DEPARTMENT OF METALLURGICAL ENGINEERING
JNTU-GV COLLEGE OF ENGINEERING VIZIANAGARAM (Autonomous)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY GURAJADA VIZIANAGARAM-535 003, A.P
(Established by Andhra Pradesh Act No.22 of 2021)

JNTU-GV COLLEGE OF ENGINEERING, VIZAINAGARAM(A)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY
GURAJADA VIZIANAGARAM-535 003, A.P
(Established by Andhra Pradesh Act No.22 of 2021)
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COURSE STRUCTURE
&
DETAILED SYLLABUS
(R23 Regulation)

For
Bachelor of Technology
B.Tech (MET)
(Applicable for Batches Admitted from 2023-2024)

Department of
METALLURGICAL ENGINEERING

DEPARTMENT OF METALLURGICAL ENGINEERING
JNTU-GV, COLLEGE OF ENGINEERING, VIZIANAGARAM (A)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY- GURAJADA VIZIANAGARAM
VIZIANAGARAM - 535003, ANDHRA PRADESH, INDIA

B.Tech. – I Year I Semester

S.No.	Course Code	Title	L	T	P	C
1	R23BS01	Linear Algebra& Calculus	3	0	0	3
2	R23BS03T	Engineering Physics	3	0	0	3
3	R23ES07T	Introduction to Programming	3	0	0	3
4	R23ES03	Engineering Graphics	1	0	4	3
5	R23ES04	Basic Electrical & Electronics Engineering	3	0	0	3
6	R23BS03P	Engineering Physics Lab	0	0	2	1
7	R23ES07P	Computer Programming Lab	0	0	3	1.5
8	R23ES05	Electrical & Electronics Engineering Workshop	0	0	3	1.5
9	R23MC02	NSS/NCC/Scouts &Guides/Community Service	0	0	1	0.5
Total						**19.5**

B.Tech. – I Year II Semester

S.No.	Course Code	Title	L	T	P	C
1	R23BS02	Differential Equations and Vector Calculus	3	0	0	3
2	R23BS04T	Engineering Chemistry	3	0	0	3
3	R23HS01T	Communicative English	2	0	0	2
4	R23ES01	Basic Civil &Mechanical Engineering	3	0	0	3
5	R23PC01T	Mineral Processing and Metallurgical Analysis	3	0	0	3
6	R23HS01P	Communicative English Lab	0	0	2	1
7	R23BS04P	Engineering Chemistry Lab	0	0	2	1
8	R23ES06	IT workshop	0	0	2	1
9	R23ES02	Engineering Workshop	0	0	3	1.5
10	R23PC01P	Mineral Processing and Metallurgical Analysis Lab	0	0	3	1.5
11	R23MC01	Health and Wellness, Yoga and Sports	0	0	1	0.5
Total						**20.5**

B.Tech. – II Year I Semester

S.No.	Course Code	Title	L	T	P	C
1	R23BS03	Transforms and Numerical Methods	3	0	0	3
2	R23HS02	Universal Human Values-Understanding Harmony and Ethical Human conduct	2	1	0	3
3	R23ES08	Heat and Mass Transfer	2	0	0	2
4	R23PC02T	Physical Metallurgy	3	0	0	3
5	R23PC03T	Principles of Extractive Metallurgy	3	0	0	3
6	R23ES09	Mechanics of solids lab	0	0	2	1
7	R23PC03P	Extractive Metallurgy lab	0	0	3	1.5
8	R23PC02P	Physical Metallurgy lab	0	0	3	1.5
9	R23SC01	Computer Aided Drafting and Modelling Lab	0	1	2	2
10	R23MC03	Environmental Science	2	0	0	-
Total						**20**

B.Tech. – II Year II Semester

S.No.	Course Code	Title	L	T	P	C
1	R23HS02	Managerial Economics and Financial analysis	2	0	0	2
2	R23BS04	Complex Variables, Probability and Statistics	3	0	0	3
3	R23PC03	Metallurgical Thermodynamics and Kinetics	3	0	0	3
4	R23PC04T	Heat Treatment	3	0	0	3
5	R23PC05T	Corrosion Engineering	3	0	0	3
6	R23PC06	Fuels lab	0	0	2	1
7	R23PC04P	Heat Treatment lab	0	0	3	1.5
8	R23PC05P	Corrosion Engineering lab	0	0	3	1.5
9	R23SC02	Soft skills	0	1	2	2
10	R23ES10	Design Thinking & Innovation	1	0	2	2
Total						22
Mandatory Community Service Project Internship of 08 weeks duration during summer vacation						

III B.Tech I Semester

S.No.	Category	Course Title	L	T	P	Credits
1	Professional Core	Foundry Technology	3	0	0	3
2	Professional Core	Mechanical Behaviour of Materials	3	0	0	3
3	Professional Elective - I	1.Welding Technology 2.Light Metals technology 3.Functional Materials	3	0	0	3
4	Open Elective - I	1.Introduction to material science 2.Basics of Crystallography 3.Metallurgical Process Modelling	3	0	0	3
5	Open Elective - II	1.Fatigue and Fracture Mechanics 2.Fuels,Furnaces and Refractories 3.Transport Phenomenon	3	0	0	3
6	Professional Core Lab	Welding Lab	0	0	3	1.5
7	Professional Core Lab	Foundry Technology Lab	0	0	3	1.5
8	Skill enhancement course	Artificial Intelligence in Materials Engineering	0	1	2	2
9	Evaluation of Community Service Internship		-	-	-	2
Total Credits			**14**	**1**	**10**	**22**

III B.Tech II Semester

S.No.	Category	Course Title	L	T	P	Credits
1	Professional Core	Metal Forming	3	0	0	3
2	Professional Core	Iron and Steel making	3	0	0	3
3	Professional Core	Materials Characterization	3	0	0	3
4	Professional Elective - II	1. Biomaterials 2. Composite Materials 3. High Temperature Materials	3	0	0	3
5	Professional Elective - III	1. Polymer Science and Technology 2. Smart Materials 3. Special purpose steels	3	0	0	3
6	Open Elective - III	1. Materials Testing 2. Non Destructive Testing and evaluation 3. Computational Material Science	3	0	0	3
7	Professional Core Lab	Metal Forming Lab	0	0	3	1.5
8	Professional Core Lab	Materials Testing and Characterization Lab	0	0	3	1.5
9	Technical Paper Writing & IPR	Technical Paper Writing & IPR	2	0	0	-
Total Credits			**20**	**0**	**6**	**21**
Industrial/Research Internship (Mandatory) 08 weeks during summer vacation						

IV B.Tech I Semester

S.No.	Category	Course Title	L	T	P	Credits
1	Professional Core	Powder Metallurgy	3	0	0	3
2	Professional Core	Non ferrous Extractive Metallurgy	3	0	0	3
3	Management Course - II	Industrial Management	2	0	0	2
4	Professional Elective - IV	1.Metallurgical failure Analysis 2.Ferro Alloy Technology 3.Solidification Processing	3	0	0	3
5	Professional Elective -V	1.Nano Materials 2.Surface Engineering 3.Superalloys	3	0	0	3
6	Open Elective - IV	1.Ceramic Science and Technology 2.Energy Materials 3.Nuclear Materials	3	0	0	3
7	Professional Core	Composite Materials lab	0	0	2	1
8	Professional Core	Powder Metallurgy lab	0	0	2	1
9	Skill enhancement course	Finite Element analysis Tools	0	1	2	2
10	Audit	Constitution of India	2	0	0	-
11	Internship	Evaluation of Industry Internship	-	-	-	2
Total Credits			19	1	06	**23**

IV B.Tech II Semester

S.No.	Category	Course Title	L	T	P	Credits
1	Internship & Project Work	Full semester Internship & project Work	0	0	24	**12**

Subjects offered for Honors degree Program with Advanced Manufacturing Technology specialization

S.No.	Category	Course Title	L	T	P	Credits
1	Honors Degree	Advanced Manufacturing Techniques	3	0	0	3
2	Honors Degree	Advanced Powder Metallurgy	3	0	0	3
3	Honors Degree	Additive Manufacturing	3	0	0	3
4	Honors Degree	Advances in Metal casting	3	0	0	3
5	Honors Degree	Advanced Material Joining Techniques	3	0	0	3
6	Honors Degree	Advanced Powder Metallurgy Lab	0	0	3	1.5
7	Honors Degree	Additive Manufacturing Lab	0	0	3	1.5
Total Credits			**15**	**0**	**6**	**18**

Subjects offered for Honors degree Program with Nano Technology specialization

S.No.	Category	Course Title	L	T	P	Credits
1	Honors Degree	Synthesis of Nanomaterials and Properties	3	0	0	3
2	Honors Degree	Nanomaterials Characterization	3	0	0	3
3	Honors Degree	Thin film Science and Technology	3	0	0	3
4	Honors Degree	Carbon Nanostructures and Applications	3	0	0	3
5	Honors Degree	Nanotechnology for Energy Systems	3	0	0	3
6	Honors Degree	Characterization of Nanomaterials Lab	0	0	3	1.5
7	Honors Degree	Synthesis of Nanomaterials Lab	0	0	3	1.5
Total Credits			**15**	**0**	**6**	**18**

Note: ***As per the guidelines for R23 Honors in Engineering, A student has to acquire 18 more credits, in addition to 160 credits. Out of the 18 extra credits required to obtain the Honors degree, at least SIX credits (i.e., two courses of 3 credits each) must be earned from NPTEL/SWAYAM MOOC courses in concerned department/discipline.***

Subjects offered for Minors degree Program

S.No.	Category	Course Title	L	T	P	Credits
1	Minors Degree	Introduction to Materials Engineering	3	0	0	3
2	Minors Degree	Engineering Materials	3	0	0	3
3	Minors Degree	Composite Materials	3	0	0	3
4	Minors Degree	Smart Materials	3	0	0	3
5	Minors Degree	Materials Testing	3	0	0	3
6	Minors Degree	Materials Testing Lab	0	0	3	1.5
7	Minors Degree	Heat Treatment Lab	0	0	3	1.5
Total Credits			**15**	**0**	**6**	**18**

Note: ***As per the guidelines for R23 Minors in Engineering, A student has to acquire 18 more credits, in addition to 160 credits required for the award of the minor by fulfilling at least THREE credits must be earned from NPTEL/SWAYAM MOOC courses and the remaining 15 credits by doing FIVE Theory/Integrated courses of 03 credits each (or) Four Theory courses of 03 credits each long with 2 Laboratory courses each of 1.5 credits either through MOOCS/Regular.***

I Year-I Semester

L	T	P	C
3	0	0	3

LINEAR ALGEBRA& CALCULUS
(Common for all branches)

Course Objectives:
To equip the students with standard concepts and tools of mathematics to handle various real-world problems and their applications.

Course Outcomes: At the end of the course, the student will be able to
- Develop matrix algebra techniques that is needed by engineers for practical applications.
- Familiarize with functions of several variables which is useful in optimization.
- Learn important tools of calculus in higher dimensions.
- Familiarize with double and triple integrals of functions of several variables in two and three dimensions.

UNIT I :Matrices
Rank of a matrix by echelon form, normal form. Cauchy –Binet formulae (without proof). Inverse of Non- singular matrices by Gauss-Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method, Gauss Seidel Iteration Method.

UNIT II: Linear Transformation and Orthogonal Transformation:
Eigenvalues, Eigenvectors and their properties, 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: Calculus
Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), Problems and applications on the above theorems.

UNIT IV:Partial differentiation and Applications (Multi variable calculus)
Partial derivatives, total derivatives, chain rule, change of variables, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

UNIT V: Multiple Integrals (Multi variable Calculus)
Double integrals, triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

Textbooks:
1. B.S.Grewal,HigherEngineeringMathematics,44/e,KhannaPublishers,2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.

Reference Books:
1. R.K .Jainan S.R.K.Iyengar,Advanced Engineering Mathematics,5/e,AlphaScienceInternational Ltd.,2021 (9th reprint).
2. George B.Thomas, MauriceD.WeirandJoelHass,ThomasCalculus,14/e,PearsonPublishers,2018.
3. Glyn James, Advanced Modern Engineering Mathematics, 5/e, Pearson publishers, 2018.
4. Michael Greenberg, Advanced EngineeringMathematics,9thedition, Pearson edn
5. H. K Das, Er. Rajnish Verma, Higher Engineering Mathematics, S. Chand,2021

L	T	P	C
3	0	0	3

I Year-I Semester

Engineering Physics

COURSE OBJECTIVES

1 Bridging the gap between the Physics in school at 10+2level and UG level engineering courses.

2 To identify the importance of the optical phenomenon i.e. interference, diffraction and polarization related to its Engineering applications

3 Enlighten the periodic arrangement of atoms in Crystalline solids by Bragg'slaw

4 To explain the significant concepts of dielectric and magnetic materials that leads to potential applications in the emerging microdevices.

5 Enlightenment of the concepts of Quantum Mechanics and to provide fundamentals of de Broglie matter waves, quantum mechanical wave equation and its application, the importance of free electron theory for metals.

6. To Understand the Physics of Semiconductors and their working mechanism, Concepts utilization of transport phenomenon of charge carriers in semiconductors.

COURSEOUTCOMES

CO1 **Explain** the need of coherent sources and the conditions for sustained interference (L2).**Identify** the applications of interference in engineering(L3). **Analyze** the differences between interference and diffraction with applications(L4). **Illustrate** the concept of polarization of light and its applications(L2). **Classify** ordinary refracted light and extraordinary refracted rays by their states of polarization (L2)

CO2 **Classify** various crystal systems(L2). **Identify** different planes in the crystal structure(L3). **Analyze** the crystalline structure by Bragg's X-ray diffractometer (L).

CO3 **Explain** the concept of dielectric constant and polarization in dielectric materials (L2). **Summarize** various types of polarization of dielectrics (L2). **Interpret** Lorentz field and Claussius-Mosotti relation in dielectrics(L2). **Classify** the magnetic materials based on susceptibility and their temperature dependence(L2).

CO4 **Describe** the dual nature of matter(L1). **Explain** the significance of wave function(L2). **Identify** the role of Schrodinger's time independent wave equation in studying particle in one-dimensional infinite potential well(L3). **Identify** the role of classical and quantum free electron theory in the study of electrical conductivity (L3).

CO5 **Classify** the crystalline solids(L2). **Outline** the properties of charge carriers in semi-conductors (L2). **Identify** the type of semiconductor using Hall effect (L2). **Apply** the concept of effective mass of electron(L3).

Unit-I: Wave Optics **12hrs**

Interference: Introduction **-** Principle of superposition–Interference of light- Interference in thin films (Reflection Geometry) & applications-Colors in thin films-Newton's Rings-Determination of wavelength and refractive index.

Diffraction: Introduction - Fresnel and Fraunhofer diffractions - Fraunhofer diffraction due to single slit, double slit & Diffraction Grating (Qualitative).

Polarization: Introduction -Types of polarization - Polarization by reflection, and Double refraction - Nicol's Prism-Half wave and Quarter wave plates.

Unit Outcomes:

The students will be able to

- **Explain** the need of coherent sources and the conditions for sustained interference(L2)
- **Identify** engineering applications of interference(L3)
- **Illustrate** the concept of polarization of light and its applications(L2)
- **Classify** ordinary polarized light and extra ordinary polarized light(L2)

Unit II: Crystallography **8hrs**

Crystallography: Space lattice, Basis, Unit Cell and lattice parameters – Bravais Lattices –crystal systems (3D) – coordination number - packing fraction of SC, BCC & FCC – Miller indices– separation between successive (hkl) planes. Bragg's law-X-ray Diffractometer.

Unit Outcomes:

The students will be able to

- **Classify** various crystal systems(L2)
- **Identify** different planes in the crystal structure(L3)
- **Analyze** the crystalline structure by Bragg's X-ray diffractometer (L4)

Unit-III: Dielectric and Magnetic Materials **8hrs**

Dielectric Materials: Introduction- Dielectric polarization- Dielectric polarizability, Susceptibility, Dielectric constant and Displacement Vector - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative)-Lorentz internal field-Clausius-Mossotti equation.

Magnetic Materials: Introduction- Magnetic dipole moment- Magnetization-Magnetic susceptibility and permeability-Classification of magnetic materials: Dia, para, Ferro, anti-ferro & Ferri magnetic materials-Domain concept for Ferro magnetism (Qualitative)- Hysteresis -soft and hard magnetic materials.

Unit Outcomes:

The students will be able to

- **Explain** the concept of dielectric constant and polarization in dielectric materials(L2)
- **Summarize** various types of polarization of dielectrics(L2)
- **Interpret** Lorentz field and Claussius Mosotti relation in dielectrics(L2)
- **Classify** the magnetic materials based on susceptibility and their temperature dependence(L2)

Unit-IV: Quantum Mechanics and Free electron theory **10hrs**

Quantum Mechanics: Dual nature of matter–Heisenberg's Uncertainty Principle–Significance and properties of wave function – Schrodinger's time independent and dependent wave equations– Particle in a one-dimensional infinite potential well.

Free Electron Theory: Classical free electron theory (Qualitative with discussion of merits anddemerits)– Quantumfreeelectrontheory–electricalconductivitybasedonquantumfreeelectrontheory**-**Fermi-Diracdistribution and its temperature dependence.

Unit Outcomes:

The students will be able to

- **Explain** the concept of dual nature of matter(L2)
- **Understand** the significance of wave function(L2)
- **Interpret** the concepts of classical and quantum free electron theories(L2)

Unit–V:Semi conductors **10hrs**

Semi conductors: Formation of energy bands – classification of crystalline solids – Intrinsic semiconductors: Density of charge carriers – Electrical conductivity – Extrinsic semiconductors: density of charge carriers - Drift and diffusion currents – Einstein's equation - Hall effect and its Applications.

Unit Outcomes:

The students will be able to

- **Outline** the properties of charge carriers in semi conductors(L2)
- **Understand** the carrier transportation in semiconductors(L2)
- **Identify** the type of semi conductor using Hall effect(L2)

Textbooks:

1. "A Textbook of Engineering Physics"-M.N.Avadhanulu, P.G.Kshirsagar & TVS Arun Murthy, S.Chand Publications, 11thEdition 2019.
2. "Engineering Physics"- D.K.Bhattacharya and Poonam Tandon, Oxford press(2015).
3. "Engineering Physics"-P.K.Palanisamy Sci Tech publications.

Reference Books:

1. "Fundamentals of Physics"-Halliday, Resnick and Walker, John Wiley & Sons.
2. "Engineering Physics"- M.R.Srinivasan, New Age international publishers(2009).
3. "Engineering Physics"-Shatendra Sharma, Jyotsna Sharma, PearsonEducation,2018.
4. "Engineering Physics"-Sanjay D. Jain, D.Sahasrabudhe and Girish, University Press.
5. "Semiconductor physics and devices: Basic principle" - A. Donald, Neamen, Mc GrawHill.
6. "Engineering Physics"- B.K.Pandey and S.Chaturvedi, Cengage Learning
7. "Solid state physics"–A.J.Dekker, Pan Macmillan publishers
8. "Introduction to Solid State Physics"-Charles Kittel, Wiley

I Year-I Semester

L	T	P	C
3	0	0	3

INTRODUCTIONTOPROGRAMMING
(Common to All branches of Engineering)

Course Objectives:

The objectives of this course are to acquire knowledge on the

- To impart adequate knowledge on the need of programming languages and problem-solving techniques and develop programming skills.
- To enable practical usage of Control Structures and Implement different operations on arrays.
- To demonstrate the use of Strings and Functions.
- To impart the knowledge of pointers and understand the principles of dynamic memory allocation.
- To understand structures and unions and illustrate the file concepts and its operations.
- To impart the Knowledge Searching and Sorting Techniques.

UNIT-I Introduction to Computer Problem Solving:

Programs and Algorithms, Computer Problem-Solving Requirements, Phases of Problem-Solving, Problem-Solving Strategies, Top-Down Approach, Algorithm Designing, Program Verification, Improving Efficiency, Algorithm Analysis and Notations.

UNIT-II Introduction to C Programming:

Introduction, Structure of a C Program, Comments, Keywords, Identifiers, Data Types, Variables, Constants, Input/Output Statements. Operators, Type Conversion, Control Flow, Relational Expressions: Conditional Branching Statements: if, if-else, if-else—if, switch. Basic Loop Structures: while, do-while loops, for loops, nested loops, The Break and Continue Statements, and go to statements.

UNIT-III Arrays:

Introduction, Operations on Arrays, Arrays as Function Arguments, Two-Dimensional Arrays, Multidimensional Arrays

Pointers: Concept of a Pointer, Declaring and Initializing Pointer Variables, Pointer Expressions and Address Arithmetic, Null Pointers, Generic Pointers, Pointers as Function Arguments, Pointers and Arrays, Pointer to Pointer, Dynamic Memory Allocation, Dangling Pointer, Command Line Arguments.

UNIT-IV Functions:

Introduction Function: Declaration, Function Definition, Function Call, Categories of Functions, Passing Parameters to Functions, Scope of Variables, Variable Storage Classes, Recursion.

Strings: String Fundamentals, String Processing with and without Library Functions, Pointers and Strings.

UNIT-V

Structures, Unions, Bit Fields: Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type—Enum variables, Using Typed ef keyword, Bit Fields. Data Files: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, Random File Access.

Note: The syllabus is designed with C Language as the fundamental language of implementation**.**

Course Outcomes:

At the end of the Course, the Student should be able to:

i. Illustrate the Fundamental concepts of Computers and basics of computer programming and problem-solving approach.

ii. Understand the Control Structures, branching, and looping statements.

iii. Use of Arrays and Pointers in solving complex problems.

iv. Develop Modular program aspects and Strings fundamentals.

v. Demonstrate the ideas of User Defined Data types files. Solve real-world problems using the concept of Structures, Unions, and File operations.

Text Books:

1. A Structured Programming Approach Using C, Forouzan, Gilberg,3rd Edition, Cengage.
2. How to solve it by Computer, R.G.Dromey, 12thEdition,PearsonEducation.
3. Programming In CA-Practia1Approach.Ajay Mittal, 1st Edition Pearson
4. The C Programming Language, Dennis Richie And Brian Kernighan,2ndEdition, Pearson Education.

References:

1. Byron Gottfried, Schaum'sOutlineofProgrammingwithC,4thEdition, 2020, McGraw-Hill.
2. Computer Programming. Reema Thareja, 3rdEdition, 2023, Oxford University Press
3. Computing fundamentals and C Programming, Balagurusamy, E.,McGraw-HillEducation,2008
4. Programming In C, Ashok Kamthane, 2nd Edition, Pearson Publication.
5. Letus C, Yaswanth Kanetkar,16th Edition, BPB Publication.

Web References:

1. http://www.c4learn.com/
2. http://www.geeksforgeeks.org/c/
3. http://nptel.ac.in/courses/122104019/
4. http://www.learn-c.org/
5. https://www.tutorialspoint.com/cprogramming/

IYear-ISemester

L	T	P	C
1	0	4	3

ENGINEERING GRAPHICS
(Common to All branches of Engineering)

Course Objectives:
The students completing the course are expected to:

- To enable the students with various concepts like dimensioning, conventions and standards related to Engineering Drawing
- To impart knowledge on the projection of points, lines and plane surfaces
- To improve the visualization skills for better understanding of projection of solids
- To develop the imaginative skills of the students required to understand Section of solids and Developments of surfaces.
- To make the students understand the viewing perception of a solid object in Isometric and Perspective projections.

Course Outcomes: On completion of the course, the student should be able to:
CO1: Understand the principles of engineering drawing, including engineering curves, scales, orthographic and isometric projections.
CO2: Draw and interpret orthographic projections of points, lines, planes and solids in front, top and side views.
CO3: Understand and draw projection of solids in various positions in first quadrant.
CO4: Explain principles behind development of surfaces.
CO5: Prepare isometric and perspective sections of simple solids

UNIT I
Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general methods.
Curves: construction of ellipse, parabola and hyperbola by general method, Cycloids, Involutes, Normal and tangent to Curves.
Scales: Plain scales, diagonal scales and vernier scales.
UNIT II
Orthographic Projections: Reference plane, importance of reference lines or Plane, Projections of a point situated in any one of the four quadrants.
Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes
Projections of Planes: Regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes.

UNIT III
Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to another plane.

UNIT IV
Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids in simple position only.
Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone.

UNIT V

Conversion of Views: Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

Computer graphics: Creating 2D&3D drawings of objects including PCB and Transformations using Auto CAD (*Not for end examination*).

Textbook:

1. N. D. Bhatt, Engineering Drawing, Charotar Publishing House, 2016.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2013.
2. Engineering Drawing, M.B.Shah and B.C. Rana, Pearson Education Inc,2009.
3. Engineering Drawing with an Introduction to AutoCAD, Dhananjay Jolhe, Tata McGraw Hill, 2017.

I Year-I Semester

L	T	P	C
3	0	0	3

BASICELECTRICAL&ELECTRONICS ENGINEERING
(Common to All branches of Engineering)

PART A: BASIC ELECTRICAL ENGINEERING

Course Objectives

To expose to the field of electrical engineering, laws and principles of electrical engineering and to acquire fundamental knowledge in the relevant field.

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

CO1: Remember the fundamental laws, operating principles of motors, generators, MC and MI instruments.

CO2: Understand the problem-solving concepts associated to AC and DC circuits, construction and operation of AC and DC machines, measuring instruments; different power generation mechanisms, Electricity billing concept and important safety measures related to electrical operations.

CO3: Apply mathematical tools and fundamental concepts to derive various equations related to machines, circuits and measuring instruments; electricity bill calculations and layout representation of electrical power systems.

CO4: Analyze different electrical circuits, performance of machines and measuring instruments.

CO5: Evaluate different circuit configurations, Machine performance and Power systems operation.

UNIT I DC & AC Circuits

DC Circuits: Electrical circuit elements (R, L and C), Ohm's Law and its limitations, KCL & KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

AC Circuits: A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of Impedance, Active power, reactive power and apparent power, Concept of power factor (Simple Numerical problems).

UNIT II Machines and Measuring Instruments

Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

Measuring Instruments: Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone bridge.

UNIT III Energy Resources, Electricity Bill & Safety Measures

Energy Resources: Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of "unit" used for consumption of electrical energy, two-part electricity tariff, calculation of electricity bill for domestic consumers.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker (MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

Textbooks:

1. Basic Electrical Engineering, D.C.Kulshreshtha,TataMcGrawHill,2019,First Edition
2. Power System Engineering, P.V.Gupta, M.L.Soni, U.S.Bhatnagarand, A.Chakrabarti, Dhanpat Rai& Co, 2013

3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Reference Books:

1. Basic Electrical Engineering, D.P.Kothariand I.J.Nagrath, McGrawHill,2019,FourthEdition
2. Principles of Power Systems, V.K.Mehtha, S.ChandTechnical Publishers,2020
3. Basic Electrical Engineering, T.K.Nagsarkarand M.S.Sukhija, Oxford UniversityPress,2017
4. Basic Electrical and Electronics Engineering, S.K.Bhatacharya, Person Publications, 2018,Second Edition.

Web Resources:

1. https://nptel.ac.in/courses/108105053
2. https://nptel.ac.in/courses/108108076

PART B: BASIC ELECTRONICS ENGINEERING

Course Objectives:

To teach the fundamentals of semi-conductor devices and its applications, principles of digital electronics.

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

CO1: Remember the fundamental concepts of semiconductor devices, rectifiers, electronic instrumentation systems, and number systems.

CO2: Understand the concepts associated with vacuum tubes, nanoelectronics, diodes, and various configurations and characteristics of transistors and digital electronics.

CO3: Apply mathematical tools and fundamental concepts to derive various equations related to PN diodes, Zener diodes, transistors, and their properties, as well as basic theorems of Boolean algebra.

CO4: Analyze the characteristics of diodes, transistors, rectifiers, and amplifiers, and analyse the truth tables and functionality of logic gates.

CO5: Evaluate different circuit configurations using diodes, transistors, electronic instrumentation systems, simple combinational and sequential circuits, flipflops, registers, and counters.

UNIT I SEMICONDUCTOR DEVICES

Introduction, Evolution of electronics -Vacuum tubes to nano electronics, Characteristics of PN Junction Diode, Zener Effect - Zener Diode and its Characteristics. Bipolar Junction Transistor -CB, CE, CC Configurations and Characteristics, Elementary Treatment of Small Signal CE Amplifier.

UNIT II BASIC ELECTRONIC CIRCUITS AND INSTRUMENTATION

Rectifiers and power supplies: Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple Zener voltage regulator. Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response.

Electronic Instrumentation: Block diagram of an electronic instrumentation system.

UNIT III DIGITAL ELECTRONICS

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code, Hamming code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits– Half and Full Adders. Introduction to sequential circuits, Flip flops, Registers and counters (Elementary treatment

only).

Textbooks:

1. R.L.Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R.P.Jain, Modern Digital Electronics, 4th Edition, Tata McGraw Hill,2009

Reference Books:

1. R.S.Sedha, A Textbook of Electronic Devices and Circuits, S.Chand&Co,2010.
2. Santiram Kal, Basic Electronics-Devices, Circuits and IT Fundamentals, Prentice Hall, India,2002.
3. R.T.Paynter,IntroductoryElectronicDevices&Circuits-ConventionalFlowVersion,PearsonEducation, 2009.

L	T	P	C
0	0	2	1

I Year-I Semester

ENGINEERING PHYSICS LAB
(Common to All Branches of Engineering)

(Any **TEN** of the following listed experiments)

(Out of which any **TWO** experiments may be conducted in virtual mode)

List of Engineering Physics Experiments

1. Determination of radius of curvature of a given plano convex lens by Newton's rings.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
3. Verification of Brewster's law
4. Determination of dielectric constant using parallel plate capacitor.
5. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
6. Determination of wavelength of Laser light using diffraction grating.
7. Estimation of Planck's constant using photo electric effect.
8. Determination of energy gap of a semiconductor using PN junction diode.
9. Magnetic field along the axis of a current carrying circular coil by Stewart & Gee's Method.
10. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall effect.
11. Determination of rigidity modulus of the material of the given wire using Torsional pendulum.
12. V-I Characteristics of a PN junction diode
13. V-I Characteristics of Zener diode
14. To study the various types of crystal structures.

References:

1. "A Text Book of Practical Physics" - S. Balasubramanian, M.N. Srinivasan, S. ChandPublishers,2017.

URL:*www.vlab.co.in*

I Year-I Semester

L	T	P	C
0	0	3	1.5

COMPUTER PROGRAMMING LAB

(Common to All branches of Engineering)

Course Objectives:

The course aims to give students hands–on experience and train them on the concepts of the C- programming language.

UNIT-I

WEEK1:

Objective: Getting familiar with the programming environment on the computer and writing the first program.

Suggested Experiments/Activities:

Tutorial1: Problem-solving using Computers.

Lab1: Familiarization with the programming environment

i) Basic Linux environment and its editors like Vi, Vim & Emacs etc.

ii) Exposure to Turbo C, gcc

iii) Writing simple programs using printf(), scanf()

WEEK2:

Objective: Getting familiar with how to formally describe a solution to a problem in a series of finite steps using textual and graphic notation.

Suggested Experiments/Activities:

Tutorial 2: Problem-solving using Algorithms and Flowcharts.

Lab 1: Converting algorithms/flow charts into C Source code. Developing the algorithms/flow charts for the following sample programs

i) Sum and average of 3 numbers

ii) Conversion of Fahrenheit to Celsius and vice-versa

iii) Simple interest calculation

WEEK3:

Objective: Learn how to define variables with the desired data-type, initialize them with appropriate values and how arithmetic operators can be used with variables and constants.

Suggested Experiments/Activities:

Tutorial 3: Variable types and type conversions:

Lab 3: Simple computational problems using arithmetic expressions.

i) Finding the square root of a given number
ii) Finding compound interest
iii) Area of a triangle using Heron's formulae
iv) Distance traveled by an object

UNIT-II

WEEK4:

Objective: Explore the full scope of expressions, type- compatibility of variables & constants and operators used in the expression, and how operator precedence works.

Suggested Experiments/Activities:

Tutorial 4: Operators and the precedence and as associativity:

Lab 4: Simple computational problems using the operator's precedence and associativity

i) Evaluate the following expressions.
   a. A+B*C+(D*E)+F*G
   b. A/B*C-B+A*D/3
   c. c.A+++B---A
   d. d.J=(i++)+(++i)

ii) Find the maximum of three numbers using the conditional operator

iii) Take marks of 5 subjects in integers, and find the total, average in float

WEEK 5:

Objective: Explore the full scope of different variants of–if construct, namely if-else, null—else ,if-elseif-else, switch, and nested-if, including in what scenario each can be used and how to use them. Explore all relational and logical operators while writing conditionals for–if construct.

Suggested Experiments/Activities:

Tutorial 5: Branching and logical expressions:

Lab 5: Problems involving if-then-else structures.

i) Write a C program to find the max and min off our numbers using if-else.
ii) Write a C program to generate electricity bill.
iii) Find the roots of the quadratic equation.
iv) Write a C program to simulate a calculator using a switch case.
v) Write a C program to find whether the given year is a leap year.

WEEK 6:

Objective: Explore the full scope of iterative constructs, namely while loop, do-while loop, and for loop in addition to structured jump constructs like break and continue, including when each of these statements is more appropriate.

Suggested Experiments/Activities:

Tutorial 6: Loops, while and for loops

Lab6: Iterative problems, e.g., the sum of series

i) Find the factorial of a given number using any loop.
ii) Find whether the given number is a prime or not.
iii) Compute sine and cos series
iv) Checking whether a number is palindrome
v) Construct a pyramid of numbers.

UNIT III

WEEK7:

Objective: Explore the full scope of the Arrays construct, namely defining and initializing 1-D and 2-D and, more generically, n-D arrays and referencing individual array elements from the defined array. Using integer1-D arrays, explore search solution linear search.

Suggested Experiments/Activities:

Tutorial7: 1 D Arrays: searching.

Lab7:1D Array manipulation, linear search

i) Find the min and max of a 1-D integer array.

ii) Perform linear search on the1D array.

iii) The reverse of a1D integer array

iv) Find 2's complement of the given binary number.

v) Eliminate duplicate elements in an array.

WEEK8:

Objective: Explore the difference between other arrays and character arrays that can be used as Strings by using null characters and get comfortable with strings by doing experiments that will reverse a string and concatenate two strings. Explore sorting solution bubble sort using integer arrays.

Suggested Experiments/Activities:

Tutorial 8: 2D arrays, sorting and Strings.

Lab 8: Matrix problems, String operations, Bubble sort

i) Addition of two matrices

ii) Multiplication two matrices

iii) Sort array elements using bubble sort

iv) Concatenate two strings with out built-in functions

v) Reverse string using built-in and without built-in string functions

UNIT-IV

WEEK9:

Objective: Explore pointers to manage a dynamic array of integers, including memory allocation value initialization, resizing, changing, and reordering the contents of an array, and memory de-allocation using malloc(), calloc(), realloc() and free() functions. Gain experience processing command-line arguments received by C

Suggested Experiments/Activities:

Tutorial 9: Pointers, structures, and dynamic memory allocation

Lab9: Pointers and structures, memory dereference.

i) Write a C program to find the sum of a1D array using malloc()

ii) Write a C program to find the total average of n students using structures

iii) Enter n students data using calloc() and display failed students list

iv) Read student name and marks from the command line and display the student details along with the total.

v) Write a C program to implement realloc()

WEEK10:

Objective: Experiment with C Structures, Unions, bit fields self-referential structures(Singly-linked lists),and nested structures

Suggested Experiments/Activities:

Tutorial 10: Bit fields, Self-Referential Structures, Linked lists

Lab 10: Bit fields, linked lists

Read and print a date using dd/mm/yyyy format using bit-fields and differentiate the same without using bit-fields

i) Create and display a singly linked list using self-referential structure.

ii) Demonstrate the differences between structures and unions using a C program.

iii) Write a C program to shift/rotate using bit fields.

iv) Write a C program to copy one structure variable to another structure of the same type.

UNIT-V

WEEK 11:

Objective: Explore the Functions, sub-routines, scope and extent of variables, doing some experiments by parameter passing using call by value. Basic methods of numerical integration

Suggested Experiments/Activities:

Tutorial11: Functions, call by value, scope and extent,

Lab11: Simple functions using call by value, solving differential equations using Eulers theorem.

i) Write a C function to calculate NCR value.

ii) Write a C function to find the length of a string.

iii) Write a C function to transpose of a matrix.

iv) Write a C function to demonstrate numerical integration of differential equations using Euler's method

WEEK 12:

Objective: Explore how recursive solutions can be programmed by writing recursive functions that can be invoked from the main by programming at-least five distinct problems that have naturally recursive solutions.

Suggested Experiments/Activities:

Tutorial 12: Recursion, the structure of recursive calls

Lab 12: Recursive functions

i) Write a recursive function to generate Fibonacci series.

ii) Write a recursive function to find the lcm of two numbers.

iii) Write a recursive function to find the factorial of a number.

iv) Write a C Program to implement Ackermann function using recursion.

v) Write a recursive function to find the sum of series.

WEEK13:

Objective: Explore the basic difference between normal and pointer variables, Arithmetic operations using pointers and passing variables to functions using pointers

Suggested Experiments/Activities:

Tutorial13: Call by reference, dangling pointers

Lab13: Simple functions using Call by reference, Dangling pointers.

i) Write a C program to swap two numbers using call by reference.

ii) Demonstrate Dangling pointer problem using a C program.

iii) Write a C program to copy one string into another using pointer.

iv) Write a C program to find no of lowercase, uppercase, digits and other characters using pointers.

WEEK 14:

Objective: To understand data files and file handling with various file I/O functions. Explore the differences between text and binary files.

Suggested Experiments/Activities:

Tutorial14: File handling

Lab14: File operations

i) Write a C program to write and read text into a file.

ii) Write a C program to write and read text into a binary file using fread() and fwrite()

iii) Copy the contents of one file to another file.

iv) Write a C program to merge two files into the third file using command-line arguments.

v) Find no. of lines, words and characters in a file

vi) Write a C program to print last n characters of a given file.

Course Outcomes:

CO1: Read, understand, and trace the execution of programs written in C language.

CO2: Select the proper control structure for solving the problem.

CO3: Develop C programs that utilize memory efficiently using programming constructs like pointers.

CO4: Develop, Debug, and Execute programs to demonstrate the applications of arrays, functions, and basic concepts of pointer sinC.

Textbooks:

1. Ajay Mittal, Programming in C: A practical approach,1st Edition, Pearson.

2. Byron Gottfried, Schaum's Outline of Programming with C, 4thEdition, 2020, McGraw Hill.

Reference Books:

1. Brian W.Kernighan and Dennis M.Ritchie, The C Programming Language, Prentice-Hall of India.

2. C Programming, A Problem-Solving Approach, Forouzan, Gilberg, Prasad,3rd Edition, CENGAGE.

I Year-I Semester

L	T	P	C
0	0	3	1.5

ELECTRICAL & ELECTRONICS ENGINEERING WORKSHOP
(Common to All branches of Engineering)

Course Objectives:

To impart knowledge on the fundamental laws & theorems of electrical circuits, functions of electrical machines and energy calculations.

Course Outcomes:

CO1: Understand the Electrical circuit design concept; Measurement of resistance, power, power factor; concept of wiring and operation of Electrical Machines and Transformer.

CO2: Apply the theoretical concepts and operating principles to derive mathematical models for circuits, Electrical machines and measuring instruments; calculations for the measurement of resistance, power and power factor.

CO3: Apply the theoretical concepts to obtain calculations for the measurement of resistance, power and power factor.

CO4: Analyse various characteristics of electrical circuits, electrical machines and measuring instruments.

CO5: Design suitable circuits and methodologies for the measurement of various electrical parameters; Household and commercial wiring.

Activities:

1. Familiarization of commonly used Electrical & Electronic Workshop Tools: Breadboard, Solder, cables, relays, switches, connectors, fuses, Cutter, plier, screwdriver set, wire stripper, flux, knife/blade, soldering iron, de-soldering pump etc.
   - Provide some exercises so that hardware tools and instruments are learned to be used by the students.

2. Familiarization of Measuring Instruments like Voltmeters, Ammeters, Multimeter, LCR-Q meter, Power Supplies, CRO, DSO, Function Generator, Frequency counter.
   - Provide some exercises so that measuring instruments are learned to be used by the students.
3. Components:
   - Familiarization/Identification of components (Resistors, Capacitors, Inductors, Diodes, transistors, IC's etc.) – Functionality, type, size, color coding package, symbol, cost etc.
   - Testing of components like Resistor, Capacitor, Diode, Transistor, IC set. - Compare values of components like resistors, inductors, capacitors etc. with the measured values by using instruments

PARTA: ELECTRICAL ENGINEERING LAB

List of experiments:

1. Verification of KCL and KVL
2. Verification of Superposition theorem
3. Measurement of Resistance using Wheatstone bridge
4. Magnetization Characteristics of DC shunt Generator
5. Measurement of Power and Power factor using Single-phase watt meter

6. Measurement of Earth Resistance using Megger
7. Calculation of Electrical Energy for Domestic Premises

Reference Books:

1. Basic Electrical Engineering, D.C.Kulshreshtha, Tata Mc GrawHill,2019, FirstEdition
2. Power System Engineering, P.V.Gupta, M.L.Soni, U.S.Bhatnagar and A.Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Note: Minimum Six Experiments to be performed.

PARTB: ELECTRONICS ENGINEERING LAB

Course Objectives:

- To impart knowledge on the principles of digital electronics and fundamentals of electron devices & its applications.

Course Outcomes: At the end of the course, the student will be able to
CO1: Identify & testing of various electronic components.
CO2: Understand the usage of electronic measuring instruments.
CO3: Plot and discuss the characteristics of various electron devices.
CO4: Explain the operation of a digital circuit.
CO5: Realize the truth tables of various Flip flops.

List of Experiments:

1. Plot V-I characteristics of PN Junction diode A)Forward bias B)Reverse bias.
2. Plot V-I characteristics of Zener Diode and its application as voltage Regulator.
3. Implementation of half wave and full wave rectifiers.
4. Plot Input & Output characteristics of BJT in CE and CB configurations.
5. Frequency response of CE amplifier.
6. Simulation of RC coupled amplifier with the design supplied.
7. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs.
8. Verification of Truth Tables of S-R, J-K & D flip flops using respective ICs.

Tools/Equipment Required: DC Power supplies, Multimeters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROs, all the required active devices.

References:

1. R.L.Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R.P.Jain,Modern Digital Electronics,4thEdition,Tata McGraw Hill,2009
3. R.T.Paynter, Introductory Electronic Devices & Circuits–Conventional Flow Version, Pearson Education, 2009.

Note: Minimum Six Experiments to be performed. All the experiments shall be implemented using both Hardware and Software.

I Year-I Semester

L	T	P	C
0	0	1	0.5

NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE
(Common to All branches of Engineering)

Course Objectives:
The objective of introducing this course is to impart discipline, character, fraternity, teamwork, social consciousness among the students and engaging them in selfless service.

Course Outcomes: After completion of the course the students will be able to
CO1: Understand the importance of discipline, character and service motto.
CO2: Solve some societal issues by applying acquired knowledge, facts, and techniques.
CO3: Explore human relationships by analyzing social problems.
CO4: Determine to extend their help for the fellow beings and down trodden people.
CO5: Develop leadership skills and civic responsibilities.

UNIT I Orientation
General Orientation on NSS/NCC/Scouts & Guides/Community Service activities, career guidance.

Activities:
i) Conducting–ice breaking sessions-expectations from the course-knowing personal talents and skills
ii) Conducting orientations programs for the students–future plans-activities-releasing road map etc.
iii) Displaying success stories-motivational biopics-award winning movies on societal issues etc.
iv) Conducting talent show in singing patriotic songs-paintings-any other contribution.

UNIT II Nature & Care
Activities:
i) Best out of waste competition.
ii) Poster and signs making competition to spread environmental awareness.
iii) Recycling and environmental pollution article writing competition.
iv) Organising Zero-waste day.
v) Digital Environmental awareness activity via various social media platforms.
vi) Virtual demonstration of different eco-friendly approaches for sustainable living.
vii) Write a summary on any book related to environmental issues.

UNIT III Community Service
Activities:

i) Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media- authorities-experts-etc

ii) Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS,
iii) Conducting consumer Awareness. Explaining various legal provisions etc.
iv) Women Empowerment Programmes-Sexual Abuse, Adolescent Health and Population Education.
v) Any other programmes in collaboration with local charities, NGOs etc.

Reference Books:

1. Nirmalya Kumar Sinha & Surajit Majumder, *A Text Book of National Service Scheme* Vol;I, Vidya Kutir Publication, 2021(ISBN978-81-952368-8-6)
2. *Red Book-National Cadet Corps*–Standing Instructions VolI & II, Directorate General of NCC, Ministry of Defence, New Delhi
3. Davis ML. and Cornwell DA, ―Introduction to Environmental Engineering, McGraw Hill New York 4/e2008
4. Masters G.M., Joseph K. and Nagendran R.―Introduction to Environmental Engineering and Science‖, Pearson Education, NewDelhi.2/e2007
5. Ram Ahuja. *Social Problems in India*, Rawat Publications, New Delhi.

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities.
2. Institutes are required to provide instructor to mentor the students.

Evaluation Guidelines:

- Evaluated for a total of 100marks.
- A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totaling to 90marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject.

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I Year-II Semester

L	T	P	C
3	0	0	3

DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS
(Common for all branches)

Course Objectives:

- To enlighten the learner, sin the concept of differential equations and multivariable calculus.
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real-world applications.

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

- Solve the differential equations related to various engineering fields.
- Identify solution methods for partial differential equations that model physical processes.
- Interpret the physical meaning of different operators such as gradient, curl and divergence.
- Estimate the work done against a field, circulation and flux using vector calculus.

UNIT I Differential equations of first order and first degree

Linear differential equations – Bernoulli's equations- Exact equations and equations reducible to exact form. Applications: orthogonal trajectories

Newton's Law of cooling – Law of natural growth and decay- Electrical circuits (RL & RC)

UNIT II Linear differential equations of higher order (Constant Coefficients)

Definitions, homogenous and non-homogenous, complimentary function, general solution, particular integral, Wronskian, method of variation of parameters. Simultaneous linear equations, Applications to L-C-R Circuit problems and Simple Harmonic motion.

UNIT III Partial Differential Equations

Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations using Lagrange's method. Charpt's method Homogeneous & Non-Homogeneous Linear Partial differential equations with constant coefficients.

UNIT IV Vector differentiation

Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions-Divergence and Curl, vector identities.

UNIT V Vector integration

Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.

Textbooks:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.
2. B.S. Grewal, Higher EngineeringMathematics,44/e, Khanna publishers,2017.

Reference Books:

1. Dennis G. Zill and Warren Wright, Advanced Engineering Mathematics, Jones and Bartlett,2018.
2. Michael Greenberg, Advanced Engineering Mathematics, 9th edition, Pearson edn
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 14/e, Pearson Publishers, 2018.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, Alpha Science International Ltd., 2021 (9th reprint).
5. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill Education, 2017

L	T	P	C
3	0	0	3

I Year-II Semester

ENGINEERING CHEMISTRY

(Civil, Mechanical and Metallurgical Engineering)

Course Objectives:

- To familiarize engineering chemistry and its applications
- To impart the concept of soft and hard waters, softening methods of hardwater
- To train the students on the principles and applications of electro chemistry, polymers, surface chemistry, and cement

.

Course Outcomes: At the end of the course, the students will be able to

CO1: Ensure the quality of a water sample.

CO2: Demonstrate the corrosion prevention methods and factors affecting corrosion.

CO3: Explain the preparation, properties, and applications of thermoplastic & thermosetting, elastomers & conducting polymers,
Explain calorific values, octane number, refining of petroleum and cracking of oils

CO4: Explain the setting and hardening of cement.

CO5: Apply the principle of Green Chemistry

UNIT I Water Technology

Soft and hardwater, Estimation of hardness of water by EDTA Method, Estimation of dissolved Oxygen-Boiler troubles–Priming, foaming**,** scale and sludge, Caustic embrittlement, Industrial water treatment– Specifications for drinking water, Bureau of Indian Standards (BIS) and World health organization (WHO) standards, Ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

UNIT II Electrochemistry and Applications

Electrodes–electrochemical cell, Nernst equation, cell potential calculations.
Primary cells – Zinc-air battery, Secondary cells – Nickel-Cadmium (NiCad), and lithium ion batteries-working principle of the batteries including cell reactions.
Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry electrochemical corrosion, Pilling Bedworth ratios and uses, Factors affecting the corrosion**,** cathodic and anodic protection, electroplating and electroless plating (Nickel and Copper).

UNIT III Polymers and Fuel Chemistry

Introduction to polymers, functionality of monomers,
Thermoplastics and Thermo-setting plastics-: Preparation, properties and applications of polystyrene. PVC Nylon6,6andBakelite.
Elastomers–Preparation, properties and applications of BunaS, BunaN, Thiokol rubbers.

Fuels – Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis of coal (Proximate and Ultimate analysis), Liquid Fuels, refining of petroleum, Octane and Cetane number- alternative fuels-propane, methanol, ethanol and biofuel-biodiesel.

UNIT IV Modern Engineering Materials

Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites, properties and Engineering applications

Refractories-Classification, Properties, Factors affecting the refractory materials and Applications.

Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils– Viscosity, Viscosity Index, Flashpoint, Fire point, Cloud point, saponification and Applications.

Building materials-Portland Cement, constituents, Setting and Hardening of cement,

Reinforced concrete construction and advantages.

UNIT V Green Chemistry and Technology

Introduction and significance of green chemistry, Goals of green chemistry, 12 principles of Green chemistry, toxicity of chemicals, material safety data sheet (MSDS), concept of zero Pollution technologies-Applications of green chemistry - Green solvents, green fuels and Propellants, bio catalysis.

Textbooks:

1. Jain and Jain, EngineeringChemistry,16/e, DhanpatRai,2013.
2. Sashi Chawla, Engineering chemistry, Dhanpat rai Publicating Co(Latest edition)
3. Hand book of Green chemistry and Technology by James Clarke and Duncan macqurrie, Blackwell Publishin.

Reference Books:

1. H.F.W.Taylor,CementChemistry,2/e,ThomasTelfordPublications,1997.
2. Textbook of Polymer Science, FredW.BillmayerJr,3rdEdition

L	T	P	C
2	0	0	2

I Year-II Semester

COMMUNICATIVE ENGLISH

(Common to All Branches of Engineering)

Course Objectives:

The main objective of introducing this course, communicative English, is to facilitate effective listening, Reading, Speaking and Writing skills among the students. It enhances the same in their comprehending abilities, oral presentations, reporting useful information and providing knowledge of grammatical structures and vocabulary. This course helps the students to make them effective in speaking and writing skills and to make them industry-ready.

Course Outcomes

- By the end of the course the students will have Learned how to understand the context, topic, and specific information from social or transactional dialogues.
- Remedially learn applying grammatical structures to formulate sentence sand use appropriate words and correct word forms.
- Using discourse markers to speak clearly on a specific topic in formal as well as informal discussions. (not required)
- Improved communicative competence in formal and informal contexts and for social and academic purposes.
- Critically comprehending and appreciating reading /listening texts and to write summaries.
- Writing coherent paragraphs essays, letters/e-mails and resume.

Instructions:

1. The reading texts can be given as podcasts to the students so that their listening skills can be enhanced.
2. While listening and reading to the text can be given as homework, the class work for the students can be to discuss and critically evaluate the texts based on the context, purpose or writing the text and understanding it from the author's as well as reader's point of view.
3. Reading as habit for both academic and non-academic (pleasure) purposes have to be inculcated in the students. So training has to be given in intensive and extensive reading strategies.
4. Writing for both academic (assignments, examinations, reports, e-mails/letters etc)
5. The writing tasks given in the class are to be self and peer evaluated by the students before they are finally graded by the faculty. Note: Please note that the texts given here are just contexts for teaching various language skills and sub skills. The students' ability to use language cannot be confined to comprehending or using the language related to the given texts (textbooks). The given texts can be used only for practice.
6. All the activities to develop language skills have to be integrated and interconnected, within each unit and across the units.

UNIT I

Lesson: HUMAN VALUES: A Power of a Plate of Rice by Ifeoma Okoye (Short story)

Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing: Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences. (That has to be part of the bridge course- 2 weeks before the actual academic

Programme starts)
Grammar: Parts of Speech, Basic Sentence Structures-forming questions
Vocabulary: Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words

UNIT-II

Lesson: **NATURE: Night of the Scorpion by Nissim Ezekiel (Indian and contemporary)**
Listening: Answering a series of questions about main ideas and supporting ideas after Listening to audio texts.
Speaking: Discussion in pairs/small groups on specific topics followed by short structure talks.
Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.
Writing: Structure of a paragraph - Paragraph writing (specific topics)
Grammar: Cohesive devices -linkers, use of articles and zero article prepositions.
Vocabulary: Homonyms, Homophones, Homographs.

UNIT-III

Lesson: BIOGRAPHY: Steve Jobs.
Listening: Listening for global comprehension and summarizing what is listened to.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed
Reading: Readingatextindetailbymakingbasicinferences-recognizingandinterpretingspecific Context clues; strategies to use text clues for comprehension.
Writing: Summarizing, Note-making, paraphrasing.
Grammar: Verbs - tenses; subject-verb agreement; Compound words, Collocations
Vocabulary: Compound words, Collocations

UNIT- IV

Lesson: INSPIRATION: The Toys of Peace by Saki
Listening: Making predictions while listening to conversations/ transactional dialogues Without video; listening with video.
Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.
Reading: Studying the use of graphic elements in texts to convey information, reveal trends/ Patterns/ relationships, communicate processes or display complicated data.
Writing: Letter Writing: Official Letters, Resumes
Grammar: Reporting verbs, Direct & Indirect speech, Active & Passive Voice
Vocabulary: Words often confused, Jargons

UNIT- V
Lesson: MOTIVATION: The Power of Intrapersonal Communication (An Essay)
Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.

Speaking: Formal oral presentations on topics from academic contexts
Reading: Reading comprehension.
Writing: Writing structured essays on specific topics.
Grammar: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)
Vocabulary: Technical Jargons

Textbooks:

1. Pathfinder: Communicative English for Undergraduate Students, 1st Edition, Orient Black Swan, 2023 (Units 1,2 & 3)
2. Empowering English by Cengage Publications, 2023 (Units 4 & 5)

Reference Books:

1. Dubey, Sham Ji & Co. English for Engineers, Vikas Publishers, 2020
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge, 2014.
3. Murphy, Raymond. English Grammar in Use, Fourth Edition, Cambridge University Press, 2019.
4. Lewis, Norman. Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary. Anchor, 2014.

Web Resources:

GRAMMAR:

1. www.bbc.co.uk/learningenglish
2. https://dictionary.cambridge.org/grammar/british-grammar/
3. www.eslpod.com/index.html
4. https://www.learngrammar.net/
5. https://english4today.com/english-grammar-online-with-quizzes/
6. https://www.talkenglish.com/grammar/grammar.aspx

VOCABULARY

1. https://www.youtube.com/c/DailyVideoVocabulary/videos
2. https://www.youtube.com/channel/UC4cmBAit8i_NJZE8qK8sfpA

L	T	P	C
3	0	0	3

I Year-II Semester

BASIC CIVIL & MECHANICAL ENGINEERING
(Common to All branches of Engineering)

Course Objectives:

- Get familiarized with the scope and importance of Civil Engineering sub-divisions.
- Introduce the preliminary concepts of surveying.
- Acquire preliminary knowledge on Transportation and its importance in nation's economy.
- Get familiarized with the importance of quality, conveyance and storage of water.
- Introduction to basic civil engineering materials and construction techniques.

Course Outcomes: On completion of the course, the student should be able to:

CO1: Understand various sub-divisions of Civil Engineering and to appreciate their role in ensuring better society.

CO2: Know the concepts of surveying and to understand the measurement of distances, angles and levels through surveying.

CO3: Realize the importance of Transportation in nation's economy and the engineering measures related to Transportation.

CO4: Understand the importance of Water Storage and Conveyance Structures so that the social responsibilities of water conservation will be appreciated.

CO5: Understand the basic characteristics of Civil Engineering Materials and attain knowledge on pre-fabricated technology.

PART A: BASIC CIVIL ENGINEERING

UNITI

Basics of Civil Engineering: Role of Civil Engineers in Society- Various Disciplines of Civil Engineering-Structural Engineering-Geo-technical Engineering-Transportation Engineering - Hydraulics and Water Resources Engineering - Environmental Engineering-Scope of each discipline-Building Constructionand Planning-Construction Materials – Cement – Aggregate – Bricks - Cement concrete-Steel. Introduction to Pre fabricated construction Techniques.

UNITII

Surveying: Objectives of Surveying-Horizontal Measurements-Angular Measurements-Introduction to Bearings Levelling instruments used for levelling-Simple problems on levelling and bearings-Contour mapping.

UNITIII

TransportationEngineeringImportanceofTransportationinNation'seconomicdevelopment- Types of Highway Pavements- Flexible Pavements and Rigid Pavements-Simple Differences. Basics of Harbour, Tunnel, Airport and Railway Engineering

Water Resources and Environmental Engineering: Introduction, Sources of water- Quality of water-Specifications-Introduction to Hydrology–Rain water Harvesting-Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

Textbooks:

1. Basic Civil Engineering, M.S.Palanisamy, , Tata Mc graw Hill publications (India) Pvt.Ltd. Fourth Edition.

2. Introduction to Civil Engineering, S.S.Bhavi katti, New Age International Publishers.2022.First Edition.
3. Basic Civil Engineering, Satheesh Gopi,Pearson Publications,2009,FirstEdition.

Reference Books:

1. Surveying, Vol-IandVol-II, S.K.Duggal,TataMcGrawHillPublishers2019.FifthEdition.
2. Hydrology and Water Resources Engineering, Santosh Kumar Garg, Khanna Publishers, Delhi.2016
3. Irrigation Engineering and Hydraulic Structures-Santosh Kumar Garg, Khanna Publishers, Delhi2023.38th Edition.
4. Highway Engineering, S.K.Khanna, C.E.G. Justo and Veeraraghavan, Nemchand and Brothers Publications2019. 10thEdition.
5. Indian Standard DRINKINGWATER—SPECIFICATIONIS10500-2012.

PART B: BASIC MECHANICAL ENGINEERING

Course Objectives: The students after completing the course are expected to

- Get familiarized with the scope and importance of Mechanical Engineering in different sectors and industries.
- Explain different engineering materials and different manufacturing processes.
- Provide an overview of different thermal and mechanical transmission systems and introduce basics of robotics and its applications.

Course Outcomes: On completion of the course, the student should be able to

CO1: Understand the different manufacturing processes.
CO2: Explain the basics of thermal engineering and its applications.
CO3: Describe the working of different mechanical power transmission systems and power plants.
CO4: Describe the basics of robotics and its applications.
CO5: Explain the basics of engineering materials and its applications

UNIT I

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.
Engineering Materials – Metals - Ferrous and Non-ferrous, Ceramics, Composites, Smart materials.

UNIT II

Manufacturing Processes: Principles of Casting**,** Forming, joining processes, Machining, Introduction to CNC machines, 3D printing, and Smart manufacturing.
Thermal Engineering– working principle of Boilers, Otto cycle, Diesel cycle, Refrigeration and air-conditioning cycles, IC engines, 2-Stroke and 4-Stroke engines, SI/CI Engines, Components of Electric and Hybrid Vehicles.

UNIT III

Power plants – working principle of Steam, Diesel, Hydro, Nuclear power plants.
Mechanical Power Transmission - Belt Drives, Chain, Rope drives, Gear Drives and their applications.
Introduction to Robotics - Joints & links, configurations, and applications of robotics.

(Note: The subject covers only the basic principles of Civil and Mechanical Engineering systems. The evaluation shall be intended to test only the fundamentals of the subject)

Textbooks:

1. Internal Combustion Engines by V.Ganesan, By Tata McGraw Hill publications (India) Pvt. Ltd.
2. A Tear book of Theory of Machines by S.S. Rattan, Tata McGraw Hill Publications, (India) Pvt. Ltd.
3. An introduction to Mechanical Engg by Jonathan Wicker and Kemper Lewis, cengage learning India pvt. Ltd.

Reference Books:

1. Appuu Kuttan KK, Robotics, I.K. International Publishing House Pvt. Ltd. Volume-I
2. 3D printing & Additive Manufacturing Technology- L. Jyothish Kumar, Pulak M Pandey, Springer publications
3. Thermal Engineering by Mahesh M Rathore Tata Mc graw Hill publications (India) Pvt. Ltd.
4. G. Shanmugam and M.S.Palanisamy, Basic Civil and the Mechanical Engineering, Tata Mcgraw Hill publications (India) Pvt. Ltd.

IYear-II Semester

L	T	P	C
3	0	0	3

MINERAL PROCESSING AND METALLURGICAL ANALYSIS

Course objectives:

1. To study the scope of ore dressing and to describe the various crushers used in ore dressing.
2. To explain the theory and principles of various sizing techniques. It also describes the movement of solids in fluids by explaining the effect of various parameters on the movement of solids.
3. The basic concepts involved in jigging and tabling will be detailed to understand the working of various jigging machines and other equipment involved with tabling.
4. To know the importance of various methods of Metallurgical chemical analysis.
5. To describe various instrumental analysis.

UNIT I

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

UNIT II

Sizing: Study of laboratory sizing techniques and reporting of sizing data. Industrial sizing units: Types of screen surfaces. Grizzlies, trommels, vibrating and shaking screens.
Classification 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.

UNIT III

Jigging: Theory of jigging. Jigging machines: hand jig, Harz jig, Denver jig, Baum jig, Hancock jig, James coal jig, and halkyn jig. Design considerations in a jig.
Flotation: Principles of flotation, Factors affecting flotation. Classification of collectors and frothers. Application of flotation process for Cu, Pb and Zn ores. Magnetic separation processes and electrostatic separation process.

UNIT IV

Scope of metallurgical analysis, classification of various methods used in metallurgical analysis. Determination of iron in iron ore, manganese in manganese ores, lime in limestone, fire-assay of precious metals.

UNIT-V:

Instrumental analysis: Importance of instrumental analysis –Comparison with standard wet chemical methods, absorptiometry, colorimetry and spectrophotometry.

Course Outcomes:

1. Able to understand the theory, principle and working of various ball mills used for size reduction.
2. Understand the principles and working of classifiers.
3. Interpret the principles and applications of flotation and other separation processes
4. Compare the results with different wet methods
5. Interpret the working of different components by instrumental analysis.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

TEXTBOOK:

1. Principles of Mineral Dressing by A.M. Gaudin.
2. S.K.Jain-Metallurgical analysis

REFERENCES:

1. Elements of Ore Dressing by A.F. Taggart
2. Mineral processing technology-.A. Wills
3. Ore dressing practices-S.K.Jain.
4. Vogel Al., A Text Book of Quantitative Inorganic Analysis Longman ELBS 1962.
5. Willard H.H.etal: Instrumental Methods of analysis Van Nostrand.

I Year-II Semester

L	T	P	C
0	0	2	1

COMMUNICATIVE ENGLISH LAB

(Common to All Branches of Engineering)

Course Objectives:

The main objective of introducing this course, Communicative English Laboratory, is to expose the students to a variety of self-instructional, learner friendly modes of language learning students will get trained in the basic communication skills and also make them ready to face job interviews.

Course Outcomes:

- Understand the different aspects of the English language proficiency with emphasis on LSRW skills.
- Apply communication skills through various language learning activities.
- Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension.
- Evaluate and exhibit professionalism in participating in debates and group discussions.
- Create effective resonate and prepare themselves to face interviews in future.

List of Topics:

1. Vowels & Consonants (Not rules but use of them in various syllable structures)
2. Neutralization/Accent Rules (No rules again, required more practice)
3. Communication Skills & JAM
4. Role Play or Conversational Practice
5. (This can be part of theory course) Resume Writing, Cover letter, SOP
6. Group Discussions-methods & practice
7. Debates- Methods & Practice
8. PPT Presentations/ Poster Presentation
9. Interviews Skills

Suggested Software:

- Walden Infotech
- Young India Films

Reference Books:

1.Meenakshi Raman, Sangeeta-Sharma. Technical Communication. Oxford Press.2018.(This can be for theory and not for lab)
2. Samson T : Innovate with English, Foundations
3. Grant Taylor: English Conversation Practice, Tata McGraw-Hill EducationIndia,2016
4. Jayashree, M Let's Hear them Speak: Developing Listening-Speaking skills in English.
. Sage Publications
5. Hewing's, Martin. Cambridge Academic English (B2). CUP, 2012. (That is for reading and writing and can be used in theory classes but not in Lab)
6. T. Bala subramanyam, A Textbook of English Phonetics for Indian Students,(3rd Ed)
Trinity Press. (This is all theory and can be for MA English students but not for B.Tech students)

Web Resources:

Spoken English:

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. https://www.britishcouncil.in/english/online
5. http://www.letstalkpodcast.com/
6. https://www.youtube.com/c/mmmEnglish_Emma/featured
7. https://www.youtube.com/c/ArnelsEverydayEnglish/featured
8. https://www.youtube.com/c/engvidAdam/featured
9. https://www.youtube.com/c/EnglishClass101/featured
10. https://www.youtube.com/c/SpeakEnglishWithTiffani/playlists
11. https://www.youtube.com/channel/UCV1h_cBE0Drdx19qkTM0WNw
12. https://www.linguahouse.com/en-GB
13. https://www.ted.com/watch/ted-ed

Voice & Accent:

1.. https://www.youtube.com/user/letstalkaccent/videos
2. https://www.youtube.com/c/EngLanguageClub/featured
3. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
4. https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

I Year-II Semester

L	T	P	C
0	0	2	1

ENGINEERING CHEMISTRY LAB

(Common to Civil, Mechanical and Metallurgical Engineering)

Objectives:

To verify the fundamental concepts with experiments

Course Outcomes:

At the end of the course, the students will be able to

- Determine the cell constant and conductance of solutions.
- Prepare advanced polymer materials.
- Determine the physical properties like surface tension, adsorption and viscosity.
- Estimate the Iron and Calcium in cement.
- Calculate the hardness of water.

List of Experiments:

1. Determination of Hardness of a groundwater sample.
2. Estimation of Dissolved Oxygen by Winkler's method
3. Determination of KnO_4 by using standard oxalic acid solution.
4. Preparation of a polymer Bakelite (Demo)
5. Determination of percentage of Iron in Cement sample by colorimetry
6. Estimation of Calcium by $K_2Cr_2O_7$
7. Preparation of nanomaterials by precipitation method.
8. Adsorption of acetic acid by charcoal.
9. Determination of percentage Moisture content in a coal sample
10. Determination of Viscosity of lubricating oil by Redwood Viscometer 1
11. Determination of Viscosity of lubricating oil by Redwood Viscometer 2
12. Determination of Calorific value of gases by Junker's gas Calorimeter
13. Preparation of Polyaniline Conducting polymer(demo)
14. Conductometric titration of strong acid and strong base.

Reference:

- "Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publications by J. Mendham, R.C.Denney, J.D.Barnes and B. Sivasankar.

I Year-II Semester

L	T	P	C
0	0	2	1

IT WORKSHOP
(Common to all branches of Engineering)

Course Objectives:

- To introduce the internal parts of a computer, peripherals, I/O ports, connecting cables
- To demonstrate configuring the system as Dual boot for Windows and other Operating Systems Viz. Linux, BOSS
- To teach basic command line interface commands on Linux.
- To teach the usage of the Internet for productivity and self-paced life-long learning
- To introduce Compression, Multimedia, Antivirus tools and Office Tools such as Word processors, spreadsheets, and Presentation tools.

PC Hardware & Software Installation

Task1: Identify the peripherals of a computer, components in a CPU, and functions. Draw the block diagram of the CPU Along with the configuration of each peripheral and submit to your instructor.

Task2: Every student should disassemble and assemble the PC back to working condition. La instructors should verify the work and follow it up with a Viva. Also, students must go through the video showing the PC assembling process. A video would be given as part of the course content.

Task 3: Students should install MS windows on their personal computer. The lab instructor should verify the installation and follow it with a Viva.

Task 4: Every student should install Linux on the computer. This computer should have Windows installed. The system should be configured as dual boot (VMWare) with Windows and Linux. Lab instructors should verify the installation and follow it up with a Viva.

Task5: Every student should install BOSS on the computer. The system should be configured as dual boot (VMWare) with Windows and BOSS. Lab instructors should verify the installation and follow it up with a Viva.

Internet & World Wide Web

Task 1: Orientation & Connectivity Boot Camp: Students should connect to their Local Area Network and access the Internet. In the process, they configure the TCP/IP setting. Finally, students should demonstrate to the instructor how to access the websites and email. Without internet connectivity, instructors must simulate the WWW on the LAN.

Task2: Web Browsers, Surfing the Web: Students customize their web browsers with the LAN proxy settings, bookmarks, search tool bars, and pop-up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.

Task3: Search Engines & Netiquette: Students should know what search engines are and how to use these arch

engines. A few topics would be given to the students for which they need to search on Google. This should be demonstrated to the instructors by the student.

Task 4: Cyber Hygiene: Students would be exposed to the various threats on the internet and asked to configure their computers to be safe on the internet. They need to customize their browsers to block pop-ups ,and block active X downloads to avoid viruses and worms.

LaTeX and WORD

Task 1 – Word Orientation: The mentor needs to give an overview of LaTeX and Microsoft (MS) Office or equivalent (FOSS) tool word: Importance of La Te X and MS office or equivalent (FOSS)tool Word as word Processors, Details of the four tasks and features that would be covered in each, Using LaTeX and word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter in word.

Task2: Using LaTeX and Word to create a project certificate. Features to be covered :- Formatting Fonts in Word ,Drop Cap in Word ,Applying Text effects ,Using Character Spacing ,Borders ,and Colors ,Inserting Header and Footer ,Using Date and Time options in LaTeX and Word.

Task 3: Creating project abstract Features to be covered: Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.

Task 4: Creating a Newsletter: Features to be covered:- Table of Contents, Newspaper columns, Images from files and clipart, Drawing toolbar and WordArt, Formatting Images, Textboxes, Paragraphs, and Mail Merge in word.

EXCEL

Excel Orientation: The mentor needs to tell the importance of the MSOffice or equivalent (FOSS)tool Excel as a Spread sheet tool give the details of the four tasks and features that would be covered in each. Using Excel – Accessing an overview of tool bars, saving Excel files, Using help and resources.

Task1: Creating a Scheduler- Features to be covered: Gridlines, Format Cells, Summation, auto-fill, Formatting Text

Task2: Calculating GPA- Features to be covered:-Cell Referencing, Formulae in Excel–average, std. deviation, Charts,
Renaming and Inserting worksheets, Hyper linking, Count function,

LOOKUP/LOOKUP

Task3: Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting

POWER POINT

Task1: Students will be working on essential Power Point utilities and tools which help them create introductory Power Point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint.

Task 2: Interactive presentations - Hyperlinks, Inserting–Images, Clip Art, Audio, Video, Objects, Tables and Charts.

Task3: Master Layouts (slide, template, ad notes), Types of views (basic, presentation, slides lotter, notes, etc),and Inserting– Background, textures, Design Templates, Hidden slides.

AI TOOLS–Chat GPT

Task1: Prompt Engineering: Experiment with different prompts to see how the model responds. Try asking questions,
Starting conversations, or even providing incomplete sentences to see how the model completes them.

- Ex: Prompt: "You area knowledge able AI. Please answer the following question: What is the capital of France?"

Task2: Creative Writing: Use the model as a writing assistant Provide the beginning of a story or a scene description, and
Let the model generate the rest of the content. This can be a fun way to brain storm creative ideas

- Ex: Prompt: "In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality."

Task3: Language Translation: Experiment with translation tasks by providing a sentence in one language and asking the model to translate it into another language. Compare the output to see how accurate and fluent the translations are.

- Ex: Prompt: "Translate the following English sentence to French: 'Hello, how are you doing today?'"

Course Outcomes:

CO1: Perform Hardware trouble shooting.

CO2: Understand Hardware components and interdependencies.

CO3: Safeguard computer systems from viruses/worms.

CO4: Document/ Presentation preparation.

CO5: Perform calculations using spread sheets.

Reference Books:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream Tech, 2003
2. The Complete Computer Upgrade and Repair Book, Chery lA Schmidt, WILEY Dream tech, 2013, 3rd edition
3. Introduction to Information Technology, ITL Education Solutions Limited, Pearson Education, 2012, 2nd edition
4. PC Hardware – A Handbook, Kate J. Chase, PHI(Microsoft)
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. IT Essentials PC Hardware and Software Companion Guide, David Anfinson and Ken Quamme. – CISCO Press,
   Pearson Education, 3rd edition
7. IT Essentials PC Hardware and Software Labs and Study Guide, Patrick Regan–CISCO Press, Pearson Education, 3rd edition

I Year – II Semester

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ENGINEERING WORKSHOP
(Common to All branches of Engineering)

Course Objectives:

To familiarize students with wood working, sheet metal operations, fitting and electrical house wiring skills

Course Outcomes:

CO1: Identify workshop tools and their operational capabilities.

CO2: Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding.

CO3: Apply fitting operations in various applications.

CO4: Apply basic electrical engineering knowledge for house wiring Practice

CO5: Construct the sheet metal jobs from GI sheets and preparation of pipe joints using plumbing

SYLLABUS

1. **Demonstration**: Safety practices and precautions to be observed in workshop.
2. **Wood Working:** Familiarity with different types of wood sand tools used in wood working and make following joints.
   a) Half– Lap joint b) Mortise and Ten on joint c) Corner Dove tail joint or Bridle joint
3. **Sheet Metal Working**: Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets.
   a) Tapered tray b) Conical funnel c) Elbow pipe d) Brazing
4. **Fitting:** Familiarity with different types of tools used in fitting and do the following fitting exercises.
   a) V-fit b) Dove tail fit c) Semi- circular fit d) Bicycle tire puncture and change of two- wheeler tyre
5. **Electrical Wiring**: Familiarity with different types of basic electrical circuits and make the following connections.
   a) Parallel and series b) Two-way switch c) God own lighting
   d) Tube light e) Three phase motor f) Soldering of wires
6. **Foundry Trade:** Demonstration and practice on Moulding tools and processes, Preparation of Green Sand Moulds forgiven Patterns.
7. **Welding Shop**: Demonstration and practice on Arc Welding and Gas welding. Preparation of Lap joint and Butt joint.
8. **Plumbing:** Demonstration and practice of Plumbing tools, Preparation of Pipe joints with coupling for same diameter and with reducer for different diameters.

Textbooks:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published,2019. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
2. A Course in Workshop Technology Vol I. & II, B.S. Raghu wanshi, Dhanpath Rai & Co., 2015 & 2017.

Reference Books:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th edition
2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.
3. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; Atul Prakashan, 2021-22.

L	T	P	C
0	0	3	1.5

I Year-II Semester

MINERAL PROCESSING AND METALLURGICAL ANALYSIS LAB

(Learning objective: Design the sequence of operations in a logical order. The relevant tabular forms are to be prepared. Experiments are to be conducted taking the necessary precautions. The data should be recorded and the results need to be interpreted using the necessary mathematical expressions)

List of Experiments

1. Sampling of ore from the bulk by: Coning and quartering method, Riffle sampler methods
2. Sizing by Sieve analysis of crushed ore
3. Determining the reduction ratio of a jaw crusher.
4. Study of the variation of reduction ratio with process variables in Rolls crusher.
5. Study of the process variables on reduction ratio and particle size distribution in ball mill.
6. To find the grindability index of ores.
7. Verification of Laws of Comminution.
8. Determination of the efficiency of a magnetic separator.
9. Determination of the efficiency of a jig.
10. Study of the particle separation by fluid flow using wilfley table.
11. To study the concentration of metallic and non-metallic ores by Froth-Flotation process.
12. Estimation of Iron in Iron ore. - To determine the percentage of Iron in Iron Ore by KMnO4 method and K2Cr2O7 method.
13. Estimation of Copper in Brass by Electrolytic method.
14. Estimation of the concentration of KMnO4 in the solution using Digital Spectrophotometer.
15. Estimation of Sulphur, Phosphorus and Manganese in cast irons
16. Estimation of Mn, Cr, and Si in Ferro-Alloys

Equipment:

1. Riffle Sampler
2. Sieve Shaker with Sieves
3. Stokes' Apparatus
4. Jaw Crusher
5. Roll Crusher
6. Ball Mill
7. Grindability Index Apparatus
8. Magnetic Separator
9. Jig
10. Wilfly's Table
11. Pneumatic Separator
12. Froth – Floatation Equipment
13. Electronic digital balances – 2 No's
14. Optical emission spectrometer

15. Flame Photometer
(Assessment: The students performance should be evaluated at the end of each class based on the following parameters)

Parameters-I.
1. Observation book,
2. Record.
3. Conduct of the experiment successfully
4. Interpretation of the data
5. Drawing the graphs where ever necessary
6. Viva-voce

Parameters-II.

1. At the end of each cycle of experiments internal exams should be conducted in addition to the end examination

I Year-II Semester

L	T	P	C
0	0	1	0.5

HEALTH AND WELLNESS, YOGA AND SPORTS
(Common to All branches of Engineering)

Course Objectives:

The main objective of introducing this course is to make the students maintain their mental and physical wellness by balancing emotions in their life. It mainly enhances the essential traits required for the development of the personality.

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

CO1: Understand the importance of yoga and sports for Physical fitness and sound health.
CO2: Demonstrate an understanding of health-related fitness components. **CO3:** Compare and contrast various activities that help enhance their health. **CO4:** Assess current personal fitness levels.
CO5: Develop Positive Personality

UNITI

Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index (BMI) of all age groups.

Activities:

i) Organizing health awareness programmes in community
ii) Preparation of health profile
iii) Preparation of chart for balance diet for all age groups

UNITII

Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.

Activities:

Yoga practices– Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar

UNIT III

Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Common wealth games.

Activities:

i) Participation in one major game and one individual sport viz., Athletics, Volley ball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-Kho, Table tennis, Cricket etc.
   Practicing general and specific warmup, aerobics
ii) Practicing cardio respiratory fitness, treadmill, run test, 9 min walk, skipping and running.

Reference Books:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning, 2022
2. T.K.V. Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J. Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon.--3rd ed. Human Kinetics, Inc. 2014

General Guidelines:

1. Institutes must assign lots in the Time table for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as many as Games/Sports.
3. Institutes are required to provide sports instructor/ yoga teacher to mentor the students.

Evaluation Guidelines:

- Evaluated for a total of 100 marks.
- A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totallingto90marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voice on the subject.

II Year-I Semester	TRANSFORMS AND NUMERICAL METHODS (Common to ME & MET)	L	T	P	C
		3	0	0	3

Course Objectives:

- To equip the students with the knowledge of Laplace Transforms.
- Provide fundamental concepts of Fourier series and Fourier Transforms.
- Introduce the concept of Solution of Algebraic & Transcendental Equations.
- Solving ordinary differential equations using Laplace transforms techniques.
- Teach the concept of Finite differences methods.

UNIT-I: Laplace Transforms: 10 hrs

Definition and Laplace transforms of some certain functions- Shifting theorems; Laplace transforms of derivatives and integrals –Unit step function- Dirac's delta function , periodic functions. Inverse Laplace transforms -Convolution theorem (without Proof).

Applications: Solving ordinary differential equations (initial value problems) using Laplace Transforms. .

UNIT-II: Fourier series and Fourier Transforms: 10 hrs

Fourier series: Introduction, Periodic functions, Fourier series of Periodic functions, Dirichlet's conditions, Even and Odd Functions, Change of interval, Half range Fourier sine and cosine series.

Fourier Transforms: Fourier integral theorem (without proof) -Fourier sine and cosine integrals- sine and cosine transforms-properties (article-22.5 in text book-I)- inverse transforms- Convolution theorem (without proof) finite Fourier Transforms.

UNIT-III: Solution of Algebraic & Transcendental Equations: 8 hrs

Introduction-Bisection method - Iterative method - Regula falsi method - Newton Raphson method

UNIT-IV: Interpolation 10 hrs

Finite differences -Newton's forward and backward interpolation formulae – Lagrange's formulae. Gauss forward and backward formula, Stirling's formula, Bessel's formula.

UNIT-V: Numerical differentiation, integration & Solution of Initial Value problems to Ordinary Differential Equations of first order: 10 hrs

Numerical Differentiation and Numerical integration: Numerical differentiation using Newton's forward & backward interpolation formulae; Numerical Integration by trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules.

Numerical Solutions of Ordinary differential equation: Solution by Taylor's series, picard's method of successive approximations, Euler's method, modified' Euler's method and Runge-Kutta method of fourth order.

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics,44/e, Khanna Publishers, 2017
2. S.S.Sastry, Introductory Methods of Numerical Analysis, 5/e, PHI publication, 2012.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, Wiley publications, 2011.
2. Steven C. Chapra and Raymond P. Canale, Numerical Methods for Engineers, 6/e, Mc Graw Hill, 2010.
3. C. Ray Wylie and Louis C. Barrett, Advanced Engineering Mathematics, 6/e, McGraw-Hill Education 1995.

Online Learning Resources:

- https://archive.nptel.ac.in/courses/127/106/127106019/
- https://archive.nptel.ac.in/courses/111/107/111107105/
- https://nptel.ac.in/courses/122106033
- https://archive.nptel.ac.in/courses/122/106/122106033/
- http://digimat.in/nptel/courses/video/111106111/L01.html
- http://acl.digimat.in/nptel/courses/video/122106033/L38.html

Course Outcomes:

COs	Statements	Blooms Level
CO1	Understand the Laplace transform for solving differential equations	L2
CO2	Find or compute the Fourier series of periodic signals	L3
CO3	Apply numerical methods to solve Algebraic & Transcendental Equations	L3
CO4	Analyze interpolating polynomials using interpolation formula	L4
CO5	Solve ordinary differential equations using different numerical schemes	L6

II Year-I Semester	UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT (Common to CE, EEE, ME, ECE, CSE, IT, MET)	L	T	P	C
		2	1	0	3

Course Objectives:

- To help the students appreciate the essential complementary between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Course Outcomes:

- Define the terms like Natural Acceptance, Happiness and Prosperity (L1, L2)
- Identify one's self, and one's surroundings (family, society nature) (L1, L2)
- Apply what they have learnt to their own self in different day-to-day settings in real life (L3)
- Relate human values with human relationship and human society. (L4)
- Justify the need for universal human values and harmonious existence (L5)
- Develop as socially and ecologically responsible engineers (L3, L6)

Course Topics

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 1-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

UNIT I Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session PS1 Sharing about Oneself
Lecture 3: self-exploration as the Process for Value Education
Lecture4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session PS2 Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfill the Basic Human Aspirations
Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

UNIT II Harmony in the Human Being (6 lectures and 3 tutorials for practice session)

Lecture 7: Understanding Human being as the Co-existence of the self and the body.
Lecture 8: Distinguishing between the Needs of the self and the body
Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body.
Lecture 9: The body as an Instrument of the self
Lecture 10: Understanding Harmony in the self
Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self
Lecture 11: Harmony of the self with the body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

UNIT III Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)
Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect
Lecture 16: Other Feelings, Justice in Human-to-Human Relationship
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

UNIT IV Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)
Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.

UNIT V Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)
Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 28: Strategies for Transition towards Value-based Life and Profession
Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Practice Sessions for UNIT I – Introduction to Value Education
PS1 Sharing about Oneself
PS2 Exploring Human Consciousness
PS3 Exploring Natural Acceptance

Practice Sessions for UNIT II – Harmony in the Human Being
PS4 Exploring the difference of Needs of self and body
PS5 Exploring Sources of Imagination in the self
PS6 Exploring Harmony of self with the body

Practice Sessions for UNIT III – Harmony in the Family and Society
PS7 Exploring the Feeling of Trust
PS8 Exploring the Feeling of Respect
PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for UNIT IV – Harmony in the Nature (Existence)
PS10 Exploring the Four Orders of Nature
PS11 Exploring Co-existence in Existence

Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics
PS12 Exploring Ethical Human Conduct
PS13 Exploring Humanistic Models in Education
PS14 Exploring Steps of Transition towards Universal Human Order

READINGS:

Textbook and Teachers Manual

a. The Textbook

R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual

R R Gaur, R Asthana, G P Bagaria,*Teachers' Manual for A Foundation Course in Human Values and Professional Ethics,* 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. *JeevanVidya: EkParichaya,* A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. *Human Values*, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book).
4. *The Story of My Experiments with Truth* - by Mohandas Karamchand Gandhi
5. *Small is Beautiful* - E. F Schumacher.
6. *Slow is Beautiful* - Cecile Andrews
7. *Economy of Permanence* - J C Kumarappa
8. *Bharat Mein Angreji Raj* – PanditSunderlal
9. *Rediscovering India* - by Dharampal
10. *Hind Swaraj or Indian Home Rule* - by Mohandas K. Gandhi
11. *India Wins Freedom* - Maulana Abdul Kalam Azad
12. *Vivekananda* - Romain Rolland (English)
13. *Gandhi* - Romain Rolland (English)

Mode of Conduct:

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.

Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

Online Resources:

1. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%20to%20Value%20Education.pdf
2. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf
3. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf
4. https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%2023.pdf
5. https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf
6. https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf
7. https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf
8. https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

II B.Tech I-Semester	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	0	3

Course Objective:

1. *Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.*
2. *Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.*
3. *Explain basic laws for radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.*
4. *Apply diffusive and convective mass transfer equations and correlations.*
5. *To understand the mechanisms of heat transfer under steady and transient conditions.*

UNIT – I

Principles of heat and mass transfer to basic engineering systems and the basic concepts and laws of the three modes of heat transfer conduction, convection, radiation and their combined effect. –General discussion about applications of heat transfer, Fundamentals of heat conduction - Steady and unsteady heat transfer , General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates, correlations for conjugate heat transfer, Fourier law of heat conduction. Thermal conductivity

UNIT – II

One dimensional steady state heat conduction heat transfer through homogenous slabs and hallow cylinders- critical radius of insulation
One Dimensional Transient Conduction Heat Transfer Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies Chart solutions of transient conduction systems

UNIT – III

Convective Heat Transfer-Free convection - Use of empirical relations for Vertical plates and pipes
Forced convection: External Flows and Internal Flows-Basic concepts
Aspects of Radiative Heat Transfer. Reflection, absorption, transmission of radiation. Black body radiation, Lambert's Law.

UNIT – IV

Fluid flow and its relevance to mass transfer. General mass transport equation. Modes of mass transfer. Film and boundary layer theories.

UNIT – V

Diffusion and its application in solid state, Steady diffusion. Pseudo-steady diffusion, Diffusion through porous solids, diffusion and chemical reactions

Course Outcomes:

Students will be able

1. *To understand the Principles of heat and mass transfer.*
2. *To apply the associated heat transfer correlations to solve problems.*
3. *To outline the to radiative heat transfer during.*
4. *To understand the concept of mass transfer equations and correlations*
5. *To understand the importance of diffusion in mass tranfer.*

CO PO Mapping

	PO1	*PO2*	*PO3*	*PO4*	*PO5*	*PO6*	*PO7*	*PO8*	*PO9*	*PO10*	*PO11*	*PO12*
CO1	√	√										
CO2	√	√										
CO3	√	√										
CO4	√	√										
CO5	√	√										

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities with special focus on academically weak students) should be tested periodically in classes by giving problems with respect to Phase diagrams and others. Unit tests are to be conducted at the end of each unit).

TEXTBOOK:

1. Rate Processes in Metallurgy, A. K. Mohanty
2. Principles of Extractive Metallurgy, A. Ghosh and H. S. Ray
3. Elements of Heat and Mass Transfer, Prof. R. C. Patel

REFERENCES:

1. Fundamentals of Heat and Mass Transfer, Inpropera and Dewitt
2. Rate Phenomena in Process Metallurgy, J. H. Szekely and N. J. Themelis
3. Fundamentals of Momentum, Heat and Mass Transfer, J. R. Welty, C. E. Wicks
4. Chemical Engineering, J. M. Coulson and J. F. Richardson (Pub.- Mc. Hill ELBS)
5. Engineering in Process Metallurgy, RLL Guthrie (Pub.- Oxford).
6. Heat Transfer, Yunus Cengel

II B.Tech I-Semester	PHYSICAL METALLURGY	L	T	P	C
		3	0	0	3

Course Objective:

1. *To understand the basic crystal structures of various materials which forms the basis for the subsequent study of properties of materials.*
2. *To understand the constitution and necessity of alloy formation.*
3. *The chapter outlines the various experimental methods of construction of phase diagrams.*
4. *The unit intended to describe various phase diagrams and phase transformations.*
5. *To provide the detailed explanation of phase transformations in steels.*

UNIT – I

Structure of Metals, classification of metals, metallic bond-crystal structure of metals, coordination number, relationship between lattice parameter and atomic radius, packing factor and density calculations, interstitials, polymorphism, plane and directional indices, transformation of indices.

UNIT – II

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

UNIT – III

Equilibrium Diagrams: Experimental methods for construction of equilibrium diagrams, Isomorphous alloy systems, eutectic, partial eutectic systems and other systems.

Solidification: Types of Nucleation, determination of the size of critical nucleus, equilibrium cooling and heating of alloys, lever rule, coring, miscibility gaps. Simple problems using lever rule.

UNIT – IV

Transformation in solid-state, allotropy, order-disorder transformation, eutectoid, peritectoid reactions and complex phase diagrams, relation between equilibrium diagrams and physical properties of alloys. Study of important binary phase diagrams like Fe-Fe3 C, Cu-Zn, Cu-Sn, and Al-Cu.

UNIT – V

Phase transformations in steels: pearlitic, martensitic and bainitic transformations, cooling curves, Isothermal transformation diagrams, transformations on continuous cooling, Concept of diffusion Fick's first law and second law.

Course Outcomes:

Students will be able

1. *To understand the geometry and crystallography of crystalline materials; Identify planes and directions in crystal systems.*
2. *To apply the associated Hume Rothery rules for the formation of alloys.*
3. *To outline the solidification behaviour of materials during cooling.*
4. *To understand the concept of phase diagram in recognizing the phase changes*
5. *To understand the importance of isothermal diagrams.*

CO PO Mapping

	PO1	*PO2*	*PO3*	*PO4*	*PO5*	*PO6*	*PO7*	*PO8*	*PO9*	*PO10*	*PO11*	*PO12*
CO1	√	√										
CO2	√	√										
CO3	√	√										
CO4	√	√										
CO5	√	√										

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities with special focus on academically weak students) should be tested periodically in classes by giving problems with respect to Phase diagrams and others. Unit tests are to be conducted at the end of each unit).

TEXTBOOK:

a. Introduction to Physical Metallurgy – S.H. Avner- McGraw-Hill publishers
b. Physical Metallurgy – Vijayendra Singh, Standard Publishers Distributors, 2005

REFERENCES:

1. Physical Metallurgy principles-Reed Hill – CENGAGE Learning Publishers
2. Engineering Physical Metallurgy and Heat Treatment – Y. Laktin.
3. Elements of Physical Metallurgy – A.Guy
4. Metallographic laboratory practice – Kehl
5. Principles of Physical Metallurgy – Smith. M.
6. Introduction to Metallurgy – A.H. Cottrell
7. Metallurgy for Engineers-Clark and Varney.
8. Physical Foundations of Materials Science – G. Gottstein
9. The Science and Engineering of Materials – Askeland et. al.
10. Physical Metallurgy – William F Hasford – CRC Press
11. Callister's Materials Science and Engineering, Adapted by R.Balasubramaniam, secondedition, Wiley, 2015

II Year - I Semester	PRINCIPLES OF EXTRACTIVE METALLURGY	L	T	P	C
		3	0	0	3

Course objectives:

1. *The unit aims to discuss unit processes during the metal extraction*
2. *Deals with different types of roasting processes*
3. *The unit out lines different reduction processes and also discusses the Ellingham diagrams*
4. *The main objective is to describe the principles of leaching and associated hydrometallurgy*
5. *The main objective is to describe the principles of electro metallurgy and electro winning, to describe the methods of refining*

UNIT-I

Introduction: Classification of ores, advantages and disadvantages of unit processes in extractive metallurgy, Calcination.

UNIT-II

Roasting: Types of roasting: Oxidizing, sulphatising and chloridizing, Simple equations/reactions. Roasting furnace: Multiple hearth roaster, flash roasting, fluidized bed roasting, blast roasting. Sintering and pelletisation

UNIT-III

Smelting, smelting furnaces and slags: Principles of reduction and matte smelting with examples. Reverberatory, BF and electric smelting. Flash smelting. Classification, properties importance of Ellingham diagrams for oxides and sulphides and ellinghams limitations.

UNIT-IV

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

UNIT-V

Classification of electrometallurgy, Advantages and disadvantages electrometallurgy. Electrolytic cell-Anodic and cathodic reactions. General discussions on the electrowinnig of metals.

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

Course outcomes:

The students should be able to

1. Understand Basic principles of Extractive metallurgy
2. Understand siginificance of roasting
3. Know Ellingham diagram and its significance
4. Know the Principles of hydrometallurgy, properties of good solvent leaching and precipitation
5. Learn principles of electrometallurgy, different types of techniques

(Assessment: The student should be evaluated based on the assignments and objective tests. Emphasis should be given by conducting tutorial classes (with special focus on academically weak students) at the end of each unit).

CO PO Mapping

	PO1	*PO2*	*PO3*	*PO4*	*PO5*	*PO6*	*PO7*	*PO8*	*PO9*	*PO10*	*PO11*	*PO12*
CO1	√	√										
CO2	√	√										
CO3	√	√										
CO4	√	√										
CO5	√	√										

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Non-ferrous extractive metallurgy: H.SRay,K.P.AbrahamandR.Sreedhar
2. Principles of extractive metallurgy - Goshand Ray–new Age Publishers

Reference Books:

1. Principles of Extractive Metallurgy – F.Habashi – CRCPress

II- Year I-Semester	MECHANICS OF SOLIDS LAB	L	T	P	C
		0	0	3	1.5

Course Objective: To impart practical exposure on the strength of materials and their properties evaluation. To impart practical knowledge on the evaluation of material properties through various destructive testing procedures.

1. Direct tension test
2. Bending test on
   a) Simple supported
   b) Cantilever beam
3. Torsion test
4. Test on springs
5. Compression test on cube
6. Compression test on helical spring.
7. Use of electrical resistance strain gauges
8. Punch shear test
9. Rockwell Hardness Test

Course Outcomes:

Upon successful completion of this course, the students will be able to:

1. Solve the ultimate stress of mild steel and bending stress for simply supported and cantilever beam. (BL-2)
2. Solve the compressive stress on cube of different materials (BL-2)
3. Solve the Modulus of rigidity of spring materials (BL-2)
4. Find torsion and punch shear test. (BL-1)
5. Analyze the hardness of engineering materials. (BL-4)

CO-PO Mapping:

S.NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√			√	√	√	√	√
CO2	√	√	√	√	√			√	√	√	√	√
CO3	√	√	√	√	√			√	√	√	√	√
CO4	√	√	√	√	√			√	√	√	√	√
CO5	√	√	√	√	√			√	√	√	√	√

(Assessment: The student's performance should be evaluated at the end of each class based on the following)

Parameters - I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Parameters - II.

At the end of each cycle of experiments internal exams should be conducted in addition to theend examination)

II Year - I Semester	EXTRACTIVE METALLURGY LAB	L	T	P	C
		0	0	3	1.5

Course objectives: The basic objective of the course is to provide hands on practice on various types of unit process industrially important nonferrous metals

List of experiments:

1. To find the efficiency of electrolytic cell for Cu refining
2. To find the effect of time on leaching of an oxide ore
3. To find the effect of temperature on leaching of an oxide ore
4. To conduct cementation of Copper ore
5. Electro wining of a nonferrous metal
6. To determine the effect of temperature on calcination of lime stone
7. To find the effect of time on calcination of lime stone
8. To find the weight loss on calcination of lime stone
9. To find the effect of time on roasting of a sulphide ore
10. To find the effect of temperature on roasting of a sulphide ore

List of equipment:

1. Muffle Furnace
2. Oxygen Cylinder
3. Digital electronic balance
4. Ceramic crucible
5. Electrochemical cell

(Assessment: The student's performance should be evaluated at the end of each class based on the following)

Parameters - I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Parameters - II.

At the end of each cycle of experiments internal exams should be conducted in addition to theend examination)

II B.Tech I-Semester	PHYSICAL METALLURGY LAB	L	T	P	C
		0	0	3	1.5

(Learning objective: Design the sequence of operations in a logical order. Experiments are to be conducted taking the necessary precautions. The microstructures should be observed at various magnifications and the structure should be interpreted and conclusions should be presented.)

LIST OF EXPERIMENTS

1. Preparation and study of Crystal models.
2. Study of Specimen cutting machine Specimen mounting press Grinding and polishing Equipment
3. Study of various Metallurgical Microscopes and use of leveling press
4. Metallographic preparation of ferrous specimens for Microscopic examination
5. Preparation of non-ferrous specimens for Metallographic examination
6. Preparation and Metallographic study of pure metals like Iron, Copper, Aluminium, etc..
7. Measurement of lattice parameters of various crystal structures and calculation ofpacking factors and size of vacancies.
8. Identification of Microstructures of steels
9. ASTM Grain size measurement
10. Second Phase Analysis using Image Analysis

Equipment:

1. Specimen Cutting Machine
2. Specimen Mounting Press
3. Belt Grinding Machine
4. Disc Polishing Machines
5. Metallurgical Microscopes
6. Specimen Leveller.
7. Image analyser
8. Standard samples with their microstructure

(Assessment: The student's performance should be evaluated at the end of each class based on the Following)

Parameters - I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Parameters - II.

At the end of each cycle of experiments internal exams should be conducted in addition to theend examination)

II Year-I Semester	COMPUTER AIDED DRAFTING AND MODELING LAB	L	T	P	C
		0	0	3	2

Course Objective:
The student will acquire knowledge
1. To enhance the student's knowledge and skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing and modeling.
2. To introduce various commands in AutoCAD to draw the geometric entities and to create 2D wire frame models.
3. To introduce various commands in AutoCAD to draw the geometric entities and to create 3D wire frame models.
4. To create geometrical model of simple solids, machines & machine parts
5. To interpret view points and view ports, view point coordinates and views displayed and develop computer aided solid models with isometric and orthographic projections.

COMPUTER AIDED DRAFTING:
1. Generation of points, lines, curves, polygons, dimensioning. Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances, Study of DXE, IGES files
2. Types of modeling : object selection commands – edit, zoom, cross hatching, pattern filling, utility commands in 2D modeling
3. Object selection commands – edit, zoom, cross hatching, pattern filling, utility commands in 3D modeling.
4. Development of part drawings for various components in the form of orthographic representation of dimensioning and tolerances using wire frame and surface modeling.
5. Development of part drawings for various components in the form of isometric representation of dimensioning and tolerances using wire frame and surface modeling.
6. View point coordinates and view ports displayed, examples to exercise different options like save, restore, delete , joint , single option.
7. **COMPUTER AIDED SOLID MODELING**: Development of part drawings for various components in the form of isometric representation.

PART MODELING: Generation of various 3D models through Pad, revolve, shell, sweep, parent child relation, Boolean operations and various standard translators.
8. Development of part drawings for various components in the form of orthographic projections.
9. Modeling of simple solids,
10. Modeling of Machines & Machine Parts.**Assembly drawings**: (Any four of the following using solid model software) Generation of various Parts/assemblies: like Screw Jack, Oldham's Coupling, Foot step bearing, Couplings, knuckle and cotter joints, Crankshaft, Connecting Rod, Piston and Cylinder.

Course outcomes:

Upon successful completion of this course, the students will be able to:

1. Understand skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing and modeling. (BL-2)
2. Utilize various commands in AutoCAD to draw the geometric entities and to create 2D wire frame models. (BL-3)
3. Interpret various commands in AutoCAD to draw the geometric entities and to create 3D wire frame models. (BL-3)
4. Construct geometrical model of simple solids, machines & machine parts. (BL-3)
5. Understand view points and view ports, view point coordinates and views displayed and develop computer aided solid models with isometric and orthographic projections. (BL-2)

CO-PO Mapping:

S.NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√	√	√	√			√	√	√	√	√
CO2	√	√	√	√	√			√	√	√	√	√
CO3	√	√	√	√	√			√	√	√	√	√
CO4	√	√	√	√	√			√	√	√	√	√
CO5	√	√	√	√	√			√	√	√	√	√

II Year-I Semester	ENVIRONMENTAL SCIENCE (Common to CE, EEE, ME, ECE, CSE, IT, MET)	L	T	P	C
		2	0	0	-

Course Objectives:

- To make the students to get awareness on environment.
- To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life
- To save earth from the inventions by the engineers.

UNIT I **7h**

Multidisciplinary Nature of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources: Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Water resources – Mineral resources- Food resources–Land resources and Energy resources - Use and over exploitation, case studies.

UNIT II **7h**

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem (Producers, consumers and decomposers), Energy flow in the ecosystem and ecological pyramids – Introduction, types, characteristic features of the following ecosystem:

a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem.
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its Conservation: Introduction - Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT III **6h**

Environmental Pollution: Definition, Cause, effects and control measures of:

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

Solid Waste Management: Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

UNIT IV **6h**

Social Issues and the Environment: From Unsustainable to Sustainable development – Water conservation, rain water harvesting, watershed management – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act.

UNIT V **6h**

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Textbooks:

1. Textbook of Environmental Studies for Undergraduate Courses Erach Bharucha for University Grants Commission, Universities Press.
2. Palaniswamy, "Environmental Studies", Pearson education
3. S.Azeem Unnisa, "Environmental Studies" Academic Publishing Company
4. K.Raghavan Nambiar, "Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus", Scitech Publications (India), Pvt. Ltd.

References:

1. Deeksha Dave and E.Sai Baba Reddy, "Textbook of Environmental Science", Cengage Publications.
2. M.Anji Reddy, "Text book of Environmental Sciences and Technology", BS Publication.
3. J.P.Sharma, Comprehensive Environmental studies, Laxmi publications.
4. J. Glynn Henry and Gary W. Heinke, "Environmental Sciences and Engineering", Prentice hall of India Private limited
5. G.R.Chatwal, "A Text Book of Environmental Studies" Himalaya Publishing House
6. Gilbert M. Masters and Wendell P. Ela, "Introduction to Environmental Engineering and Science, Prentice hall of India Private limited.

II Year-II Semester	MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS (Common to CE, EEE, ECE, CSE, IT & MET)	L	T	P	C
		2	0	0	2

Course Objectives:

- To inculcate the basic knowledge of microeconomics and financial accounting
- To make the students learn how demand is estimated for different products, input-output relationship for optimizing production and cost
- To Know the Various types of market structure and pricing methods and strategy
- To give an overview on investment appraisal methods to promote the students to learn how to plan long-term investment decisions.
- To provide fundamental skills on accounting and to explain the process of preparing financial statements.

Course Outcomes:

- Define the concepts related to Managerial Economics, financial accounting and management(L2)
- Understand the fundamentals of Economics viz., Demand, Production, cost, revenue and markets (L2)
- Apply the Concept of Production cost and revenues for effective Business decision (L3)
- Analyze how to invest their capital and maximize returns (L4)
- Evaluate the capital budgeting techniques. (L5)
- Develop the accounting statements and evaluate the financial performance of business entity (L5)

UNIT - I Managerial Economics 6h

Introduction – Nature, meaning, significance, functions, and advantages. Demand-Concept, Function, Law of Demand - Demand Elasticity- Types – Measurement. Demand Forecasting- Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management.

UNIT - II Production and Cost Analysis 4h

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least- cost combination– Short run and long run Production Function- Isoquants and Is costs, Cost & Break-Even Analysis - Cost concepts and Cost behaviour-Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems).

UNIT - III Business Organizations and Markets 4h

Introduction – Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises. Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition Monopoly- Monopolistic Competition–Oligopoly-Price-Output Determination - Pricing Methods and Strategies

UNIT - IV Capital Budgeting 8h

Introduction – Nature, meaning, significance. Types of Working Capital, Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting– Features, Proposals, Methods and Evaluation. Projects – Pay Back Method, Accounting Rate of Return (ARR) Net Present Value (NPV) Internal Rate Return (IRR) Method (sample problems)

UNIT - V Financial Accounting and Analysis 10h

Introduction – Concepts and Conventions- Double-Entry Bookkeeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). Introduction to Financial Analysis - Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability.

Textbooks:

1. Varshney & Maheswari: Managerial Economics, Sultan Chand.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH.

Reference Books:

1. Ahuja Hl Managerial economics Schand.
2. S.A. Siddiqui and A.S. Siddiqui: Managerial Economics and Financial Analysis, New Age International.
3. Joseph G. Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, New Delhi.
4. Domnick Salvatore: Managerial Economics in a Global Economy, Cengage.

Online Learning Resources:

https://www.slideshare.net/123ps/managerial-economics-ppt https://www.slideshare.net/rossanz/production-and-cost-45827016 https://www.slideshare.net/darkyla/business-organizations-19917607 https://www.slideshare.net/balarajbl/market-and-classification-of-market https://www.slideshare.net/ruchi101/capital-budgeting-ppt-59565396 https://www.slideshare.net/ashu1983/financial-accounting

II Year-II Semester	COMPLEX VARIABLES, PROBABILITY AND STATISTICS (Common to ME & MET)	L	T	P	C
		3	0	0	3

Course Objectives:

- To familiarize the complex variables.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.

UNIT – I: Functions of a complex variable and Complex integration: 10 hrs

Introduction – Continuity – Differentiability – Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne – Thompson method.

Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Generalized integral formula (all without proofs) and problems on above theorems.

UNIT – II: Series expansions and Residue Theorem: 10 hrs

Radius of convergence – Expansion in Taylor's series, Maclaurin's series and Laurent series.

Types of Singularities: Isolated – Essential –Pole of order m– Residues – Residue theorem (without proof) – Evaluation of real integral of the types $\int_{-\infty}^{\infty} f(x)dx$ and $\int_c f(\cos\theta, \sin\theta)d\theta$.

UNIT – III: Probability and Distributions: 10 hrs

Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory: 10 hrs

Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Representation of the normal theory distributions – Introduction to t, χ^2 and F-distributions- point and interval estimations – maximum error of estimate.

UNIT – V: Tests of Hypothesis: 8 hrs

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples) – Tests on proportions.

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers.
2. Miller and Freund's, Probability and Statistics for Engineers,7/e, Pearson, 2008.

Reference Books:

1. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 9/e, Mc- Graw Hill, 2013.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
3. Jay l. Devore, Probability and Statistics for Engineering and the Sciences, 8/e, Cengage.
4. Shron L.Myers, Keying Ye, Ronald E Walpole, Probability and Statistics Engineers and the Scientists, 8/e, Pearson 2007.
5. Sheldon, M. Ross, Introduction to probability and statistics Engineers and the Scientists, 4/e, Academic Foundation, 2011.

Online Learning Sources:

- https://archive.nptel.ac.in/courses/111/103/111103070/
- https://biet.ac.in/pdfs/PROBABILITY%20AND%20STATISTICS%20&%20COMPLEX%20VARIABLES.pdf
- https://archive.nptel.ac.in/courses/111/105/111105090/
- http://acl.digimat.in/nptel/courses/video/111102160/L23.html
- https://onlinecourses.nptel.ac.in/noc21_ma57/preview

Course Outcomes:

COs	Statements	Blooms Level
CO1	Apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic	L3
CO2	Make use of the Cauchy residue theorem to evaluate certain integrals	L3
CO3	infer the statistical inferential methods based on small and large sampling tests	L4
CO4	Find the differentiation and integration of complex functions used in engineering problems	L5
CO5	Design the components of a classical hypothesis test	L6

II B.Tech II-Semester	METALLURGICAL THERMODYNAMICS AND KINETICS	L	T	P	C
		3	0	0	3

Course Objective:

1. The student can understand the basic concepts of the properties of a system to help them to get aclear understanding of reversible and irreversible processes.

2. The student can understand the clear concept of enthalpy and internal energy. It also helps in understanding the classification of work.

3. To understand the concepts of free energy and entropy.

4. To know the concepts of activity and equilibrium constants.

5. To understand the kinetics of chemical processes and simultaneous reactions. It helps the studentto identify, formulate and solve engineering problems.

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, Reversible and irreversible processes.

UNIT-II

First and Second laws Law of thermodynamics: Nature of first law, relationship between heat and work, internal energy and the first law of thermodynamics, calculations of work, constant capacity, reversible adiabatic processes, reversible isothermal pressure or volume changes of an ideal gas, enthalpy change with temperature, Kirchhoff's equation. Second law of thermodynamics: Efficiency of a cyclic process, Carnot cycle, Carnot theorem, second law of thermodynamics, concept of entropy

UNIT-III

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

UNIT-IV

Fugacity, activity and equilibrium constant: Concepts of fugacity, activity and equilibrium constant variation of the equilibrium constant with temperature, Calculation of equilibrium constant from free energy changes, derivation of the Clausius – Clapeyron equation for single substance, Duhriges rule for the estimation of the vapour pressures of an element, Integration of Clausius – Clapeyronequation and Problems.

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, consecutive and simultaneous reactions, catalysis in chemical reactions.

Course Outcomes:

Student will be able

1. To apply the concepts and properties of system in engineering problems.

2. To understand systems concept of manufacturing processes.

3. To understand the relationship between these functions and their applications in various thermodynamic processes.

4. To identify, formulate and solve engineering problems.

5. To understand kinetics, order of a reaction and rate constants.

CO PO Mapping

	PO1	*PO2*	*PO3*	*PO4*	*PO5*	*PO6*	*PO7*	*PO8*	*PO9*	*PO10*	*PO11*	*PO12*
CO1	√	√										
CO2	√	√										
CO3	√	√										
CO4	√	√										
CO5	√	√										

TEXTBOOK:

1. Introduction to the thermodynamics of materials 5th Edition– D.R. Gaskell – CRC Press
2. Principles of metallurgical thermodynamics- S. K. Bose and S.K. Roy, University Press2014

REFERENCES:

1. Thermodynamics of solids-R.S.Swalin
2. Physical chemistry of metals-L.S.Darken & Gurry
3. Physical Metallurgy Principles – RH Reed hill.
4. Thermodynamics An Engineering Approach – Cengel – Mcgraw-Hill – 7th Edition
5. Fundamentals of thermodynamics-Sonntag et al
6. An Introduction to thermodynamics-Y.V.C.Rao
7. Chemical and Metallurgical thermodynamics – Prasad Krishnakanth – New AgePublications
8. Text Book of Materials and Metallurgical Thermodynamics: Ahindra Ghosh (PHI)

II B.Tech II-Semester	HEAT TREATMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. *This unit deals with principles of heat treatment, and different hardenability methods.*
2. *To learn about different surface hardening methods.*
3. *This topic throws light on TTT Curves and the effect of alloying elements on Fe-Fe3C system.*
4. *This topic explains heat treatment of various types of tool, die steels and cast irons.*
5. *To understand the principles of heat treatment of various non-ferrous alloys.*

UNIT-I

Principles Of Heat Treatment: Austenitic Transformation, Pearlitic Transformation, Bainitic Transformation, Martensitic Transformation, Annealing, Normalizing, Hardening, , quenching media, size and mass effect, hardenability, tempering, austempering, deep freezing. Industrial Heat treatment furnaces and their design, atmosphere control vacuum heat treatment.

UNIT-II

Surface heat treatment, carburizing, cyaniding, flame and induction hardening, residual stresses, deepfreezing, thermo mechanical treatments: Low and High temperature thermo mechanical treatments, Aus forming, Iso forming, Cryo forming.

UNIT-III

Effect of Alloy Elements in Heat Treatment: Purpose of alloying, effect of alloying elements on ferrite, cementite, Fe- Fe3C system, tempering, and TTT Curves.

UNIT-IV

Effect of Heat treatment on Alloy Steels: Structural and constructional steels, maraging steels, tool and die steels. Corrosion and heat resistant steels, Hadfield steels.

Effect of Heat treatment on Cast Irons: White cast iron, grey cast iron, spheroidal graphite iron, malleable cast iron, alloy cast iron.

UNIT-V

Heat treatment of Non-Ferrous Metals And Alloys: Precipitation hardening, aging treatment, the study of copper and its alloys, aluminium and its alloys, nickel and its alloys.

Course Outcomes:

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

1. *Modify the microstructure and properties using different heat treatments*
2. *Understand the various types of heat treatment mechanisms to improve the material properties.*
3. *Understand the role of alloying elements and heat treatment*
4. *Understand the effect of heat treatment on Alloy steels and castirons*
5. *Analyze and Understand the effect of heat treatment on Non –ferrous metals and Alloys*

CO-PO Mapping

S.NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√										
CO2	√	√	√									
CO3	√	√										
CO4	√	√										
CO5	√	√										

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with grinding focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

TEXTBOOK

1. Heat Treatment Principle and Techniques-Rajan & Sharma
2. Heat treatment of metals- Vijayendra Singh, 2nd edition, Standard Publishers Distributors, 2006

REFERENCES

1.Heat Treatment of metals-Zakharv-Mir Publishers
2.Physical Metallurgy Lakhtin-Mir Publishers
3.Physical Metallurgy - Clark and Varney 4.Physical Metallurgy Principles - Reed Hill 5.Physical metallurgy-Raghavan
6.Materials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015

II B.Tech II-Semester	CORROSION ENGINEERING	L	T	P	C
		3	0	0	3

Course objectives:

1. *To learn about electrochemical principles*
2. *To learn about the Polarization and electrochemical behavior of metals*
3. *To learn the principles and various types of corrosion.*
4. *To learn about various corrosion testing procedures and sequential procedure for laboratory andon-site corrosion investigations*
5. *To understand various protective methods of corrosion.*

UNIT – I

Electrochemical and thermodynamic principles, Nernst equation and electrode potentials of metals, EMF and galvanic series, merits and demerits; origin of Roubaix diagram and its importance to iron, aluminum and magnesium metals

UNIT – II

Exchange current density, polarization- concentration, activation and resistance, Tafel equation; passivity, electrochemical behavior of active/passive metals, theories of passivity

UNIT – III

Atmospheric, pitting, dealloying, stress corrosion cracking, inter granular corrosion, corrosion fatigue, erosion-corrosion, fretting corrosion and high temperature oxidation; hot corrosion; causes and remedial measures

UNIT – IV

Purpose of testing, laboratory, semi-plant and field tests, susceptibility tests for IGC, stress corrosion cracking and pitting, immersion and salt spray testing, impedance analysis, sequential procedure for laboratory and on-site corrosion investigations, corrosion auditing and corrosion map of India

UNIT – V

Corrosion prevention by design improvements, anodic and cathodic protection, metallic, non- metallic and inorganic coatings, mechanical and chemical methods and various corrosion inhibitors

Course Outcomes:

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

1. *Understand the principles of electrochemistry and corrosion*
2. *Understand basics of kinetics of electrochemical corrosion, relevant theories and equations*
3. *origin and causes of high temperature oxidation through their kinetics, governing equations and remedies.*
4. *Different methods of corrosion testing, susceptibility tests, corrosion auditing and map of India.*
5. *Learn Various corrosion preventive methods*

CO-PO Mapping

S.NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√	√										
CO2	√	√										
CO3	√	√										
CO4	√	√		√			√					
CO5			√			√						√

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should by conducting concept tests. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Fontana M. G., Greene N.D., 'CorrosionEngineering',2nd Edition, McGrawHill,1983

Reference Books:

1. Raj Narayan, 'An Introduction to Metallic Corrosion and itsPrevention',1stEdition,

Oxford and IBH, 1983

2. Denny Jones, "Principles and Prevention of Corrosion", Prentice Hall of India,1996.

II B.Tech II-Semester	FUELS LAB	L	T	P	C
		0	0	2	1

Course Objectives: To impart practical exposure on the fuels and their properties evaluation. Also to impart practical knowledge on the evaluation of fuel properties through various destructive testing procedures.

1.To determine the calorific value of coal using Bomb Calorimeter.

2. To determine the calorific value of coke using Bomb Calorimeter.

3. Proximate Analysis of coal and coke

4. To find the Flash and Fire points of fuel oil by "PENSKY MARTINS" open and closed cup apparatus.

5. To find the viscosity of lubricant oil by using Red-wood-I Viscometer

6. To find the viscosity of lubricant oil by using Red-wood-II Viscometer

7. To find the viscosity of lubricant oil by using Saybolt Viscometer

8. To determine the effect of temperature on Kinematic Viscosity of glycerine

Equipment:

1. Muffle Furnaces 1000^0C – 2 No's
2. Muffle Furnaces 300^0C – 2 No's
3. Muffle Furnaces 120^0C – 1 No's
4. Pensky-Martins Apparatus
5. Different grades of coal, Kbr press and Bomb calorimeter
6. Redwood viscometer

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

Parameters-I.

1.observation book,
2.Record.
3.Conduct of the experiment successfully
4.Interpretation of the data
5.Drawing the graphs where ever necessary
6.Viva voce.

Parameters-II.

At the end of each cycle of experiments internal exams should be conducted in addition tothe end examination)

II B.Tech II-Semester	HEAT TREATMENT LAB	L	T	P	C
		0	0	3	1.5

(Learning objective: Design the sequence of operations in a logical order. The relevant tabular formsare to be prepared. Experiments are to be conducted taking the necessary precautions. The data should be recorded and the results need to be interpreted using the necessary mathematical expressions. The graphs are to be drawn where ever required and the appropriate conclusions shouldbe presented.)

List of Experiments:

1. Annealing of medium carbon steel and observation of microstructure.
2. Normalizing of medium carbon steel and observation of microstructure.
3. Hardening of medium carbon steel and observation of microstructure.
4. Study of tempering characteristics of water quenched steel.
5. Study of age hardening phenomena in duralumin.
6. Spheroidizing of given high carbon steel.
7. Determination of hardenability of medium carbon steel by Jominy end Quench Test.
8. To conduct Re-crystallization studies on cold-worked copper.

Equipment:

1. Muffle Furnaces 1000^0C – 2 No's
2. Muffle Furnaces 300^0C – 2 No's
3. Muffle Furnaces 120^0C – 1 No's
4. Hardenability Apparatus
5. Optical Microscopes
6. Vickers Hardness Tester

(Assessment: The student's performance should be evaluated at the end of each class based on thefollowing parameters:

Parameters-I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Parameters-II.

1. *At the end of each cycle of experiments internal exams should be conducted in addition tothe end examination)*

II B.Tech II-Semester	CORROSION ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

(Course objective: This lab course is designed to conduct the experiments on electro deposition, verification of Faraday's laws and evaluation of factors affecting on corrosion)

List of experiments:

1. Study the effect of concentration and temperature on conductivity of an aqueous electrolyte(NaCl)
2. Verification of Faraday's laws
3. Potentio dynamic polarization analysis
4. Impedance analysis.
5. Electroplating of copper/ nickel/chromium
6. To anodise the given aluminum sample and observation of microstructure
7. To understand the principles in galvanic cell corrosion using "Ferroxyl" indicating test solution.
8. To analyze the stress corrosion behavior of steel
9. To study the inter granular corrosion of Austenitic stainless steels
10. To conduct electro polishing of stainless steel using Nitric acid batch

List of equipment:

1.Potentio dynamic polarization unit
2.Stress corrosion analysis unit
3.Rectifier
4.Ammeters
5.Rheostats
6.D C Regulated Power Supply instrument
7. Electro polishing Equipment
8. Multimeters
9. Conductometers
10. Digital weighing balance

Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

Parameters-I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Paraneters-II.

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

II Year-II Semester	SOFT SKILLS (Common to ME, ECE, MET)	L	T	P	C
		0	1	2	2

Course Objectives:

- To encourage all round development of the students by focusing on soft skills
- To make the students aware of critical thinking and problem-solving skills
- To enhance healthy relationship and understanding within and outside an organization
- To function effectively with heterogeneous teams

Course Outcomes

- List out various elements of soft skills (L1, L2)
- Describe methods for building professional image (L1, L2)
- Apply critical thinking skills in problem solving (L3)
- Analyse the needs of an individual and team for well-being (L4)
- Assess the situation and take necessary decisions (L5)
- Create a productive workplace atmosphere using social and work-life skills ensuring personal and emotional well-being (L6)

UNIT I Soft Skills & Communication Skills 10h

Soft Skills - Introduction, Need - Mastering Techniques of Soft Skills – Communication Skills -Significance, process, types - Barriers of communication - Improving techniques.

Activities:

Intrapersonal Skills- Narration about self- strengths and weaknesses- clarity of thought – self- expression – articulating with felicity.

(The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes and literary sources)

Interpersonal Skills- Group Discussion – Debate – Team Tasks - Book and film Reviews by groups - Group leader presenting views (non- controversial and secular) on contemporary issues or on a given topic.

Verbal Communication- Oral Presentations- Extempore- brief addresses and speeches- convincing- negotiating- agreeing and disagreeing with professional grace.

Non-verbal communication – Public speaking – Mock interviews – presentations with an objective to identify non- verbal clues and remedy the lapses on observation.

UNIT II Critical Thinking 8h

Active Listening – Observation – Curiosity – Introspection – Analytical Thinking – Open-mindedness – Creative Thinking - Positive thinking - Reflection

Activities:

Gathering information and statistics on a topic - sequencing – assorting – reasoning – critiquing issues –placing the problem – finding the root cause - seeking viable solution – judging with rationale – evaluating the views of others - Case Study, Story Analysis

UNIT III Problem Solving & Decision Making 10h

Meaning & features of Problem Solving – Managing Conflict – Conflict resolution – Team building - Effective decision making in teams – Methods & Styles

Activities:

Placing a problem which involves conflict of interests, choice and views – formulating the problem – exploring solutions by proper reasoning – Discussion on important professional, career and organizational decisions and initiate debate on the appropriateness of the decision.

Case Study & Group Discussion

UNIT IV Emotional Intelligence & Stress Management 10h

Managing Emotions – Thinking before Reacting – Empathy for Others – Self-awareness – Self-Regulation – Stress factors – Controlling Stress – Tips

Activities:

Providing situations for the participants to express emotions such as happiness, enthusiasm, gratitude, sympathy, and confidence, compassion in the form of written or oral presentations.

Providing opportunities for the participants to narrate certain crisis and stress –ridden situations caused by failure, anger, jealousy, resentment and frustration in the form of written and oral presentation, Organizing Debates

UNIT V Corporate Etiquette 10h

Etiquette- Introduction, concept, significance - Corporate etiquette - meaning, modern etiquette, benefits - Global and local culture sensitivity - Gender Sensitivity - Etiquette in interaction- Cell phone etiquette - Dining etiquette - Netiquette - Job interview etiquette -Corporate grooming tips -Overcoming challenges

Activities

Providing situations to take part in the Role Plays where the students will learn about bad and good manners and etiquette - Group Activities to showcase gender sensitivity, dining etiquette etc. - Conducting mock job interviews - Case Study - Business Etiquette Games

NOTE-:

1. The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes, epics, scriptures, autobiographies and literary sources which bear true relevance to the prescribed skill.
2. Case studies may be given wherever feasible for example for Decision Making- The decision of King Lear.

Prescribed Books:

1. Mitra Barun K, Personality Development and Soft Skills, Oxford University Press, Pap/Cdr edition 2012
2. Dr Shikha Kapoor, Personality Development and Soft Skills: Preparing for Tomorrow, I K International Publishing House, 2018

Reference Books

1. Sharma, Prashant, Soft Skills: Personality Development for Life Success, BPB Publications 2018.
2. Alex K, Soft Skills S.Chand & Co, 2012 (Revised edition)
3. Gajendra Singh Chauhan & Sangeetha Sharma, Soft Skills: An Integrated Approach to Maximise Personality Published by Wiley, 2013
4. Pillai, Sabina & Fernandez Agna, Soft Skills and Employability Skills, Cambridge University Press, 2018
5. Soft Skills for a Big Impact (English, Paperback, Renu Shorey) Publisher: Notion Press
6. Dr. Rajiv Kumar Jain, Dr. Usha Jain, Life Skills (Paperback English) Publisher : Vayu Education of India, 2014

Online Learning Resources:

1. https://youtu.be/DUlsNJtg2L8?list=PLLy_2iUCG87CQhELCytvXh0E_y-bOO1_q
2. https://youtu.be/xBaLgJZ0t6A?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7KlJ
3. https://youtu.be/-Y-R9hDl7lU
4. https://youtu.be/gkLsn4ddmTs
5. https://youtu.be/2bf9K2rRWwo
6. https://youtu.be/FchfE3c2jzc
7. https://www.businesstrainingworks.com/training-resource/five-free-business-etiquette-training-games/
8. https://onlinecourses.nptel.ac.in/noc24_hs15/preview
9. https://onlinecourses.nptel.ac.in/noc21_hs76/preview

II B.Tech II-Semester	DESIGN THINKING & INNOVATION	L	T	P	C
		1	0	2	2

Course Objectives:

The objective of this course is to familiarize students with design thinking process as a tool for breakthrough innovation. It aims to equip students with design thinking skills and ignite the minds to create innovative ideas, develop solutions for real-time problems.

UNIT – I Introduction to Design Thinking

Introduction to elements and principles of Design, basics of design - dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

UNIT - II Design Thinking Process

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development

Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

UNIT - III Innovation

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

UNIT - IV Product Design

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

UNIT – V Design Thinking in Business Processes

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

Textbooks:

1. Change by design, Tim Brown, Harper Bollins (2009).
2. Design Thinking for Strategic Innovation, Idris Mootee, 2013, John Wiley & Sons.

III Year I Semester	FOUNDRY TECHNOLOGY (Professional Core)	L	T	P	C
		3	0	0	3

Course objectives:

1. To know about various types of foundries and know the patterns and moulding sands and additives used for getting good moulds.
2. To know in detail about various casting processes and properties in moulds. Gating and risering in moulds.
3. Study of different moulding processes and their equipment
4. Solidification of metals and alloys and melting practices to be studied.
5. Various casting defects and their prevention to be studied.

UNIT-I: Scope and development of Foundry. Types of foundries. Materials for patterns, types of patterns; functions and pattern allowance. Moulding sands, properties and selection of materials and additives used.
UNIT-II: Green and dry sand moulding; shell moulding, CO_2 moulding. Core moulds and cores. Plaster mould casting, composite mould casting, Investment casting.
Gate nomenclature and types, types of risers, Gating Ratio.
UNIT-III: Permanent mould casting, pressure die-casting, Gravity die-casting and centrifugal casting, Types of moulding equipment.
UNIT-IV: Nucleation crystal growth. Freezing of metals and alloys. Dendritic freezing. Coring and segregation, ingot defects, Flow of metals in moulds.
Melting of Gray iron in cupola, Cupola operation and control, Effect of chemical composition, carbon equivalent and effect of alloying elements on foundry characteristics. Melting of non-ferrous alloys: Melting of Aluminium and copper alloys production processes: Production of Gray Iron, ductile iron. Malleable iron castings
UNIT-V: Continuous casting and casting defects: Casting defects arising due to moulding, coring melting, and poring practice. solidification simulation.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

Student will be able
1. To select materials and additives used in moulding and patterns.
2. To understand the concepts of casting processes and gating.
3. To identify types of moulding equipments.
4. To understand solidification of metals and melting of ferrous alloys.
5. *To estimate casting defects.*

Text Books:

1. Principles of Metal casting by Heine, Loper, and Rosenthal.
2. Foundry Technology – Dhuvendra Kumar & S.K.Jain

References:

1. Metals Handbook Vol. 5 published by ASM, Ohio.
2. Foundry Technology-Jain
3. Foundry Technology Principles-T.V.Ramana Rao

III Year I Semester	MECHANICAL BEHAVIOR OF MATERIALS (Professional Core)	L	T	P	C
		3	0	0	3

Course objectives:

1. To know the effect of transformation of axes. To understand the concept of stress, strain, principal stress, stress tensors and elastic anisotropy
2. To know the importance of yield criteria and the concept of Mohr's circle
3. To understand the concept of Strengthening mechanism and various methods of Strengthening mechanisms
4. To understand the principle of hardness measurement and types of hardness measurements
5. To know the fundamentals, failure and the factors affecting fatigue and creep.

UNIT–I: Definition of stress and strain; transformation of axes, tensor notations; relationship between stress and strain; concepts of principal stress and principal strain; concepts of modulus; Hooke's law and understanding stiffness and compliance tensors; Elastic anisotropy.
UNIT–II: Yield criterion; equivalent stress and plastic strain, theoretical shear of perfect crystal; Moh's circle, concept of dislocations and dislocation theory; dislocation interaction; kink and jog; sessile and glissiles, partial dislocations, Thomson tetrahedra.
UNIT–III: Work hardening; solid solution strengthening; grain boundary strengthening; ageing; dispersion strengthening; composite strengthening.
UNIT–IV: Types of hardness measurements; comparison among hardness methods and scales; micro-hardness; nano-indentation.
UNIT–V: Introduction to Fracture Mechanics, griffth theory of fracture, types of fracture, mechanism of ductile and brittle fracture, S-N curves; life data presentation; influence of stress; linear elastic fracture mechanics in fatigue, crack growth studies, Paris law, metallurgical aspects of fatigue failure; concepts of remedial methods; stress rupture and creep studies; deformation mechanism maps; super-plasticity; fatigue-creep interaction.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to apply the concepts of stress and strain
2. Able to apply the concept of yielding phenomena
3. Able to understand various types of strengthening mechanisms
4. Able to understand various types of hardness mechanisms
5. Able to understand the concept of fracture, fatigue and creep

Text Books:

1. Dieter G.E., Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H. Courtney, Mechanical Behaviour of Materials, 2nd Edition, Overseas Press India Private Limited

References:

1. Suryanarayana, Testing of Metallic Materials; Prentice Hall India
2. Dowling N.E., Mechanical Behaviour of Materials, International Edition, contributed by K.Sivaprasad and R.Narayanasamy, 2013, Pearson Education Limited.

III Year I Semester	WELDING TECHNOLOGY (Professional Elective–I)	L	T	P	C
		3	0	0	3

Course objectives:

1. *To know the working principle, variables of welding process and microstructural changes in Weld zone*
2. *To know the working principle, merits and demerits of fusion welding processes.*
3. *To Understand the working principle and importance of welding allied processes.*
4. *To know the weldability and welding related problems of ferrous materials and , various defects of welds.*
5. *To Learn weldability of various Non ferrous alloys*

UNIT–I: The principles and theory, mechanism and key variables of different welding processes, types of tooling and equipment. Microstructure of fusion and heat affected zone, welding stresses, pre and post treatments.

UNIT-II: Advantages, disadvantages and field of application of the welding with reference to the following welding processes, Gas welding, Arc welding, submerged arc welding, TIG, MIG, MAG, CMT ,Plasma arc welding.

UNIT–III: Electron Beam welding, spot-welding, Laser welding, diffusion joining, Friction welding, Friction stir welding, ultrasonic welding and explosive welding, MIAB welding

UNIT-IV: Welding of structural steel, welding of cast iron, welding of stainless steel and other high-alloyed steels. Welding defects and remedies

UNIT-V: Welding of copper and its alloys, welding of aluminium and its alloys, joining of dissimilar alloys mechanism, Techniques and scope of brazing, soldering and adhesive bonding processes.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1: Able to understand welding mechanisms
2. Able to understand different types of welding processes
3. Able to understand modern welding processes
4. Able to understand welding of different materials
5. Able to understand welding mechanism of joining techniques

Text Books:

1. Welding Technology-R.S.Parmar**.**
2. A Textbook welding technology by O.P Khanna
3. Welding and welding technology by R L Little

References:

1. JF Lancaster: Welding Metallurgy
2. Little: Welding and Welding Technology
3. Agarwal Manghmani: Welding Engineering
4. BE Rossi: Welding Engineering

III Year I Semester	LIGHT METALS TECHNOLOGY (Professional Elective–I)	L	T	P	C
		3	0	0	3

Course Objectives:

1. *To learn the extraction process, properties, and applications of Al and its alloys.*
2. *To learn the properties and applications of Ti and its alloys*
3. *To learn the properties and applications of Mg and its alloys*
4. *To learn the properties and applications of Be and its alloys*
5. *To learn the properties and applications of Li and its alloys*

UNIT-I: General introduction –Light metals and alloys, strengthening by solid solution, precipitation, dispersion of second phase particles, grain refinement and work hardening; Scenario of India in worlds production of light metals and alloys.

UNIT-II: Aluminium and its alloys: Extraction flowsheet processing – Properties – Applications. Wrought and Casting Alloys (Al-Cu, Al-Mn, Al-Si Applications in consumer, automotive and aerospace industry

UNIT–III: Commercially Pure Titanium and its properties, applications, interstitial solid solutions of Titanium, Titanium alloys, Strengthening mechanisms of Ti alloy, alpha Ti alloys, Beta Ti alloys, alpha plus Beta Ti alloys, Heat treatment, Properties and applications of Ti-8Al-1Mo-1V, Ti-6Al-4V, Ti-5553 alloys; Processing of Ti -alloys.

UNIT-IV: Magnesium Alloys: Properties, Designation, Heat treatment of Magnesium alloys Mg-Sn, MgZn, Mg-Gd, Mg-Li systems. Corrosion resistance of Mg-alloys; Production and processing of Mg alloys; Applications in consumer, automotive and aerospace industry.

UNIT-V: Extraction flow sheet processing - properties and applications of Beryllium and Lithium alloys

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to understand Al-Cu, Al-Mn, Al-Si alloys
2. Able to understand Titanium and its alloys
3. Able to understand Magnesium and its alloys
4. Able to understand Beryllium and its alloys
5. Able to understand Lithium and its alloys

Text Book:

1. Light alloys: Metallurgy of light metals, I. J. Polmear, 2nd edition, Edward Arnold Publishers, 1989

References:

1. Light alloys: from traditional alloys to nanocrystals, I. J. Polmear and David St. John, BH-Elsevier, 4th edition 2006
2. ASM Metals Handbook Vol-1 & 2

III Year I Semester	FUNCTIONAL MATERIALS (Professional Elective-I)	L	T	P	C
		3	0	0	3

Course objectives:

1. *To learn crystal structure of materials and how structure can be relate to properties*
2. *To understand phenomena of magnetic materials*
3. *To understand the semi conductivity and its applications with respect to materials aspects*
4. *To know about the concepts related to Dielectric and ferro electric materials*
5. *To Understand the effect of structures on the properties and applications of 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: Basics of magnetic materials, soft magnetic materials, hard magnetic materials, High Temperature Behaviour of Amorphous and Nanocrystalline Soft Magnetic Materials, Magnetic storage devices to store data using combination of magnetic fields and binary data.
UNIT-III: Basics of semiconductor electrical properties, operation of the semiconductor devices. Semiconductor devices – Theory, examples and applications of optically active materials Band structure, Diode, MOS device capacitor, MOS transistor structure operation, Transistor formation and Transistor isolation
UNIT-IV: Dielectrics, pies 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, factors affecting properties of smart materials. Applications in electronic, communication, aerospace, automotive, energy industries.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. *Able to understand crystallography of materials*
2. *Able to understand magnetic nature of materials*
3. *Able to understand semiconductor electrical properties*
4. *Able to understand Dielectrics, piezo and ferroelectric materials*
5. *Able to understand smart materials*

Text Books:

1. Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications; Deborah D L Chung, World Scientific Publishing, 2010

References:

1. Functional Materials 1st Edition, Preparation, Processing and Applications by S. Banerjee, A.K.Tyagi.
2. Advanced Functional Materials by Woo, Hee-Gweon, Li, Hong.
3. Functional Materials: Properties, Performance and Evaluation by Ewa Klodzinska

III Year I Semester	INTRODUCTION TO MATERIALS SCIENCE (Open Elective – I)	L	T	P	C
		3	0	0	3

Course objectives:

1. *To learn about the fundamentals of crystal structure, defects*
2. *To learn about the fundamentals of dislocations and their interaction*
3. *To learn about the electrical and magnetic Properties of materials*
4. *To learn about the Properties of advance materials*
5. *To learn about the glass and amorphous materials*

UNIT–I: Introduction: classification of materials**,** Space lattice and unit cells,
Crystal systems: Indices for planes and directions. Structures of common metallic materials.
Crystal defects: Point, Line and surface defects. Dislocations, types of dislocations
UNIT–II: Dislocation movement by slip, climb and cross slip. Dislocation sources, dislocation interaction. **Slip systems** for BCC, FCC and HCP metals, Critical resolved shear stress (CRSS) for slip, Twinning, Stacking faults, Jogs, Kinks. Strengthening mechanisms
UNIT–III: Electrical and Electronic properties of materials, Electronic conductivity, free electron theory and band theory of solids. Intrinsic semi-conductors. Super conductivity. Dia, para, ferro, ferri magnetism in materials , Soft and hard magnetic materials and applications.
UNIT–IV: Optical properties of materials. Refractive index, absorption emission of light, optical fibers. Opto-electronic materials.
UNIT-V: Bulk metallic glasses, glass forming ability, quasi crystals, Nano crystalline materials, amorphous materials
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

At end of the course, the student shall be

1. Able to understand crystal systems and crystal defects
2. Able to understand dislocation mechanisms
3. Able to understand electrical, electronics and magnetic nature of materials
4. Able to understand the optical properties of materials
5. Able to understand the amorphous materials

Text books:

1. Material Science and Engineering by V.Raghavan
2. Physical Metallurgy by S. H. Avner.

References:

1. Material Science and Engineering by L.H.VanVleck, 5th edition, AddisionWealey(1985)
2. Structure and properties of Materials by R.M.Rose, L.A.Shepard and J.Wulff, Vol.1,4 John Willey (1966) .
3. Essentials of Material Science by A.G.Guy, McGraw Hill(1976).
4. The Science and Engineering Materials by D.R.Askeland. 2nd Edition, Chapman and Hall (1990).
5. Physical Metallurgy, Vijendra Singh

III Year I Semester	BASICS OF CRYSTALLOGRAPHY (Open Elective – I)	L	T	P	C
		3	0	0	3

Course objectives:

1. *to learn about the fundamentals of crystal structure and perform relevant numerical calculation*
2. *to study about various diffraction techniques used for crystallography*
3. *To study about the various type of various interstitial solid solution, compounds and intermetallics*
4. *To study the impact of defects on material properties.*
5. *To study about the symmetry and crystallography in crystals*

UNIT–I: Motif, lattices, lattice points, lattice parameter, Crystal systems,14 Bravice lattices, Coordination number, number of atoms per unit cell, packing factor, Miller indices of planes directions, repeat distance, linear density packing factor along a direction, planar density, planar packing fraction

UNIT–II: Usage of diffraction techniques for crystallography- XRD, Neutron Diffraction, and synchrotron diffraction.

UNIT–III: Radius ratio for coordination number 2,4,6,8. Interstitial solid solution, Interstitial compounds. AX, AX2, AB03 AB04 crystal structures

UNIT–IV: Frenkel-Schkotty ionic defects, Ionic defect concentration, solute incorporation, Electronic defect concentration, Defects and chemical reactions. Symmetry and types of Symmetry in crystals.

UNIT–V: Stereographic projection. Crystallographic point groups, micro translations, symmetry of reciprocal lattice, systematic absences, space groups.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. *Able to understand basics of crystallography*
2. *Able to Able to understand diffraction techniques*
3. *Able to understand calculations involved in crystal structures*
4. *Able to understand mechanisms of crystal defects*
5. *Able to understand stereographic projection*

Text book:

1. Introduction to crystallography, Donald E. Sands, Courier Corporation, 2012

References:

1. The science and Engineering Materials, Donald R. Askeland and Pradeep phule, Thmson, 2003
2. Elements of X-ray diffraction, Cullity B.D., Addison-Wesley Publishing company 1956

III Year I Semester	METALLURGICAL PROCESS MODELLING (Open Elective – I)	L	T	P	C
		3	0	0	3

Course objectives:

1. *To know various mathematical models and their advantages*
2. *To differentiate finite element and finite differential modeling.*
3. *know the application of artificial intelligence in various metallurgical problems*
4. *To develop physical models in various metallurgical applications.*
5. *To analyse different case studies related to process modeling.*

UNIT-I: Mathematical modeling, physical simulation, advantages and limitations; process control, instrumentation and data acquisition systems, review of transport phenomena, review of differential equations, review of numerical methods;

UNIT-II: Concept of physical domain and computational domain, assumptions and limitations in numerical solutions, introduction to FEM & FDM, Introduction to software packages – useful websites and generic information about different products - ANSYS, Thermocalc, CFD

UNIT-III: Introduction to expert systems and artificial intelligence. Demonstration and practical training in some software packages.

UNIT-IV: Physical modeling – cold and hot models; case studies of water models, use of computers for the construction of phase diagrams, alloy design, crystallography, phase transformations and thermo chemical calculations.

UNIT–V: Case studies from literature – pertaining to modeling of solidification/heat transfer, fluid flow, casting, welding and liquid metal treatment

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. *Able to understand what is modelling*
2. *Able to understand software packages*
3. *Able to understand practical knowledge in software packages*
4. *Able to understand physical modelling of materials*
5. *Able to do case studies in metallurgy*

Text Books:

1. Szekely J., Themelis N. J., 'Rate Phenomena in Process Metallurgy', Wiley, 1971
2. P.S. Ghosh Dastidar, "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill, New Delhi, 1998

III Year I Semester	FATIGUE AND FRACTURE MECHANICS (Open Elective – II)	L	T	P	C
		3	0	0	3

Course objectives:

1. *To know basic mechanisms of fatigue behaviour and effect of stress concentration*
2. *To know about the effect of low cycle and high cycle fatigue on materials*
3. *To learn the fatigue fracture phenomenon, crack initiation and growth*
4. *To understand fracture mechanics and concept of fracture toughness*
5. *To know how to e*valuate and analyze the *life of material by testing and good design*

UNIT-I: Fatigue of structures, S-N curves, Endurance limits, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, Plastic stress concentration factors, Notched S.N. curves, Fatigue of composite materials.

UNIT-II: Statistical aspects of fatigue behaviour, low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, cyclic strain hardening and softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory, Other theories.

UNIT-III: Physical aspects of parameters of fatigue life, crack initiation, crack growth, final Fracture, Dislocations, fatigue fracture surfaces. Fatigue design and testing, safe life and Fail-safe design philosophies

UNIT-IV: Fracture mechanics, strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin-Orwin extension of Griffith's theory to ductile materials, stress analysis of cracked bodies, effect of thickness on fracture toughness, stress intensity factors for typical geometries.

UNIT-V: Importance of Fracture Mechanics in aerospace structures, application to composite materials and structures.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to understand fatigue behaviour
2. Able to understand statistical aspects of fatigue behaviour
3. Able to understand different stages of fatigue behaviour.
4 Able to understand theories involved in fracture mechanics
5. Able to understand fatigue design and testing in applications

Text Books:

1. Barrois W, Ripely, E.L., "Fatigue of aircraft structure," Pergamon press. Oxford, 1983.
2. Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 1999.

References:

1. KareHellan, 'Introduction to Fracture Mechanics', McGraw Hill, Singapore,1985
2. Knott, J.F., "Fundamentals of Fracture Mechanics," - Buterworth& Co., Ltd., London, 1983.
3. Sih C.G., "Mechanics of fracture." Vol - I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.

III Year I Semester	FUELS, FURNACES AND REFRACTORIES (Open Elective – II)	L	T	P	C
		3	0	0	3

Course objectives:

1. To study the origin, classification, and analysis of industrial fuels. Manufacture and testing of metallurgical coke along with the properties are to be studied

2. Study of fuel oil production and fuel gases production and their uses

3. Study of heat transfer through various bodies. Solving problems pertaining to them. Study of different furnaces.

4. To study various types of pyrometers used in the industry.

5. To study different types of Refractories, their manufacturer, properties and industrial users.

UNIT-I: Introduction to Fuels technology - Classification of fuels Origin and classification of coal Analysis of Coal Proximate and ultimate analysis. Pulverized fuels Principle of Carbonization Manufacture of Metallurgical coke Properties of Metallurgical Coke Testing of Coke.

UNIT-II: Principles of production of fuel oils from crude. Manufacture, properties and uses of a) Producer gas b) Water-gas Properties and uses of Blast furnace gas and coke oven gas; cleaning of Blast Furnace gas.

UNIT-III: Steady-State Heat Transfer: Importance of Heat transfer, conduction through a plane, cylindrical, Spherical and compound walls, shape factor and effect of variable thermal conductivity

Furnaces: Characteristic features of vertical shaft furnaces, reverberatory furnaces, Arc and Induction furnaces. Tube and muffle type resistance furnaces, continuous furnaces. Sources of heat losses in furnaces and heat balance.

UNIT-IV: Pyrometry: Thermoelectric pyrometry- Peltier and Thomas e.m.f's. Thermo-electric power of thermocouples. Required properties of thermocouples. Noble and base metal thermocouples. Thermo-pile. Measurement of e.m.f by Milli-voltmeters and potentiometers. Thermometer; optical and radiation pyrometer.

UNIT-V: Refractories: Desirable properties of Refractories. Methods of classification. Modes of failure of refractories in service and their prevention. Manufacturing methods and properties of Fireclay, Silica Magnesite and Chrome-Refractories. Testing of Refractories. Applications of refractories in the metallurgical industries.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to understand basics of fuel technology related to coal and coke

2. Able to understand the principles of oils and gases

3. Able to understand concept of heat transfer and various types of furnaces

4. Able to understand pyrometry

5. Able to understand refractories

Text Book:

1. Furnaces, Fuels, and Refractoriness by O.P. Gupta, Khanna Publishers.

References:

1. Elements of fuel technology -HIMUS
2. Refractories- R.Chisti.
3. Fuels, Furnaces, Refractories & Pyrometry- A.V.K.Surya Narayana.

III Year I Semester	TRANSPORT PHENOMENA (Open Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand basic concepts related to fluid flow in the context of metallurgical processes
2. To understand basic concepts related to heat transfer in the context of metallurgical processes
3. To become familiar with the equations related to heat transfer phenomena
4. To understand basic concepts related to mass transfer in the context of metallurgical processes
5. To become familiarwiththemathematicaltreatmentandequationsrelatedtotransport phenomena

UNIT– I: Fluid Flow-Viscosity–differential mass and momentum balances–overall momentum balance–Mechanical energy balance–applications
UNIT-II: Heat Transfer–heat conduction equation–applications–steady and transient heat conduction. Two dimensional heat conduction
UNIT-III: Convective heat transfer–concept of heat transfer coefficient–forced and free convection; Radiation–View factor-radioactive heat exchange between surfaces
UNIT-IV: Mass Transfer-Diffusion: Diffusivity in gases, liquids, solids–convective mass transfer–concept of mass transfer coefficient
UNIT-V: Dimensionless analysis–Rayleigh's method, Buckingham method–use of differential equations–Similarity criteria–applications in physical modelling
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able to:
Understand Solve mass and energy balance calculations involved in fluid flow
1. Use the heat conduction equations in solving 1Dand 2Dheat transfer in real time situations
2. Differentiatetheforcedandfreeconvectionandperformcalculationsonconvectiveandradiative heat transfer
3. Understand the concepts of diffusion, diffusivity in different materials and mass transfer coefficient
4. Model any processes by converting actual (descriptive)processes into appropriate equations
and then attempt to solve the same

Text Books:

1. A.K.Mohanty, "Rate Processes in Metallurgy", PH India Ltd.,2000
2. B.R.Bird,Stewart,Lightfoot,'TransportPhenomena',JohnWiley,NewYork, 1994

References:

1. PoirierD.R.andGeigerG.H.,'TransportPhenomenainMaterialsProcessing',SpringerInternational Publishers, Switzerland, 2016

III Year I Semester	WELDING LAB (Professional Core Lab)	L	T	P	C
		0	0	3	1.5

Course objectives:

1. To give hands-on practice on various arc welding practices

2. To study the microstructure of welds and to write the welding reports

List of Experiments:

1. Arc striking practice.
2. Bead-on-plate welding
3. Effect of welding parameters on weld bead
4. GTA welding
5. GMA welding
6. Submerged arc welding
7. Microstructural observation of weldments
   - Carbon steel
   - Stainless steel
   - Aluminium alloys
   - Titanium alloys
   - Dissimilar joints
8. Weld overlaying of austenitic stainless steels on mild steels
9. Practice for preparation of welding procedure specification.
10. Practice for preparation of procedure qualification record.

List of Equipment:

1. Multipower welding source capable of SMAW, SAW, GMAW, GTAW. - 1No
2. Individual power sources and accessories for MMAW - 4 Nos.
3. Metallurgical microscopes - - 4 Nos.

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter-I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Parameter-II

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

III Year I Semester	FOUNDRY TECHNOLOGY LAB (Professional Core Lab)	L	T	P	C
		0	0	3	1.5

Course objectives:

1. This Laboratory course is designed to make the student to understand and demonstrate

2. This lab course is mainly designed to provide hands on practice on the various foundry testing methods for evaluation of moulding sand properties

LIST OF EXPERIMENTS:

1. Preparation of gating system using green sand.
2. Study of the 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. Founding of Al and Cu alloys in a pit furnace and casting into light components.
9. Study Charge calculations and melting practice of cast iron in a cupola.
10. Preparation of a shell-by-shell moulding process.
11. Non-destructive testing of a few cast-iron components.

Equipment:

1. Mould Boxes, Patterns, Cove Boxes, Tool Boxes.
2. Rotap Sieve Shaker with Sieves
3. Permeability Apparatus.
4. Universal Sand Testing Machine with Accessories.
5. Sand Hardness tester.
6. Clay Content Apparatus
7. Shatter Index test.
8. For Melting: Pit Furnace, Electric Furnace
9. Shell Moulding Machine
10. Centrifugal Casting Machine
11. Ultra Sonic Tester
12. Ladles, Crucibles and other Accessories
13. Muffle Furnace 1000^0c

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter-I:

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Parameter-II:

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

III Year I Semester	ARTIFICIAL INTELLIGENCE IN MATERIALS ENGINEERING (Skill Enhancement Course)	L	T	P	C
		0	1	2	2

Course objective:

1. To explore the scope of artificial intelligence (AI) in materials engineering and research

UNIT-I: Introduction To Artificial Intelligence: Definition – Future of Artificial Intelligence – Characteristic of Intelligent Agents – Typical Intelligent Agents –Problem Solving Approach to typical AI problems. Problem solving by Searching: Uninformed and informed strategies

UNIT-II: Need for AI in Materials Engineering and Research – Data Analysis, Factor Analysis, Image Analysis, Material Discovery

UNIT-III: Machine Learning as a subset of AI – Introduction, Types of Data; Supervised Learning – Basics, Regression, Linear and Non-Linear Regression, Gradient Descent, Logistic Regression; Unsupervised Learning – Clustering; Reinforced Learning

UNIT-IV: Deep Learning – Introduction; Neural Networks – Feed forward, Back propagation and Parameters; Types – Convolutional and Recurrent Neural Networks; Auto encoders

UNIT-V: Quantitative Microstructure Analysis – Computer Vision, Segmentation, Classification, Object Detection and Counting; Data Visualization – Introduction, Types and Techniques

Course outcomes:

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

1. Know the Artificial Intelligence and Machine Learning
2. Know fundamentals of artificial neural networks
3. Solve a materials problem using artificial neural networks
4. Know genetic algorithms and its application in materials engineering
5. Know data mining and Fuzzy logic its application in materials engineering

Text books:

1. Artificial Intelligence - A Modern Approach, Stuart Russell, Pearson Publication, 3rd Edition,

References:

1. Basics of Artificial Intelligence and Machine Learning, Deeraj Mehrotra, Notion Press, 2019
2. Artificial Intelligence by Example, Dennis Rothman, Packt Publishing, 2020

III Year I Semester	EVALUATION OF COMMUNITY SERVICE INTERNSHIP	L	T	P	C
		-	-	-	2

III B.Tech II Semester	METAL FORMING (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand basic concepts of yield criteria and theories of failure to develop solutions of material behaviour under varied loading conditions

2. To study mechanics of metal working and understand material flow behaviour under different service Conditions in metal forming. It also makes the students to understand the role of friction and Lubrication in development of residual stresses during deformation

3. To understand operations of various forging equipment and principles of variety of forging operations. To understand effect of various process parameters during rolling operations and determination of rolling loads that help in designing proper roll mills with improved product yields

4. To understand extrusion and drawing processes and analyze the processes to develop optimal process parameters for a defect free product

5. To make the students aware of specialized forming processes and their specific applications to improve their analytical and simulation skills

UNIT–I: State of stress, components of stress, symmetry of stress tensor, principal stresses, stress deviator, Von Mises, Tresca yield criteria, comparison of yield criteria, Octahedral shear stress and shear strain, Forming load calculations.

UNIT–II: Classification of forming processes, Mechanics of metal working, Flow stress determination, Effect of temperature, strain rate and metallurgical structure on metal working, Friction and lubrication. Deformation zone geometry, Workability.

UNIT–III: Forging-types of presses and hammers, Classification, Open die forging and closed die forging, forging in plane strain, forging defects- causes and remedies, residual stresses in forging.

ROLLING: Classification of rolling processes, types of rolling mills, hot and cold rolling, rolling of bars and shapes, forces and geometrical relationship in rolling, analysis of rolling load, torque and power, rolling mill control, rolling defects - causes and remedies.

UNIT–IV: Direct and indirect extrusion, variables affecting extrusion, deformation pattern, equipments, design of extrusion die, hydrostatic extrusion, defects and remedies, Analysis of extrusion force, tube extrusion and production of seamless pipe and tube. Drawing of rods, wires and tubes**.**

UNIT–V: Forming methods - Shearing, blanking, bending, deep drawing. Types of dies used in press working, defects in formed part and remedial measures, sheet metal formability, formability limit diagram. High Velocity forming techniques – Electromagnetic forming, electro hydraulic forming, explosive forming

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes*:*

The student should be able to

1. *Understand elements of plastic deformation which is required as a pre-requisite for studying fracture mechanics course*
2. *Design press tools which are essential for hot and cold working*
3. *understand forging and rolling*
4. *understand extrusion and drawing*
5. *understand sheet metal forming and other processes*

Text Books:

1. Dieter.G.E ., "Mechanical Metallurgy", McGraw-Hill Co., SI Edition, 1995.
2. Nagpal.G.R., "Metal Forming Processes", Khanna Pub., New Delhi, 2000.

References:

1. Kurt Lange “Handbook of Metal Forming”, Society of Manufacturing Engineers. Michigan, USA, 1988
2. Avitzur, “Metal Forming - Processes and Analysis”, Tata McGraw-Hill Co., New Delhi, 1977.
3. ASM Metals Handbook. Vol.14, “Forming and Forging”, Metals Park, Ohio, USA, 1990.
4. Taylor Altan, Soo I.K. Oh, Harold.L.Gegel. “Metal Forming: Fundamentals and Applications”, ASM, Metals Park, Ohio, USA, 1983.

III Year II Semester	IRON AND STEEL MAKING (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know about concepts of blast furnace
2. To learn about hot metal and slag reactions
3. To know about various types of iron making
4. To learn about basic concepts of steel making
5. To learn about various types of steel making processes

UNIT-I: Classification of furnaces; different kinds of furnaces, heat balance, energy conservation and energy audit; parts, construction and design aspects of blast furnace, ancillary equipment; blast furnace instrumentation.

UNIT-II: Blast furnace reactions; Gruner's theorem, carbon deposition, the partitioning of solute elements between the Iron and the slag; reactions in blast furnace; blast furnace slags; mass balance and heat balance

UNIT-III: Blast furnace (B/F) operations; B/F irregularities and remedial measures, B/F refractories and causes of failure, modern trends in (B/F) technology overview of direct reduction processes, electric smelting; production of DRI (HBI/ Sponge iron)

UNIT-IV: Review of traditional steel making; physical chemistry and thermodynamics; air/O2 impurity interaction, slag metal interaction, role of slags in refining, continuous casting; foaming slag; removal of S and P; de-oxidizers, alloying;

UNIT-V: Open hearth F/C; Bessemer converters; bottom blown and top blown processes; slag practices and sequencing; LD, VD, AOD, and VOD; Ladle metallurgy; electric arc furnace and DRI usage; energy, environmental and quality considerations

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to understand the design, accessories and energy calculations of blast furnace
2. Able to understand mass balance and heat balance for various reactions in bf
3. Able to understand alternate routes of iron making
4. Able to understand basic concepts of steel making
5. Able to know the processes of steel making

Text Books:

1. Modern Steelmaking, Dr. R.H. Tupkary and V.H. Tupkary
2. A first course in iron and steel making by Deepak Majundar

References:

1. Steel making by Kudrin V A
2. Making Shaping and Treating of Steels by United States Steel Corporation, Pittsburgh.
3. Open Hearth furnace practice - Bornatsky,
4. Manufacture of Iron and Steel, Vol. II by Gr Bashforth
5. Steel Making: A. K. Chakrabarthi (PHI)

III Year II Semester	MATERIAL CHARACTERIZATION (Professional Core)	L	T	P	C
		3	0	0	3

Course Objectives:

1. *To understand various characterization techniques for solids*
2. *To understand spectroscopy and optical microscopy characterization techniques*
3. *To understand Electron microscopy methods of characterization*
4. *To learn different thermal methods of characterization*
5. *To know the Diffraction methods of characterization with focus on XRD*

UNIT-I: Scope of subject, classification of techniques for characterization, macro and micro-characterization structure of solids.

UNIT–II: Optical emission spectroscopy, Atomic absorption spectroscopy, infrared spectroscopy and Raman spectroscopy. Metallographic Techniques: Optical metallography, image analysis, quantitative phase estimation.

UNIT–III: Scanning electron microscopy and image formation in the SEM and TEM, Atomic force microscopy (AFM), scanning tunneling microscope (STM),

UNIT-IV: X-ray diffraction (Bragg law, powder diffraction and phase identification, structure factor, estimation of crystallite size and strain; residual stress measurement single crystal diffraction).

UNIT-V: Thermal analysis, DTA, DSC, TGA, dilatometry, resistivity/conductivity.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able

1. *Understand the classification various techniques for material characterization*
2. *Explain the principles of microscopy and perform quantitative analysis of microstructures*
3. *Prepare samples and analyze microstructure using scanning and transmission electron microscopes*
4. *Demonstrate the various application the x-ray diffraction techniques for material characterization*
5. *Analyze and characterize the materials using different thermal analysis*

Text Books:

1. The Principles of metallogrphy laboratory practices –George L.Khel-Eurasia publishing house (Pvt Ltd)
2. Transmission electron Microscopy of metals –Garet Thomas.-John wiley and sons.

Reference Books:

1. Modern Metallographic Techniques & their application – victor phillips.
2. Physical Metallurgy, Part – I – RW Chao and P. Haasan.
3. Experimental Techniques in Physical Metallurgy – VT Cherepin and AK Mallik.
4. Electron Microscopy in the study of materials –P.J.Grundy.

III Year II Semester	BIOMATERIALS (Professional Elective–II)	L	T	P	C
		3	0	0	3

Course Objectives:

1. *To learn history and common use of biomaterials*
2. *To understand common use of metals, ceramics as biomaterials*
3. *To understand common use of polymers as biomaterials*
4. *To know about the materials used for dental applications*
5. *To understand about the advanced bio materials used for specific applications*

UNIT–I: Introduction: Historical background, construction materials, impact of biomaterials, strength of biological tissues, performance of implants, tissue response to implants, interfacial phenomena, safety and efficacy testing

UNIT–II: Metallic and Ceramic materials: Stainless steels, Co-Cr alloys, Ti-based alloys, Nitinol, biological tolerance of implant metals, ceramic implant materials, alumina, Zirconia, hydroxyapatite, glass ceramics, composites, Degradation of Materials in the biological environment, degradation effects on metals and ceramics

UNIT–III: Polymeric implant materials: Polymers in biomedical use, polyethylene, polypropylene, acrylic polymer, hydro gels, polyurethanes, polyamides, bio-gradable synthetic polymers, silicon rubber, microorganisms in polymeric implants, polymer sterilization, Chemical and biochemical degradation of polymers,

UNIT–IV: Dental Materials: Tooth composition and mechanical properties, impression materials, bones, liners, and varnishes for cavities, filling and restorative materials, oral implants, use of collagen in dentistry.

UNIT–V: Cardiovascular and Orthopedic implants: Artificial heart, aorta and valves, geometry of circulation, vascular implants, cardiac pace makers, bone composition and properties, fracture healing, joint replacement, knee joint repair, bone regeneration with restorable materials.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. *Able to understand importance of bio-materials*
2. *Able to understand metallic and ceramic materials behaviour in biological environment*
3. *Able to understand polymeric implant materials behaviour in biological environment*
4. *Able to understand dental materials*
5. *Able to understand Cardiovascular and Orthopedic implants*

Text Books:

1. Bhat, S.V., Biomaterials, 2nd edition reprint 2010, Narosa Publishing House
2. Park J.B. and Lakes R.S., Biomaterials: An Introduction, 3rd edition, Springer press , 2007

References:

1. Park J.B. and Bronzino J.D., Biomaterials: Principals and Applications, CRC Press, 2003
2. Park J.B., Biomaterials Science and Engineering, Springer Press 1984
3. Rattner B.D., Hoffman A.S, Schoen F.J., Lemons J.E., Biomaterials Science: An Introduction to Materials in Medicine, Academic Press 2004

III YEAR II Semester	COMPOSITE MATERIALS (Professional Elective–II)	L	T	P	C
		3	0	0	3

Course objectives:

1. *To know various types of composite materials and their applications*
2. *To Learn various types of fibers and their role as reinforcement in matrix material*
3. *To Learn different processing methods of composites.*
4. *To learn different processing methods based on their application.*
5. *To understand how composites behave under various stress conditions.*

UNIT-I: Classification of composite materials based on structure, matrix and reinforcement. Advantages of composites, application of composites, functional requirements of reinforcement and matrix.

UNIT-II: Fibers: Preparation, properties and applications of glass fibers, carbon fibers, Kevlar fibers and metal fibers-properties and application of whiskers, particle reinforcements.

UNIT-III: Manufacturing of Polymer matrix composites: Preparation of Moulding compounds and – hand layup method – Autoclave method - Filament winding method - compression moulding – Reaction injection moulding.

UNIT-IV: Manufacturing of Metal Matrix Composites: Casting-Solid state diffusion technique. Cladding – Hot isostatic pressing. Manufacturing of Ceramic Matrix Composites: Liquid Metal infiltration-Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving

UNIT-V: Response of Composites to Stress: (a) Iso-strain condition (b) Iso-stress condition (c) Load friction shared by the fibers

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

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

1. Understand concept of reinforcement and its role in the composite
2. Use various fibers as reinforcement in the composite based on the application
3. Know about various manufacturing methods and their limitations
4. Understand fabrication metal matrix composite materials
5. Understand how composites behave under various stress conditions

Text Books:

1. Composite Materials-K.K.Chawla, Springer, 2nd Edition, 1998
2. An introduction to composite materials, D. Hull an T.W. Clyne, 2nd edition, Cambridge University press, 1996

References:

1. Composites ASM Hand Book, Vol. 21, 9th edition, 1989
2. Fundamentals of composites: Materials, manufacturing, methods an applications, Society of manufacturing engineers, 1989
3. Material Sciences and Technology – (R.. W. Cahn, P. Haasen, E, J, Kramer eds.) Vol 13
4. Structure and properties of composites (T. W. Chou ed.) VCH Winheim, 1993 – Composites by Cahn – VCH

III YEAR II SEMESTER	HIGH TEMPERATURE MATERIALS (Professional Elective-II)	L	T	P	C
		3	0	0	3

Course objectives:

1. *To Understand the Creep phenomena at elevated temperature*
2. *To understand oxidation and corrosion effect on materials due to elevated temperatures*
3. *To know properties of different alloy steels and to understand how they are used for high temperature applications*
4. *To know properties of different super alloys*
5. To Understand the effect of thermal barriers coatings

UNIT-I: Introduction to Creep, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate. Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.

UNIT–II: Oxidation, Pilling-Bedworth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion.

UNIT-III: Cr-Mo Steels, Cr-Mo-V Steels, Austenitic Stainless Steels, Ferritic steels for Irradiation damage control, ODS Steels Processing, Properties and Applications

UNIT-IV: Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, Embrittlement, solidification of single crystals.

UNIT–V: Alumina, Zirconia, Silicon carbide, Silicon Nitride, Glass Ceramics, Thermal barriercoatings

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. *Able to understand creep phenomena*
2. *Able to understand oxidation and hot corrosion*
3. *Able to understand high temperature steels*
4. *Able to understand super alloys*
5. *Able to understand ceramics and thermal barrier coatings*

Text Books:

1. Callister's Materials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015
2. Courtney T.H, "Mechanical Behaviour of Materials", McGraw-Hill, USA, 1990.

References:

1. G. W. Meetham and M. H. Van-de-Voordee, Materials for high temperature applications, Springer 2000
2. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals, USA..
3. Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 1996.Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 1983

III YEAR II Semester	POLYMER SCIENCE AND TECHNOLOGY (Professional Elective-III)	L	T	P	C
		3	0	0	3

Course objective:

1. *To understand Different kind of polymers and their properties*
2. *To learn classification of polymers and Concept of Molecular Weight and distribution*
3. *To understand the role of additives used in polymers*
4. *To understand thermo plastic and thermosetting polymers*
5. *To learn the processing methods of polymers uses of various important polymers*

UNIT-I: Conception of polymers, formation of polymers, types of polymers reactions such as addition and condensation, Mechanism of polymerization - Thermoplastic and Thermosetting materials methods of polymerization. Natural rubbers and synthetic rubbers

UNIT –II: Polymeric structure, raw materials and properties - Classification of polymers, raw materials for polymers and their sources. Crystallinity of polymeric materials, effect of time, temperature, catalysts and solvents on polymer properties, molecular weight of polymers.

UNIT–III: Functions of the following types of additives used in Polymers fillers, lubricants, reinforcing agents, plasticizers, stabilizers, antioxidants, inhibitors, promoters, catalysts, retarders, limitators, colorants, cross-linking agents, blowing agents, photo degradiant agents, bio-degradiant agents, laminated polymers.

UNIT- IV: Thermo plastics -Methods of addition polymerization, raw materials, manufacturing methods, properties and uses of the Important Thermoplastic Polymers

Thermosetting resins - Methods of condensation polymerization, raw materials, manufacturing method, properties and uses of the important Thermosetting Polymers.

UNIT – V: Raw materials, manufacturing methods, properties and uses of the following plastics Acetals, Nylons, Polymethyl, Methocrylate (PMMA), Saturated polyesters – PETP and PC, Cellulose acetate and viscose rayon.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. *Able to understand basics of polymers and plastics*
2. *Able to understand polymeric materials*
3. *Able to understand additives used in polymers*
4. *Able to understand thermo plastics and thermo setting resins*
5. *Able to understand manufacturing and properties of plastics*

Text Books:

1. The elements of polymer science and engineering, Rudin A, Academic Press, 3rd edition, 2013
2. Introduction to polymers, R.J. Young and P. A. Lovell, CRC Press, 3rdedition , 2013

Reference Books:

1. Polymers hand book, J, Brandrup and E. H. Emmergut Wiley-Interscience 4th edition, 1999
2. Material Science and Metallurgy for Engineers –V.D.Kodgire and S. V. Kodgire, Everest Publishers, 2011
3. Callister's Mateials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015

III YEAR II Semester	SMART MATERIALS (Professional Elective-III)	L	T	P	C
		3	0	0	3

Course Objectives:

The students will acquire the knowledge:

1. *Have insight in the latest developments regarding smart materials*
2. *Know principles of Mangetostrictive materials*
3. *Learn important polymers which are used as smart materials*
4. *Know the importance and properties of shape memory alloys*
5. *Learn about sensor materials and energy materials*

UNIT-I: Introduction Smart Materials, Principles of Piezoelectricity, Perovskyte Piezoceramic Materials, Single Crystals vs. Polycrystalline Systems, Piezoelectric Polymers.

UNIT-II: Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magnetoresistance Effect

UNIT-III: Introduction Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC)

UNIT-IV: Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto-Rheological Fluids

UNIT-V: Piezoelectric Strain Sensors, Self-healing Polymers**,** smart composites, Energy Harvesting Materials

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able

1. *Learn about various smart materials*
2. *Learn the properties of magneto-strictive materials*
3. *Learn about advance polymer materials usage as in smart devices*
4. *Understand shape memory alloy effect*
5. *Understand smart sensor systems and energy materials*

Text Books

1. Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2. Gauenzi, P., Smart Structures, Wiley, 2009
3. Cady, W. G., Piezoelectricity, Dover Publication

III YEAR II Semester	SPECIAL PURPOSE STEELS (Professional Elective-III)	L	T	P	C
		2	0	0	2

Course objectives:

1. *Understand principles of microalloying and problem associated with developing high strength steels*
2. *To know the properties, types and applications of stainless steels.*
3. *Selection of advanced and ultra-high strength steels for specific engineering applications.*
4. *To know the properties, types and applications of tool steels.*
5. *To know the properties, types and applications of Die steels.*

UNIT-I: Definition of high strength steels, problems in developing high strength steels; discussion on fracture toughness; HSLA steels, principle of microalloying and thermomechanical processing; importance of fine-grained steels

UNIT-II: Phase diagrams, composition, properties and applications of ferritic, austenitic, martensitic, duplex and precipitation hardenable stainless steels

UNIT-III: Dual phase steels, TRIP steels, TWIP steels, UHSS - maraging steels, metallurgical advantages, heat treatment, properties and applications

UNIT-IV: Tool steels; classification, composition, and application, constitution diagram of high-speed steels, special problems in heat treatment of tool steels

UNIT-V: Die steels; classification, composition, and application, special cutting steels, Hadfield mangnese steels,

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

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

1. *Understand principles of micro alloying and problem associated with developing high strength steels*
2. *Understand the properties, types and applications of stainless steels.*
3. *Understand the properties, types of special steels having specific engineering applications*
4. *Understand the properties, types and applications of tool steels and heat treatment procedure to obtain required properties*
5. *Understand the properties, types and applications of die steels and Hadfield steels*

Text Books:

1. ASM Handbook, Vol 1. Properties and Selection: Irons, Steels, and High-Performance Alloys
2. Tool steels-Wilson-Pergamon Press
3. Pickering P. B., 'Physical Metallurgy and the Design of Steels', Applied Science Publishers,

III YEAR II Semester	MATERIALS TESTING (Open Elective-III)	L	T	P	C
		3	0	0	3

Course objectives:

1. *To understand about various types of dislocations, slip and twinning*
2. *To understand the principles of various hardness tests and theories of fracture*
3. *To understand the principle of tensile test, compression Test etc*
4. *To know the fundamentals, failure and the factors affecting fatigue and creep.*
5. *To know the non-destructive testing methods and evaluation of flaws in materials*

UNIT-I: Methods of hardness testing Brinell, Vickers, Rockwell, Rockwell superficial, Shore and Poldi methods, Microhardness test, relationship between hardness and other mechanical properties.

UNIT-II: Notched bar impact test and its significance, Charpy and Izod Tests, significance of transition temperature curve, Metallurgical factors affecting on transition temperature, temper embrittlement.

UNIT–III: Mechanism of elastic 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 in compression, elastic and in-elastic properties in compression.

UNIT–IV: 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. Effect of metallurgical variables on fatigue. Low cycle fatigue - High cycle fatigue.

Creep Test: 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.

UNIT-V: Non-Destructive Tests: Introduction, various NDT methods, applications advantages of one test over the other.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. *Able to understand deformation behavior with respect to metallurgical fundamentals*
2. *Able to understand Hardness testing and Impact testing*
3. *Able to understand tension test and compression testing*
4. *Able to understand fatigue test and creep test*
5. *Able to understand non destructive testing*

Text Books:

1. Mechanical Metallurgy - GE Dieter

References:

1. Engineering Materials Science - CW Richards
2. Mechanical behaviour of material-A.H.Courteny
3. Mechanical behavior-Ed.Wulf.

III YEAR II Semester	NON DESTRUCTIVE TESTING AND EVALUATION (Open Elective–III)	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand the various non-destructive techniques for testing and inspection of materials to detect surface defects

2. To understand the various non-destructive techniques for testing and inspection of materials to detect sub-surface defects

3. To understand the various non-destructive techniques for testing and inspection of materials to detect internal defects

UNIT–I*:* Visual Inspection- tools, applications and limitations.

Liquid Penetrate Inspection - principles, types and properties of penetrants and developers. Advantages and limitations of various methods of LPI.

Magnetic particle inspection- principles, applications, advantages and limitations

UNIT–II: Ultrasonic testing(UT) - Nature of sound waves, wave propagation - modes of sound wave generation - Various methods of ultrasonic wave generation, types of UT Principles, applications, advantages, limitations, A, B and C scan - Time of Flight Diffraction (TOFD)

UNIT–III: Radiography testing (RT) – Principles, applications, advantages and limitations of RT. Types and characteristics of X ray and gamma radiation sources, Principles and applications of Fluoroscopy/Real-time radioscopy - advantages and limitations - recent advances.

UNIT–IV: Eddy current testing - Principles, types, applications, advantages and limitations of eddy current testing.

UNIT–V: Thermography - Principles, types, applications, advantages and limitations. Optical & Acoustical holography- Principles, types, applications, advantages and limitations. Case studies: weld, cast and formed components.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to understand visual inspection

2. Able to understand Ultrasonic testing

3. Able to understand Radiography

4. Able to understand Eddy current testing

5. Able to understand Thermograph

Text books:

1. Non-Destructive Testing by P. Halmshaw

References:

1. Metals Handbook Vol.II, Nondestructive inspection and quality control
2. Practical non destructive testing by Dr.Baldev Raj

III YEAR II Semester	COMPUTATIONAL MATERIALS SCIENCE (Open Elective-III)	L	T	P	C
		3	0	0	3

Course objectives:

1. *Basic concepts related to numerical methods*
2. *To Learn various computer applications for steel making*
3. *To learn burden calculations.*
4. *To learn computer modeling of material behavior.*
5. *To understand artificial intelligence.*

UNIT–I: Numerical methods for solution of ordinary differential equations. Applications of regression analysis and curve fitting techniques.

UNIT-II: Computer applications for energy & material balance in B.F. and BOF Steel making processes

UNIT-III: Numerical solution of partial differential equations pertinent to heat, mass & momentum transfer. Computer applications in solidification, potential energy diagrams and experiments in metallurgy. Analysis of test data using software's.

UNIT-IV: Use of computers for the construction of phase diagrams, alloys design and crystallography. Basics of Atomistic Computation techniques, Molecular Dynamics (MD) and Monte Carlo (MC) simulations

UNIT-V: Elements of modern artificial intelligence (AI) related techniques. Introduction to Genetic Algorithm and Artificial Neural Networks.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

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

1. *Understand concept of numerical methods*
2. *Understand use of computers in B.F. and BOF Steel making processes*
3. *Know about various numerical methods, their limitations and related equations*
4. *Understand use of computers related to various metallurgical processes*
5. *Become familiar with use of AI as a tool for wide range of metallurgical process*

Text Books:

1. S.Yip (Ed.): Handbook of Materials Modelling, Springer, 2005.
2. Santosh K. Gupta: Numerical Methods for Engineers, New Age International (P) Limited, New Delhi, 1998.

III YEAR II Semester	METAL FORMING LAB (Professional Core Lab)	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To enable the students to understand the principles and practice of metal forming.

LIST OF EXPERIMENTS:

1. Tension test - finding out n and k
2. Cold rolling of aluminium and brass sheets
3. Recrystallisation annealing of cold worked alloys
4. Hammer forging
5. Upset forming using Hydraulic Press
6. Simulation of metal flow using a model material
7. Extrusion of metals/alloys
8. Microstructure of Cold worked and hot worked metals
9. Analysis of friction behaviour in sheet metal forming
10. To determine the Forming Limit Diagram for various metals and alloys

LIST OF EQUIPMENTS

1. Hounsfield tensometer
2. Cold rolling mill
3. Muffle furnace
4. Forging hammer
5. Hydraulic press
6. Metallurgical microscope
7. Various die sets
8. DC regulated power supply
9. Stereo microscope
10. Sieve shaker with sieve set
11. Hall flow meter

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameters-I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Parameters-II.

1. *At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)*

III YEAR II Semester	MATERIALS TESTING AND CHARACTERIZATION LAB (Professional Core Lab)	L	T	P	C
		0	0	0	1.5

Course objective:

1. To enable the students to understand about the principles of materials characterization.

List of Experiments:

1. To determine the Rockwell hardness of ferrous and non-ferrous samples
2. To determine the hardness of ferrous and non-ferrous samples by using Vickers hardness tester.
3. To Determination of hardness profile across weldments using microvickers hardness tester
4. To determine the elastic modulus, ultimate tensile strength, breaking stress, percentage of elongation percentage reduction in area of the given specimen by tensiletest.
5. To determine the Charpy and Izod (V&U Groove notch) impact strength of a given material at room temperature.
6. To determine the fatigue strength of given material at a given stress
7. Optical microscopy – grain size measurement and inclusion analysis in steel
8. X-ray diffractrometry- phase identification
9. X-ray diffractrometry- crystal structure determination and lattice parameter measurement
10. Electron microscopy-fractography analysis
11. Electron microscopy-BSE imaging in composite microstructures
12. Microchemical analysis using EDS

List of Equipment:

1. Rockwell Hardness Machine	1 No.
2. Universal Testing Machine	1 No.
3. Impact Testing Machine	1 No.
4. Fatigue Testing Machine	1 No.
5. Vickers Hardness Tester	1 No.
6. Microvickers Hardness Tester	1 No.
7. Metallurgical microscope with image analysis	1 No.
8. X-ray diffractometer	1 No.
9. Scanning electron microscope with energy dispersive X-ray spectrometer	1 No.

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameters-I.

7. *observation book,*
8. *Record.*
9. *Conduct of the experiment successfully*
10. *Interpretation of the data*
11. *Drawing the graphs where ever necessary*
12. *Viva-voce.*

Parameters-II.

2. *At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)*

III YEAR II Semester	TECHNICAL PAPER WRITING & IPR (Audit Course)	L	T	P	C
		2	0	0	0

UNIT I: Introduction: An introduction to writing technical reports, technical sentences formation, using transitions to join sentences, Using tenses for technical writing, Planning and Structuring: Planning the report, Sections of a technical report, Minutes of meeting writing. Drafting report and design issues: The use of drafts, Illustrations and graphics.

UNIT II: Final edits: Grammar, spelling, readability and writing in plain English: Writing in plain English, Jargon and final layout issues, Spelling, punctuation and Grammar, Padding, Paragraphs, Ambiguity.

UNIT III: Using word processor: Adding a Table of Contents, Updating the Table of Contents, Deleting the Table of Contents, Adding an Index, Creating an Outline, Adding Comments, Tracking Changes, Viewing Changes, Additions, and Comments, Accepting and Rejecting Changes, Working with Footnotes and Endnotes, Inserting citations and Bibliography.

UNIT IV: Concept of Property - Introduction to IPR – International Instruments and IPR - WIPO - TRIPS – WTO -Laws Relating to IPR - IPR Tool Kit - Protection and Regulation - Copyrights and Neighboring Rights – Industrial Property – Patents - Agencies for IPR Registration – Traditional Knowledge –Emerging Areas of IPR - Layout Designs and Integrated Circuits – Use and Misuse of Intellectual Property Rights.Laws Relating to Patents in India – Patent Requirements – Product Patent and Process Patent - Patent Search - Patent Registration and Granting of Patent.

UNIT V: Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights - Subject Matters of Copyright – Copyright Ownership –Copyright Registration - Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Distinction between Trademark and Property Mark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance

References:

1. Deborah E.Bouchoux: Intellectual Property, Cengage Learning, New Delhi.
2. Prabhuddha Ganguli: Intellectual Property Rights, Tata Mc-Graw –Hill, New Delhi
3. Richard Stim: Intellectual Property, Cengage Learning, New Delhi.
4. https://www.udemy.com/course/reportwriting/
5. https://www.udemy.com/course/professional-business-english-and-technical-report-writing/
6. https://www.udemy.com/course/betterbusinesswriting/
7. T. Ramappa, Intellectual Property Rights Under WTO, S. Chand Publishers, 2008
8. R. P. Merges, P. S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age 1997

IV Year I Semester	POWDER METALLURGY (Professional Core)	L	T	P	C
		3	0	0	3

Course objectives:

1. To get acquainted with the importance of powder metallurgy and to know the advantages of PM techniques over other fabrication techniques

2. To get acquainted with various powder production methods and also get an idea of powder characterization.

3. To study the mechanism of compaction and sintering.

4. To gain knowledge on various applications of powder metallurgy parts.

5. To get acquainted with the advanced powder metallurgy materials.

UNIT–I: Emergence and importance of powder metallurgy**,** Comparison of powder metallurgy with other fabrication techniques, its scope and limitations.

UNIT–II: Characterization and production of powders **-** General characteristics of metal powders, particle shape flow rate, apparent density, and specific surface area, particle size distribution, Determination of powder characteristics**;**

Different methods of production of metal powders: influence of manufacturing process on powder characteristics.

UNIT–III: Consolidation of Metal Powders: Compaction - Theory of consolidation: Pressure transmission in powders; compressibility and compactibility of powders; Green strength; Powder rolling. Sintering - Mechanisms of Sintering; Factors affecting sintering; Activated sintering; Liquid phase sintering; Sintering atmospheres; Properties of sintered parts, Hot isostatic pressing , spark palsma sintering. Properties of sintered parts.

UNIT–IV: Applications: Porous parts: Self-lubricating bearings, filters: Dispersion strengthened materials: Cu /Al2O3, Sintered Aluminum Powder.

UNIT–V: Electrical and Magnetic materials, Tungsten lamp filaments, electrical contacts, welding electrodes. Soft magnetic materials (Fe, Fe-N); Permanent magnets (Alnico, SnCo5), Cemented carbides; Cermets.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to understand importance of powder metallurgy

2. Able to understand production and characteristics of powders

3. Able to understand compacting and sintering powders

4. Able to understand applications of powder metallurgy

5. Able to understand making of different types of powder metallurgy components

Text Books:

1. Powder Metallurgy: Anish Upadhya and GS Upadhya- University Press, 2013
2. Powder Metallurgy, P.C. Angelo and R. Subramanian, PHI Pvt. Ltd., 2008
3. Powder Metallurgy and particulate materials processing by RM German

References:

1. Powder Metallurgy, ASM Metals Hand Book , Vol. 7, 1984
2. Powder Metallurgy Science, Randall M. German, 1994

IV Year I Semester	NON FERROUS EXTRACTIVE METALLURGY (Professional Core)	L	T	P	C
		3	0	0	3

Course objectives:

1. *Study of Extraction of copper from minerals to electro winning.*
2. *Study of Extraction of lead and Zinc.*
3. *Study of Extraction of Aluminium by different processes*
4. *Extraction of light metals like magnesium and titanium from various sources and methods*
5. *Purification of Uranium ore and production of reactor grade UO2 and U and study of simplified flow sheets of various metals and review of NF Industry in India.*

UNIT–I: COPPER: Principal Ore and Minerals; Matte smelting – Blast furnace, Reverberatory furnace, 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 aluminium production.

UNIT–IV: MAGNESIUM: Production of a hydrous Magnesium chloride from sea water 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.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

Student will be able to

1. Understand the extraction of copper from minerals to electro winning.
2. Understand the Extraction of lead and Zinc.
3. *Understand the Extraction of Aluminium by different processes*
4. *Understand the Extraction of magnesium and titanium from various sources and methods*
5. *Will gain the knowledge about the purification of Uranium ore and production of reactor grade UO2 and U and study of simplified flow sheets of various metals and review of NF Industry in India.*

Text Books:

1. Extraction of Non-Ferrous Metals - HS Ray, KP Abraham and R. Sridhar
2. Metallurgy of Non-Ferrous Metals - WH Dennis

References:

1. Rare Metals Hand book - C.A. Hampel
2. Nuclear Reacto General Metallurgy - N. Sevryukov, B. Kuzmin and Y. helishchevr
3. Engineering - S. Glass Stone and A. Sesonske.

IV Year I Semester	INDUSTRIAL MANAGEMENT (Management Course - II)	L	T	P	C
		2	0	0	2

Course Objectives:

- To impart knowledge on scientific principles of management to improve productivity in manufacturing Industry.
- To impart knowledge on fundamentals of functional management to improve performance in industry.
- To introduce basic tools of operations management
- To teach concepts of personnel management and value engineering
- To provide fundamental principles of project management

Unit – I: Introduction: Definition of Industrial Engineering, Development, Applications, Role of an industrial engineer, Quantitative tools of IE and productivity measurement, Concepts of Management, Importance, Functions of management, Scientific management, Taylor's principles, Douglas McGregor's Theory X and Theory Y, Fayol's principles of management.

Unit-II: Functional Management: Human Resource management: Concept and functions of Human Resource Management, Concept of HRM and HRD Industrial relations, Job-evaluation and merit rating, wage and salary administration.- Marketing Management: Marketing mix and elements of marketing, strategies.- Financial management: objective and functions of Financial Management.

Unit – III: Operations Management: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

Unit – IV: Plant location and layout: Types and principles of plant layouts, Factors affecting plant location and layout, -Statistical Quality Control: Types of control charts, control charts for variables and control charts for attributes and its applications with numerical examples.

Unit – V: Project management: Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats, Project crashing and its procedure.

Course Outcomes:

Upon successful completion of this course you should be able to:

- The learner is able to analyses, interpret data and gain knowledge of Industrial Management.
- The knowledge of designing a system, component or process and synthesize solutions to achieve desired needs.
- The learner can use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints through work study.
- The learner can able to know about the application of statistics in quality control and management.The student can know their role as engineers in the present modern society and function effectively within multi-disciplinary teams.
- The learner can understand the fundamental concepts of effective project management design and conduct experiments.

Text Books:

1. Industrial Engineering and Management by O.P Khanna, Khanna Publishers
2. Industrial Engineering and Management by N.V.S. Raju, Cengage Learning

Reference Books:

1. Industrial Engineering and Production Management, Martand Telsang,S.Chand& Company Ltd. New Delhi
2. Operations Management by J.G Monks, Mc Graw Hill Publishers.

3. Production and Operations Management – R.Panneerselvam- PHI- 3rd Edition
4. Principles of Management by Koontz O' Donnel, McGraw Hill Publishers.
5. PERT and CPM by L.S Srinath, East west Press.
6. Production and operations management by K.C Arora.
7. Statistical Quality Control by Gupta.
8. Manufacturing Organization and Management, Harold T. Amrine, John

IV Year I Semester	METALLURGICAL FAILURE ANALYSIS (Professional Elective–IV)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know the sources, types and microscopic features of different types of fracture
2. To understand the factors influence on the fatigue and creep failures and their remedial measures.
3. To know the role of various factors on the wear and corrosion failures
4. To Identify the causes for failures in castings, forgings and weldments
5. To understand how we can carry out failure analysis and life testing using mathematical methods

UNIT–I: Stages of failure analysis, classification and identification of various types of fracture. Overview of fracture mechanics, characteristics of ductile and brittle fracture.
UNIT–II: General concepts, fracture characteristics revealed by microscopy, factors affecting fatigue life Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure. Some case studies of failures.
UNIT–III: Analysis of wear failure. Corrosion failures- factors influencing corrosion and wear failures, Procedure for analyzing wear and corrosion failures, various types of hydrogen damage failures. Some case Studies
UNIT–IV: Causes of failure in forming, failure of iron and steel castings, improper heat treatment, stress concentration and service conditions. Failure of weldments - reasons for failure procedure for weld failure analysis. Some case Studies
UNIT–V: Reliability concept and hazard function, life prediction, condition monitoring, application of Poisson, exponential and Weibull distribution for reliability, mean time analysis between failures and life testing.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able to:
1. Understand and analyze the fracture phenomenon
2. Analyze the fracture phenomenon in various materials in high temperature failures
3. Know about role of various factors on the wear and corrosion failures
4. Various types of failures involved in manufactureing processes
5. Become familiar with important remedial measures

Text Books:

1. Colangelo V.J. and Heiser F.A., Analysis of Metallurgical Failure, 2nd 1987 edition, Wiley-Inter science
2. Metallurgical Failure Analysis Techniques and Case Studies by K P Balan, BS publication 2019 Edition

References:

1. Shipley R.J. and Becker W.T., Failure Analysis and Prevention, ASM handbook, Vol. 11, ASM International 2002
2. Powell G.W. and Mahmoud S.E., Failure Analysis and Prevention, Metals Handbook, Vol. 11, 9th 1986 edition, ASM International

IV Year I Semester	FERRO ALLOY TECHNOLOGY (Professional Elective–IV)	L	T	P	C
		3	0	0	3

Course objective:

1. To obtain knowledge over the importance of ferroalloys and present status of ferro alloys in India
2. To obtain knowledge over the ferro alloy production and the physico chemical aspects involved
3. To study and learn about various furnaces used for production of ferro alloys
4. To study and learn about various production methods of ferro alloys
5. To study in detail about the production of ferro tungsten, ferro titanium and ferro vanadium

UNIT-I: Introduction: Types of Ferro alloys and their uses: Present status of ferroalloy industry in India. Future plans and developments.
Lay out: Lay out of a ferro alloy plant and its production economics.
UNIT-II: Principles: Physicochemical aspects of ferroalloys. Production by various methods.
UNIT-III: Furnace types and its design, refractories, auxiliaries, power supply, Working voltage, power factor and efficiency.
UNIT-IV: Production: Production of ferro-silicon-calcium, ferromanganese (high and low carbon), Ferro-chrome(high and low carbon),Ferro-molybdenum.
UNIT-V: Ferro-tungsten,ferro-titanium,ferro-vanadium.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able to:
1. Know different types of ferro alloys
2. Analyze the physic-chemical aspects involved in ferro alloy production
3. Learn how to design furnaces for ferro alloy production
4. Understand production of ferro manganese, ferro chrome and ferro molybdenum
5. Understand production of ferro tungsten, ferro titanium and ferro vanadium

Text Books:

1. A. Riss and Y. Khodorovsky , Production ferroalloys Mir Publishers, Moscow 1967.
2. B. P. Bharadwaj, The complete book on ferroalloys, NIIR Project consultancy services, 2014

References:

1. Hand book of Ferro alloys: theory and technology Edited by Michael Gasik, BH publishers, 2013

IV Year I Semester	SOLIDIFICATION PROCESSING (Professional Elective –IV)	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand thermodynamic principles relevant to solidification
2. To understand thermodynamic principles relevant to nucleation and growth
3. To Understand the thermodynamics of solutions, principles of free energy minimization and quasi chemical theory
4. To analyze the binary, ternary and multi component phase diagrams to determine various thermodynamic parameters
5. To learn the importance of interface energy and shape on segregation

UNIT-I: Introduction and important thermodynamic functions: Laws of thermodynamics-enthalpy, heat capacity, applications of first law to open and closed systems including chemical reactions; entropy, free energy and their interrelationships

UNIT-II: Thermodynamics of solidification; Nucleation and growth; Pure metal solidification, Alloy Solidification, Constitutional undercooling, Mullins-Sekerka instability; Single phase solidification: Cellular and Dendritic growth; Multiphase solidification: eutectic, peritectic and monotectic.

UNIT-III: Heterogeneous systems –equilibrium constants, Ellingham-Richardson diagrams, predominant area diagrams, principles of free energy minimization; energy balance of industrial systems; solutions- chemical potential, Raoult/Henry's law, Gibbs-Duhem equations, regular solutions, quasi chemical theory

UNIT-IV: Basics of Phase diagrams -phase rule, free-energy-composition diagrams, solidus-liquidus lines, retrograde solidus; determination of activity and other thermodynamic parameters from phase diagrams; thermodynamic analysis of ternary and multi component systems, interaction parameters

UNIT- V: Principles and applications of molten slags and silicate melts; electrochemical methods and applications, aqueous systems; Interfaces-energy, shape, segregation at external and internal interfaces; solid electrolytes; Effect of high pressure on phase transformations.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

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

1. Understand thermodynamic principles of solidification
2. Attain knowledge on nucleation, growth, single phase and multi-phase solidification
3. Know about various thermodynamic concepts related to heterogeneous systems
4. Understand how phase diagrams evolved
5. Understand important principles of interfaces

Text Books:

1. Solidification Processing; Fleming, M.C., McGraw-Hill, N.Y., 1974

References:

1. Fundamentals of Solidification by Kurz, W. and Fisher, D.J., Trans-Tech Pub, Switzerland, 1989

IV Year I Semester	NANO MATERIALS (Professional Elective–V)	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand importance of nano materials and applications of various nano materials
2. To know about the different synthesis processes used for getting nano materials
3. To understand the mechanical behaviour of nano materials under various conditions
4. To know about the electrical and optical phenomena of nano materials
5. To know about the various characterization techniques used for seeing nano materials

UNIT-I: General Introduction1-D ,2-D, 3-D nano structured materials, applications of Nano materials Synthesis of Nano materials-Top-down approach and Bottom-Up approach,
UNIT-II: Nano particle synthesis by Chemical Methods and Mechanical Methods
UNIT-III: Mechanical Behaviour, Anamolis Deformation behavior of nano sturctutred materials ,Room temperature creep
UNIT-IV: Electronic Properties: Free electron theory of metals, Band theory of solids, Bloch theorem, Kroning-Penne model, Metals and Insulators,
Optical Properties: Optical properties, special properties and the coloured glasses
UNIT-V: Structural characterization: Electron microscopy, scanning probe microscopy for nano science and technology, X-ray diffraction.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able to:
1. Gain an overview of future technological advancements and increasing role of nanotechnology
2. Understand synthesis route according to the requirements of the end product.
3. Understand mechanical behaviour of nano structured materials
4. Understand about electrical and optical properties of nano materials and their usage
5. Understand how to see nano particles using microscopy techniques

Text Books

1. Textbook of nanoscience and nanotechnology, B.S. Murty et al. Universities Press 2012
2. Nano: The essentials- T.Pradeep, Tata McGraw Hill Publishers, 2007

References:

1. Introduction to nanotechnology, Charles P. Poole, Wiley publishers, 2003

IV Year I Semester	SURFACE ENGINEERING (Professional Elective–V)	L	T	P	C
		3	0	0	3

Course objective:

1. To explore different surface electrochemical reactions
2. To learn different electrochemical coating methods
3. To understand different physical coating methods
4. To understand different thermal spray coatings and various surface laser techniques
5. To understand various surface degradation phenomena

UNIT–I: Chemical and electrochemical polishing, significance, specific examples, chemical conversion coatings, phosphating, chromating, chemical colouring, anodizing of aluminium alloys, thermochemical processes -industrial practices

UNIT–II: Surface pre-treatment, deposition of copper, zinc, nickel and chromium-principles and practices, alloy plating, electro composite plating, properties of electrodeposits, electroless, electroless composite plating; application areas, properties.

UNIT–III: Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities, chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD.

UNIT–IV: Thermal spraying, techniques, advanced spraying techniques- plasma surfacing, detonation gun and high velocity oxy-fuel processes, laser surface alloying, laser cladding, specific industrial applications, tests for assessment of wear and corrosion

UNIT–V: Introduction to tribology, types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

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

1. Learn about the practice of chemical and electro polishings ,coatings and their industrial applications
2. Understand Electro deposition of metals and alloys of Cu, Zn, Ni, Cr, etc., with knowledge on prior surface pre-treatment
3. Understand Concepts behind PVD, CVD and their various types with suitable industrial illustrations.
4. Learn about Principles and practice of various thermal spray and LASER techniques
5. Understand Surface degradation through various types of wear and corrosion

Text Books:

1. 'Surface modification technologies - An Engineer's guide' Sudarshan T.S., Marcel Dekker, Newyork, 1989
2. Varghese C.D, 'Electroplating and Other Surface Treatments- A Practical Guide', TMH,1993
3. Surface engineering by D SRINIVASA RAO AND S.V.JOSHI

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IV Year I Semester	SUPERALLOYS (Professional Elective–V)	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know about superalloys
2. To learn about physical metallurgy of supereralloys
3. To learn about microstructure/defect - property relationships in superalloys
4. To learn about processing of superallous
5. To learn about casting methods of superalloys

UNIT–I: Introduction: Introduction to super alloys, Guide to selection of super alloys, Wrought super alloys, Heat Resistant castings.
UNIT–II: Microstructure of wrought Heat-Resisting Alloys, Microstructure of Ni-base & Co-base heat-resistant casting alloys. Temperature and Time-dependent Transformation. Application to Heat Treatment of High Temperature Alloys.
UNIT–III: Relationship of properties to Microstructure in super alloys. Fracture properties of super alloys. High temperature corrosion and use of castings for protection.
UNIT–IV: Wrought super alloys. Process and Metallurgical factors affecting on superalloys and other high temperature materials.
Melting of Super alloys: Principles and practices of vacuum Induction Melting and Vacuum Arc melting.
UNIT-V: Casting methods - Improving turbine blade performance by solidification control-The development of single crystal turbine blades, Forming and Fabrication of super alloys: Recent developments in Powder metallurgy of super alloys- Production of components, additive manufacturing.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be :
1. Understand various types of superalloys
2. Understand physical metallurgy of superalloys
3. Understand corrosion and fracture properties of superalloys
4. Knowing the processing of superalloys
5. Understanding the various methods of superalloys production

Text Books:

1. Super alloys: Source book: Mathew J. Donachie. Jr. editor : 1984.
2. The super alloys: edited by Chester T. Sins and William C Haagel: 1972.

References:

1. Campbell IE High temperature MATERIALS, John wiley and sons Inc.;1956

IV Year I Semester	CERAMIC SCIENCE AND TECHNOLOGY (Open Elective–V)	L	T	P	C
		3	0	0	3

Course objectives:

1. To know the structure and properties of ceramic materials
2. To know phase diagrams and comprehend the phase transformations in ceramic materials
3. To know about various processing techniques used for making ceramic materials
4. To Learn about various ceramic processing methods
5. To Understand and design the electrical, magnetic and optical properties of ceramic systems

UNIT–I: Introduction and Crystal structures: Definition, Classification of Ceramics, Traditional Ceramics, Structural Ceramics, Crystal structures in Ceramics, Grouping of ions and Pouling's rules, Oxide structures, Silicate structures, Glass formation, Models of glass structure, Types of glasses, defects in ceramics

UNIT–II: Equilibrium Diagrams of ceramic systems: Two component systems like Al2O3 – SiO2 and BaO – TiO2 and Three component systems MgO – Al2O3 – SiO2

UNIT–III: Powder Preparation Techniques: Sol-gel technology – Precipitation, Co-precipitation and Hydrothermal precipitation techniques. Preparation of Al2O3, ZrO2, SiC, Si3N4, BN & B4C.

UNIT–IV: Ceramic Processing Techniques: Injection moulding, Slip casting, Tape casting, Gel casting, Extrusion Sintering, Hot Pressing, Hot Isostatic Pressing, (HIP), Spark Plasma Sintering, Microwave sintering.

UNIT–V: Microstructure, mechanical, Thermal, electrical, optical, magnetic, and chemical properties of ceramic materials

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

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

1. Know the structure and properties of different ceramic materials
2. Understand the phase diagrams and comprehend the phase transformations in ceramic materials
3. Understand the powder techiques for making ceramics
4. Learn about concept of sinteing and other ceramic producing methods .
5. Understand and design the electrical, magnetic and optical properties of ceramic systems

Text Books:

1. Introduction to Ceramics, W.D. Kingery et al, John Wiley
2. Callister's Materials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015

References:

1. FINCER proceedings of workshop on fine ceramics synthesis, properties and applications, T.R. Rammohan et al.
2. Hand Book of Fibre, reinforced composite materials, Ed. Lubin.
3. Fundamentals of Ceramics, M W Barsoum
4. Ceramics, Mechanical Properties, Failure Behaviour, Material Selection, D. Munz& T.Fett
5. Ceramic Science and Technology, Vol. 2 Material Selection and Properties Ed., Ralf Riedel and I, Wei Chen, Wiely, VCH

IV Year I Semester	ENERGY MATERIALS (Open Elective–V)	L	T	P	C
		3	0	0	3

Course objectives:

1. To learn the solar cells phenomenon, different photovoltaic materials
2. To learn the concept the concept of fuel cell technology, materials usage of materials in batteries
3. To understand usage of materials in energy harvesting
4. To understand usage of materials in energy storage
5. To know about the different synthesis processes used for making energy materials

UNIT–I: Solar cell materials: single and polycrystalline Silicon, amorphous silicon, CdSe, CdTe, Copper Indium Gallium Selenide (CIGS), Gallium Arsenide for applications in photovoltaic's, Quantum Dots

UNIT–II: Basics of electrochemical energy devices: mechanism and materials for different types of batteries, concept of fuel cell technology, super capacitors and hybrid fuel cells (PEM fuel cell, Acid/alkaline (fuel cells.)

UNIT–III: Materials for energy harvesting: Piezoelectric, Pyroelectric and Thermo-electrics materials, Electrostatic (capacitive) Energy Harvesting materials, electro active polymers (EAPs), energy harvesting using Magnetic Induction.

UNIT–IV: Different types of energy storage and conversion devices: Solar energy conversion devices, Wind& Mechanical Energy storages, Sensible Heat Storage Materials. failure modes and environmental impact of energy materials

UNIT–V: Materials Synthesis Methods - Physical Methods: Vacuum Evaporation, Sputtering, Cathodic Arc Deposition, Chemical Vapour Deposition, Lithography

Chemical Methods: Sol-Gel technique, self-assembly, colloidal method, hydro-thermal method, Co-precipitation method, solid state synthesis, micro-emulsion method.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able

1. Learn about various smart materials
2. Learn the properties of Magnetostrictive materials
3. Learn about advance polymer materials usage as In smart devices
4. Understand shape memory alloy effect
5. Understand smart sensor systems and energy materials

Text Books:

1. Advanced Energy Materials, Ashutosh Tiwari & Sergiy Valyukh, J. Wiley & Sons
2. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press.

References:

1. Materials Science in Energy Technology 1st Edition by G Libowitz.
2. Energy Storage & Conversion: Materials & Devices by A. Kumar, S. K. Das.

IV Year I Semester	Nuclear Materials (Open Elective– V)	L	T	P	C
		3	0	0	3

Course objectives:

1. To learn about the fundamentals of nuclear physics, Nuclear interaction and nuclear reactions
2. To learn about the various types of reactors and their construction and working principle
3. To understand about the various materials used in nuclear reactors and their production
4. To have the knowledge about Occurrence, general characteristics and the processing of nuclear materials
5. To understand the production of various nuclear fuel elements and power production in India

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 absorption cross-section; multiplication and criticality concepts and factors.
UNIT–II: Reactor components; Types of reactors; PWR, BWR, Graphite Moderator Reactor, Heavy water Reactor, Graphite moderator Reactor, Light Water moderator Reactor, Liquid metal coolant reactor. 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: Materials for nuclear reactors; Considerations in selection and properties of common materials used as fuels, their physical and chemical properties; canning materials; coolants; control rods; reflectors and shielding materials. Production of reactor materials.
UNIT–IV: Indian resources: 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 enriched uranium and fabrication of fuel elements. Irradiated fuel processing for recovery of Plutonium. Nuclear power production in India and its economics and safety measures.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able to:
1. Understand about nuclear Fission and fusion
2. Understand various reactor components and their applications
3. Analyze various materials that can be used as nuclear materials
4. Have an idea on the sources of nuclear materials
5. Learn about production nuclear power generation

Text Books:

1. Wright JC -Metallurgy in Nuclear Power Technology; Iliffe Book Ltd.,1962
2. Glasstone S and Snesonske A; Principles of Nuclear Reactor Engineering; Macmillan,London

References:

1. Wilkinson WD and Mrphy WF Nuclear Reactor Metallurgy Van Nostrand1958
2. Symposium on Rare materials; Indian Institute of Metals.
3. Gurinsky DH and Dienes JL Nulcear Fuels, Macmillan.
4. Proceedings of the symposium on Nuclear Science and Engineering – Bhabha Atomic Research Centre, Bombay.

IV Year I Semester	COMPOSITE MATERIALS LAB (Professional Core Lab)	L	T	P	C
		0	0	2	1

Course objective:

1. To become familiar with the fabrication techniques used to prepare the composite materials

2. To become familiar with the various methods used to evaluate the composite materials

List of Experiments:

1. Fabrication of metal matrix composites by liquid state process.
2. Fabrication of metal matrix composites by solid state process.
3. Fabrication of polymer matrix composites with natural fibers.
4. Fabrication of carbon fiber reinforced PMC.
5. Metallography of metal matrix composite materials
6. Hardness of various composite materials
7. Tensile strength of the various composite materials
8. Flexural Strength of various composite materials
9. Impact strength of various composite materials
10. Ageing Studies of PMCs

List of Equipment:

1. Auto clave
2. Sintering furnace with controlled atmosphere
3. Bottom pouring vacuum stir casting furnace
4. Laboratory pyrolysis unit
5. Impact strength tester
6. Universal Testing machine with tensile and flexural testing accessories
7. Brinell Hardness tester
8. Rockwell hardness tester
9. Metallurgical Microscope

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter-I:

1. Observation book,

2. Record.

3. Conduct of the experiment successfully

4. Interpretation of the data

5. Drawing the graphs where ever necessary

6. Viva-voce.

Parameter-II:

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

IV Year I Semester	POWDER METALLURGY LAB (Professional Core Lab)	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS:

1. Production of metal powders
2. Separation of particles using sieve analysis
3. Determination of flow rate of metal powders
4. Determination of apparent and tap densities
5. To Study Various Characteristics of copper Powders and Evaluate Green Density
6. To find Mechanical Characteristics of Cold-compacted and sintered compact
7. To study the behavior of metal powder during Conventional and Microwave Sintering of Particulate Compacts
8. To study the behavior of ceramic powder during Conventional and Microwave Sintering of Particulate Compacts
9. Hardness of the sintered product
10. Mechanical alloying using high energy ball mill
11. Study of microstructure of sintered compounds

LIST OF EQUIPMENTS

1. Hall flow meter
2. High Energy ball mill
3. Ball mill
4. Sintering furnace
5. Compaction press
6. Hot Isostatic Press

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter-I:

1. Observation book,
2. Record.
3. Conduct of the experiment successfully
4. Interpretation of the data
5. Drawing the graphs where ever necessary
6. Viva-voce.

Parameter-II:

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

IV Year I Semester	FINITE ELEMENT ANALYSIS TOOLS (Skill Enhancement Course)	L	T	P	C
		0	1	2	2

UNIT–I: Meaning of Finite Element Analysis, Introduction to nodes and elements, Need for meshing and different types of meshing, different software using FEM

UNIT–II: Getting to know the basics of ANSYS, Overview of different analysis systems available in ANSYS workbench, Overview of different component systems in ANSYS

UNIT–III: Introduction to engineering data, going through various material libraries provided by ANSYS, Understanding where and when to use particular materials, Creation of new material, Adding a material for analysis

UNIT–IV: Concept of Modeling, Study of stress analysis using ANSYS - Stress analysis of a rectangular plate with a circular hole, axi-symmetric problems. Study of Dynamic Analysis using ANSYS

UNIT–V: Study of Thermal Analysis using ANSYS: 2D problems with conduction and convection boundary conditions, Study of Fluid flow Analysis using ANSYS: Potential distribution in the 2D bodies

Reference Books:

1. ANSYS Workbench Tutorial Release 14, Structural and Thermal Analysis Using Ansys Mechanical APDL Release 14 Environment, Kent Lawrence, Schroff Development Corporation,
2. Practical Finite Element Analysis, Nitin S. Gokhale, Sanjay S. Despande, Dr. Anand N. Thite, Finite To Infinite, ISBN 978-81-906195-0-9
3. FINITE ELEMENT ANALYSIS USING ANSYS®, Srinivas Paleti, Sambana, Krishna Chaitanya, Datti, Rajesh Kumar, PHI Publication, ISBN: 978-81-203-4108-1

Web References:

1. www.ansys.com
2.www.mece.ualberta.ca/tutorials/ansys
3. http://mae.uta.edu/~lawrence/
4. http://expertfea.com/tutorials.html

IV Year I Semester	CONSTITUTION OF INDIA (Audit Course)	L	T	P	C
		2	0	0	2

Course Objectives:

- To Enable the student to understand the importance of constitution
- To understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
- To understand the central and state relation financial and administrative.

UNIT-I: Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT-II: Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions;

UNIT-III: State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

UNIT-IV: A.Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: 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 of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women

Course Outcomes:

At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- Understand historical background of the constitution making and its importance for building a democratic India.
- Understand the functioning of three wings of the government ie., executive, legislative and judiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and local self-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.

1. Know the sources, features and principles of Indian Constitution.
2. Learn about Union Government, State government and its administration.
3. Get acquainted with Local administration and Pachayati Raj.
4. Be aware of basic concepts and developments of Human Rights.
5. Gain knowledge on roles and functioning of Election Commission

References:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)

6. J.C. Johari, Indian Government andPolitics Hans
7. J. Raj IndianGovernment and Politics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details

IV Year I Semester	EVALUATION OF INDUSTRY INTERNSHIP	L	T	P	C
		-	-	-	2

IV Year II Semester	INTERNSHIP AND PROJECT WORK	L	T	P	C
		0	0	24	12

Subjects offered for Honors degree Program with Advanced Manufacturing Technology specialization

B.Tech Honors	ADVANCED MANUFACTURING TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:
1. To get knowledge on various advanced casting and joining techniques
2. To get knowledge on various advanced machining and forming techniques

UNIT-I: Advanced machining theory & practices - mechanisms of chip formation, shear angle relations, and theoretical determination of cutting forces in orthogonal cutting; analysis of turning, drilling, and milling operations; mechanics of grinding; dynamometry; thermal aspects of machining; tool wear; economics of machining; processing of polymers, ceramics, and composites.
UNIT-II: Advanced machining processes – Process principles, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes.
UNIT-III: Advanced Casting Processes: Metal mould casting, Continuous casting, Squeeze casting, vacuum mould casting, Evaporative pattern casting, ceramic shell casting.
UNIT-IV: Advanced Forming processes - electro-magnetic forming, explosive forming, electro-hydraulic forming, stretch forming, and contour roll forming.
UNIT-V: Advanced welding processes - EBW, LBW, USW; Advanced foundry processes - metal mould, continuous, squeeze, vacuum mould, evaporative pattern, and ceramic shell casting. Basics of Additive manufacturing
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:
1. The student will understand the principles of machining manufacture a particular component
2. The student will have the knowledge of manufacturing of a component with modern technology

Text books:
1. Materials and Processes in Manufacturing, E.P. DeGarmo, J. T Black, R.A.Kohser
2. Manufacturing Science, A. Ghosh, and A.K. Mallik,
3. Nontraditional Manufacturing Processes, G.F.Benedict, Marcel Dekker

Reference books:
1. ASM Hand book, Volume 15; Casting
2. ASM Hand book, Volume 6; Welding
3. ASM Hand book, Volume 16; Machining
4. ASM Hand book, Volume 14; Forming

B.Tech Honors	ADVANCED POWDER METALLURGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To build the necessary background 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 to particulate processing – advantages, limitations and applications of particulate processing
UNIT-II: Science of particulate processing – issues related to particle morphology – differences in mechanical behaviour (with respect to cast and wrought materials) and related mathematical treatment - similarities and differences between metal powder and ceramic powder processing
UNIT-III: Production and characterization of metal and ceramic powders – compaction processes – powder properties and powder compaction – Pressing, Hot Iso-static Processing and extrusion
UNIT-IV: Sintering – thermodynamic and process aspects – recent developments in mechanical alloying and reaction milling
UNIT-V: Production of particulate composites - application of P/M based on case studies - manufacturing of typical products – near net shape processing
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

1. Classify powder preparation techniques.
2. Explain the characterization techniques of powders.
3. Describe hot, cold and pressure-less powder compaction and sintering techniques of powder compacts.
4. To understand sintering zones and gain knowledge about sintering atmospheres.

Text books:

1. German R.M., 'Powder Metallurgy Science', Metal Powder Industries Federation, New Jersey, 1994
2. A.K.Sinha, Powder Metallurgy.

References:

1. Kuhn H. A. and Alan Lawley, 'Powder Metallurgy Processing - New Techniques and Analysis', Oxford IBH, Delhi, 1978.
2. P.C. Angelo, R.Subramanyam, Powder Metallurgy,

B.Tech Honors	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques.

2. To familiarize students with different processes in rapid prototyping systems.

3. To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.

UNIT-I: Introduction to Additive Manufacturing, AM evolution, Distinction between AM & CNC machining, advantages of AM.

UNIT-II : AM process chain, Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, machine setup, build , removal and clean up, post processing

UNIT-III: Classification of AM processes, Liquid polymer system, discrete particle system, molten material systems, and solid sheet system.

UNIT-IV: Design for AM, Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of supports, hollowing out parts, Inclusion of undercuts and other manufacturing constraining features, interlocking features.

UNIT-V: Application examples for aerospace, defense, automobile, Bio-medical and general engineering industries

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

1. Demonstrate the knowledge of Additive Manufacturing and Rapid Prototyping technologies.

2. Describe different RP techniques.

3. Discuss fundamentals of Reverse Engineering.

Text books:

1. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003.

2. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010

References:

1. Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory & Practice", Springer, 2006.

2. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001

B.Tech Honors	ADVANCES IN METAL CASTING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce and explain various moulding, casting techniques and equipment used.

2. to learn about the principles of Solidification of casting, defects in castings and their remedies are also dealt in detail.

3. To learn about different types of pattern materials using for casting.

UNIT-I: Introduction to special casting techniques-Shell moulding machines - pattern equipments - sands, resins and other materials used in shell moulding - closing of shells - dimensional tolerances -applications of shell moulding - comparison of shell moulding with other competitive methods.

UNIT-II: Types of centrifugal casting processes - calculation of mould rotary speeds - techniques and equipments used in production processes - advantages and limitations of centrifugal casting methods.

UNIT-III: Introduction - Pattern and mould materials used in investment casting - technique and production of investment moulds and castings - dimensional tolerances - applications of investment casting process - Shaw process - comparison with other processes - full mould process.

UNIT-IV: Die casting machines - operation details - die materials - materials cast by die casting method. Die design - comparison with other processes. low pressure die casting. Metal Injection Moulding.

UNIT-V: Fluid sand process - V Process - Rheo, thixo and compo casting processes - squeeze casting, Magnetic moulding, Hot box process, cold box process. No-bake processes, Graphite moulding process, Plaster moulding process-High Pressure moulding and continuous casting

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

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

1. The casting technology.
2. Solidification of metals and alloys and knowledge about nucleation and growth.
3. Advantage and limitations of conventional manufacturing techniques.
4. Designing pattern techniques for different material with suitable materials
5. Advanced techniques in casting

Text Books:

1. Beeley, P.R., "Foundry Technology",2nd edition, Butterworths, Heinmann,oxford,2001..
2. Clegg, A.J.,"Precision Casting Processes", Pergamon Press,London,U.K,1991
3. Barton, H.K., "Die Casting Processes", Odhams Press Ltd,1985.
4. Dumond, T.C.,"ShellMoulding and Shell Moulded Castings", ReReinhold publishing corporation Inc.,1984

References:

1. Doehler,E.h., "Die casting", Mcgraw Hill Book Co,Newyork,1991
2. Heine, Loper and Rosenthal, "Principles of Metal Casting", Tata McGraw Hill Publishing Co,1995
3. "ASM Handbook", Vol. 15, Casting, ASM Publication, 1998.

B.Tech Honors	ADVANCED METAL JOINING TECHNIQUES	L	T	P	C
		3	0	0	3

Course objectives:

1. To understand different metal joining techniques and their applicability for various ferrous and non-ferrous metals.

2. To understand the principle and problems associated with the welding of various metals

UNIT–I: Radiant energy welding: Electron Beam Welding (EBW) - principle and theory-equipment and systems- process characteristics and variables- weld joint design- applications- EBW process variants. Laser Beam Welding-principle and theory-operation-types of lasers-process variables and characteristics-applications..

UNIT–II: Diffusion welding-principle and theory-methods- welding parameters-advantages and limitations - applications. Cold pressure welding-process, equipment and set-up-applications. Adhesive Bonding- principle and theory-types of adhesives-joint design-bonding methods applications.

UNIT–III: Explosive welding-principle and theory-process variables-equipment-joint design-advantages and limitations-applications. Friction welding-principle and theory-process variables advantages and limitations-applications. Friction stir welding- metal flow phenomena-tools process variables – applications.

UNIT–IV: Ultrasonic welding-principle and theory-process variables and equipment-types of ultrasonic welds- advantages and limitations-applications. Brazing- principle- brazing processes-torch brazing- furnace brazing- vacuum brazing-induction brazing-advantages and limitations applications.

UNIT–V: Plasma arc welding –principle and theory- transferred arc and non-transferred arc techniques equipment-advantages and limitations-applications. Magnetically impelled arc butt (MIAB) welding- principle of operation-applications. Under water welding-wet and dry under water welding- set-up for underwater welding systems.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

1. The student will understand the basic theoretical knowledge of welding of ferrous metals and non-ferrous metals.

2. The student will have the knowledge about different welding processes and heat affected zone and its analysis.

3. The student will understand the quality control tests conducted on welded joints.

Text books:

1. Parmar R.S., Welding Processes and Technology, Khanna Publishers, Delhi, 1998.

References:

1. ASM Metals Handbook "Welding and Brazing", Vol.6, ASM, Ohio, 1988
2. Rossi, B.E., Welding Engineering, Mc Graw-Hill, 1954
3. Schwartz M.M., "Metal Joining Manual", McGraw-Hill Inc., 1979
4. Udin et al., Welding for Engineers, John Wiley & Sons, New York, 1967
5. Welding Engineers Handbook – ASHE Vol. I, II, III, IV

B.Tech Honors	ADVANCED POWDER METALLURGY LAB	L	T	P	C
		0	0	3	1.5

Course objectives*:*

1. To know about the production of powders and their testing

2. To know about the evaluation of mechanical properties of green compacts and sintered products

List of Experiments:

1. Synthesis of Nano powders by high energy ball milling
2. Determination of Flowability and compressibility of powders
3. Determination of specific surface area of powder particles
4. Determination of powder particle and its distribution
5. Determination of flexural strength of the green powder compacts by three point test
6. Consolidation of powder particles by Cold isostatic pressing
7. Consolidation of powder particles by Hot isostatic pressing
8. Determination of mechanical properties of sintered products

Equipment required:

1. High energy ball mill
2. Hall flow meter
3. B.E.T apparatus
4. Sieve analyzer for micro powder particles
5. Three point attachment for UTM
6. CIP setup
7. HIP setup
8. Sintering furnace with provision to control the atmosphere

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter- I:

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

Parameter-II:

1. *At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)*

B.Tech Honors	ADDITIVE MANUFACTURING LAB	L	T	P	C
		0	0	3	1.5

Course objectives:

1. *To know the principal methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies*
2. *To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.*

List of Experiments:

1. Designing and manufacturing a mechanical component using FDM 3D printing
2. Analysis and optimization of key printing parameters, including layer height, print speed, temperature, and infill patterns.
3. Assessment of various material options such as PLA, ABS, PETG, and others for 3D printing applications.
4. Evaluation the mechanical properties by conducting tensile, compression, and impact testing on 3D-printed samples.
5. Analyzing the effect of various materials and printing parameters on the mechanical behavior of 3D-printed samples.
6. Investigation of the prevalent defects, including warping, layer separation, and surface roughness in 3D printed parts.
7. Assessment of the effect of different post-processing methods, including sanding, painting, vapor smoothing, and annealing for 3D-printed parts.

List of equipment:

1. 3D printing machine
2. Hounsefield tensometer
3. Impact testing machine
4. Sintering Furnace

Course Outcomes:

1. *Will have the knowledge about the different methods and discuss the effects of the Additive Manufacturing technologies*
2. *Will analyze the characteristics of the different materials in Additive Manufacturing*
3. *Will have the knowledge about the selection of the appropriate techniques according to the applications*

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter- I:

7. *observation book,*
8. *Record.*
9. *Conduct of the experiment successfully*
10. *Interpretation of the data*
11. *Drawing the graphs where ever necessary*
12. *Viva-voce.*

Parameter-II:

2. *At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)*

Subjects offered for Honors degree Program with Nano Technology specialization

B.Tech Honors	SYNTHESIS OF NANOMATERIALS AND PROPERTIES	L	T	P	C
		3	0	0	3

Course objectives:

1. *To make students know about physical, chemical and biological methods of synthesis of nano materials*

2. To make students know about the evaluation of distinct properties like electronic, magnetic, and optical properties of nanostructures.

UNIT-I: Introduction to synthesis of nanostructure materials, Bottom-up approach and Top-down approach with examples, Stabilization techniques – Electrostatic and Steric stabilizations. Physical methods: Inert gas condensation, Arc discharge, RF-plasma, plasma arc technique, electric explosion of wires, ball milling, Chemical methods: Chemical Kinetics, Gibbs Free Energy-Thermodynamics. Thermolysis route - spray pyrolysis and solvated metal atom dispersion, sol-gel method, solvothermal and hydrothermal routes, solution combustion synthesis, Chemical vapor synthesis; Introduction to Plasma technique of Synthesis of Nanomaterials in bulk.

UNIT-II: Nanocrystals by chemical reduction, photochemical synthesis, electrochemical synthesis; Nanocrystals of semiconductors and other materials by arrested precipitation, emulsion synthesis, sonochemical routes and mild solution methods, Biological methods: Use of bacteria, fungi, actinomycetes for nano-particle synthesis – magneto-tactic bacteria for natural synthesis of magnetic nano-particle.

UNIT-III: Energy bands and gaps in semiconductors, Fermi surfaces ,localized particle, donors, acceptors, deep traps, excitons, mobility, size dependent effects, conduction electrons and dimensionality Fermi gas and density of states, semiconducting nanoparticles. Optical properties: Photonic crystals, optical properties of semiconductors, band edge energy, band gap, dependence on nanocrystalline size, Quantum dots, optical transitions, absorptions, interband transitions, quantum confinements.

Unit–IV: Fluorescence, Phosphorescence, optically excited emission, electroluminescence, Laser emission of quantum dot, Photo fragmentation and columbic explosion, phonons in nanostructures, luminescent quantum dots for biological labeling.

Unit–V: Introduction of magnetic materials, basics of ferromagnetism – ferro magnetic resonance and relaxation, magnetic properties of bulk nanostructures, magnetic clusters, dynamics of nanomagnets, nanopore containment of magnetic particles, nanocarbon ferromagnets, ferrofluids, electron transport in magnetic multilayers.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

1. To develop knowledge about the electronic properties of semiconductor devices.

2. To construct the magnetic properties of bulk Nano structured materials.

3. To visualize the effect of optical properties of various materials

4. Students can able to acquire knowledge based on the physical, chemical and biological methods of synthesis of nanomaterials

Textbooks:

1. Inorganic Materials Synthesis and Fabrication by J.N. Lalena, D.A. Cleary, E.E. Carpenter, N.F. Dean, John Wiley & Sons Inc.

2. Introduction to Nano Technology by Charles P. Poole Jr and Frank J. Owens. Wiley India Pvt Ltd.
3. The Chemistry of nanomaterials: Synthesis, Properties and Applications, Vol-I by C.N.R. Rao, A. Muller and A.K. Cheetham

Reference books:

1. Encyclopedia of Nanotechnology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X, Campus books.
2. Encyclopedia of Nanotechnology by H.S. Nalwa
3. Nano: The Essentials – Understanding Nano Scinece and Nanotechnology – by T.Pradeep; Tata Mc.Graw Hill

B.Tech Honors	NANOMATERIALS CHARACTERIZATION	L	T	P	C
		3	0	0	3

Course objectives:

1. To familiarize students with Compositional, Structural, Morphological and Spectroscopic Characterization techniques

2. To familiarize students with Electrical, Thermal and Magnetic Characterization techniques of materials at the nanoscale

3. To have the knowledge on the interpretation of results including standards etc.

UNIT-I: Compositional Analysis**:** X-ray Photoelectron spectroscopy (XPS), Energy Dispersive X-ray Analysis (EDX), Inductively Coupled Plasma Optical Emission Spectroscopy (ICPOES), Inert Gas Fusion for Oxygen analysis, Electron Probe Micro Analysis (EPMA).
Structural Analysis: X-ray Diffraction (XRD), Electron Diffraction, Ion Beam Techniques – SIMS and RBS.

UNIT–II: Surface characterization Techniques- High resolution microscopy; Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), scanning tunnelling microscopy (STM), Surface Area Measurements – Adsorption principle - Freundlich, Langmuir, and BET methods of measurement.

UNIT–III: Spectroscopic techniques: Fourier Transform infrared (FTIR) spectroscopy, Raman spectroscopy techniques: micro Raman and laser Raman.

UNIT–IV: Electrical characterization techniques: Measurement of resistivity by 4-probe method, Hall measurement, Seebeck coefficient measurements, Nano indentation techniques, electron beam induced current measurement (EBIC).

UNIT-V: Thermal and Magnetic characterization: VSM, Thermal analysis, impedance and ferroelectric measurements

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

1. To evaluate the spectroscopic characterization techniques of nano materials.

2. To compare various compositional and structural characterization techniques.

3. To infer the importance of advanced characterization techniques.

4. Student can able to develop knowledge about various electrical and magnetic characterization techniques.

5. Gain overall knowledge of various thermal and magnetic characterization techniques.

Text Books:

1. Characterization of Nanostructured Materials by Z L Wang
2. Principles of Instrumental Analysis by D A Skoog, F J Hollen and T A Niemann
3. A Practical Approach to X-Ray Diffraction Analysis by C Suryanarayana

Reference Books:

1. Specimen Preparation for Transmission Electron microscopy by John &Bravmno et al, published by MRS
2. Photoelectron spectroscopy by JHD Eland, Butterworth & Co. Publishers, 2nd edition
3. Encyclopaedia of Nanoscience and Nanotechnology by H S Nalwa
4. Electron Microscopy and Analysis by P J Goodhew and F J Humpreys
5. Scanning Electron Microscopy and X- ray Microanalysis by J I Goldstein
6. Modern Raman Spectroscopy: A Practical Approach by E Smith and G Dent.

B.Tech Honors	THIN FILM SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know about the importance of thin film technology and nanofabrication, vacuum technology,
2. To know about the various physical and chemical methods of thin film fabrication
3. To know about the various applications of thin films including sensors.

UNIT–I: Vacuum technology: Clean Room – Clean room technology and its Classes.
Principles of vacuum pumps in range of 10 -2 torr to 10-11 torr, principle of different vacuum pumps: roots pump, rotary, oil diffusion pump, turbo molecular pump, cryogenic-pump, ion pump, Ti-sublimation pump, importance of measurement of vacuum, Concept of different gauges: Bayet-Albert gauge, Pirani, Penning and pressure control.
UNIT–II: Conditions for the formation of thin films: Environment for thin film deposition, deposition parameters and their effects on film growth, formation of thin films (sticking coefficient, formation of thermodynamically stable cluster – theory of nucleation), capillarity
theory, microstructure in thin films, adhesion, properties of thin films: Mechanical, electrical, and optical properties of thin films, few applications of thin films in various fields; Thermomechanical behaviour of thin film nanostructures.
UNIT-III: Physical Vapor Deposition techniques: Thermal evaporation, resistive evaporation, Electron beam evaporation, Laser ablation, Flash and Cathodic arc deposition.
UNIT–IV: Electrical discharges used in thin film deposition: Sputtering, Glow discharge sputtering, Magnetron sputtering, Ion beam sputtering, R.F sputtering, Triode sputtering, Ion Plating, Difference between thin films and coating.
UNIT–V: Electro deposition, molecular beam epitaxy and laser pyrolysis. Chemical vapor deposition techniques: Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, boundaries and flow, Different kinds of CVD techniques: Metal Organic CVD (MOCVD), Thermally activated CVD, CVD, Spray pyrolysis, etc.
*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

1. To develop deep understanding on Vacuum Technology.
2. To compile all the Conditions for formation of thin films
3. To know the importance of Physical Vapor Deposition techniques.
4. To prioritize the role of Electrical discharges used in Thin Film Deposition
5. To improve the understanding of deposition using CVD.

Text Books

1. Thin Film Phenomenon by K.L. Chopra, McGraw-Hill

References

1. Methods of Experimental Physics (Vol 14) by G.L.Weissler and R.W.Carlson "Vacuum Physics and Technology"
2. A User's Guide to vacuum Technology by J.F.O'Hanlon, John Wiley and Sons
3. Vacuum Physics and Techniques by T.A. Delchar, Chapman and Hall
4. Evaporation: Nucleation and Growth Kinetics" by J.P. Hirth and G.M.Pound, Pergamon Press

B.Tech Honors	CARBON NANOSTRUCTURES AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To familiarize students with different carbon nanostructures
2. To know about the synthesis of different carbon nanostructures
3. To know about the different carbon nanostructures and their applications.

UNIT–I: Allotropy of Carbon, Carbon Nanostructures - Carbon clusters Fullerenes and types of Carbon Nano tubes, growth mechanisms, Mechanical reinforcements, Solid Disordered carbon Nanostructures, Nano structured crystals; Graphene, Carbon nanofibers; Electrical, Vibrational, Mechanical Properties of CNTs, Optical properties & Raman spectroscopy of CNTs

UNIT–II: Synthesis of CNTs by Flame, CVD, Laser & Arc-discharge process; Lithium & Hydrogen adsorption & storages, Fuel cell applications and energy storage, Chemical Sensors applications of CNTs, Computer applications (Nano chip), Optical and telecommunication applications, CNT Nano composites, Silicon Nanowires.

UNIT-III: Graphene - Fundamentals of Graphene, Synthesis – Different routes, Exfoliation method, Industrial applications

UNIT-IV: Graphene oxide – Synthesis, Properties and Applications.

UNIT-V: Graphene like Structures – Borophene, Pure Metal Single layers – Properties and Applications

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

1. Students can develop understanding of carbon clusters, fullerenes and carbon nanotubes
2. Students understand synthesis methods of carbon nanotubes, and their applications
3. Students can develop knowledge about graphene and graphene like nanostructures.

Text Books:

1. Introduction to Nanotechnology by Charles P. Poole Jr and Frank J.Owens Wiley India Pvt Ltd.
2. Nanotechnology and Nano Electronics – Materials, devices and measurement techniques by WR Fahrner, Springer publications

Reference Books:

1. Encyclopedia of Nanotechnology by M.Balakrishnarao and K.Krishna Reddy, Vol I to X Campus books.
2. Encyclopedia of Nanotechnology by HS Nalwa
3. Nanotechnology – Science, innovation and opportunity by Lynn E.Foster. Prentice Hall Pearson education.
4. Nano: The Essentials – Understanding Nano Science and Nanotechnology by T.Pradeep; Tata Mc.GrawHill

B.Tech Honors	NANOTECHNOLOGY FOR ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know about the various energy forms, alternate and renewable energy system using nanotechnology.

2. To understand the importance of nanomaterials for the storage of energy

Unit–I: Battery materials and batteries: Lithium Ion based batteries. Renewable energy Technology: Energy challenges, nanomaterials and nanostructures in energy harvesting, developments and implementation of nanotechnology based renewable energy technologies, solar cell structures: quantum well and quantum dot solar cells, photo- thermal cells for solar energy harvesting, Thin film solar cells, CIGS solar cells, Die sensitized solar cells.

Unit-II: Nano materials used in energy and environmental applications and their properties: Evaluation of properties and performance of practical power systems that benefit from optimization of materials processing approaches.

Unit–III: Hydrogen storage Technology: Hydrogen production methods, purification, hydrogen storage methods and materials: metal hydrides and metal-organic framework materials, volumetric and gravimetric storage capacities, hydriding and dehydriding kinetics, high enthalpy formations and thermal management during hydriding reaction, multiple catalytic – degradation of sorption properties, automotive applications.

Unit–IV: Fuel cell Technology: Fuel cell Principles, types of fuel cells (Alkaline Electrolyte, Phosphoric acid, Molten Carbonate, solid oxide and direct methanol and Proton exchange fuel cells), Principle and operation of Proton Exchange Membrane (PEM) fuel cell, Materials and fabrication methods for fuel cell technology, micro fuel cell power sources – Biofuels.

Unit–V: Microfluidic Technology: MEMS & NEMS technology for microfluidic devices: micro and nano engines and driving mechanism, power generation, microchannel battery pump (TCP), piezoelectric membrane and their applications.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Study the basic Energy need and role of Battery materials

2. To grade up knowledge of Super Capacitors, and its Applications.

3. Study the role of nanostructured material to meet Energy Challenges.

4. Learn about the concept of Hydrogen Storage Technology.

5. Gain knowledge on role of Fuel Cell Technology and Microfluidic Technology.

Text Book:

1. Renewable Energy Resources by J. Twidell and T.Weir, E&FN Spon Ltd.

References:

1. Hydrogen from Renewable Energy Source by D.Infield

2. .Fundamentals of Industrial Catalytic Process by C.H. Bartholomew and Robert J. Farraoto, John Wiley & Sons Inc.

3. Fuel storage on Board Hydrogen storage in Carbon Nanostructures by R.A. Shatwell

4. Fuel cell Technology Handbook by Hoogers, CRC Press

5. Hand book of fuel cells: Fuel cell technology and applications by Vielstich, Wiley:CRC Press

B.Tech Honors	NANO COMPOSITES AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know about the nano composites, reinforcing nanostructures dispersed in various matrix materials like polymers, ceramics, metals, etc,.
2. To know about the synthesis methods of nanocomposites
3. To know about modeling and evaluation of nanocomposites.

Unit–I: Introduction to Nanocomposites, Composite material, Mechanical properties of Nano composite material: stress - strain relationship, toughness, strength, plasticity.

Unit–II: Ceramic-Metal Nanocomposites, Ceramic based nanoporous composite, Metal matrix nanocomposites, Polymer-based nanocomposites Carbon nanotube based nanocomposites and Natural nanobiocomposites, Biomimetic nanocomposites and Biologically inspired nanocomposites; Applications to Strategic Sector (Aerospace, Defense - CNT based structures - CNT based Nose cones for reentry vehicles), Armour protection (Polymer-Tungsten, Polymer-CNT Nanocomposites)

Unit–III: Synthesis methods for various nanocomposite materials: mechanical alloying, thermal spray synthesis etc. Nano composites for hard coatings; DLC coatings; Thin film nanocomposites; Modeling of nanocomposites.

Unit–IV: Nano Indentation, Types of indentation: Oliver & Pharr, Joslin-Oliver, Vickers Indentation process.

Unit–V: Processing of polymer nanocomposites, properties of nanocomposites, Salt infiltration, Powder mixing, Intrusion method, Exfoliation & interaction, Gel-casting impregnation techniques: Hot melt impregnation, solution impregnation.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course outcomes:

1. Student can able to discuss the basic concepts of Nano Composites.
2. Student can able to prioritize the role of Ceramic Metal Composites in Nano Technology.
3. To understand the role of Synthesis Methods for various Nano Composite materials.
4. Learn about the concepts of Indentations and types of Indentations.
5. Correlate the applications of Polymer Nano Composites and Impregnation Techniques.

Text Books:

1. Nanocomposite Science & Technology by P.M. Ajayan, L.S. Schadler and P.V. Braun, Wiley-VCH GmbH Co.
2. Thomas E. Twardowski, Introduction to Nanocomposite Materials, Properties, Processing, Characterization, DesTech Publications, April 2007

Reference Books:

1. Encyclopedia of Nanotechnology by H.S.Nalwa
2. Encyclopedia of Nano Technology by M.Balakrishnarao and K.Krishna Reddy, Vol I to X
3. Introduction to Nano Technology by Charles. P.Poole Jr and Frank J. Owens; Wiley India Pvt Ltd.
4. Nanotechnology, A gentle introduction to the next big idea by Mark Ratner, Daniel Ratner Pearson education.

B.Tech Honors	CHARACTERIZATION OF NANOMATERIALS LAB	L	T	P	C
		3	0	0	3

Course Objective:

1. The course is intended to cover basic characterization methods of nanomaterials

List of Experiments:

1. Nano Particle Size Analysis by Dynamic light scattering
2. Characterization of nanopowders using AFM, SEM, etc
3. Characterization of 1D, 2D and 3D structures using AFM, SEM, etc
4. Raman Spectroscopy of synthesized nanomaterials using BWTEK Raman Spectrophotometer 5. Determination of average Crystallite size and microstrain by X-Ray diffraction analysis
6. Determination of energy band gap by using UV – Visible spectroscopy
7. Study of thermal properties by using Differential Scanning Calorimetry
8. Study of thermal properties by TG/DTA Analysis.

Course outcomes:

1. Gain knowledge on the Dynamic Light Scattering, AFM, SEM, Raman Spectroscopy and Differential Scanning Calorimetry

2. To construct a theoretical knowledge on the experiments.

3. To analyze results of X-Ray diffraction, UV-Visible Spectroscopy and TG/DTA apparatus

4. The ability to write and present the laboratory reports.

5. To maximize knowledge regarding Characterization of nanomaterials.

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter- I:

1. Observation book,
2. Record.
3. Conduct of the experiment successfully
4. Interpretation of the data
5. Drawing the graphs where ever necessary
6. Viva-voce.

Parameter-II:

1. *At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)*

B.Tech Honors	SYNTHESIS OF NANOMATERIALS LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. The course is intended to cover basic preparation methods of nano materials

List of Experiments:

1. Two methods for the synthesis of CNTs (CVD method and Flame Synthesis)
2. Nano – Catalyst Preparation by Chemical methods.
3. Synthesis of oxide Nanostructures / nano composites by Sol-gel Process
4. Preparation of any two types of Ceramic Powders, $BaTiO_3$ (ball milling) & Al_2O_3 (flame) – Composite preparation using Ball Milling
5. Synthesis of NiO nanoparticles using Urea as fuel by Solution Combustion method.
6. Synthesis of Silica gel (SiO_2) using Sol – gel method
7. Synthesis of Silver (Ag) nanoparticles using green synthesis
8. Fabrication of thin film by Spin Coating
9. Fabrication of thin film by Spray Pyrolysis
10. Fabrication of thin film by PVD

Course outcomes:

1. Gain knowledge on the physical, chemical and biological synthesis techniques involved in experiments.

2. To fabricate thin films using spin coating and spray pyrolysis equipments

3. To construct a theoretical knowledge on the experiments.

4. The ability to write and present the laboratory reports.

5. To maximize knowledge regarding synthesis of nano materials.

*(***Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter- I:

1. Observation book,

2. Record.

3. Conduct of the experiment successfully

4. Interpretation of the data

5. Drawing the graphs where ever necessary

6. Viva-voce.

Parameter- II:

1. At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

Subjects offered for Minors degree Program

B.Tech Minors	INTRODUCTION TO MATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

Course objective:

1. *To learn about the fundamentals of crystal structure, defects*
2. *To learn about the fundamentals of dislocations and their interaction*
3. *To learn about the optical, electrical and magnetic Properties of materials*
4. *To learn about the polymers*
5. *To learn about the Ceramic materials*

UNIT-I: Introduction to materials engineering - classification of materials**,** Space lattice and unit cells, Crystal systems: Indices for planes and directions. Structure of common metallic materials.

UNIT–II: Crystal defects - Point, Line and surface defects. Dislocations, types, Burger's Vector. Dislocation movement by slip, climb and cross slip. Dislocation sources.

Slip systems for BCC, FCC and HCP metals, Critical resolved shear stress (CRSS) for slip, Twinning, Stacking faults, Jogs, Kinks.

UNIT–III: Optical, Magnetic and Electronic properties of materials - Refractive index, absorption emission of light, optical fibers. Opto-electronic materials. Dia, para, ferro, ferri magnetism. Soft and hard magnetic materials and applications. Electronic conductivity, free electron theory and band theory of solids. Intrinsic semi-conductors. Super conductivity.

UNIT–IV: Polymers - Functional polymers and structural polymers.Properties and applications.

UNIT–V: Ceramic Materials **-** Introduction to ceramics, structural ceramics and functional ceramics –properties and applications.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to understand crystal systems and crystal defects
2. Able to understand dislocation mechanisms
3. Able to understand optical, electronics and magnetic nature of materials
4. Able to understand the polymers
5. Able to understand the ceramic materials

Text books:

1. "Callister's Materials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015".
2. Material science by Ashby
3. Material Science and Engineering by V.Raghavan
4. Physical Metallurgy by S. H. Avner.

Reference books:

1. Material Science and Engineering by L.H.VanVleck, 5th edition, Addision Wealey(1985)
2. Structure and properties of Materials by R.M.Rose, L.A.Shepard and J.Wulff, Vol.1,4 John Willey (1966) .
3. Essentials of Material Science by A.G.Guy, McGraw Hill(1976).
4. The Science and Engineering Materials by D.R.Askeland. 2nd Edition, Chapman and Hall
5. Physical Metallurgy, Vijendra Singh

B.Tech Minors	ENGINEERING MATERIALS	L	T	P	C
		3	0	0	3

Course objectives:

1. Know about the structural materials and they are used in engineering applications
2. Know the Magnetic materials properties and applications
3. Know the Electrical materials properties and applications
4. Know the Smart materials properties and applications
5. Know various types of Bio materials

UNIT-I: Metals & Alloys, Structural Polymers, Ceramics, Intermetallics, Bulk Metallic Glasses, Amorphous Materials

UNIT-II: Magnetic Materials - Ferri and Ferro magnetic materials; Soft Magnets; Hard Magnets; Fe-Si alloys; Fe-Ni Alloys; Ferrites and Garnets; Fine particle magnets; Giant magnets, resistance; Nanomagnetic materials.

UNIT-III: Electronic Materials - Semi-conducting materials – concept of doping; compound semi-conductors – amorphous silicon, oxide semiconductors; amorphous semiconductors; MOSFET and CMOS

UNIT-IV: Smart Materials - Shape memory alloys; rheological fluids, Piezoelectric materials

UNIT-V: Biomaterials - Biocompatibility; Ti-implants; Hydroxyapatite; Bioactivity; Biopolymers, Bioceramics

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able :

1. Learn all significant materials under one umbrella
2. Design an advanced system based on magnetism with the knowledge on Magnetic Materials
3. Design an advanced component by acquiring knowledge of Electronic Materials
4. Learn various fundamentals and concepts of various smart materials,
5. learn which materials can be used as bio materials and understand the concept of bio compactibilty and processing of biomaterials

Text books:

1. Callister's Materials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015".

References:

1. Material Science and Engineering – V. Raghavan
2. Park J.B. and Lakes R.S., Biomaterials: An Introduction
3. Mel Schwartz, " Encyclopedia of Smart Materials", Vol. I, John Wiley and Sons.

B.Tech Minors	MATERIALS TESTING	L	T	P	C
		3	0	0	3

Course objectives:

1. *The topic deals with various types of dislocations, slip and twinning*
2. *To understand the principles of various hardness tests and theories of fracture*
3. *To understand the principle of tensile test, compression Test etc*
4. *To know the fundamentals, failure and the factors affecting fatigue and creep.*
5. *To know the non-destructive testing methods and evaluation of flaws in materials*

UNIT-I: Methods of hardness testing Brinell, Vickers, Rockwell, Rockwell superficial, Shoreand Poldi methods, Microhardness test, relationship between hardness and other mechanical properties.

UNIT-II: Notched bar impact test and its significance, Charpy and Izod Tests, significance of transition temperature curve, Metallurgical factors affecting on transition temperature, temper embrittlement.

UNIT–III: Mechanism of elastic 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 in compression, elastic and in-elastic properties in compression.

UNIT–IV: 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. Effect of metallurgical variables on fatigue. Low cycle fatigue - High cycle fatigue.

Creep Test: 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.

UNIT-V: Non-Destructive Tests: Introduction, various NDT methods, applications advantages of one test over the other.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. *Able to understand deformation behavior with respect to metallurgical fundamentals*
2. *Able to understand Hardness testing and Impact testing*
3. *Able to understand tension test and compression testing*
4. *Able to understand fatigue test and creep test*
5. *Able to understand non destructive testing*

Text Books:

1. Mechanical Metallurgy - GE Dieter

Reference Books:

1. Engineering Materials Science - CW Richards
2. Mechanical behaviour of material-A.H.Courteny
3. Mechanical behavior-Ed.Wulf.

B.Tech Minors	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

Course objectives:

1. *To know various types of composite materials and their applications*
2. *To Learn various types of fibers and their role as reinforcement in matrix material*
3. *To Learn different processing methods of composites.*
4. *To learn different processing methods based on their application.*
5. *To understand how composites behave under various stress conditions.*

UNIT-I: Introduction - Classification of composite materials based on structure, matrix and reinforcement. Advantages of composites - application of composites - functional requirements of reinforcement and matrix.

UNIT-II: Fibers: Preparation, properties and applications of glass fibers, carbon fibers, Kevlar fibers and metal fibers-properties and application of whiskers, particle reinforcements.

UNIT-III: Manufacturing of Polymer matrix composites: Preparation of Moulding compounds and – hand lay up method – Autoclave method - Filament winding method - compression moulding – Reaction injection moulding.

UNIT-IV: Manufacturing of Metal Matrix Composites: Casting-Solid state diffusion technique. Cladding – Hot isostatic pressing. Manufacturing of Ceramic Matrix Composites: Liquid Metal infiltration-Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving

UNIT-V: Response of Composites to Stress: (a) Iso-strain condition (b) Iso-stress condition (c) Load friction shared by the fibers

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

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

1. Understand concept of reinforcement and its role in the composite
2. Use various fibers as reinforcement in the composite based on the application
3. Know about various manufacturing methods and their limitations
4. Understand fabrication metal matrix composite materials
5. Understand how composites behave under various stress conditions

Text Books:

1. Composite Materials-K.K.Chawla, Springer, 2nd Edition, 1998
2. An introduction to composite materials, D. Hull an T.W. Clyne, 2nd edition, Cambridge University press, 1996

Reference Books:

1. Composites ASM Hand Book, Vol. 21, 9th edition, 1989
2. Fundamentals of composites: Materials, manufacturing, methods an applications, Society of manufacturing engineers, 1989
3. Material Sciences and Technology – (R.. W. Cahn, P. Haasen, E, J, Kramer eds.) Vol 13
4. Structure and properties of composites (T. W. Chou ed.) VCH Winheim, 1993 – Composites by Cahn – VCH

B.Tech Minors	SMART MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:

The students will acquire the knowledge:

1. *Have insight in the latest developments regarding smart materials*
2. *Know principles of Mangeto-strictive materials*
3. *Learn important polymers which are used as smart materials*
4. *Know the importance and properties of shape memory alloys*
5. *Learn about sensor materials and energy materials*

UNIT-I: Introduction to Smart Materials, Principles of Piezo-electricty, Perovskyte Piezo-ceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers.

UNIT-II: Principles of Magneto-striction Rare earth Magneto-strictive materials, Giant Magneto-striction and Magneto -resistance Effect

UNIT-III: Introduction Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC)

UNIT-IV: Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rheological Fluids

UNIT-V: Piezo-electric Strain Sensors, Self Healing Polymers, smart composites, Energy Harvesting Materials

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

After completing the course, the student shall be able

1. *Learn about various smart materials*
2. *Learn the properties of magneto-strictive materials*
3. *Learn about advance polymer materials usage as in smart devices*
4. *Understand shape memory alloy effect*
5. *Understand smart sensor systems and energy materials*

Text Books:

1. Brian Culshaw, Smart Structures and Materials, Artech House, 2000

References:

1. Gauenzi, P., Smart Structures, Wiley, 2009
2. Cady, W. G., Piezoelectricity, Dover Publication

B.Tech Minors	MATERIALS TESTING	L	T	P	C
		3	0	0	3

Course objectives:

1. *The topic deals with various types of dislocations, slip and twinning*
2. *To understand the principles of various hardness tests and theories of fracture*
3. *To understand the principle of tensile test, compression Test etc*
4. *To know the fundamentals, failure and the factors affecting fatigue and creep.*
5. *To know the non-destructive testing methods and evaluation of flaws in materials*

UNIT-I: Methods of hardness testing Brinell, Vickers, Rockwell, Rockwell superficial, Shoreand Poldi methods, Microhardness test, relationship between hardness and other mechanical properties.

UNIT-II: Notched bar impact test and its significance, Charpy and Izod Tests, significance of transition temperature curve, Metallurgical factors affecting on transition temperature, temper embrittlement.

UNIT–III: Mechanism of elastic 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 in compression, elastic and in-elastic properties in compression.

UNIT–IV: 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. Effect of metallurgical variables on fatigue. Low cycle fatigue - High cycle fatigue.

Creep Test: 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.

UNIT-V: Non-Destructive Tests: Introduction, various NDT methods, applications advantages of one test over the other.

*(***Assessment:** *The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

Course Outcomes:

1. Able to understand deformation behavior with respect to metallurgical fundamentals
2. Able to understand Hardness testing and Impact testing
3. Able to understand tension test and compression testing
4. Able to understand fatigue test and creep test
5. Able to understand non destructive testing

Text Books:

1. Mechanical Metallurgy - GE Dieter

Reference Books:

1. Engineering Materials Science - CW Richards
2. Mechanical behaviour of material-A.H.Courteny
3. Mechanical behavior-Ed.Wulf.

B.Tech Minors	MATERIAL TESTING LAB	L	T	P	C
		0	0	3	1.5

Course objective:

1. To obtain knowledge on various material testing machines

2. To understand the material testing methodology.

List of experiments:

1. To determine the Brinell Hardness of ferrous and non-ferrous samples.
2. To determine the Rockwell hardness of ferrous and non-ferrous samples.
3. To determine the hardness of ferrous and non-ferrous samples by using Vickers hardness tester.
4. To Determination of hardness profile across weldments using microvickers hardness tester
5. To determine the elastic modulus, ultimate tensile strength, breaking stress, percentage elongation, percentage reduction in area of the given specimen by tensile test.
6. To determine the compressive strength of metals and alloys.
7. To determine the modulus of rigidity of given material by torsion test
8. To determine the Charpy and Izod (V&U Groove notch) impact strength of a given material at room temperature.
9. To determine the fatigue strength of given material at a given stress
10. To estimate steady state creep rate of materials

List of equipment:

1. Brinell Hardness Machine
2. Vickers Hardness Machine
3. Rockwell Hardness Machine
4. UTM
5. Torsion Testing Machine
6. Impact Testing Machine
7. Fatigue Testing Machine
8. Indentation Creep unit

(**Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter- I:

1. Observation book,

2. Record.

3. Conduct of the experiment successfully

4. Interpretation of the data

5. Drawing the graphs where ever necessary

6. Viva-voce.

Parameter- II:

1. At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

B.Tech Minors	HEAT TREATMENT LAB	L	T	P	C
		0	0	3	1.5

Course objective:

1. To understand and demonstrate the various types of heat treatment processes and process variables for ferrous and non-ferrous metals and alloys.

2. To understand and demonstrate the various types of surface hardening treatments for ferrous and non-ferrous metals and alloys.

List of Experiments:

1. Annealing of medium carbon steel and observation of microstructure.
2. Normalizing of medium carbon steel and observation of microstructure.
3. Hardening of medium carbon steel and observation of microstructure.
4. Study of tempering characteristics of water quenched steel.
5. Study of age hardening phenomena in duralumin.
6. Spheroidizing of a given high carbon steel.
7. Determination of hardenability of medium carbon steel by Jominy end Quench Test.
8. To conduct Re-crystallization studies on cold worked copper.

Equipment:

1. Muffle Furnaces 1000^0c – 2 No's
2. Muffle Furnaces 300^0c – 2 No's
3. Muffle Furnaces 120^0c – 1 No's
4. Hardenability Apparatus
5. Micro Scopes
6. Vickers Hardness Tester

(**Assessment:** *The student's performance should be evaluated at the end of each class based on the following parameters:*

Parameter- I:

1. Observation book,

2. Record.

3. Conduct of the experiment successfully

4. Interpretation of the data

5. Drawing the graphs where ever necessary

6. Viva-voce.

Parameter- II:

1. At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)