analyzing different materials.
3. Interpret and identify the elements through analysis, explain about analysis of precious metals through assaying.
4. Understand the theoretical principles behind modern analytical instrumentation. Apply theory and operational principles of analytical instruments. Select and apply appropriate instrumental methods of analysis to problems in any of the sciences.
5. Develop a range of knowledge relating to instrument operation, observation, measurement and interpretation of results. Convert between wavelength, energy and frequency for light and understand the relationship between absorbed light and color.
6. Assess and choose different methods to identify the nature of the material given.

THERMODYNAMICS AND KINETICS

II Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Nil

Course Objectives:

1. The prime aim of this course is to apply thermodynamics and kinetics to various metallurgical aspects like Solutions, Phase diagrams, Diffusion, and Ellingham Diagrams.
2. The course is also intended to correlate electrochemical principles with thermodynamics.
3. To provide a consistent picture of thermodynamic concepts when applied to various topics.

UNIT-I

Objectives and limitations to thermodynamics, concepts of system and state, heterogeneous and homogeneous systems, extensive and intensive properties of system, thermodynamic variables, thermodynamic equilibrium and Zeroth law of thermodynamics. Reversible and irreversible processes.

UNIT-II

First Law of thermodynamics: Relationship between heat and work, internal energy and the first law of thermodynamics, calculations of work, Heat capacity, reversible adiabatic processes, reversible isothermal pressure or volume changes, of an ideal gas, Joules experiment, Joule- Thompson experiment, Joule-Thompson co-efficient, Enthalpy change with temperature, Kirchhoff's equation. Efficiency of a cyclic process, Carnot cycle, Carnot theorem, Second law of thermodynamics, concept of entropy, Quantification of irreversibility.

UNIT-III

Free energy functions: Purposes of the new functions, definition of Helmholtz and Gibbs free energy change, meaning of thermodynamically possible process, determination of ΔG from thermal data, useful relationships between free energies and other thermodynamic functions, Maxwell's equations and Gibbs-Helmholtz equation.

Third law of thermodynamics: Background of third law, deductions from third law, applications of third law, other methods of obtaining ΔS^0 for a reaction.

UNIT-IV

Fugacity, activity and equilibrium constant: Concepts of fugacity, activity and equilibrium constant variation of the equilibrium constant with temperature, Tabular methods recording, thermodynamic data, sigma functions.

Claussius – Clapeyron equation: Introduction, derivation of the Claussius – Clapeyron equation for single substance, Duhring rule for the estimation of the vapour pressures of an element, Integration of Claussius – Clapeyron equation.

UNIT-V

Kinetics: Kinetics of chemical process, Molecularity and order of a reaction, zero order reactions, first order, second order reactions, Determination of order of reaction, collision theory, theory of absolute reaction rates, consecutives and simultaneous reactions, catalysis in chemical reactions.

Text Books:

1. Introduction to Metallurgical Thermodynamics – D.R. Gaskell, hemisphere Publishing Corporation, 1981.
2. Chemical and Metallurgical Thermodynamics (Vol I &II) - M.L. Kapoor, Nemchand & Bros Publishers, 1984.

Reference Books:

1. Physical chemistry for Metallurgists – J. Mackowiak, Allen & Unwin, 2nd edition, 1967.
2. Thermodynamics of solids- R.S. Swalin, John Wiley Publisher, 1972.
3. Physical chemistry of metals- L.S. Darken & Gurry, CBS publishers & Distributors 2002.
4. Problems in Metallurgical Thermodynamics: G.S Upadhyaya, R.K. Dubey, Elsevier Science, 2013.

Course Outcomes:

At the end of the course the student would be able to:

1. Knowledge of the type of variable that affects heterogeneous reaction rates nucleation, interfacial energy, interface equilibrium and diffusion.
2. Relate 1st and 2nd Law of thermodynamics.
3. Knowledge of enthalpy, entropy and free energy.
4. Understand the principles of kinetics and thermodynamics as applied to rates and equilibrium positions of chemical reactions.
5. Calculate the temperature dependence of rate constants and relate this calculation to activity and fugacity.
6. Determine order of reaction. Explain the central concepts of chemical kinetics. Formulate and solve rate equations for various reactions.

BASIC ELECTRICAL ENGINEERING LAB

II Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Basic Electrical Engineering

Course Objectives:

1. To analyze a given network by applying various electrical laws and network theorems.
2. To know the response of electrical circuits for different excitations.
3. To calculate, measure and know the relation between basic electrical parameters.
4. To analyze the performance characteristics of DC and AC electrical machines

List of Experiments / Demonstrations:

1. Verification of Ohms Law.
2. Verification of KVL and KCL.
3. Transient Response of Series RL and RC circuits for DC excitation.
4. Transient Response of RLC Series circuit for DC excitation.
5. Resonance in series RLC circuit.
6. Calculations and Verification of Impedance and Current of RL, RC and RLC series circuits.
7. Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single Phase Transformer.
8. Load Test on Single Phase Transformer (Calculate Efficiency and Regulation).
9. Three Phase Transformer: Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta-star, Star-Star).
10. Measurement of Active and Reactive Power in a balanced Three-phase circuit.
11. Performance Characteristics of a Separately / Self Excited DC Shunt / Compound Motor.
12. Torque-Speed Characteristics of a Separately/ Self Excited DC Shunt / Compound Motor.
13. Performance Characteristics of a Three-phase Induction Motor.
14. Torque-Speed Characteristics of a Three-phase Induction Motor.
15. No-Load Characteristics of a Three-phase Alternator.

Text Books:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.

Reference Books:

1. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
2. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
3. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

Course Outcomes:

1. Get an exposure to basic electrical laws.
2. Understand the response of different types of electrical circuits to different excitations.
3. Understand the measurement, calculation and relation between the basic electrical parameters
4. Understand the basic characteristics of transformers and electrical machines.

MINERAL DRESSING LAB

II Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre- Requisites: Mineral Dressing

Course Objectives:

This laboratory course is designed to

1. To teach the student how to conduct sampling and sieve analysis.
2. Make the student to learn and demonstrate the usage of crushers and grinders.
3. Learn to conduct concentration methods at laboratory scale.
4. Teach the students how to note down the observations and results obtained in the experiments.

List of Experiments:

1. Sampling of an ore from the bulk by
   (i) Coning and quartering method.
   (ii) Riffle sampler.
2. Determination of average particle size of a given material by sieve analysis.
3. Verification of Stoke's Law.
4. Size reduction of the given material using Jaw Crusher and determining the reduction ratio.
5. Size reduction of the given material using Roll Crusher and determining the reduction ratio.
6. Size reduction of the given material using Ball Mill and determining the reduction ratio.
7. Determine the grindability index of coal using hard groove grindability machine.
8. Separation of the given material into magnetic and non magnetic particles using magnetic separator.
9. Determination of recovery percentage of the concentrate by Froth- Floatation process.
10. Study of a jigging machine.

Course Outcomes:

At the end of the laboratory course the student will be able to:

1. Pick or take a representative amount of sample and conduct experiments / tests.
2. Determine the reduction ratio in crushing and grinding of different materials using various types of size reduction units.
3. Analyze the grindability of different coals.
4. Separate or concentrate the given materials using magnetic separation and froth flotation processes.
5. Prepare formal laboratory reports.

METALLURGICAL ANALYSIS LAB

II Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre- Requisites: Metallurgical Analysis

Course Objectives:

1. This course introduces chemical analysis of metallic alloys using laboratory practice.
2. This course gives knowledge on principles and working of various instruments used in analysis.

List of Experiments:

1. Estimation of Iron in Iron ore by $KMnO_4$ method.
2. Estimation of Iron in scrap by $KMnO_4$ method.
3. Estimation of Iron in Iron ore by $K_2Cr_2O_7$ method.
4. Estimation of Iron in scrap by $K_2Cr_2O_7$ method.
5. Estimation of lime in Limestone.
6. Estimation of Silicon in Cast Iron.
7. Estimation of manganese in cast iron.
8. Estimation of Sulphur and Phosphorus in cast irons.
9. Estimation of Chromium in Steel.
10. Estimation of Sodium and Potassium in Chloride Salts by Flame Photometry.

Course Outcomes:

At the end of this laboratory course, the student will be able to:

1. Identify the major elements in a metallic alloy using chemical methods.
2. Quantify specific elements in ferrous and non-ferrous alloys using titration.
3. Identify certain elements in salts by flame photometry.
4. Interpret the results from different spectroscopy instruments to determine chemical composition.
5. Learn operating techniques of different instruments used in analysis.
6. Prepare formal laboratory reports.

ENVIRONMENTAL SCIENCE

II Year B.Tech. I-Sem

L	T	P	C
2	0	0	0

Pre-Requisites: NIL

Course Objectives:

1. Understanding the importance of ecological balance for sustainable development.
2. Understanding the impacts of developmental activities and mitigation measures.
3. Understanding the environmental policies and regulations

UNIT-I:

Ecosystems: Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity. Structural features, Biotic structure, Abiotic structure, Ecological succession, Types of Ecosystems, Field visits.

UNIT–II:

Natural Resources: Classification of Resources: Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and using mineral resources, **Land resources:** Forest resources, **Energy resources:** growing energy needs, renewable and non renewable energy sources, use of alternate energy source, case studies. **Food recourses**: Desertification, Equitable use of resource for sustainable use style.

UNIT–III:

Biodiversity And Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

UNIT–IV:

Environmental Pollution and Control Technologies: Environmental Pollution: Classification of pollution, **Air Pollution:** Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. Landslides, floods, cyclones. **Noise Pollution:** Sources and Health hazards, standards, **Thermal pollution:** Introduction, causes and consequences. **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.

Overview of air pollution control technologies, Concepts of bioremediation. **Global Environmental Issues and Global Efforts: C**limate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol. NAPCC-GoI Initiatives.

UNIT–V:

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act- 1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development Goals, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

Text Books:

1 Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
2 Environmental Studies by R. Rajagopalan, Oxford University Press.

Reference Books:

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
4. Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BS Publications.
6. Introduction to Environmental Science by Y. Anjaneyulu, BS.Publications.

Course Outcomes:

1. Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

ECONOMICS AND FINANCIAL ANALYSIS

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Course Objective:

To prepare engineering students to analyze cost/ revenue/ financial data and to make economic and financial analysis in decision making process and to examine the performance of companies engaged in engineering.

Unit- I:

Macro Economic Concepts: Economics- Micro & Macroeconomics-National Income Accounting - Methods of Estimation- Various Concepts of National Income - Inflation – Causes of Inflation and Measures to Control Inflation - New Economic Policy - Industrial policy, Trade policy, and Fiscal policy and its Impact on Industry-Types of companies-Features.

Unit- II:

Introduction to Business Economics- Basic Principles of Economics– Fundamental Concepts- Demand – Demand Determinants - Law of Demand- Demand Forecasting and Methods- Elasticity of Demand– Supply- Elasticity of Supply- Theory of Firm.

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UNIT- III:

Production, Cost, Market Structures & Pricing:

Production Analysis: Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions. Cost analysis: Types of Costs, Short run and Long run Cost Functions. Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, and Monopolistic Competition. Pricing: Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, Cost Volume Profit Analysis (simple problems).

Unit- IV:

Introduction to Accounting: Accounting Principles (GAPP), concepts, conventions- - Double entry system of Book keeping–Accounting rules- Journal- ledger- Trial balance-Trading and Profit and Loss account- Balance Sheet. (Simple Problems).

Unit- V:

Capital Budgeting Techniques: Significance of Capital Budgeting - cash flows-Time Value of Money- Choosing between alternative investment proposals- Methods of Appraisal Techniques- Pay Back Period - Average Rate of Return – Net Present Value- Internal Rate of Return – Profitability Index (simple problems).

Suggested Readings:

1. Henry Malcom Steinar-Engineering Economics, Principles, McGraw Hill Pub.
2. D.D.Chaturvedi, S.L.Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
3. Jain and Narang" Accounting, Kalyani Publishers.
4. Arora, M.N." Cost Accounting, Vikas Publication.
5. S.N.Maheshwari, Financial Management, Vikas Publishing House.

Course Outcome:

To perform and evaluate present and future worth of the alternate projects and to appraise projects by using traditional and DCF Methods. To carry out cost benefit analysis of projects and to calculate BEP of different alternative projects.

PHYSICAL METALLURGY

II Year B.Tech. II-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Engineering Physics & Engineering Chemistry

Course Objectives:

1. Give basic concepts of material science.
2. The prime objective of this course is to make the student gain an understanding of the relation between microstructural characteristics and properties of metals and alloys.
3. The course also critically focuses on the crystallography, phase transformations that occur in several ferrous and nonferrous metallurgical systems as a function of temperature and composition through phase equilibrium diagrams.

UNIT–I

Structure of Metals, Types of chemical bonding, crystal systems, plane and directional indices, transformation of indices, coordination number, relationship between lattice parameter and atomic radius, packing factor and density calculations, interstitial voids.

UNIT–II

Microscopy: Metallurgical Microscope, principle and construction, types of objectives and eyepieces, common defects of lenses. Introduction to electron Microscopy-Principle and operation of SEM, TEM.

UNIT–III

Constitution of Alloys: Necessity of alloying, types of solid solutions, Hume-Rothery's rules. Intermediate alloy phases, electron-chemical compounds and electron phases.

Equilibrium Diagrams: Construction, phase rule. Types of Phase diagrams: Binary Isomorphous alloy systems, non- equilibrium cooling, binary eutectic system, peritectic and monotectic reactions. Phase diagrams with intermediate phases and compounds

UNIT–IV

Types of nucleation, determination of the size of critical nucleus, equilibrium cooling and heating of alloys, lever rule, miscibility gaps. Study of Fe-Fe_3 C phase diagram, Transformation in solid state: allotropy, eutectoid, peritectoid reactions and order-disorder transformations

UNIT–V

Study of other important binary phase diagrams: Al-Cu, Cu-Zn, Cu-Sn, Pb-Sn, and complex phase diagrams. Strengthening mechanisms: strengthening of grain boundary, work hardening, solid solution strengthening, precipitation hardening and dispersion strengthening.

Text Books:

1. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
2. Introduction to Physical Metallurgy – SH Avner, TATA Mc GRAW HILL,1997.

Reference Books:

1. Physical Metallurgy Principles- R.E. Reed Hill, Affiliated East-West Press, 2008.
2. Physical Metallurgy - V. Raghavan, PHI Learning; 3rd edition, 2015.
3. Physical Metallurgy - Vijendra Singh, Standard Publishers Distributors, 2020.
4. Foundations of Materials Science and Engineering – WF Smith McGraw-Hill Education, 5^{th} edition 2009.
5. Metallurgy for Engineers- Clark and Varney, Van Nostrand Reinhold Company, 2^{nd} Revised edition ,1962.

Course Outcomes:

At the end of the course the student will be able to:

1. Analyze the structure of crystalline materials and calculate the various crystals parameters.
2. Explain the working of metallurgical microscope and its different parts.
3. Explain the necessity of alloys, will identify the different types of alloy phases.
4. Explain the construction and identification of phase diagrams and reactions.
5. Explain the Fe-Fe_3C diagram with invariant reactions.
6. Explain the Cu-Zn and other binary diagrams and complex phase diagrams etc.

PRINCIPLES OF EXTRACTIVE METALLURGY

II Year B.Tech. II-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Mineral Dressing and Thermodynamics and Kinetics

Course Objectives:

1. To learn and emphasize the principles of pyrometallurgy, hydrometallurgy and electrometallurgy.
2. To learn scientific concepts of extraction and refining.
3. Obtain knowledge of equipment used in pyrometallurgy, hydrometallurgy and electrometallurgy.
4. Gain basic knowledge about pelletisation and Sintering.

UNIT-I

Introduction: Classification of ores. Basics of Pyrometallurgy, Calcination, Roasting and types of roasting, Oxidising, sulphatising, and chloridizing. Roasting furnaces: Multiple hearth roaster, flash roasting, fluidized bed roasting and blast roasting.

UNIT-II

Pelletisation and Sintering, Smelting: Principles of reduction and matte smelting with examples. Smelting furnaces: Reverberatory, Blast Furnace and electric smelting. Flash smelting.

Slags: Classification, properties, Application of Ellingham diagrams for oxides and sulphides.

UNIT-III

Hydrometallurgy: Flowchart, Principles and types of leaching, Advantages and limitations, Solution purification by ion and solvent exchange methods, Metal recovery from leach solution by cementation.

UNIT-IV

Classification of electrometallurgy, Principles of electrometallurgy, Advantages and limitations of electrometallurgy, Electro winning and Electro refining with typical examples.

UNIT-V

Principles of Refining: Fire refining, Distillation, liquation, electro-refining and zone refining with some examples.

Text Books:

1. Non-ferrous extractive metallurgy: H.S.Ray, K.P.Abraham and R.Sreedhar, Affiliated East West Private Limited, 2008.
2. Principles of extractive metallurgy - H.S. Ray & A. Ghosh, New - Age International Publisher, 3rd Edition, 2018.

Reference Books:

1. Extractive Metallurgy: Process and Applications: Sujay Kumar Dutta, Avinash B. Lele and Yakshil B. Chokshi, PHI Learning Pvt. Ltd., 2018.
2. A text book of metallurgy - A. R. Bailey, Macmillan & Co, 1st edition, 1960.
3. Principles of extractive metallurgy - Terkel Rosenqvist, Tapir Academic Press, 2004.

Course Outcomes:

At the end of the course the student will be able to:

1. Classify the different ores and describe the various units operating like pyro metallurgy, hydrometallurgy and electrometallurgy.
2. Differentiate the various types of slags, properties and their applications.
3. Illustrate with the help of flow sheet of process taking place in pyro metallurgy, hydrometallurgy and electrometallurgical extractions of metal/matte.
4. Choose the type of refining process according purity required.
5. Understand the impact of extractive process on health environment society and will be able to suggest suitable techniques to recycle the byproducts or to decrease energy consumptions.
6. Design the suitable process for extraction.

METALLURGICAL THERMODYNAMICS

II Year B.Tech. II-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Nil

Course Objectives:

This course is mainly intended to deals with

1. The laws of diffusion.
2. Interpret Ellingham diagrams
3. Identify metallurgical thermodynamics principles to be applied in phase diagrams.

UNIT-I

Diffusion: Fick's laws of diffusion and its applications, Kirkendall effect, Darken's equations, the Matano Method. Determination of intrinsic diffusivities, self diffusion in pure metals, Temperature dependence of the diffusion coefficient, diffusion along the grain boundaries and surfaces.

UNIT-II

Ellingham Diagrams: Introduction, calculation of equilibrium constants from standard free energy changes, general description of Ellingham diagrams, Interpretation of free energy changes Vs. temperature lines, Richardson's diagrams.

UNIT-III

Thermal Properties: Specific heats of solids, classical theory, Einstein and Debye's models of the lattice.

Anharmonicity, thermal expansion, thermal conductivity of solids, lattice thermal conductivity and thermo-electric effects. Stability of crystal disorders.

UNIT-IV

Solutions: Solution definition, Composition, partial molal quantities, ideal solutions, Raoult's Law, actual (Nonideal) solutions, Sievert's law, Gibbs - Duhem equation, integration of Gibbs - Duhem equation, Excess thermodynamics quantities.

Application to phase diagrams: Concept of chemical potential, equality of chemical potentials in equilibrated phases, Derivation of Gibbs phase rule, solidus and liquidus lines for an ideal solution, calculation of liquidus line for eutectic systems.

UNIT-V

Reversible Cells: Electro- Chemical cells, galvanic cells, chemical and electrical energy, thermodynamics of Electro-chemical cells, standard electrode potentials, sign convention of electrode potentials, application of Gibbs - Helmholtz equation to galvanic cells. Concentration Cells.

Text Books:

1. Physical Chemistry for Metallurgist by J. Mackowick, Allen and Unwin publisher, 1966.
2. Physical Chemistry of Metals by LS Darken and Gurry, CBS publisher and Distributor, 2002.

Reference Books:

1. Thermodynamics of solids by RA Swalin, Wiley VCH; 2nd edition, 1973.
2. Essentials of Metallurgical Thermodynamics – R.H. Tupkary, Khanna Book Publishing Co. (P) Ltd. 2016.
3. Principles of Metallurgical Thermodynamics: Subir Kumar Bose, Sanat Kumar Roy, Universities Press, 2014.

Course Outcomes:

Obtain the skill to use Metallurgical Thermodynamics concept for

1. Understand and able to use Fick's I and II law.
2. Interpret Ellingham Diagram for oxides.
3. Understand the thermal properties of solids, specifically, specific heat and some models for specific heat calculation.
4. Knowledge of ideal and regular solutions and free energy of mixing.
5. Apply the phase rule on the metallurgical systems.
6. Understanding of the nature of polarized electrochemical reactions and an introduction of their application in corrosion behavior of metals.

FUELS, FURNACES & REFRACTORIES

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. Relate the properties and applications of solid, liquid and gaseous fuels.
2. Broad knowledge on modes of heat transfer.
3. Describe the different types of refractories and pyrometers and their properties and uses.
4. Have a basic knowledge on working of different types of furnaces.

UNIT–I

Introduction to Fuels technology: Classification of fuels, Origin and classification of coal, Proximate and ultimate analysis of coal and its applications. Properties and uses of Pulverized coal, Carbonization of coal and types of Carbonization. Properties, uses and testing of Metallurgical Coke.

Liquid fuels: Properties and applications.

UNIT –II

Manufacture, properties and uses of Producer gas and Water gas.

Modes of heat transfer, Importance of heat transfer. Steady State Heat Transfer: Conduction through plane, cylindrical, Spherical and compound walls. Convection: Free and Forced conventions. Heat transfer by combined effect of conduction and convection between two fluids separated by a plane wall and cylindrical wall.

UNIT-III

Furnaces: Classification and uses of furnaces, characteristic features of Vertical Shaft furnaces, Reverberatory furnaces, Arc and Induction furnaces, Tube and Muffle type Resistance furnaces, Continuous furnaces. Heat losses in furnaces and heat balance.

UNIT-IV

Pyrometry: Thermo electric pyrometer - Peltier and Thomson e.m.f. Thermo-electric power of thermocouples. Required properties of thermocouples. Noble and base metal thermocouples.

Principle, operation and applications of Thermometer, Optical and Radiation pyrometers.

UNIT – V

Refractories: Classification and desirable properties of refractories, modes of failure of refractories in service and their prevention. Manufacturing methods and properties of Fireclay, Silica, Magnesite, Dolomite, Chromite and Carbon refractories. Testing of Refractories, Applications of refractories in the metallurgical industries.

Text Books:

1. Fuels, Furnaces and Refractories – O.P. Gupta, 6th edition, Khanna Publishers, 1989.
2. Metallurgical furnaces – Krivadan and Markov, MIR publishers, 1980.

Reference Books:

1. Elements of fuel technology – HIMUS, TBS The Book Service Ltd; 2nd Revised edition 1958.
2. Furnaces - J. D. Gilchrist, Pergamon Pr; 2nd edition, 1977.
3. Pyrometry -W.P. wood & J. M. Corck.
4. Elements of heat transfer - Jakob & Hawikns, John Wiley & Sons, 3rd edition, 1957.
5. Elements of thermodynamics & heat transfer - Obert & Young, McGraw-Hill Inc., US, 3rd edition,1962.
6. Control systems & Instrumentation – S. Bhasker.

Course Outcomes:

At the end of the course the student would be able to:

1. Know about a fuel, classify them and compare different types of fuels and describe their testing methods. Explain the coke making process, list out the properties and its by-products recovery and suggest methods for decreasing environmental pollution and energy consumption.
2. Apply principles of heat and mass transfer to basic engineering systems and understand the basic concepts and laws of the three modes of heat transfer and apply analytical techniques to the solution of conduction heat-transfer problems.
3. Classify and explain construction and working of different furnaces. Analyze the causes of heat losses in furnaces and suggest methods of minimization of heat loss and waste heat recovery.
4. Describe the operation of a thermocouple. Describe various temperature-measuring devices - thermometers and pyrometers. Discuss the principles that govern noncontact thermal measurements and describe the operation of optical and radiation pyrometers.
5. Explain various manufacturing and testing processes of refractories. Itemize many examples of metallurgical refractories under different categories, their main properties and applications. Link inherent properties of the refractory mineral and how it affects the production technology and the application.
6. Select the relevant fuel, furnace and refractory material for the metallurgical operations and can justify the interpretation.

PHYSICAL METALLURGY LAB

II Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Physical Metallurgy

Course Objectives:

The laboratory course helps to:

1. Gain skills of preparation of samples for metallographic examinations.
2. Find and analyze the microstructures of various ferrous and non ferrous materials.
3. Use the suitable metallurgical microscope with suitable magnification.

List of Experiments:

1. Preparation and study of Crystal models.
2. Study of various microscopes (Optical microscope, SEM, TEM) and specimen preparation techniques for metallurgical microscope.
3. Metallographic preparation and microstructure evaluation of low carbon steel.
4. Metallographic preparation and microstructure evaluation of medium carbon steel.
5. Metallographic preparation and microstructure evaluation of high carbon steel.
6. Metallographic preparation and microstructure evaluation of different cast irons (grey cast iron, white cast iron, malleable cast iron, spheroidal graphite iron).
7. Metallographic preparation and microstructure evaluation of Copper.
8. Metallographic preparation and microstructure evaluation of Brass.
9. Determination of phase fraction and grain size using Image analyzer.
10. Drawing of the Binary phase diagrams of Isomorphous (Cu-Ni), Eutectic (Pb-Sn, Al-Si) and partial solubility diagram (Al-Cu) with interpretation.
11. Drawing of complex binary phase diagrams (Al_2O_3-SiO_2, MgO-Al_2O_3) and identification of points, lines and areas in them.
12. Experiments to obtain cooling curves for pure metals and alloys and to establish binary phase diagram.

Course Outcomes:

By completing this laboratory course, students:

1. Can describe the metallurgical microscope, sample preparation, mounting and use/choosing of different etching reagents.
2. Can identify and report the microstructural features of ferrous and non ferrous samples observed.
3. Can operate optical microscope with an ease.
4. Characterize microstructures of engineering alloys using optical microscopy and image analyzer.
5. Prepare formal laboratory reports.

PRINCIPLES OF EXTRACTIVE METALLURGY LAB

II Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Principles of Extractive Metallurgy

Course Objectives:

1. This is course is design to give knowledge about different types of extraction processes.
2. Know the importance of EMF series.

List of Experiments

1. Important flow sheets for Metal Extraction.
2. Electro Cleaning of a given material by using electrolysis principle.
3. Electro Etching of a given material by using electrolytic cell.
4. Electro polishing of a given material by using electrolytic cell.
5. Importance of EMF series.
6. Calculate cathode current efficiency electro plating of Copper.
7. Calculate cathode current efficiency electroplating of Nickel.
8. Galvanization of Zinc on mild steel.
9. Electrowinning of Copper by using aqueous electrolyte.
10. Electrowinning of Copper by using prepared electrolyte from raw materials.

Course Outcomes:

1. To study the importance of EMF series.
2. Understand different types of electro cleaning, electro etching, electro polishing techniques.
3. Study the concepts of metal extraction processes.
4. To calculate cathode current efficiency of electroplating of metals.
5. To perform electrowinning of Cu by different electrolytes.
6. To perform galvanisation of Zinc

FUELS, FURNACES AND REFRACTORIES LAB

II Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Nil

Course Objectives:

This laboratory course deals with:

1. Analysis of fuels and their importance.
2. Characterization of refractories.
3. Use different types of fuel testing equipment.

List of Experiments:

1. Proximate analysis of Coal (percentage of moisture, volatile matter, ash content & Fixed Carbon).
2. Ultimate analysis of Coal (Carbon, hydrogen, sulfur and oxygen).
3. Determination of Flash and Fire points of diesel using PENSKY MARTINS open and closed cup apparatus.
4. Determination of Flash and Fire points of kerosene using PENSKY MARTINS open and closed cup apparatus.
5. Determination of Flash and Fire points of diesel using ABEL's apparatus.
6. Determination of Flash and Fire points of kerosene using ABEL's apparatus.
7. Determine the effect of kinematic viscosity of lubricant oil by using Red - wood Viscometer-I.
8. Determine the effect of kinematic viscosity of lubricant oil by using Red - wood Viscometer-II.
9. Determine the calorific value of coal by using "Bomb Calorimeter".
10. Determination of apparent density of refractories.

Course Outcomes:

At the end of the course the student would be able to:

1. Gain hands-on experience on the equipment that facilitate property evaluation of fuels, and refractories.
2. Choose the fuels and refractories for specific use in construction and operation of different furnaces.
3. Select fuels, refractories to minimize overall cost of production for given applications.
4. Operate various types of fuel testing equipment and analyze the observations recorded.

CONSTITUTION OF INDIA

II Year B.Tech. II-Sem

L	T	P	C
2	0	0	0

Course Objectives: Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution

UNIT – I

History of Making of the Indian Constitution- History of Drafting Committee - Philosophy of the Indian Constitution- Preamble Salient Features.

UNIT – II

Contours of Constitutional Rights & Duties - Fundamental Rights

- Right to Equality
- Right to Freedom
- Right against Exploitation
- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies
- Directive Principles of State Policy
- Fundamental Duties.

UNIT – III

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT – IV

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO ZilaPanchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT – V

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Text Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

MANAGEMENT FUNDAMENTALS FOR ENGINEERS

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Course Objectives:

To understand the Management Concepts, applications of Concepts in Practical aspects of business and development of Managerial Skills for Engineers.

UNIT I

(a) **Introduction to Management** Evolution of Management, Nature & Scope - Functions of Management-Role of Manager-levels of Management-Managerial Skills - Challenges-Social Responsibility &Ethics.

(b) Planning & Organizing: Planning-Planning Process - Types of Plans – MBO - Organization Design - Organizational Structure – Departmentation – Delegation - Centralization – Decentralization – Recentralization - Organizational Culture - Organizational climate - Organizational change.

UNIT II

Human Resource Management – Human Resource Planning - Recruitment & Selection - Types & Process of selection - Training & Development - Performance appraisal methods - Employee Separation - Stress Management Practices-cross cultural management - Diversity.

UNIT III

Operation Management - Introduction to Operations Management - Principles and Types of Plant Layout-Methods of production (Job Batch and Mass production) - Method study and Work Measurement - Quality Management – TQM - Six sigma - Inventory Management - EOQ - ABC Analysis - JIT System-Business Process Re-engineering (BPR) - Bench marking.

UNIT IV

Marketing Management - Introduction to Marketing-Functions of Marketing-Marketing vs. Selling-Marketing Mix - Marketing Strategies - Product Life Cycle - Market Segmentation -Types of Marketing - Direct Marketing - Network Marketing - Digital Marketing - Social media marketing - Supply Chain Management (SCM).

UNIT V

Project Management - Introduction to Project Management - steps in Project Management - Project Planning - Project Life Cycle-Network Analysis - Program Evaluation & Review Technique(PERT) - Critical Path Method(CPM) - Project Cost Analysis - Project Crashing - Project Information Systems - Project Risk Management.

Suggested Readings:

1. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.
2. Principles of Management, Anastasia H. Cortes, David S. Bright, and Eva Hartmann 2019.
3. Essentials of Management, Koontz Kleihrich, Tata Mc - Graw Hill.
4. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013.
5. Industrial Engineering and Management: Including Production Management, T.R.Banga, S.C Sharma, Khanna Publishers.

Course Outcome: The students understand the significance of Management in their Profession. The various Management Functions like Planning, Organizing, Staffing, Leading, Motivation and Control aspects are learnt in this course. The students can explore the Management Practices in their domain area.

HEAT TREATMENT AND PHASE TRANSFORMATIONS

III Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Physical Metallurgy

Course Objectives:

1. This course is mainly designed to impart knowledge about basic principles and process variables of different heat treatment processes.
2. Thermo mechanical treatment, Surface hardening techniques, heat treatment of steels, cast irons, non ferrous alloys will also be dealt in detail.
3. Identification of heat treatment defects and related knowledge of heat treatment furnaces will also be dealt in detail.

UNIT-I

Principles of Heat Treatment of steels, Formation of Austenite on heating, Austenitic grain size, determination and decomposition of austenite. TTT and CCT curves. Effect of alloying elements on TTT curves and Fe-Fe_3C diagram. Phase Transformations: Pearlitic Transformation, Bainitic Transformation, Martensitic Transformation, Order-disorder transformation, Spinodal decomposition.

UNIT-II

Annealing, Normalizing, Hardening and tempering. Mechanism of heat removal during quenching, quenching media, size effect and mass effect. Tempering and its stages, Austempering, Martempering, Subzero treatment, Patenting. Hardenability of steels, Factors affecting and its determination.

UNIT-III

Surface Heat Treatment: Principles and Applications of Carburizing, Nitriding, Carbonitriding, Nitrocarburizing, Boronizing and Aluminizing. Thermal Surface Modification Processes - Flame, Induction and Laser hardening. Thermo mechanical treatments: HTMT, LTMT, Ausforming, Isoforming, Cryoforming.

UNIT–IV

Heat-Treatment of Cast Irons, Copper and its alloys and Aluminium and its alloys.

UNIT-V

Heat treatment furnaces, Atmospheres and their design, Heat treatment defects.

Text Books:

1. Heat Treatment Principle and Techniques, 2nd edition – T.V. Rajan, C.P. Sharma, Ashok Sharma, 2011.
2. Phase Transformations in Metals and Alloys, 4th edition - David A. Porter, Kenneth E. Easterling, and Mohamed Y. Sherif, CRC Press, Taylor & Francis Group, 2021

Reference Books:

1. Heat Treatment of Metals - Vijendra Singh, Standard Publishers Distributors, 2020.
2. Engineering Physical Metallurgy –Y. Lakhtin, CBS Publishers & Distributors, 2009.
3. Physical Metallurgy for Engineers - R. Varney Wilbur Donald S. Clark, published by Affiliated East-West Press (Pvt.) Ltd, 2018.
4. Physical Metallurgy Principles - Robert E. Reed-Hill, published by Affiliated East-West Press, 2008.

Course Outcomes:

At the end of the course the student will be able to:

1. Apply and interpret phase and continuous cooling diagrams information to assess the impact of a range of heat treatment procedures.
2. Demonstrate a critical understanding of the importance of heat treatment in achieving fit for purpose in metals and alloys.
3. Learn the fundamentals of microstructure modifications through thermo mechanical and surface heat treatment processes to achieve the desired properties.
4. Propose suitable heat treatment procedures for non ferrous metals like Cu, Al etc.
5. Identify and give reasons for the heat treatment defects and explain the various heat treatment furnaces and atmospheres.
6. Correlate the microstructure properties, processing and performance of alloys.

MECHANICAL METALLURGY

III Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Nil

Course Objectives:

1. To gain an understanding of the response of various metals under the application of stress and/or temperature.
2. To build necessary theoretical back ground of the role of lattice defects in governing both elastic and plastic properties of metals will be discussed.
3. Obtain a working knowledge of various hardness testing machines BHN, VHN, RHN.
4. Obtain a working knowledge of creep and fatigue and analysis of data.

UNIT-I

Metallurgical fundamentals: Defects in crystalline materials – Point defects and line defects. The concept of dislocations, edge dislocation and screw dislocation. Slip and twinning. Interaction between dislocations, sessile dislocation, glissile dislocation, energy of a dislocation, dislocation climb, Jogs, forces on dislocations. Frank Reed source, Critical resolved shear stress.

UNIT–II

Hardness Test: Methods of hardness testing – Brinell, Vickers, Rockwell, Shore and Poldi methods, Microhardness test, relationship between hardness and other mechanical properties.

The Impact Test: Notched bar impact test and its significance, Charpy and Izod Tests, fracture toughness testing - COD and CTOD tests, significance of transition temperature curve, metallurgical factors affecting on transition temperature, temper embrittlement.

UNIT-III

The Tension Test: Mechanism of classic action, linear elastic properties. Engineering stress-strain and True stress-strain curve. Tensile properties, conditions for necking, effect of temperature and strain rate on tensile properties. Elastic and in-elastic action and properties in compression test.

Fracture: Elementary theories of fracture, Griffith's theory of brittle fracture, ductile fracture, notch sensitivity. Strain-Energy release rate, Stress Intensity Factor, Fracture Toughness and design, K_{IC} Plane-Strain Toughness testing, plasticity corrections, J-Integral.

UNIT–IV

Fatigue Test: Introduction, Stress cycles, S-N Curve, mechanism of fatigue failure, effect of mean stress, stress concentration, size, surface condition and environments on fatigue. Effect of metallurgical variables on fatigue. Low-cycle fatigue. High-cycle fatigue and thermal fatigue.

UNIT–V

Creep and Stress Rupture: Introduction, The creep curve, Stress-rupture test, structural changes during creep, mechanism of creep deformation, theories of creep. Fracture at elevated temperature, effect of metallurgical variables on creep.

Text Books:

1. Mechanical Metallurgy – G. E. Dieter, 3rd edition, published by McGraw Hill Education, 2017.
2. Mechanical behavior of material - Thomas H. Courtney, Published by Waveland Pr Inc, 2005.

Reference Books:

1. Engineering Materials Science – Cedric William Richards, published by Literary Licensing, LLC, 2012.
2. Mechanical behavior, 3rd Edition - Wayne Hayden, William G. Moffatt, John Wulff published by John wiley and Sons, Inc, 1974.
3. Mechanical Metallurgy – White & Lemay.

Course Outcomes:

At the end of the course the student will be able to:

1. Interpret the effect of crystalline defects on the behavior of metals.
2. Can conduct hardness, Impact test and interpret COD, CTOD and DBTT diagrams.
3. Determine the appropriate test for analysis of tensile and compression properties of materials.
4. Can design creep and fatigue resistant materials.
5. Assess and describe the mechanism leading failure of a given material.
6. Solve numerical problems and gain of knowledge of how to incorporate material strength limitation into engineering design.

METAL CASTING

III Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Nil

Course Objectives:

This course is mainly intended to

1. Introduce and explain various moulding, casting techniques and equipment used.
2. Principles of Solidification of casting, defects in castings and their remedies are also dealt in detail.

UNIT - I

Scope and development of foundry, Types of foundries. Introduction to Foundry - Steps involved in casting, advantages, limitations and applications of casting process. Pattern types, allowances for pattern, pattern materials, color coding and storing of patterns.
Moulding methods and processes - materials, equipment, Moulding sand ingredients, essential requirements, sand preparation and control, testing, cores and core making - its types.

UNIT - II

Sand castings - Green and dry, pressure die casting, Gravity die casting, permanent mould casting, centrifugal casting, precision investment casting, shell Moulding, CO_2 Moulding, Recently developed processes - V-forming, full mould process: Furon-no-bake sand moulds and cores. Continuous casting - squeeze casting, Cold setting and self-setting processes.

UNIT - III

Purpose of the gating system, Components of gating system and its functions, Design of gating system, Types of gates, Gating ratio and its functions, Gating systems and their characteristics.

UNIT - IV

Solidification of metals, Homogeneous and heterogeneous nucleation, Growth mechanism, Solidification of Pure metals and alloys, Coring or Segregation, Solidification time and Chvorinov's rule, concept of progressive and directional solidifications, Metallurgical aspects of Casting. Melting furnaces - crucibles oil fired furnaces - electric furnaces - cupola, selection of furnace, calculation of cupola charges - Degasification, inoculation, pouring techniques.

UNIT - V

Gray Cast iron- effect of chemical composition, carbon equivalent, and effect of alloying. Production of gray Cast Iron, ductile iron and malleable iron castings. Melting of Aluminium and Copper alloys. Casting defects arising due to moulding, coring, melting and pouring practice.

Text Books:

1. Principles of Metal Casting - Heine, Loper and Rosenthal, Tata Mc Graw Hill Publishing Co, Ltd; New Delhi, 1995.
2. Foundry Technology - Peter Beeley, Elsevier Science Publisher, 2001

Reference Books:

1. Foundry Technology - Dharmendra Kumar / S.K.Jain, CBS Publisher, 2007.
2. Metal Casting: Principles and Practice, 1st edition by T.V. Ramana Rao, Newagepublishers,1996,
3. Principles of Foundry Technology, 5th edition by P. L. Jain, published by McGraw Hill Education, 2017

Course Outcomes:

This course would pave a platform for students to develop a thorough understanding on

1. Have fundamental knowledge of possibilities of using castings in different practical applications from their design and material point of view.
2. Understand different types of pattern, core and mould making processes.
3. Have basic knowledge of casting and its gating system.
4. Learn Principle and theory of solidification of metals during casting in relation with the properties.
5. Evaluate the effect of chemical composition of grey cast iron and casting defects.
6. Learn more by practical knowledge and develop their scientific and technical competences in the field of foundry.

CERAMICS AND COMPOSITE MATERIALS
(Professional Elective - I)

III Year B.Tech. I -Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. Develop understanding of the structure of ceramic materials on multiple length scales.
2. Develop knowledge of point defect generation in ceramic materials, and their impact on transport properties.
3. To describe key processing techniques for producing metal, ceramic and polymer-matrix composites.
4. To demonstrate the relationship among synthesis, processing and properties in composite materials.

UNIT-I

Introduction – classification of ceramics – imperfections in ceramics – structure of ceramics – crystal structures – oxide structures – silicate structures – glass formation – types of glasses.

UNIT-II

Ceramic Phase diagrams: Study of binary phase diagrams like MgO-NiO; CaO-MgO; MgO-Al_2O_3, $Al_2O_3 - SiO_2$.

UNIT-III

Composite materials – Introduction – classification of composite materials based on structure – based on matrix – functional requirements of reinforcement and matrix - advantages and applications of composites.

UNIT-IV

Fibers: Fabrication, structures, properties and applications of glass fibers, boron fibers, carbon fibers, organic fibers, ceramic fibers and metallic fibers.
Matrix materials: Polymers, metals and ceramic matrix materials.

UNIT-V

Manufacturing of composites: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon fiber composites.

Text Books:

1. Introduction to Ceramics by William David Kingery, John Wiley and Sons Ltd. publishers, 1976.
2. Composite Materials-science and Engineering, 2nd edition - Krishan K. Chawla, Springer (Sie) publishers, 2006.

Reference Books:

1. Engineering Materials and their applications, 4th edition - Richard A. Flinn, Paul K. Trojan, Wiley publishers, 1990.
2. Hand book of Fibre – reinforced composite materials – George Lubin, Springer publishers, 1982.

Course Outcomes:

1. Identify and explain the types of ceramic materials and their applications.
2. Illustrate and interpret the ceramic phase diagrams.
3. Identify and explain the types of composite materials and their characteristic features
4. Predict and list out the properties matrix and reinforcement materials
5. Describe fundamental fabrication processes for polymer matrix, metal matrix, and ceramic matrix composites
6. Able to undertake any technical assignment in R&D and production of newer and smarter materials.

COMPUTATIONAL MATERIALS ENGINEERING
(Professional Elective – I)

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course objective:

1. This course introduces computational methods in the domain of metallurgical engineering.
2. To understand the structure property correlations in materials engineering.
3. To understand evolution of materials structure and to control material properties.
4. To calculate the miscellaneous problems by using computational techniques.

UNIT- I

Introduction, **Tools of the trade: a short tutorial introduction:** The C programming language, GNU plot – the plotting freeware, GNU Octave for computations and plotting, Introduction to FEM, FDM, FVM and Computer packages: MATLAB, Sci Lab. Plotting, Fitting, Interpolation, Numerical integration, Numerical differentiation.

UNIT-II

Structure and Thermodynamics: Basics of Mathematical Modelling-Deterministic and stochastic / probabilistic models. Structure and defects. Computing free energy of common metallurgical systems from enthalpy and entropy or heat capacity and determination of temperature of reduction of metal oxides. Regular solution model.

UNIT- III

Phase Transformations: Mathematical formulation of Solid state processes of Heat treatment & Microstructure evolution, Diffusion and precipitate growth kinetics. Transport phenomena based Modelling: model formulation based on heat, mass and momentum transfer, governing equations and boundary conditions. Spinodal decomposition, Classical Molecular Dynamics Modelling and simulations and its applications in materials, Monte Carlo simulations: phase separation and ordering.

UNIT-IV

Phase-Field and Heat-Mass Transfer: Mathematical formulation of Liquid state Metallurgical Processes of Iron Making, Primary Steel Making and Secondary Steel Making using Momentum, Mass and Energy Balance. Principles of Computational Fluid flow and setting up the governing equation with boundary conditions. Formulation of Laminar and Turbulent flows. Case Studies of Tapping of Liquid steel, melting behaviour of additions, IGP. Computation of % CO/CO_2 at different heights with a given function of temperature profile along the height of BF and Simulations of Blast furnace reduction reactions at various heights. Mathematical Modeling of Solidification of Steel in Sand Moulds, Ingot Moulds & Concast.

UNIT-V

New approach: Optimization and control. Elements of modern artificial intelligence (AI) related techniques. Introduction to Genetic Algorithm and Artificial Neural Nets. Discritized Methods of Taylor's series expansion, polynomial Interpolation and least square approximation for numerical computation of Non linear algebraic equations, ODE & PDE. Statistical methods for validating models.

Text Books:

1. Introduction to Computational Materials Science – Richard Lesar, Cambridge University Press publishers, 2013.
2. Applied Numerical Methods for Engineers using MATLAB and C - Robert J. Schilling & Sandra L. Harris, Cengage Learning (2007).

Reference Books:

1. Mathematical Methods for Physics and Engineering, 3rd Edition – K.F. Riley, M.P. Hobson and S.J. Bence, Cambridge University Press, 2006.
2. Modeling in Materials Processing – Jonathan A. Dantzig, Charles L. Tucker III, Cambridge University Press Publishers, 2001.
3. Materials Science and Engineering, 5th edition - V Raghavan, published by Prentice-Hall India s, 2004.
4. Advanced Engineering Mathematics, 10th edition - Erwin Kreyszig, Published by Wiley, 2010.
5. Modelling of Steel Making Processes, 1st Edition, - Dipak Mazumdar, James W. Evans, Published by CRC Press, 2010.
6. An Introduction to Computational Fluid Dynamics, 2nd edition - H.K.Versteeg , W. Malalsekera, Pearson Education Limited, 2007.
7. Numerical Methods for Engineers, 7th Edition - Steven C. Chapra and Raymond P. Canale, published by Mc Graw Hill Education, 2015.
8. Handbook of Materials Modelling, 2nd edition, Wanda Andreoni and Sidney Yip published by Springer, 2020.
9. Numerical Methods for Engineers, 4th edition - Santosh K. Gupta, New Age International publishers, New Delhi, 2019.

Course Outcomes:

At the end of the course the student should be able to:

1. Analyse a metallurgical problem to create a well posed numerical problem.
2. Identify initial and boundary conditions of a problem relevant to materials domain.
3. Propose a solution procedure for a numerical problem in the domain of materials engineering.
4. Demonstrate ability to quantify a materials engineering problem through numerical analysis.
5. Select materials for specific applications and also to design advanced materials for new applications.
6. To use preferred tools at electronic, continuum and structural levels.

FERRO ALLOY TECHNOLOGY
(Professional Elective – I)

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

The prime objective of the course is to

1. Make the student aware of various ferroalloys their properties and uses.
2. To expose the students to various production methods of ferro alloys.

UNIT-I

Mechanical equipment of ferro alloy furnaces: Principle elements, Closed top furnaces, Lining of furnaces. Electrical equipment and dimensions of reaction chamber.

UNIT-II

Manufacture of Ferro – Silicon: Raw materials, furnaces, Physico – chemical conditions of the process, Melt procedure.

Manufacture of Ferro – chrome: Chrome Ores, Methods for making ferro – chrome, High-carbon ferro – chrome, Low-carbon and Extralow carbon ferro – chrome.

UNIT-III

Manufacture of Ferro – Manganese: High-Carbon Ferro-Manganese, Silicon – Manganese, Medium and Low - Carbon Ferro-Manganese.

Manufacture of Ferro – Vanadium: Recovery of vanadium form Ores, Chemical processing of vanadium slags, Smelting of Ferro-Vanadium.

UNIT-IV

Manufacture of Ferro – Tungsten: Physico - chemical properties of Tungsten, smelting of Ferro-Tungsten.

Manufacture of Ferro – Titanium: Physico - chemical properties of Titanium, smelting of Ferro- Titanium.

UNIT-V

Manufacture of Ferro – Molybdenum: Physico - chemical properties of Molybdenum, Charge materials and charge preparation and smelting of Ferro- Molybdenum.

Manufacture of Ferro – Boron: Physico - chemical properties of Boron, smelting of Ferro-Boron.

Text Books:

1. Production of Ferroalloys - Mark Riss. and Yakov. Khodorovsky - Mir Publishers, Moscow 1967.
2. Electrometallurgy of Steel and Ferro alloys - F. P. Edneral, Mir Publishers 1979.

Reference Book:

1. Symposium on ferro alloys - NML Technical Jl. - Feb 1962.
2. Handbook of Ferroalloys Theory and Technology, 1st Edition by Michael Gasik published by Butterworth-Heinemann, 2013.

Course Outcomes:

At the end of the course, student would be able to:

1. Can list out the various ferro alloys, their applications, illustrate and know the importance of design of furnaces.
2. Explain the process/production methods for Ferro – Silicon and Ferro – chrome and the necessary corrective steps to be taken to overcome the problems arising during production.
3. Describe the raw materials and production for Ferro – Manganese, Ferro – Vanadium process.
4. Describe the smelting procedure of Ferro – Tungsten and Ferro – Titanium.
5. Appreciate the need for recover, reuse, and recycle of by-products.
6. Judge and predict the future of Ferro alloy technology.

HEAT TREATMENT AND PHASE TRANSFORMATIONS LAB

III Year B.Tech. I-Sem

L	T	P	C
0	0	3	1.5

Pre-Requisites: Heat Treatment and Phase Transformations

Course Objectives:

This course is mainly designed to

1. To conduct various heat treatment processes, surface hardening techniques and age hardening processes on different materials.
2. Gain knowledge of phase transformations taking place under various conditions of heat treatment.

List of Experiments:

1. Annealing of plain carbon steel and observation of microstructure.
2. Normalizing of plain carbon steel and observation of microstructure.
3. Hardening of plain carbon steel with quenching in water and brine solution and observation of microstructures.
4. Hardening of plain carbon steel with quenching in oil and observation of microstructure.
5. Effect of tempering temperature on plain carbon steel.
6. Effect of tempering time on plain carbon steel.
7. Age hardening of Aluminium - Copper alloys.
8. Spheroidizing of a given high carbon steel.
9. Surface hardening of plain carbon steel.
10. Determination of hardenability of medium carbon steel by Jominy end quench test.
11. Determination of phase fraction and grain size using Image analyzer.

Course Outcomes:

At the end of the course the student will be able to:

1. Conduct heat treatment in furnaces under suitable/ required time, temperature and atmospheric conditions.
2. Modify the microstructures of metals and alloys through heat treatment practice for obtaining desired properties in present and future.
3. To modify the surface properties of steels.
4. To determine hardenability by performing Jominy end quench test
5. Analyze, correlate and interpret the results obtained in the tests conducted.
6. Report the observations in a formal manner.

MECHANICAL METALLURGY LAB

III Year B.Tech. I - Sem

L	T	P	C
0	0	3	1.5

Pre-Requisites: Mechanical Metallurgy

Course Objectives:

Students will be able:

1. Demonstrate skill in using different hardness testing machines.
2. Explain the rationale for using particular loads in testing hardness and tensile properties of materials.
3. Knowledge of the standard specimens dimensions and determining toughness of materials by impact test.
4. Become aware of working principle and use of various Non Destructive Tests.

List of Experiments:

1. Determine the hardness of ferrous and non-ferrous samples using Brinell hardness.
2. Determine the hardness of ferrous and non-ferrous samples using Rockwell hardness.
3. Tension test:
    a. Determine the Tensile properties of ductile ferrous materials.
    b. Determine the Tensile properties of ductile non-ferrous materials.
4. Determine the Compression properties of brittle materials.
5. To determine the Toughness of the given material by Charpy and Izod (V & U Groove notch).
6. Determination the variation of formability of the given various thickness materials by Erichson cupping test.
7. Liquid penetrant Test: To detect the surface flaws in a given materials by dye penetrant.
8. To detect the surface flaws in steel by fluorescent penetrant method.
9. Magnetic flaw detector: To inspect a given material for cracks.
10. Ultrasonic flaw detection: To inspect a given material for locating cracks.

Course Outcomes:

After completing the course, the student will be able:

1. Explain the methods of destructive testing (Hardness testing, Tensile testing, Impact and cupping tests) and non destructive testing (LPT, MPT and UT).
2. Analyze, interpret and present the observation from the tests conducted.
3. Identify the reasons for failure through Non Destructive Examination.
4. Can prepare formal laboratory reports describing the experimental and the results obtained.
5. Solve material problems associated by proper testing.

METAL CASTING LAB

III Year B.Tech. I - Sem

L	T	P	C
0	0	2	1

Pre-Requisites:

Course Objectives:

1. This lab course is designed to provide hands on experience on various foundry testing methods for evaluation of moulding sand properties.

LIST OF EXPERIMENTS:

1. Preparation of gating system using green sand.
2. Study of particle size distribution of the sand.
3. Study of the variation of permeability of the green sand with clay and water.
4. Determination of the variation of sand properties like green hardness, green compact strength with additives in sands.
5. Determination of the variation of hot compact hardness and hot shear strength with additives in sands.
6. Determination of clay content in sand.
7. Determination of the shatter index of green sand.
8. Melting and casting of Aluminum alloys.
9. Melting and casting of Cast Iron.
10. Charge calculations of cast iron in a cupola.
11. Non-destructive testing of cast iron components.

Course Outcomes:

1. Broad knowledge about different types of pattern materials and designing of patterns.
2. Understand different methods of particle size measurement and properties measurements.
3. Determination of clay content present in the mould sand.
4. Understanding of different Nondestructive techniques for testing of materials
5. Able to prepare patterns with sand
6. Able to operate cupola furnace

INTRODUCTION TO ARTIFICAL INTELLIGENCE

III Year B.Tech. I - Sem

L	T	P	C
2	0	0	0

Course Objectives: To train the students to:

- Understand different types of AI agents, various AI search algorithms, fundamentals of knowledge representation, building of simple knowledge-based systems.
- To apply knowledge representation, reasoning. Study of Markov Models enable the student ready to step into applied AI.

UNIT - I

Introduction: AI problems, Agents and Environments, Structure of Agents, Problem Solving Agents

Basic Search Strategies: Problem Spaces, Uninformed Search (Breadth-First, Depth-First Search, Depth-first with Iterative Deepening), Heuristic Search (Hill Climbing, Generic Best-First, A*), Constraint Satisfaction (Backtracking, Local Search).

UNIT - II

Advanced Search: Constructing Search Trees, Stochastic Search, A* Search Implementation, Minimax Search, Alpha-Beta Pruning

Basic Knowledge Representation and Reasoning: Propositional Logic, First-Order Logic, Forward Chaining and Backward Chaining, Introduction to Probabilistic Reasoning, Bayes Theorem.

UNIT - III

Advanced Knowledge Representation and Reasoning: Knowledge Representation Issues, Nonmonotonic Reasoning, Other Knowledge Representation Schemes.

Reasoning Under Uncertainty: Basic probability, Acting Under Uncertainty, Bayes' Rule, Representing Knowledge in an Uncertain Domain, Bayesian Networks.

UNIT - IV

Learning: What Is Learning? Rote Learning, Learning by Taking Advice, Learning in Problem Solving, Learning from Examples, Winston's Learning Program, Decision Trees.

UNIT - V

Expert Systems: Representing and Using Domain Knowledge, Shell, Explanation, Knowledge Acquisition.

Text Book

1. Russell, S. and Norvig, P, Artificial Intelligence: A Modern Approach, Third Edition, Prentice - Hall, 2010.
2. Artificial Intelligence, Elaine Rich, Kevin Knight, Shivasankar B. Nair, The McGraw Hill publications, Third Edition, 2009.

Reference Books

1. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 6th ed., 2009.

Learning resources:

1.www.techopedia.com
2.www.classcentral.com

Course Outcomes:

- Classify basic search strategies for application to AI problems.
- Use probabilistic reasoning for search trees.
- Correlate the domain knowledge for learning and decision process.

METALLURGY FOR NON METALLURGISTS
(Open Elective - I)

III B.Tech. Met. Engg. II-Semester

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To describe the basic principles of metallurgy and the importance of metallurgy in various disciplines of engineering.
2. Gain thorough knowledge about heat treatment of steels.
3. Gain knowledge about properties and uses of cast irons and non ferrous metals.
4. Gain working knowledge of basic testing methods for metals.

UNIT-I

Introduction: Crystal structure and defects, Crystal structure of metals, Classification of steels, Carbon steels.

UNIT-II

Heat Treatment of Steels: The Iron carbon systems, Common phases in steels, Annealing, Normalizing, Hardening and tempering.

UNIT-III

Cast irons: Properties and applications of Ductile irons, Malleable irons, Compacted graphite iron.

UNIT-IV

Non Ferrous Metals: Properties and applications of Light Metals (Al, Be, Mg, Ti), Super alloys.

UNIT-V

Testing of Metals: Hardness testing, Tensile Testing, Impact Testing, Fatigue Testing.

Text Books:

1. Materials Science and Engineering: An introduction, 9^{th} edition - William D. Callister Jr., David G. Rethwisch, published by John Wiley, 2013.
2. Introduction to Physical Metallurgy, 2^{nd} edition – Sidney H Avner, published by Tata Mc Graw-Hill ,1997.

Reference Books:

1. Engineering Physical Metallurgy, 1st Edition – Y Lakhtin, published by CBS Publishers & Distributors, 2005.
2. Experimental Techniques in Materials and Mechanics - C. Suryanarayana, CRC Press, 2011.
3. Foundations of Materials Science and Engineering, 5th edition – William F. Smith Professor, Javad Hashemi Prof., published by Mc-Graw Hill, 2009.
4. Physical Metallurgy for Engineers, 2nd Edition - Donald Sherman Clark and Wilbur Richmond Varney, CBS Publishers, 1962.
5. Mechanical Metallurgy, 3rd Edition – George E. Dieter Published by Mc Graw Hill Education, 2017.

Course Outcomes:

At the end of the course student will be able to:

1. Classify steels and understand the different crystal structures of metals and defects.
2. Establish heat treatment process – structure – properties correlation.
3. Know the metallurgical and mechanical properties of various cast iron and their applications.
4. Justify the choice of light metals and super alloys based on their properties.
5. Evaluate the various mechanical properties in materials by different methods.
6. Able to understand the areas and domains of metallurgy and materials.

NON-FERROUS EXTRACTIVE METALLURGY

III Year B.Tech. II-Sem

L	T	P	C
4	0	0	4

Pre-Requisites: Mineral Dressing and Principles of Extractive Metallurgy

Course Objectives:

1. To explain the various methods of extraction of non ferrous metals.
2. To draw the flow sheets for extraction of various non ferrous metals.
3. To describe the procedure and equipment used for production of non ferrous metals from their ores.

UNIT-I

Copper: Principal Ore and Minerals; Matte smelting – Blast furnace, Reverberatory; Electric furnace, Flash; Converting; Continuous production of blister Copper; Fire refining; Electrolytic refining, Hydro-Metallurgical copper extraction, Leaching processes, Recovery of copper from leach solutions, Electro-winning.

UNIT-II

Zinc: General Principles: Horizontal and vertical retort processes, Production in a Blast furnace, Leaching purification, Electrolysis, Refining.

Lead: Blast furnace smelting, Refining of lead bullion.

UNIT-III

Aluminium: Bayer process: Hall - Heroult process: Anode effect: Efficiency of the process: Refining, Alternative processes of aluminum production.

UNIT-IV

Magnesium: Production of a hydrous Magnesium chloride from seawater and magnesite. Electro-winning practice and problem, refining, Pidgeon and Hansgrig processes.

Titanium: Upgrading of ilmenite, chlorination of titania, Kroll's process. Refining.

UNIT-V

Uranium: Acid and alkali processes for digestion of uranium ores, Purification of crude salt, Production of reactor grade UO_2 and uranium.

Simplified flow sheets for the extraction of nickel, tungsten and gold. Review of non-ferrous metal industries in India.

Text Books:

1. Extraction of Non-Ferrous Metals – H.S. Ray, K.P. Abraham and R. Sridhar, Published by East West Press, 2020.
2. Metallurgy of Non-Ferrous Metals, 1st edition – W.H. Dennis, published by Sir Isaac Pitman & Sons Ltd, 1954.

Reference Books:

1. Rare Metals Hand book, 2nd Edition - Clifford A. Hampel, Published by Krieger Publishing Company, 1971.
2. Nuclear Reactor General Metallurgy, 1st Edition - B. Kuznetsov Sevryukov N, Kuzmin B, Chelishchev - Peace Publishers, 1965.
3. Nuclear Chemical Engineering, 2nd Edition - Manson Benedict, Thomas Pigford, Hans Levi, Published by McGraw-Hill Education, 1981.

Course Outcomes:

At the end of the course, student would be able to recommend:

1. Get detailed information about the properties of non ferrous metals, ores of non ferrous metals, pre treatment processes, thermodynamics and kinetics involved in extraction process.
2. Describe and explain ore treatment techniques and learn the fundamental concepts of metallurgical pre-treatment methods, production of metals from ore, concentrate and secondary sources.
3. Emphasize the strategic importance of raw and supplementary materials in the production, and explain the concepts of technological and economical feasibility.
4. Identify the beneficiation of by products materialize during the metal production, within the framework of technology-environment-ecology.
5. Explain processes based on an advanced thermodynamic perspective and explain material and energy flows related to extraction of metals and alloys.
6. Understand about extractive metallurgy processes and explain their relative merits and demerits and also conduct a detailed and individual research about production of a specific metal, as part of their responsibility.

METAL FORMING

III Year B.Tech. II-Sem

L	T	P	C
3	1	0	4

Pre-requisites: Mechanical Metallurgy

Course Objective:

1. Gain an understanding of fundamentals of metal working.
2. Analyze the behavior of metals during plastic deformation.
3. Obtain a working knowledge of forging, rolling, extrusion, and wiredrawing.

UNIT-I:

FUNDAMENTALS OF METAL WORKING: Classification of forming processes, Mechanics of metal working for slab method and uniform deformation energy method. Cold working, Recovery, Recrystallization and grain growth, hot working, Strain-Rate effects, Work of plastic deformation.

UNIT - II:

FORGING: Classification of forging processes, forging equipment. Forging in plane strain. Open-die forging, closed-die forging, Forging of a cylinder in plane-strain. Forging defects, powder metallurgy forging.

UNIT-III:

ROLLING OF METALS**:** Classification of rolling processes, rolling mills. Hot rolling, cold rolling, rolling of bars and shapes, forging and geometrical relationships in rolling.
Simplified analysis of rolling load, rolling variables, problems and defects in rolled products. Theories of hot rolling, torque and horsepower, theories of cold rolling, torque and horsepower.

UNIT-IV:

EXTRUSION: Classification of extrusion processes, extrusion equipment. Hot extrusion. Deformation and defects in extrusion. Analysis of extrusion process. Cold extrusion. Extrusion of tubing and production of seamless pipe and tubing.

UNIT-V:

Rod and wire drawing, tube drawing processes, residual stresses in rod, wire and tubes.
Sheet metal forming processes.

Text Books:

1. Mechanical Metallurgy, 3rd Edition - by George E. Dieter, Published by McGraw Hill Education, 2017.
2. Engineering Metallurgy (Part-II) – Raymond Aurelius Higgins, Published by English Universities Press, 1960

Reference Books:

1. Fundamentals of Metal Forming Processes, 2nd Edition – B.L. Juneja, New age International Publishers, 2018.
2. Technology of Metal Forming Processes – Surender Kumar, PHI publication, 2008.
3. Handbook of Metal Forming Process - Darren Wang, published by NY Research Press, 2015.

Course Outcomes:

At the end of the course the student will be able to:

1. Compare and classify different forming processes.
2. Analyze the behaviour of materials during forming processes.
3. Determine forming processes controlling parameters.
4. Estimate required forming loads, powers of different forming equipment and processes.
5. Determine the cause of the defects that may take place during forming processes.
6. Integrate knowledge gained in this course to select and design a complete metal forming system.

IRON MAKING AND STEEL MAKING TECHNOLOGIES

III Year B.Tech. II-Sem

L	T	P	C
4	0	0	4

Pre-Requisites: Mineral Dressing, Thermodynamics and Kinetics and Principles of Extractive Metallurgy

Course Objectives:

1. To provide the knowledge of Iron making by Blast Furnace, Physico- chemical principles involved in iron making.
2. To provide knowledge of the various types of steel making processes, and the importance of slag and its control mechanisms.
3. Explain and describe the importance of modern steel making processes.

UNIT-I

Raw materials for Iron making, Preparation of iron ores; Agglomeration of Iron ore fines: Sintering - Purpose and Principle, Factors affecting sintering, sintering bonds; Pelletisation - Purpose and Principle, Production of green pellets, Induration of pellets.

UNIT-II

Iron making through blast furnace route, Blast Furnace profile and its design, refractory lining, blast furnace cooling system, raw materials handling and charging. Construction and operation of Hot blast stoves. Gas cleaning system and its utilization.

UNIT-III

Physical chemistry of Iron making, Blast furnace reactions, Physical and chemical factors affecting reduction of ores; Effect of temperature, CO/CO_2 and H_2/H_2O on reduction of iron ore. Control of C, Si, S, P in pig iron. Blast furnace operations and difficulties, modern trends in blast furnace.

UNIT-IV

Classification and raw materials of steel making. Principles of Steel making, Removal of carbon, silicon, manganese, phosphorous and sulphur. Role of slag, types and properties of slags. Principles and types of deoxidation.

UNIT-V

Basic oxygen steel making: LD, LDAC, oxygen steel making, Ingot casting, Continuous casting of steel.

Text Books:

1. A first course in iron and steel making - Dipak Mazumdar, Published by Orient Blackswan Pvt. Ltd., 2015.
2. Iron making and steelmaking: Theory and Practice - Ahindra Ghosh and Amit Chatterjee, published by PHI Learning Private Limited, 2008.

Reference Books:

1. Extractive Metallurgy 1: Basic Thermodynamics and Kinetics, 1st Edition - Alain Vignes Published by Wiley – ISTE Ltd., 2013.
2. Extractive Metallurgy 2: Metallurgical Reaction Processes, 1st Edition - Alain Vignes Published by Wiley – ISTE Ltd., 2013.
3. Extractive Metallurgy 3: Processing Operations and Routes, 1st Edition - Alain Vignes Published by Wiley – ISTE Ltd., 2013.
4. An introduction to Modern Steel Making, 7th Edition - R. H. Tupkary, Khanna Publishers, 2000.
5. An introduction to Modern Iron Making, - R. H. Tupkary, Khanna Publishers, 2004.

Course Outcomes:

At the end of this course the student will be able to:

1. Describe the raw materials and agglomeration techniques for production of pig iron in the blast furnace.
2. Illustrate and describe the blast furnace and its auxiliary equipments, analyse the physical and chemical processes taking place in blast furnace and factors influencing the quality of the blast furnace product.
3. Analyse the irregularities and causes of failures in blast furnace and apply remedial measures for immediate rectification and relate the modern trends to improved productivity and quality.
4. Explain the principles of steel making process and describe the various production techniques for quality steel making.
5. Explain the conventional/ingot casting practice in steel making, auxiliary units and their importance in casting and the various cast structures obtained and their control mechanism.
6. Able to undertake any technical assignment in R&D and production units with professional responsibility towards profession and society.

METAL JOINING
(Professional Elective - II)

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-requisites: None

Course Objectives:

1. To provide with the knowledge on basics of joining processes
2. To gain the knowledge on the Gas and Arc welding and Resistance and Pressure welding processes.
3. To gain the knowledge on the special welding processes and soldering and brazing techniques.
4. To gain hands on experience on inspection and testing of weldments.

UNIT-I

Basic Science of Welding Processes. Sources of heat energy, the flame, the electric arc. Chemical reactions during welding, oxidation reaction, protection of weld pool with fluxes or gases. Microstructural changes during welding, the effect of heat on metals. Pre-treatment and post-treatment of welds.

UNIT-II

Gas and Arc Welding processes: Classification of welding processes- fusion welding processes, oxy-acetylene welding, arc welding-manual, submerged arc welding, gas tungsten arc and gas metal arc welding; practice, joint design and preparation and their advantages and disadvantages

UNIT-III

Resistance and Pressure Welding processes: Pressure welding- Cold and hot pressure welding, friction and friction stir welding, and diffusion welding. Resistance welding- spot and projection welding; practice, joint design and preparation and their advantages and disadvantages.

UNIT-IV

Special welding processes: Principle, equipment, process variables, merits, Limitations and applications of Electron beam, plasma arc and laser beam welding processes.

Soldering and Brazing: Principles and practices.

UNIT-V

Concept of Weldability and its assessment, dilution**.**

Inspection and Testing of Welds and Joints. Mechanical testing. Non-destructive testing. Weld defects- their causes and remedies.

Text Books:

1. Welding Processes and Technology, 3rd Edition, - Dr. R.S. Parmar, Khanna Publishers, 2013.
2. Modern Welding Technology, 4th edition - Howard B. Cary, Published by Prentice Hall, New Jersey, USA, 1997.

Reference Books:

1. ASM Metals Handbook. Vol.6: Welding Brazing & Soldering - ASM International, Metals Park, Ohio, USA, 1997.
2. "Welding", Vol-2, 10th Edition – A.C. Davies, Published by Cambridge University Press, 2008.
3. Metallurgy of Welding, 3rd Edition - J.F. Lancaster, London George Allen & Unwin, Boston, 1980.

Course Outcomes:

1. Know the basic science of welding processes and list out their types and the principles guiding the operations. Appreciate the effect of welding parameters on the structure and mechanical properties of welded parts.
2. Identify different energy sources like electron beam, laser beam, plasma arc, explosion welding, ultrasonic welding etc., and analyze the concept, mechanism, parameters associated with the processes.
3. Demonstrate weld design procedures and also describe soldering and brazing techniques convincingly.
4. Categorize different welding techniques for metals, alloys, non metals, dissimilar metals etc.,
5. Understand the causes of welding defects and how they can be prevented.
6. Selectively select a process for a specific application/ need/situation depending upon the availability of sources.

NON METALLIC MATERIALS
(Professional Elective - I)

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To introduce the student to the range of non-metallic materials available for engineering.
2. To understand the classification and significance of nonmetallic materials to apply them in Industries.
3. To get an exposure to the techniques associated with the synthesis, processing and characterization of these materials.
4. To become aware of the applications where these materials are preferred.

UNIT-I

Definition and classification of materials, comparison of properties of metals and nonmetallic materials. Nature of bonding.

UNIT-II

Ceramics: Structure, defects. Ionic and semiconducting behavior. Processing techniques. Glasses and glass-ceramics, glass fibres. Structural ceramics: fracture toughness, toughening mechanisms. Special ceramics: Electro-optic, dielectric, ferroelectric, piezoelectric, magnetic, superconducting, laser and dilute magnetic and bio-ceramics.

UNIT-III

Polymers: Structure, properties and applications of thermoplastics and thermosets. Conducting and biopolymers.

UNIT-IV

Composites: Introduction, classification, and applications of composite materials. Manufacturing of Polymer matrix, metal matrix, and ceramic matrix composites.

UNIT-V

Textiles. Adhesives, and Foams: Introduction, classification and applications of textile materials. Structure of Adhesives and their applications. Classification and applications of foam materials, Manufacturing methods of industrially important adhesives and foams.

Text Books:

1. Textbook of Polymer Science 3rd Edition - Fred W. Billmeyer, Published by Wiley 2007.
2. Introduction to Ceramics, 2nd Edition - W. David Kingery, H.K. Bowen, Donald R. Uhlmann, published by Wiley India Pvt Limited, 2012.

Reference Books:

1. Composite Materials: Science and Engineering, 4th Edition - Krishan K. Chawla, Springer, 2019.
2. Principles of Materials Science and Engineering, 3rd Edition - William Smith, Published by McGraw-Hill Education, 1995.
3. Materials Science and Engineering, 6th Edition - V. Raghavan, published by Prentice Hall India Learning Private Limited, 2015.

Course Outcomes:

After completing this course the student can:

1. List the prominent non-metallic materials available for engineering applications.
2. Indicate the synthesis and processing steps associated with non-metallic materials.
3. Indicate the structure property relations in non-metallic materials.
4. Understand the behavior of each non-metallic material in detail.
5. Indicate the uses for which non-metallic materials are preferred.
6. Explain the manufacturing methods of industrially important adhesives and foams.

ELECTRONIC MATERIALS
(Professional Elective - II)

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre- Requisites: Nil

Course Objectives:

1. To become familiar with the science, synthesis, evaluation, and applications of electronic materials.
2. To know the manufacturing processes associated with use of electronic materials for devices.

UNIT- I

Electronic structure and its relevance in crystalline materials: Review of quantum mechanics: Electron as waves and particles; Wave-function; Electron as a plane-wave, Operators; Schrodinger Equation, Wave-vector (k); Energy of free-electron as a function of wave-vector k (ε - k diagram, a parabola), k-space; Density-of states [g(ε)]; Fermi-sphere, -energy, -surface, -temperature, and – velocity. Electrons in a solid following Fermi-Dirac distribution; DC conductivity in metals. Lattice; Bravais-Lattice; Wigner-Seitz cell; k-space: Reciprocal space; Reciprocal lattice and it's connection to its direct-lattice, Brillouin zone; Von-Lau condition of Bragg diffraction and boundaries of Brillouin-zone being the Bragg-Planes Electrons in a periodic-potential; Bloch Theorem, Kronig-Penny model; Origin of energy bands and band-gap; Free electron band diagram, Extended-, Periodic and reduced-zone representation for ε - k diagram; Allowed number of states in a band.

UNIT-II

Electron Dynamics: Group-velocity, electron dynamics from ε - k diagram and the concept of effective-mass and concept of holes; Conductivity in relation to band structure; Band structure of metals and semiconductors, and insulators; Band-overlap: why some metals show positive charge carriers in Hall-effect.

UNIT- III

Semiconductors and Magnetic Materials: Band diagrams, direct and indirect bandgap, applications of semiconductors; Effective-mass of electron in conduction-band and that of hole in valence-band Intrinsic semiconductors: Fermi-level; Density-of-states near the edges of conduction and valence-band; Fermi-dirac statistics approximated by Maxwell-Boltzman; Intrinsic charge-carrier concentration, Law-of mass-action; Direct vs Indirect Semiconductors, Extrinsic-semiconductor: Hydrogen-model for rough estimate of the donor and acceptor energy level, n- and p-type semiconductors; Population of impurity levels in thermal equilibrium, charge-carrier concentration in n- and p- type semiconductors; Fermi-level, Degenerate and non-degenerate semiconductors, determination of dopant levels and mobility measurements Semiconductor Devices: p-n junction and solar cells; Bandgap engineering: Solid-state LEDs, Lasers and IR detectors. Orbital and spin - permanent magnetic moment of atoms, diamagnetism, paramagnetism, and Pauli-paramagnetism, Ferro, anti-ferro and ferri magnetism, Fe, Co and Ni and alloy additions, ferrites, magnetic hysteresis, exchange energy, magnetocrystalline energy, magnetorestriction; Highly correlated systems. Applications: Spintronics and memory devices Superconductors, Multiferroic materials

UNIT- IV

Ionic conductors and Dielectric materials: Ionic conduction – review of defect equilibrium and diffusion mechanisms; Theory of ionic conduction, conduction in glasses; Effect of stoichiometric and extrinsic defects on conduction, Applications in sensors and fuel cells.

Dielectric constants and polarization, linear dielectric materials, capacitors; Polarization mechanisms; Non-linear dielectrics, pyro-, piezo-, and ferro-electric properties, hysterisis and ferroelectric domains; Applications in sensors, actuators and memory devices.

UNIT -V

Manufacturing of Electronic Materials: Introduction to semiconductor manufacturing. History, overview of process flow, manufacturing goals. Scaling. Wafer manufacturing. Si ingot preparation. Poly to single crystal conversion. Czochralski vs. float zone method. IC device manufacturing overview. Thermal oxidation. Doping. Lithography. Etching and growth. Metallization and growth.

Text Books:

1. Electronic Properties of Materials, 4th Edition - Rolf E. Hummel, Published by Springer, 2011.
2. Physical Properties of Semiconductors, 1st Edition - Charles M. Wolfe, Nick Holonyak and Gregory E. Stillman, Published by Prentice Hall, 1989.
3. Semiconductor Materials, Devices and Fabrication - Parasuraman Swaminathan, Published by Wiley, 2017.

Reference Books:

1. Principles of Electronic Materials and Devices,4th Edition - Safa. O. Kasap Prof., Published by McGraw Hill Education, 2017.
2. Electronic Materials by James R. Chelikowsky, Alfonso Franciosi (Eds.), Published by Springer-Verlag, 2011.
3. Electronic Materials and Processes Handbook, 3rd Edition - Charles A. Harper published by McGraw Hill, 2003.

Course Outcomes:

After completing this course the student should be able to:

1. Indicate and explain important scientific parameters associated with electronic materials.
2. Describe different semiconductors and their properties with examples.
3. Explain the features and functioning of several electronic devices.
4. Describe the manufacturing processes associated with electronic materials and devices.
5. Use simple band diagrams to understand the optical activity of a semiconductor.

METAL FORMING LAB

III Year B.Tech. II-Sem

L	T	P	C
0	0	3	1.5

Pre Requisites:

Course Objectives:

This lab course is designed to know

1. To know the behaviour of the materials under various types of loading.
2. Provide knowledge and experience in the measurement of various material properties.
3. To operate the various equipment like Erichson cupping, Rolling mill etc.., and analyze the process in them.

LIST OF EXPERIMENTS:

1. Determination of forming limit diagram
2. Kinetics of static recrystallization in a cold worked metal.
3. Growing of single crystals by Strain annealing technique.
4. Verification of Hall-Petch relation.
5. The work hardening and strain rate sensitivity of a metal.
6. The effect of plastic anisotropy on the deformation behaviour.
7. The effect of rolling variables on the mechanical properties of metals.
8. Forging operations in the production of a hook.
9. Ring compression test to determine the friction coefficient.
10. The flow pattern in plasticine clay when extruded through a die.
11. The defects produced in rolled and forged products.

Course Outcomes:

1. To know the behaviour of the materials under various types of loading.
2. Provide knowledge and experience in the measurement of various material properties.
3. Determine strain hardening exponent, effect of grain size and plastic anisotropy under various types of experiments/ practical conditions.
4. Determine the effect of process variables affecting various forming methods.
5. Work on forging, extrusion and rolling mills and analyze and interpret the outcome of the processes.
6. Prepare formal laboratory reports.

METAL JOINING LAB

III Year B.Tech. II-Sem

L	T	P	C
0	0	3	1.5

Pre Requisites:

Course Objectives:

1. It also designed to make the student to understand and demonstrate the various types of welding processes and its variables.
2. Understand and apply the principles of metal casting process and develop relation between input and output parameters.
3. To study the various modes of metal transfer that exists in welding processes.

LIST OF EXPERIMENTS:

1. Making of welded joints using conventional welding processes- arc welding.
2. Making of welded joints using conventional welding processes- gas welding.
3. Making of at least one joint using TIG Welding techniques of mild steel.
4. Making of at least one joint using MIG Welding techniques of mild steel.
5. Soldering
6. Arc welding of dissimilar metals
7. Microstructure study of HAZ
8. Testing of welded joints – Hardness survey and Tensile test
9. Microstructure study of welded joints
10. Inspection of welded joints by dye penetration, Magnetic methods and ultrasonic method.

Course Outcomes:

1. To identify welding process.
2. To analyse the HAZ after welding.
3. To prepare weld joints using different methods.
4. To test weld joints and study them.
5. To join different metals by soldering methods.
6. To prepare laboratory reports.

ADVANCED ENGLISH COMMUNICATION SKILLS LAB

III Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

1. Introduction

The introduction of the Advanced Communication Skills Lab is considered essential at 3rd year level. At this stage, the students need to prepare themselves for their careers which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalised context.

The proposed course should be a laboratory course to enable students to use 'good' English and perform the following:

- Gathering ideas and information to organize ideas relevantly and coherently.
- Engaging in debates.
- Participating in group discussions.
- Facing interviews.
- Writing project/research reports/technical reports.
- Making oral presentations.
- Writing formal letters.
- Transferring information from non-verbal to verbal texts and vice-versa.
- Taking part in social and professional communication.

2. Objectives:

This Lab focuses on using multi-media instruction for language development to meet the following targets:

- To improve the students' fluency in English, through a well-developed vocabulary and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
- Further, they would be required to communicate their ideas relevantly and coherently in writing.
- To prepare all the students for their placements.

3. Syllabus:

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills (AECS) Lab:

1. **Activities on Fundamentals of Inter-personal Communication and Building Vocabulary** - Starting a conversation – responding appropriately and relevantly – using the right body language – Role Play in different situations & Discourse Skills- using visuals - Synonyms and antonyms, word roots, one-word substitutes, prefixes and suffixes, study of word origin, business vocabulary, analogy, idioms and phrases, collocations & usage of vocabulary.
2. **Activities on Reading Comprehension** –General Vs Local comprehension, reading for facts, guessing meanings from context, scanning, skimming, inferring meaning, critical reading & effective googling.

3. **Activities on Writing Skills** – Structure and presentation of different types of writing – *letter writing/Resume writing/ e-correspondence/Technical report writing/* – planning for writing –improving one's writing.
4. **Activities on Presentation Skills** – Oral presentations (individual and group) through JAM sessions/seminars/**PPTs** and written presentations through posters/projects/reports/ e-mails/assignments etc.
5. **Activities on Group Discussion and Interview Skills** – Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and organization of ideas and rubrics for evaluation- Concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele-conference & video-conference and Mock Interviews.

4. Minimum Requirement:

The Advanced English Communication Skills (AECS) Laboratory shall have the following infrastructural facilities to accommodate at least 35 students in the lab:

- **Spacious room with appropriate acoustics.**
- **Round Tables with movable chairs**
- **Audio-visual aids**
- **LCD Projector**
- **Public Address system**
- **P – IV Processor, Hard Disk – 80 GB, RAM–512 MB Minimum, Speed – 2.8 GHZ**
- **T. V, a digital stereo & Camcorder**
- **Headphones of High quality**

5. Suggested Software:

The software consisting of the prescribed topics elaborated above should be procured and used.

- **Oxford Advanced Learner's Compass**, 7th Edition
- **DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.**
- **Lingua TOEFL CBT Insider**, by Dreamtech
- **TOEFL & GRE**(KAPLAN, AARCO&BARRONS, USA, Cracking GRE by CLIFFS)

6. Books Recommended:

1. **Effective Technical Communication** by M Asharaf Rizvi**.** McGraw Hill Education (India) Pvt. Ltd. 2nd Edition
2. **Academic Writing: A Handbook for International Students b**y Stephen Bailey, Routledge, 5th Edition
3. **Learn Correct English – A Book of Grammar, Usage and Composition** by Shiv K. Kumar and Hemalatha Nagarajan. Pearson 2007
4. **Professional Communication** by Aruna Koneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
5. **Technical Communication** by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.

6. **Technical Communication** by Paul V. Anderson. 2007. Cengage Learning pvt. Ltd. New Delhi.
7. **English Vocabulary in Use** series, Cambridge University Press 2008.
8. **Handbook for Technical Communication** by David A. McMurrey& Joanne Buckley. 2012. Cengage Learning.
9. **Communication Skills** by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.
10. **Job Hunting by** Colm Downes, Cambridge University Press 2008.
11. **English for Technical Communication for Engineering Students,** Aysha Vishwamohan**, Tata Mc Graw-Hil 2009.**

INTRODUCTION TO CYBER SECURITY

III Year B.Tech. II-Sem

L	T	P	C
2	0	0	0

Prerequisites: NIL

Course objectives:

- To familiarize various types of cyber-attacks and cyber-crimes.
- To give an overview of the cyber laws.
- To study the defensive techniques against these attacks.

UNIT - I

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

UNIT - II

Cyberspace and the Law & Cyber Forensics: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy.
Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

UNIT - III

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

UNIT- IV

Cyber Security: Organizational Implications: Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations.

Cybercrime and Cyber terrorism: Introduction, intellectual property in the cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

UNIT - V

Privacy Issues: Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.

Cybercrime: Examples and Mini-Cases

Examples: Official Website of Maharashtra Government Hacked, Indian Banks Lose Millions of Rupees, Parliament Attack, Pune City Police Bust Nigerian Racket, e-mail spoofing instances.

Mini-Cases: The Indian Case of online Gambling, An Indian Case of Intellectual Property Crime, Financial Frauds in Cyber Domain.

Text Books:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

References:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.

Online resources :

1.https:// www.mygreatlearning.com
2.https://sl-cources.iitb.ac.in
3.https://iitk.talentsprint.com

Course Outcomes:

The students will be able to

- Understand cyber-attacks, types of cybercrimes, cyber laws
- Understand how to protect them self and ultimately the entire Internet community from such attacks.

INTRODUCTION TO INSTRUMENTATION

IV Year B.Tech. I-Sem

L	T	P	C
2	0	0	2

Pre- Requisites: Nil

Course Objectives:

To have a knowledge of:

1. Electronic Instruments.
2. Pressure measurements.
3. Flow measurements.
4. Vibration, Viscosity and Humidity Level measurement.
5. Various analyzers.

UNIT-I

Electronic Instruments: CRO- Storage oscilloscope – Digital voltage meter (DVM) –Digital multi meter – XY Recorder, Strip chart recorder – Digital recording- Data logger – Introduction to virtual instrumentation.

UNIT-II

Pressure Measurements: Unit of Pressure – Manometers- Different types, - Elastic type pressure gauges – Bourdon tube – Bellows – Diaphragm – Elastic elements with LVDT and strain gauge – Capacitive type pressure gauge – Measurement of vacuum – McLeod gauge – Thermal conductivity gauge – Ionisation gauge.

UNIT-III

Flow Measurements: Flow meters – Variable head type flow meter – Orifice plate – Venture tube – Positive displacement flow meter: Nutating disc, Reciprocating piston, oval gear and helix type flow meter – Rota meter – Mass flow meters.

UNIT-IV

Vibration, Viscosity, Humidity, Level Measurement: Mechanical type vibration measuring instruments – Seismic instruments as an accelerometer- Vibrometers – Viscosity – Saybolt viscometer. Humidity – Hot wire electro type hygro meter - Dew cell – Electrolysis type hygrometer.

UNIT- V

Analyzers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyzer – Sodium analyzer – Silica analyzer – Turbidity meter – Gas analyzer – NOx analyzer – H_2S analyzer – CO and CO_2 monitor, Dust & Smoke measurement.

Text Books:

1. Alan S. Morrris. Principles of Measurement and Instrumentation, Prentice-Hall of India Pvt., Ltd. New Delhi, 1999.
2. Ernest O Doeblin. Measurement Systems Application & Design, Tata McGraw Hill Publishing Co., New. Delhi, 1999.

Reference Books:

1. Murthy, D.V.S. Transducers and Instrument and Instrumentation, Prentice Hall of India Pvt. Ltd. New Delhi.
2. Patranabir, D. Principle of Industrial Instrumentation, Tata McGraw Hill Publishing Co., New Delhi 1999.
3. Jain, R.K. Mechanical and Industrial Measurements, Khanna Publishing, New Delhi, 1999.
4. Liptak B.G. Instrumentation Engineers Hand Book (Measurement), Chilton Book Co., 1994 .

Course Outcomes:

1. The knowledge gained on electronic, pressure, flow and vibration measurement will provide a strong platform to understand the concepts on these subjects for further learning**.**
2. Comprehend various pressure measurements.
3. Make accuracy statements for various types of measurements.
4. Differentiate between digital and analogue measurements and demonstrate advantages/disadvantages of each.
5. To be able to describe the operation of instruments used for various gas, liquid and solid materials.

TESTING OF MATERIALS
(Open Elective- II)

IV B.Tech. Met. Engg. I-Semester

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Course Objectives:

1. To gain an understanding of the response of various metals under the application of stress and/or temperature.
2. Obtain a working knowledge of various hardness testing machines BHN, VHN, RHN
3. Obtain a working knowledge of creep and fatigue testing methods and analysis of data.
4. To get an exposure to NDT techniques for detection of various types of flaws.

UNIT–I

Introduction, Importance of testing.

Hardness Test: Methods of hardness testing – Brinell, Vickers, Rockwell hardness tests.

The Impact Test: Notched bar impact test and its significance, Charpy and Izod Tests, fracture toughness testing - COD and CTOD tests, significance of transition temperature curve.

UNIT-II

The Tension Test: Engineering stress-strain and True stress-strain curves. Tensile properties, conditions for necking. Stress-Strain diagrams for Steel, Aluminum and Cast Iron.

UNIT-III

Fatigue Test: Introduction, Stress cycles, S-N Curve, Effect of mean stress, mechanism of fatigue failure, effect of stress concentration, size, surface condition and environments on fatigue.

UNIT–IV

Creep and Stress Rupture: Introduction, The creep curve, Stress-rupture test, structural changes during creep, mechanism of creep deformation, theories of creep. Fracture at elevated temperature.

UNIT–V

NDT: Principle, operation, advantages and limitations of Liquid Penetrant, Magnetic Particle, Radiography and Ultrasonic tests.

Text Books:

1. Mechanical Metallurgy, 3rd Edition – George E. Dieter, published by Mc Graw Hill Education, 2017.
2. Testing of Metallic Materials, 2nd Edition - A.V.K. Suryanarayana, published by BSP Books Private Limited, 2018.

Reference Books:

1. Testing of Metals - Alok Nayar, published by Tata Mc Graw Hill, 2005.
2. Mechanical Behaviour and Testing of Materials, 1st edition – A.K. Bhargava and C.P. Sharma published by PHI Learning, 2011.

Course Outcomes:

At the end of the course the student will be able to:

1. Understand and interpret the results of various hardness tests and impact tests.
2. Evaluate various tensile properties of ferrous and non-ferrous metals and solve problems related to the tensile tests.
3. Analyze the modes of failure occurring due to fatigue and suggest remedial measures.
4. Analyze the methods of failure of materials at high temperature by creep and stress rupture and the mechanisms responsible for fracture.
5. Determine appropriate tests to be employed to determine the given mechanical properties using both destructive and non-destructive techniques.
6. Knowledge of various testing methods based on destructive & non destructive techniques and their importance in enhancing service life of the component.

ENVIRONMENTAL DEGRADATION OF MATERIALS

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Engineering Chemistry, Thermodynamics and Kinetics and Principles of Extractive Metallurgy.

Course Objectives:

1. Electrometallurgy principles in deposition winning and the efficiency of the bath to be discussed.
2. Testing methods are to be studied. Various ways in which corrosion takes place in metals / alloys together with corrosion protection methods and tests conducted are to be studied.
3. Able to use principles to understand, the prevention of corrosion.

UNIT-I

Electro chemical principles, Nernst equation, electrode potentials, Faradays laws. Polarization, passivity, environmental effects (oxygen, oxidizers, velocity, temperature, corrosive concentration, Galvanic coupling).

UNIT – II

Forms of corrosion, uniform corrosion, galvanic corrosion, EMF and Galvanic Series, Pitting corrosion, Crevice corrosion. Intergranular corrosion.

UNIT - III

Stress corrosion cracking: crack morphology, stress effects, environmental factors, metallurgical factors, Erosion corrosion: cavitation damage, fretting corrosion,

UNIT-IV

Corrosion prevention methods: Alteration of Environment (Inhibitors), Design, Coatings, cathodic and anodic protection. Material selection, Metallurgical aspects, Hydrogen damage (hydrogen blistering, Hydrogen embrittlement, Prevention), Electroplating.

UNIT - V

Corrosion fatigue, Corrosion testing methods: Immersion technique, Linear polarization, salt spray method, and Corrosion rate calculations.

Text Books:

1. Corrosion Engineering, 3rd Edition – Mars Fontana, published by McGraw Hill Education, 2017.
2. Electrometallurgy – William Blum.

Reference Books:

1. An Introduction to Electrometallurgy & Corrosion - Dr. R. Sharan and Satya Narain published by Standard Publishers Distributors, 2017.
2. Corrosion Engineering: Principles and Solved Problems, 1st Edition - Branko N. Popov published by Elsevier, 2015
3. Handbook of Corrosion Engineering, 2nd Edition - Pierre R. Roberge, published by McGraw-Hill Education, 2012.

Course Outcomes:

1. Outline the electrochemistry of the corrosion process.
2. Identify and analyze the "Eight Forms of Corrosion".
3. Describe the effects of specific corrosion environments prevailing in the oil and gas industry.
4. Select appropriate corrosion monitoring and control techniques.
5. To design for corrosion protection, minimization.
6. Review and select appropriate materials for corrosion resistant applications.

LIGHT METALS & ALLOYS
(Professional Elective – III)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

This course is mainly intended:

1. To give an exposure of various alloy systems, phase diagrams and their applications.
2. To highlight the importance of alloy selection.
3. To demonstrate the influence of composition, processing and microstructural effect on properties of the non ferrous alloys.

UNIT-I

Aluminium alloys: Classification, Properties and applications, Physical metallurgy of Al-Cu alloys, Al-Mg alloys, Al-Zn alloys, Al-Mn alloys, Al-Si alloys, Al-Li alloys, Ternary alloys, Al-Cu-Mg alloys, Al-Si-Mg alloys and Al-Zn-Mg alloys.

UNIT-II

Magnesium Alloys: Classification, properties and applications, Alloying elements to magnesium and their purpose, Designation of magnesium alloys, Mg-Al-Zn alloys, Corrosion resistance of Mg-alloys.

UNIT-III

Zinc Alloys: Classification, Properties and applications. Alloying elements to zinc and their purpose. Designation of Zinc alloys.

UNIT-IV

Titanium alloys: Classification, properties and applications, Ti-6Al-4V, Ti-8Al-1Mo-1V, Ti-13V-11Cr-3Al alloys. Titanium alloys for aerospace and aero engine applications.

UNIT-V

Beryllium alloys: Classification properties and applications, Al-Be alloys, Corrosion resistance of Beryllium alloys.

Text Books:

1. Light alloys: Metallurgy of the Light Metals, 5th Edition - Ian Polmear, David St.John, Jian-Feng Nie, Ma Qian published by Butterworth-Heinemann, 2017.
2. Introduction to Physical Metallurgy, 2nd Edition – Sidney H. Avner, published by McGraw Hill Education, 2017

Reference Books:

1. Heat Treatment, structure and properties of Nonferrous Alloys - Charlie R. Brooks, Published by ASM International, 1982.
2. Engineering Physical Metallurgy, 1st Edition – Lakhtin published by CBS Publishers and Distributors Pvt. Ltd., 2005.
3. ASM Metals Handbook Vol-1 & 2.
4. Metallurgical Abstracts on Light Metals and Alloys, Volume – 32 - Keikinzoku Shōgakukai, published by Light Metal Educational Foundation, 1999.

Course Outcomes:

At the end of the course, the student will be:

1. Able to classify Aluminum alloys and understand the importance of structure - property correlation in binary and ternary alloys.
2. Knowledge of Magnesium and Zinc alloys and their applications.
3. List out the properties of Titanium and its alloys and comprehend their usage.
4. Analyze the importance of properties and applications of Beryllium alloys.
5. Can develop and design stronger and safer new light weight alloys with the knowledge of metal properties for specialized applications with minimum consumption of materials.

FATIGUE AND FRACTURE MECHANICS
(Professional Elective – III)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To study the different types of fatigue failures and their mechanisms in the engineering applications.
2. To study the basic theory of fracture mechanics and its relationship with fatigue and creep failure mechanisms.
3. To understand the damage tolerance approach in the life estimation of structures.

UNIT-I

Introduction and historical overview, S - N curves, Types of fatigue – low cycle fatigue, high cycle fatigue, very high cycle (giga cycle) fatigue, Fatigue test methods and equipment, Total life approaches based on cyclic stress and cyclic strain, Cyclic hardening and softening in single crystals and polycrystals.

UNIT-II

Crack initiation, propagation and fracture, Mechanisms of fracture. Macrostructural and microstructural aspects, Use of fracture mechanics in fatigue.

UNIT-III

Local strain approach, effect of different factors on fatigue – Stress concentration, Size, Surface, Temperature, Frequency, Environment, Microstructure, Residual stresses, Fretting, Creep-fatigue interaction, Multiaxial stresses, Thermomechanical loading, Variable amplitude loading, Load sequence, Crack closure, Effect of notches.

UNIT-IV

Fatigue behaviour of different materials – Metallic materials and weldments, Ceramics, Polymers, Composites, Metallic glasses, Shape memory alloys, Ultrafine grained materials, Nanocrystalline materials, Biomaterials, Metallic foams.

UNIT-V

Elementary theories of fracture, Griffith's theory of brittle fracture, Strain-Energy Release Rate, Stress Intensity Factor, Fracture Toughness and Design, K_{IC} Plane-Strain Toughness Testing, Plasticity Corrections, Crack Opening Displacement, J-Integral, R Curve, Probabilistic Aspects of Fracture Mechanics, Toughness of Materials.

Case studies on fatigue failures, Design considerations, Methods for fatigue life improvement.

Text Books:

1. Fatigue of Materials, 2nd Edition – S. Suresh, published by Cambridge India, 2015.
2. Fracture Mechanics: Fundamentals and Applications, 3rd Edition - T.L. Anderson, published by CRC Press, 2017.

Reference Books:

1. Fracture Mechanics Ewalds, - H.L.Ewalds, R.J.H. Wanhill published by Edward Arnolds, London, 1986.
2. Deformation and Fracture Mechanics of Engineering Materials, 5th Edition - R.W. Hertzberg, published by John Wiley & Sons Inc, 2012.

Course Outcomes:

After completing this course, the student will have:

1. Complete understanding of flow stress and S-N curve.
2. The ability to identify the characteristic fatigue failures in the engineering structures.
3. Knowledge of connecting fracture mechanics concepts to fatigue failure.
4. Knowledge of fatigue failure mechanisms in metallic and non-metallic materials.
5. Knowledge on the methods of combating and preventing further failure.
6. Able to comprehend the failure theories using case studies.

FAILURE ANALYSIS
(Professional Elective– III)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To highlight factors governing the failure of materials and types of failures.
2. To evaluate the mechanisms and environmental effects associated with failure.
3. To identify various failures in heat treatment and deformation processing, and methods to prevent them.

UNIT-I

Aims of failure analysis, general procedures of failure analysis. Important factors causing the premature failure of metallic components and structures., classification of failure sources: Design deficiencies, material deficiencies, processing deficiencies, assembly errors, service conditions, neglect and improper operation. Methods and equipment for failure analysis, Sample selection and treatment, equipment for materials examination, materials analysis equipment for failure analysis, commonly used NDT methods.

UNIT-II

Fractography. Types of failures: ductile, brittle, fatigue, creep, corrosion, wear.

Fatigue failures, fractography, effect of variables: part shape, type of loading, stress concentration, metallurgical factors, etc. Wear failures, adhesive, abrasive, erosive, corrosive wear.

Corrosion failures, types of corrosion: uniform, pitting, selective leaching, intergranular, crevice, etc. Elevated temperature failures, creep, thermal fatigue, microstructural instability, oxidation.

UNIT-III

Failure mechanisms. Embrittlement phenomena. Environmental effects.

UNIT-IV

Failures due to faulty heat treatments. Failures in metal forming and welding.

UNIT-V

Case studies in failure analysis and prevention of failures.

Test Books:

1. Failure Analysis of Engineering Materials, 1st Edition - Charles R. Brooks, Ashok Choudhury, published by Mc Graw-Hill Professional, 2001.
2. Metallurgical Failure Analysis: Techniques and Case Studies, 1st Edition – Kannadi Palankeezhe Balan, published by Elsevier, 2018.

Reference Books:

1. Failure Analysis: Fundamentals and Applications in Mechanical Components - Jose Luis Otegui, Springer, 2016.
2. Failure Analysis Case Studies: A Source Book of Case Studies Selected from the Pages of Engineering Failure Analysis 1994 -1996 - D.R. H. Jones published by Peragmon, 1998.

Course Outcomes:

After completing this course the student will have:

1. The ability to identify the types of failures in engineering components under service.
2. Able to determine fracture toughness of ductile and brittle materials.
3. Knowledge of the tools and techniques to perform failure analysis.
4. Ability to perform fractographic analysis after various failures.
5. The ability to identify different failure mechanisms resulting from manufacturing processes.
6. Able to analyze the failures with the help of case studies and suggest prevention methods for failure.

SURFACE ENGINEERING
(Professional Elective -IV)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Physical Metallurgy and Thermodynamics and Kinetics

Course Objectives:

1. To provide a state - of - the art knowledge to the students about the various surface engineering techniques.
2. To explain the importance, need of surface engineering and past, present and future status of surface engineering.
3. To comprehend the laser processing, electrons and ion beam processing of surfaces, to characterize and evaluate coatings etc.
4. To understand the combat techniques to protect the surfaces from wear, corrosion and other failure causing environments.

UNIT-I

Introduction to surface modification, need for surface modification, surface properties, surface property modification, history of surface modification techniques.

UNIT-II

Plating and coating process: Concept of coating, types of coatings, properties of coatings, hard facing, anodizing, PVD, CVD, Electro deposition, Electro less deposition, hot deposition, hot dipping.

UNIT-III

Thermo-chemical Processes: Carburizing, Nitriding, Carbo-Nitriding, Nitro Carburizing, Boronising, Plasma Nitriding, Thermal spraying, Plasma spraying, Alumnizing.

UNIT-IV

Thermal Processes: Flame hardening, Induction hardening, laser hardening, laser surface alloying, laser cladding, Electro-beam hardening, shot peening, laser shock peening.

UNIT-V

General design principles related to surface engineering, design guidelines for surface preparation, surface engineering solution to specific problems. Case studies related to Engineering Components, Shafts, Bearings, Turbine blades.

Text Books:

1. Advanced Thermal Assisted Surface Engineering Processes - Ramnarayan Chattopadhyay, published by Kluwer Academic Publishers, 2004.
2. Surface Engineering of Metals: Principles, Equipment and Technology, 1st Edition - Tadeusz Burokowski, Tadeusz Wierzchon, CRC Press Inc, 1998.

Reference Books:

1. Advanced Techniques for Surface Engineering, 1st Edition - W. Gissler, and Herman A. Jehn, published by Kluwer Academic Publishers,1992.
2. Laser Material Processing, 4th Edition -William M. Steen and Jyotirmoy Mazumder, Published by Springer, 2010.

Course Outcomes:

At the end of the course, the student will be able to:

1. Gain knowledge of different surface properties, appreciate the need for surface modification and past practices.
2. Knowledge of plating and coatings techniques.
3. Knowledge of surface modification by chemical and thermal processes.
4. Differentiate between the methods used and indicate their relative merits and demerits
5. This course provides an opportunity to the students to understand the various aspects associated with industrial applications of surface engineering.
6. Design various surface modifications according to the needs, compatibility and efficiency of the processes and the desired output.

NANO MATERIALS
(Professional Elective – IV)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Engineering Physics and Engineering Chemistry

Course Objectives:

1. This course is primarily intended to expose the students to a highly interdisciplinary subject.
2. This would emphasize on the classification, synthesis and applications of Nano materials.
3. To enhance the various nano synthesis techniques and to identify and solve problems.
4. To describe methods for production of nano materials and their characterization techniques for applications of nano materials.

UNIT-I

Introduction, Importance of Nano-technology, Emergence of Nano-Technology, Bottom-up and Top-down approaches, challenges in Nano Technology.

UNIT-II

Zero Dimensional Nano-structures, Nano particles through homogenous nucleation; Growth of nuclei, synthesis of metallic Nano particles, Nano particles through heterogeneous nucleation; Fundamentals of heterogeneous nucleation and synthesis of nano particles using micro emulsions and Aerosol.

UNIT-III

One Dimensional Nano-structures: Nano wires and nano rods, Spontaneous growth: Evaporation and condensation growth, vapor-liquid-solid growth, stress induced recrystallization.

Template based synthesis: Electrochemical deposition, Electro-phoretic deposition. Electro-spinning and Lithography.

UNIT-IV

Two dimensional Nano-Structures, Fundamentals of film growth. Physical Vapour Deposition (PVD): Evaporation molecular beam epitaxy (MBE), Sputtering, Comparison of Evaporation and sputtering.

Chemical Vapour Deposition (CVD): Typical chemical reactions, Reaction kinetics, transport phenomena, CVD methods, diamond films by CVD.

UNIT-V

Thin films, Atomic layer deposition (ALD), Electrochemical deposition (ECD), Sol-Gel films.

Special Nano Materials, Carbon fullerene and nano tubes: carbon fullerenes, formation, properties and applications. Carbon nano tubes: formation and applications.

Text Books:

1. Nanostructures And Nanomaterials: Synthesis, Properties and Applications, 2nd Edition - Guozhong Cao, published by World Scientific Publishing Co Pte Ltd, 2011.
2. Nano Materials - A. K. Bandyopadyay, published by New Age Science Ltd., 2009.

Reference Books:

1. Springer Handbook of Nanotechnology, 3rd Edition - Bharat Bhushan, Published by Springer, 2010.
2. The Quest for New materials, S. T. Lakshmi Kumar, Published by Vigyan Prasar,2005.
3. Nano: The Essentials, 1st Edition - T. Pradeep, Published by Mc Graw Hill Education, 2017.
4. Nano Materials: Synthesis, Properties and Applications, 1st Edition - Alex S. Edelstein, Robert C. Cammarata, published by Taylor & Francis, 1996.

Course Outcomes:

At the end of the course the student would be able to:

1. Describe the importance and impact of nanomaterials and their diversified applications, listing out their salient properties and uses in commercial and industrial applications.
2. Describe the various types of nano materials used in semi conductors, ferro electric devices etc.
3. Illustrate and categorize the synthesis procedures and characterization techniques with respect to nano particles
4. Illustrate and categorize the synthesis procedures and characterization techniques in case of nano tubes and nano wires.
5. Describe the various types of thin film deposition techniques and differentiate their merits and demerits.
6. Demonstrate the capacity and exhibit interest for self-directed learning on topics related to nanoscience and nanotechnology.

NON DESTRUCTIVE TESTING
(Professional Elective – IV)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. Provide an opportunity to learn visual methods, electrical methods and magnetic methods.
2. To develop a fundamental understanding of ultrasonic testing of material and radiographic methods.

UNIT-I

Introduction. Visual methods**:** Optical aids, In-situ metallography, Optical holographic methods, Dynamic inspection. Penetrant flaw detection**:** Principles, Process, and Penetrant systems. Liquid penetrant materials, Emulsifiers, cleaners, developers, sensitivity. Advantages, limitations and applications.

UNIT-II

Magnetic methods**:** Methods of generating fields, magnetic particles and suspending liquids. Magnetography, field sensitive probes, advantages, limitations and applications of magnetic methods.

UNIT-III

Electrical methods: Eddy current methods, potential-drop methods, applications.

Electromagnetic testing: Magnetism, Magnetic domains, Magnetization curves, Magnetic Hysteresis. Hysteresis-loop tests, comparator - bridge tests Absolute single-coil system, applications.

UNIT-IV

Ultrasonic testing of materials: Generation of Ultrasonic waves, general characteristics of ultrasonic waves; methods and instruments for ultrasonic materials testing; special techniques. Principles, test procedures of composites by Ultrasonic flaw inspection. Advantages, disadvantages, Applications.

UNIT-V

Radiographic methods: Principles of radiography, sources of radiation, Ionizing radiation - X-rays sources, gamma-rays sources. Recording of radiation. Radiographic sensitivity. Fluoroscopic methods, Special techniques, Radiation safety, advantages and limitations.

Text Books:

1. Non-Destructive Testing by P. Halmshaw,1987.
2. Ultrasonic Testing of Metals by J Krantkramer and H. Krantkramer, Spinger-Verlag, 1987.

Reference Books:

1. Testing of Metallic Materials, 2nd Edition, - A. V. K. Suryanarayana published by BSP Books Pvt. Ltd., 2018.
2. Nondestructive Inspection and Quality Control, Metals handbook, 8th Edition, Vol. 11 - American Society for Metals, 1976.
3. Nondestructive Testing Handbook, Vol-1 – Robert. C. McMaster (American Society of Nondestructive Testing) published by Ronald Phillips Ltd., 1959.
4. Non-destructive Testing - J. F. Hinsley, published by Macdonald and Evans, London, 1959.

Course Outcomes:

The end of the student gain will be:

1. Complete knowledge on microscopic evaluation and dynamic inspection.
2. Knowledge about application of NDT methods like visual observation, penetrant detection, electrical methods etc.
3. Ability to use ultrasonic testing and radiographic methods for checking various types of defects.
4. Selection of suitable NDT methods for various environments.
5. Documentation of testing and evaluation of results for further analysis.

ENVIRONMENTAL DEGRADATION AND PROTECTION LAB

IV Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: **NIL**

Course Objectives:

1. This lab course is designed to conduct the experiments on electro deposition, verification of Faraday's laws and evaluation of factors affecting on corrosion.
2. To provide understanding of basic electro kinetics.
3. To provide basic knowledge on current efficiency for various electrolytes and electro metallurgy processes.

List of Experiments:

1. EMF series
2. Electroplating of copper.
3. Anodizing.
4. Electroplating of Nickel.
5. Electroplating of chromium.
6. Electroplating of Zinc.
7. Galvanic corrosion.
8. Pitting corrosion.
9. Uniform corrosion acid environments.
10. Uniform corrosion basic environments.
11. Corrosion rate measurement in acid environments.
12. Corrosion rate measurements in basic environment.

Course Outcomes:

Through this laboratory practice, the student will be able:

1. To judge the process variables like current efficiency, current density.
2. To obtain desired electro deposition.
3. Hands on experience on equipment designed for evaluation of corrosion studies.

SEMINAR

IV Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre- Requisites: Nil

Course Objectives:

1. The prime objective of this course is to make students become effective communicators and enhance their presentational and creative abilities.
2. Enhance the technical knowledge of the selected topics.

Course Outcomes:

1. Students will be able to show competence in identifying relevant information, defining and explaining the topics under discussion.
2. Able to evaluate information and use and apply relevant theories concerned to the chosen topic.
3. Able to use conventional and modern methods of presentation techniques to support the presentation / topic.
4. Develop presentation skills and confidently face the audience.
5. Respond to a range of questions posed and take part in the discussions fruitfully.
6. Recognize and demonstrate effective oral and written formats.

MINI PROJECT

IV Year B.Tech. I-Semester

L	T	P	C
0	0	4	2

Pre-Requisites: Nil

Course Objectives:

1. This course is mainly intended to make the students acquire real time practical experience on the industry oriented processes, technologies, and applications.
2. Students will be exposed to sophisticated equipments and modern technologies.

Course Outcomes:

At the end of the course the student will be able to:

1. Exposed to the various practical aspects relating to Metallurgical Engineering with respect to characterization, analysis and extraction principles and are getting hands on experience in using / handling equipments and hence they are able to solve problems and analyze the results.
2. Carry out project work related to modern and novel techniques and synthesis of newer materials with wide applications and tailor made properties.
3. Exposed to various safety measures, ethical practices and environmental concerns.
4. Good attitude, co-ordination and co-operation is developed when interacting with various categories of persons like scientists, production engineers, quality control engineers and team members etc.
5. Conduct the project in groups or as an individual and exhibit work, project, and financial management.
6. Deliver a well-organized technical presentation at conferences and other symposia and write a project report.

MAJOR PROJECT (STAGE - I)

IV Year B.Tech. I-Sem

L	T	P	C
0	0	6	3

Pre-Requisites: Nil

Course Objectives:

1. This course is mainly intended to make the students acquire real time practical experience on the industry oriented processes, technologies, and applications.
2. Students will be exposed to sophisticated equipments and modern technologies.

Course Outcomes:

At the end of the course the student will be able to:

1. Identify a research problem after thorough literature review in metallurgical engineering, plan and execute experimental work to obtain desired results.
2. Appreciate the need to work in teams and to take a lead in execution of the project allotted.

ALLOY STEELS
(Open Elective - III)

IV B.Tech. Met. Engg. II-Semester

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

This course deals with:

1. Describe the physical metallurgy of steels and alloy steels.
2. Explain the microstructure and properties of steels and alloy steels.
3. Make judgments on microstructural evolution and properties developed in alloy steels.

UNIT – I

Classification of Steels. Advantages and limitations of Plain carbon steels. Alloy steels classification, purpose and general effects of alloy elements in steels. Cold forming steels, High strength packing steels; HSLA steels.

UNIT – II

Medium - High carbon ferrite-pearlite steels, Bainitic steels, Low-carbon bainitic steels requirements, development and choice of alloying elements, Mechanical properties, microstructure and impact properties, High-Carbon bainitic steels.

UNIT – III

Ultra-high strength steels: Classification and applications. Cryogenic steels, Thermo-mechanical treatments, maraging steels.

UNIT – IV

Stainless steels: Classification, Composition, role of alloying elements, Heat treatment, microstructure and applications. Nitrogen steels and dual phase steels

UNIT- V

Tool steels and Heat resistant steels: Classification, Composition, role of alloying elements, Heat treatment, microstructure and applications.

Text Books:

1. Physical Metallurgy and the Design of steels - F. B. Pickering, Applied Science publisher, London, 1978.
2. The physical Metallurgy of steels: William C. Leslie, Hempisphere Publishers Corporation, 1981.

Reference Books:

1. Alloys Steels – Wilson.
2. Heat Treatment of steels, 2nd Edition – Rajan & Sharma, PHI publications, 2011.

Course Outcomes:

1. Able to classify plain carbon steels, alloy steels and differentiate the steels and appreciate the role of alloy elements in steels and how to modify the structures to get the desired properties in steels.
2. Know the importance of structure - property correlation study in HSLA, Ultra high strength steels etc.., and their suitable applications.
3. Analyze the importance of composition, heat treatment and microstructure effects on properties and uses of stainless steels.
4. Analyze the importance of composition, heat treatment and microstructure effects on properties and uses of tool steels and heat resistant steels.
5. Able to apply the knowledge gained on microstructural evolution and its stability to optimize the processing routes for specific applications.

MATERIALS CHARACTERIZATION TECHNIQUES
(Professional Elective – V)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To explain and describe the various working techniques of optical microscope, Scanning and Transmission Microscopes used for evaluating material properties.
2. To explain and describe the various working techniques of XRD, SPM, AFM for evaluating material properties.
3. To differentiate and compare between various characterization techniques.
4. Obtain knowledge on the various thermal analyses techniques.

UNIT – I

Optical Microscopy–Introduction, optical principles, Instrumentation, specimen preparation- metallographic principles, Imaging Modes, Applications, Limitations.

UNIT – II

(a) Scanning Electron Microscopy (SEM) -Introduction, instrumentation, Contrast formation, Operational variables, Specimen Preparation, Imaging Modes, Applications, and Limitations.

(b) Transmission Electron Microscopy (TEM**)-**Introduction, instrumentation, Specimen preparation –pre thinning, final thinning, Image modes-mass density contrast, diffraction contrast, Phase contrast, Applications, Limitations.

UNIT – III

X-Ray Diffraction (XRD) - Introduction, Basic principles of diffraction, X-ray generation, Instrumentation, Types of analysis, Applications, Limitations.

UNIT – IV

Thermal Analysis: Basic Principles, Instrumentation, working principles, Applications, Limitations of DSC, TGA, Dilatometry, DMA.

UNIT – V

Basic Principles, instrumentation, operational modes, Applications and Limitations of SPM, STM and AFM.

Text Books:

1. Experimental Techniques in Physical Metallurgy, V.T. Cherepin and A.K. Mallik, Asia Publishing House, 1967.
2. Thermal Analysis of Materials - Robert F. Speyer, published by Marcel Dekker, Inc. New York, 1994.

Reference Books:

1. Electron Microprobe Analysis - S.J.B. Reed, Cambridge University Press, 1975.
2. Materials Characterization, ASM Hand book, vol -10, ASM International, 2019.

Course Outcomes:

At the end of the course, student will be:

1. Able to use metallurgical microscopes to analyze the experimental results.
2. Understand the various specimen preparation techniques for SEM, TEM and analyze the experimental results.
3. Describe the construction of XRD machine and understand its principle and analyze / interpret the experimental results.
4. Conduct characterization measurement by thermal analysis and solve problem using the thermo dynamic principles.
5. Knowledge on thermal analyses methods such as DSC, calorimetry and dilatometry etc.,
6. Analyze, evaluate and interpret data and solve practical characterization problems using modern tools like SPM, AFM etc.

NUCLEAR METALLURGY
(Professional Elective – V)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre requisites: Nil

Course Objectives:

1. To explain and describe the basics of Nuclear technology and relevance of metallurgy to nuclear reactors.
2. To gain a working knowledge of extraction of nuclear metals like Uranium, Thorium, and Beryllium.
3. To understand principles of nucleation reactors and its safety.

UNIT – I

Elementary nuclear physics and chemistry: Structure of nucleus, radioactivity, binding energy: nuclear interaction; fission and fusion: nuclear reaction; energy release and chain reactions; neutron cross-section; multiplication and criticality concepts and factors.

UNIT - II

Mechanisms of moderation, radiation detection, radiation effects on fissile and non-fissile materials; radiation damage and radiation growth; thermal cycling; protection against radiations.

UNIT – III

Types of reactors and classification.

Considerations in selection and properties of common materials used as nuclear fuels, their physical and chemical properties; canning materials; coolants; control rods; reflectors shielding materials and Clad tubes

UNIT – IV

Occurrence and general characteristics of nuclear minerals. Flow sheets of processing of nuclear minerals for the production of nuclear grade Uranium, Thorium, Beryllium and Zirconium with emphasis on basic scientific principles involved.

UNIT – V

Production and enrichment of uranium, Fabrication of fuel elements. Irradiated fuel processing for recovery of Plutonium.

Nuclear power production in India and its economics.

Text Books:

1. Metallurgy in Nuclear Power Technology – J.C.Wright, published by Iliffe Books Ltd., 1962.
2. Nuclear Reactor Metallurgy – Wilkinson, WD and Murphy, WF. Published by D.Van Nostrand company, 1958.

Reference Books:

1. Symposium on Rare Materials - Indian Institute of Metals, 1957.
2. Nuclear Chemical Engineering, 2nd Edition - Manson Bendict and Thomas Pigford published by McGraw-Hill Education, 1981.
3. Nuclear Reactor General Metallurgy - B. N. Kuznetsov Sevryukov, B. Kuzmin, Chelishchev - Peace Publishers, 1965.

Course Outcomes:

At the end of the course, student would be able to:

1. Use fundamental concepts of physics and chemistry to know the basics of nuclear energy, understand the use of nuclear energy as a major source of energy.
2. Recognize the predominant mechanisms for materials failure in radiation environments, and understand the fundamentals of radiation damage events and gain knowledge about the safety measures and control.
3. Understand the guiding principles of reactor safety and report findings including recommendations for improvement.
4. Understand materials design issues in various reactor configurations and recognize the materials used in different types of reactor applications.
5. Understand the manufacturing processes and fabrications methods used for various materials used in reactors.
6. Work and communicate effectively in diverse and multi-disciplinary teams and be aware of modern professional, ethical, and societal issues as well as recognize the need for lifelong learning.

FUNCTIONAL MATERIALS
(Professional Elective – V)

IV Year B.Tech. II-Semester

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To introduce the student to functional materials and the science behind the performance of the functional materials.
2. To enable the student to understand the applications of functional materials.
3. To study about semi conductors, dielectrics, Piezo, Ferro electric and smart materials.

UNIT-I

Characteristics and types of functional materials. Crystal structure and Properties. Effect of size on properties, effect of interfaces on properties. Magnetic materials and storage applications.

UNIT-II

High Temperature Behaviour of Amorphous and Nanocrystalline Soft Magnetic Materials Magnetic storage devices store data using a combination of magnetic fields and binary data, Band structure, Semiconductor devices – Theory, examples and applications of Optically active materials.

UNIT-III

Basics of semiconductor electrical properties, operation of the semiconductor devices. Eg: Band structure, Diode, MOS device capacitor, MOS transistor structure and operation, Transistor formation and Transistor isolation.

UNIT-IV

Dielectrics, Piezo and ferroelectric materials: Introduction, properties, applications. Recent developments in advanced dielectric, piezoelectric and ferroelectric materials. High strain high performance piezo- and ferroelectric single crystals; Electric field-induced effects and domain engineering; Morphotropic phase boundary related phenomena; High power piezoelectric and microwave dielectric materials; Nanoscale piezo- and ferroelectrics.

UNIT-V

Smart materials: Introduction, definition, applications, factors affecting properties of smart materials. Applications in electronic, communication, aerospace, automotive, energy industries.

Text Books:

1. Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications, - Deborah D L Chung, World Scientific Publishing, 2010.
2. Advanced Functional Materials (Advanced Material Series), 1st Edition – Ashutosh Tiwari, Lokman Uzun, published by Wiley-Scrivener, 2015.

Reference Books:

1. Functional Materials: Preparation, Processing and Applications, 1st Edition – by S. Banerjee, A.K.Tyagi, published by Elsevier, 2011.
2. Advanced Functional Materials by Hee – Gweon Woo, Hong Li, published by Springer, 2011.
3. Functional Materials: Properties, Performance and Evaluation, 1st Edition - Ewa Klodzinska published by Apple Academic Press, 2015.

Course Outcomes:

After completion of the course the student will be able to:

1. Indicate the various types of functional materials.
2. Explain the principle of operation of the functional materials.
3. Indicate the applications of the functional materials.
4. Judge the factors that affect the interface and size on the properties of functional materials.
5. Identify the applications of functional materials in advance and modern systems.

POWDER METALLURGY
(Professional Elective - VI)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil.

Course Objectives:

1. To build the necessary back ground of emergence and importance of powder metallurgy scope and limitations.
2. Obtain a necessary knowledge about various powder production techniques and characteristics.
3. Obtain a working knowledge of compaction and sintering techniques.
4. Gain an effective knowledge of applications of powder metallurgy products.

UNIT–I

Introduction: Emergence and importance of powder metallurgy**:** Comparison of powder metallurgy with other fabrication techniques, its scope and limitations. Powder Production Methods: Physical, Chemical and Mechanical.

UNIT–II

General Characterization of powders**:** Chemical composition, Particle size, Particle shape, Surface area, Apparent density, Tap density, Flow rate, Green density, Green strength, Compressibility and Compactability of powders.

UNIT–III

Compaction**:** Classification and theory of consolidation. Die compaction. Cold and hot isostatic pressing, Powder rolling or roll compaction.

UNIT–IV

Sintering: Mechanisms of Sintering, Activated sintering, Liquid phase sintering, Factors affecting sintering, Sintering atmospheres, Properties of sintered parts.

UNIT –V

Applications**:** Porous parts**:** Self-lubricating bearings, filters: Dispersion strengthened alloys by powder metallurgy route**:** Cu / Al_2O_3, Sintered Aluminum Powder. Electrical materials**:** Tungsten lamp filaments. Magnetic materials**:** Soft magnetic materials (Fe, Fe-Ni); Permanent magnets (Alnico, $SmCo_5$), Cemented carbides and Cermets.

Text Books:

1. Powder Metallurgy, 2nd Edition - A.K. Sinha, Dhanpat Rai Publications, 2016.
2. Powder Metallurgy Technology - G S Upadhyaya, published by Cambridge International Science Publishing Ltd., 1998.

Reference Books:

1. Introduction to Powder Metallurgy, 1st Edition – J.S. Hirshhorn published by American Powder Metallurgy Institute, 1969.
2. Powder Metallurgy: Principles and Applications – Lenel, Fritz V, published by Metal Powder Industry, 1980.
3. Powder Metallurgy: Practice and Applications, 1st Edition – Sands, R. L. and C.R. Shakespeare, published by George Newnes Limited, 1966.
4. Powder Metallurgy Science by Randall M. German, published by Metal Powder Industry, 1994.
5. Powder Metallurgy: Science, Technology and Applications, 2nd Edition – P.C. Angelo, R. Subramanian and B. Ravisankar, published by PHI Learning, 2022.

Course Outcomes:

At the end of the course the student will be able to:

1. Appreciate the importance of powder metallurgy technology for production of materials and components in comparison with other fabrication techniques.
2. List out the advantages, limitations and applications of powder metallurgy technique.
3. Able to choose the production method to get the required size and shape of the powders.
4. Knowledge of various characterization methods to control the properties of the powders.
5. Describe the consolidation and sintering processes in powder metallurgy route.
6. Can develop and design powder metallurgical components for specific applications and needs of various industries.

BIO MATERIALS
(Professional Elective - VI)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre- Requisites: Nil

Course Objectives:

1. To introduce the student to the range of biomaterials and the science and engineering of biomaterials.
2. To understand constraints associated with the use of biomaterials.
3. To study various real time applications of bio materials.

UNIT-I

Introduction to basic concepts of Materials Science, Salient properties of important material classes. Property requirement of biomaterials. Concept of biocompatibility. Structure and properties of biological cells & tissues. Cell-material interactions and foreign body response.

UNIT-II

Assessment of biocompatibility of biomaterials. In vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation using ALP assay; Biomnuneralisation using Osteocalcin assay). In vivo testing and histocompatibility assessment. Genotoxicity assessment (Physical damage to DNA by biomaterial eluates).

UNIT–III

Important bio-metallic alloys: Ti-based, stainless steels, Co-Cr-Mo alloys. Bio-inert, Bioactive and bioresorbable ceramics. Biocompatibility of Alumina & Carbon Nanotube Reinforced Hydroxyapatite. Glass -ceramics for dental restoration applications.

UNIT–IV

Processing and properties of different bio-ceramic materials with emphasize on hydroxyapatite. Synthesis of biocompatible coatings on structural implant materials. Plasma spraying of carbon nanotube reinforced hydroxyapatite on Ti-6Al-4V substrate, in-vitro cytocompatibility. Microstructure and properties of glass-ceramics. Biodegradable polymers.

UNIT-V

External field and cell – material interaction, Tissue Engineering and Wound healing. Design concept of developing new materials for bio-implant applications.

Text Books:

1. Introduction to Biomaterials: Basic Theory with Engineering Applications, 1st Edition - C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford and Gopinath Mani, published by Cambridge University Press, 2013.

2. Biomaterials Science: An introduction to Materials in Medicine, 3rd Edition - Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons - Academic Press, 2012.

Reference Books:

1. Comprehensive Structural Interity, Vol.9: Bioengineering Editors: Mithe, Ritchie and Karihalo, Elsevier Academic Press, 2003.
2. Biomaterials Science and Biocompatability, 1st Edition - Fredrick H. Silver and David L. Christiansen, published by Springer, 2012.
3. Biological Performance of Materials: Fundamentals of Biocompatibility, 3rd Edition - Jonathan Black, published by Marcel Dekker, Inc., 1992.
4. Basic Cell Culture: A Practical Approach - Edited by J.M. Davis, published by Oxford University Press, 1995.

Course Outcomes:

After completing the course, the student will be able to:

1. Explain the types of biomaterials and their relative advantages and disadvantages.
2. Indicate the constraints placed on the use of materials in biological environments.
3. Explain the characterization of materials from the perspective of application as a biomaterial.
4. Explain the factors affecting the bio compatibility of materials.
5. Develop and design new advanced materials.
6. Develop biodegradable materials for sensitive applications.

TRANSPORT PHENOMENA
(Professional Elective - VI)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. This course will introduce the concepts of fluid flow, heat transfer and mass transfer with behavior and processing of engineering materials as the focus.
2. To learn Newton's law of viscosity, Navier-strokes equation, Darcy's law and their applications.
3. To study the methods of diffusion and their applications.

UNIT-I

Balance of quantities using elemental volume approach, continuity equation Newton's law of viscosity.

UNIT-II

Navier-Stokes equation, laminar flow problems, exact solutions in rectangular, cylindrical and spherical coordinate systems.

UNIT-III

Friction factors, correlations for turbulent regime, Darcy's law, flow through porous media, Fundamentals of heat conduction, convection, radiation and their combined effect.

UNIT-IV

Steady and unsteady heat transfer, exact analytical solutions, correlations for conjugate heat transfer. Coupled phenomena in transport, Non-dimensional numbers and their correlations of different regimes and analogies.

UNIT-V

Diffusion and its application in solid state, convective mass transfer, unsteady diffusion in finite and infinite bodies, diffusion and chemical reactions.

Text Books:

1. Transport phenomena, 2nd Edition- R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot, published by John Wiley & Sons, 2006.
2. Fundamentals of Momentum, Heat and Mass Transfer, 5th Edition - Welty, Wicks Wilson, Rorrer published by John Wiley & Sons, 2008.

Reference Books:

1. Transport Phenomena in Materials Processing - D.R. Poirier and G.H. Geiger, published by John Wiley & Sons, 2010.
2. Introduction to Fluid Mechanics, 5th Edition – Alan T. McDonald, Fox, Robert W Fox, John Wiley & Sons, 2002.

Course Outcomes:

At the end of this course, the student should be able to:

1. Demonstrate and understanding of heat transfer, fluid flow and mass transfer.
2. Pose a problem in transport phenomena as a balance equation.
3. Make suitable assumptions to make the problem a well defined one.
4. Identify suitable geometry and boundary conditions for the problem.
5. Solve simple partial differential equations relevant to transport phenomena.
6. Plot different parameters and interpret the solutions.

MAJOR PROJECT (STAGE-II)

IV Year B.Tech. II-Sem

L	T	P	C
0	0	16	8

Pre- Requisites: Nil

Course Objectives:

1. This course is mainly intended to make the students acquire real time practical experience on the industry oriented processes, technologies, and applications.
2. Students will be exposed to sophisticated equipments and modern technologies.

Course Outcomes:

At the end of the course the student will be able to:

1. Exposed to the various practical aspects relating to Metallurgical Engineering with respect to characterization, analysis and extraction principles and are getting hands on experience in using / handling equipments and hence they are able to solve problems and analyze the results.
2. Carry out project work related to modern and novel techniques and synthesis of newer materials with wide applications and tailor made properties.
3. Exposed to various safety measures, ethical practices and environmental concerns.
4. Good attitude, co-ordination and co-operation is developed when interacting with various categories of persons like scientists, production engineers, quality control engineers and team members etc.
5. Conduct the project in groups or as an individual and exhibit work, project, and financial management.
6. Deliver a well-organized technical presentation at conferences and other symposia and write a project report.