COURSE STRUCTURE & DETAILED SYLLABUS (R-22)

METALLURGICAL ENGINEERING

For

B.TECH. FOUR YEAR DEGREE COURSE

(Applicable for the batches admitted from 2022-2023)

DEPARTMENT OF METALLURGICAL ENGINEEERING

JNTUH UNIVERSITY COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY, HYDERABAD

Kukatpally, Hyderabad – 500085

Telangana, India

JNTUH UNIVERSITY COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY, HYDERABAD

VISION

To be recognized as one of the top 10 institutes in the country offering technical education, sustaining and improving its repute of UG programmes, expanding need based PG and research programmes with global outlook, synergising teaching and research for societal relevance

MISSION

1. To identify technological advancements and build the right level of skills at the right time contributing to the industrial and national growth.
2. To identify and keep abreast with the state of the art technology maintaining its legacy of striving for excellence in higher education.
3. To promote world class research of local relevance to society.
4. With a research community of professors, research fellows and research centres, expand the scale and multidisciplinary character of its research activities.
5. With a global outlook strive for collaborations to network with International Universities and National Institutes of Research and Higher Learning.

METALLURGICAL ENGINEERING DEPARTMENT

VISION

To impart quality education in Metallurgical Engineering and constantly pursuing excellence by upgrading knowledge skills and attitude useful to Industry, Academic and Society.

MISSION

1. To produce graduates having professional excellence in Basic Sciences and Metallurgical Engineering with concern towards society
2. To provide a scientific environment, to help meet the desires and needs of students and faculty for enhancing research efforts and technological innovations.
3. To provide technical support to higher education, industry and R&D units.

Program Educational Objectives (Metallurgical Engineering)

The Metallurgical Engineering program at JNTUH-UCESTH prepares graduates who can

PEO 1

Obtain good and high positions in public or private institutions as engineers and researchers.

PEO 2

Follow higher education in prestigious universities and have a successful academic career.

PEO 3

Demonstrate advancement in their chosen career by upgrading their skills continuously.

PEO 4

Exhibit high ethical standards and responsibilities towards their profession and society.

Program Outcomes (Metallurgical Engineering)

PO 1	**Engineering Knowledge:** Knowledge of mathematics, science, and engineering fundamentals and ability to apply them to solve complex metallurgical phenomena.
PO 2	**Problem Analysis:** Identification and analysis of process - structure – property – performance correlation of metals and materials with the knowledge of science and engineering principles.
PO 3	**Design/Development of solutions:** Ability to design material systems, components, process to meet the desired needs within the realistic constraints of economic, public safety, environmental, manufacturability, and sustainability.
PO 4	**Conduct Investigations of Complex problems:** Design, conduct, analyze, and interpret the results of tests and researches in the field of metallurgical engineering and propose appropriate measures for efficient capacity utilization of systems; components and equipment etc. with minimum energy and rejects.
PO 5	**Modern Tool Usage:** Select and apply appropriate methods for analysis and characterization of materials to check the quality and performance and usage of modern tools to address the specific needs of metallurgical industries.
PO 6	**The Engineer and Society:** Propose appropriate measures for protection and modifying equipment, systems and processes from damage, degradation and inefficiency due to various physical, chemical and mechanical environments.

PO 7	**Environment and Sustainability:** Understanding the impact of various metallurgical processes on environment and suggest appropriate measures for viable alternatives and taking measures for reuse, recycle and reclamation of rejects and byproducts.
PO 8	**Ethics:** An understanding of professional and ethical responsibility towards engineering practice and profession.
PO 9	**Individual and Team Work:** Ability to function in diverse teams and works.
PO 10	**Communication:** Ability to effectively communicate in professional context through oral presentations and written technical reports as well as successfully work in group oriented tasks.
PO 11	**Project Management and Finance:** Demonstrate the fundamental knowledge and skills associated with technical and management principles and application of them at individual and as member or a leader of a team and in multidisciplinary environment at various platforms.
PO 12	**Life-Long Learning:** Recognition of the need; ability and awareness to engage independently and exhibit creativity; innovations and proactive demeanor for engaging in lifelong learning.

Program Specific Outcomes (Metallurgical Engineering)

PSO 1

Apply metallurgical principles to provide ecological and cost effective solutions for metal extraction and refining industries and manufacturing industries.

PSO 2

Identify, evaluate and modify existing materials and their behaviour with respect to structure – property – processing – performance applications and develop new materials that are sustainable, economical and eco-friendly with tailor made properties and applications.

PSO 3

Understand, evaluate, modify and design existing manufacturing processes, characterization techniques and develop new processes to specific engineering applications and ensure reliable and sustainable products.

JNTUH University College of Engineering Science and Technology Hyderabad
B.Tech. in METALLURGICAL ENGINEERING

COURSE STRUCTURE, I & II YEAR SYLLABUS (R22 Regulations)

Applicable from AY 2022-23 Batch

I YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1.	BSC	Matrices and Calculus	3	1	0	4
2.	BSC	Applied Physics	3	1	0	4
3.	ESC	C Programming and Data Structures	3	0	0	3
4.	ESC	Engineering Workshop	0	1	3	2.5
5.	HSMC	English for Skill Enhancement	2	0	0	2
6.		Elements of Metallurgical Engineering	0	0	2	1
7.	BSC-LC	Applied Physics Laboratory	0	0	3	1.5
8.	HSMC-LC	English Language and Communication Skills Laboratory	0	0	2	1
9.	ESC-LC	C Programming and Data Structures Laboratory	0	0	2	1
10.		Environmental Science	3	0	0	0
11.	MC	Induction Programme				
		Total	**14**	**3**	**12**	**20**

I YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1.		Ordinary Differential Equations and Vector Calculus	3	1	0	4
2.	BSC	Engineering Chemistry	3	1	0	4
3.	ESC	Computer Aided Engineering Graphics	1	0	4	3
4.	ESC	Engineering Mechanics	3	0	0	3
5.		Introduction to Engineering Materials	2	0	0	2
6.	ESC - LC	Python Programming Laboratory	0	1	2	2
7.	BSC - LC	Engineering Chemistry Laboratory	0	0	2	1
8.		Engineering Materials Laboratory	0	0	2	1
		Total	**12**	**3**	**10**	**20**

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Applicable from AY 2022-23 Batch

II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1.	BSC	Probability, Statistics & Complex Variables	3	1	0	4
2.	PCC - 1	Mineral Processing	3	0	0	3
3.	PCC - 2	Metallurgical Analysis	3	0	0	3
4.	PCC - 3	Metallurgical Thermodynamics - I	3	1	0	4
5.	PCC - 4	Physical Metallurgy	3	0	0	3
6.	PCC - Lab 1	Physical Metallurgy Lab	0	0	2	1
7.	PCC - Lab 2	Mineral Processing Lab	0	0	2	1
8.	PCC - Lab 3	Metallurgical Analysis Lab	0	0	2	1
9.	*MC	Constitution of India	3	0	0	0
		Total	**18**	**2**	**6**	**20**

II YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1.	ESC	Basic Electrical and Electronics Engineering	3	0	0	3
2.	PCC - 5	Metallurgical Thermodynamics - II	3	0	0	3
3.	PCC - 6	Principles of Extractive Metallurgy	3	0	0	3
4.	PCC - 7	Fuels, Furnaces and Refractories	3	0	0	3
5.	PCC - 8	Iron Making	3	0	0	3
6.	ESC - Lab	Basic Electrical and Electronics Engineering Lab	0	0	2	1
7.	PCC - Lab 4	Principles of Extractive Metallurgy Lab	0	0	2	1
8.	PCC - Lab 5	Fuels, Furnaces and Refractories Lab	0	0	2	1
9.		Real-time Research Project / Field - Based Project	0	0	4	2
10.	*MC	Gender Sensitization Laboratory	0	0	2	0
		Total	**15**	**0**	**12**	**20**

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III YEAR I SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1.	HSMC	Business Economics & Financial Analysis	3	0	0	3
2.	PCC - 9	Mechanical Metallurgy	3	1	0	4
3.	PCC - 10	Heat Treatment and Phase Transformations	3	0	0	3
4.	PCC - 11	Metal Casting	3	0	0	3
5.	PCC - 12	Steel Making	3	1	0	4
6.	PCC - Lab 6	Metal Casting Lab	0	0	2	1
7.	PCC - Lab 7	Heat Treatment and Phase Transformations Lab	0	0	2	1
8.	PCC - Lab 8	Mechanical Metallurgy lab	0	0	2	1
9.	*MC	Intellectual Property Rights	3	0	0	0
		Total	**21**	**0**	**4**	**20**

III YEAR II SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1.	PCC - 13	Non Ferrous Extractive Metallurgy	3	0	0	3
2.	PCC - 14	Metal Forming	3	0	0	3
3.	PCC - 15	Metal Joining	3	0	0	3
4.	PEC - 1	**Professional Elective – I** 1. Ceramics and Composite Materials 2. Computational Materials Engineering 3. Ferro Alloy Technology	3	0	0	3
5.	OEC - I	**Open Elective – I** 1. Metallurgy for Non Metallurgists 2. Composite Materials	3	0	0	3
6.	PCC-Lab 9	Metal Forming Lab	0	0	2	1
7.	PCC-Lab 10	Metal Joining Lab	0	0	2	1
8.	HSMC Lab	Advanced English Communication Skills Laboratory	0	0	2	1
9.		Industry Oriented Mini Project/ Internship	0	0	4	2
10.	*MC	Environmental Science	3	0	0	0
		Total	**18**	**0**	**10**	**20**

Environmental Science in III Yr II Sem Should be Registered by Lateral Entry Students Only.

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IV YEAR I SEMESTER

S.No.	Course Code	Course Title	L	T	P	Credits
1.	ESC	Introduction to Instrumentation	2	0	0	2
2.	PCC - 16	Environmental Degradation of Materials	2	0	0	2
3.	PEC – 2	**Professional Elective – II** 1. Materials Characterization Techniques 2. Nuclear Metallurgy 3. Electronic Materials	3	0	0	3
4.	PEC – 3	**Professional Elective – III** 1. Light Metals & Alloys 2. Fatigue and Fracture Mechanics 3. Failure Analysis	3	0	0	3
5.	PEC - 4	**Professional Elective – IV** 1. Surface Engineering 2. Energy Materials 3. Non Destructive Testing	3	0	0	3
6.	OEC - II	**Open Elective – II** 1. Testing of Materials 2. Corrosion Process and Control	3	0	0	3
7.	PCC-Lab 11	Environmental Degradation of Materials Lab	0	0	2	1
8.	UG	Project Stage - I	0	0	6	3
		Total	**16**	**0**	**8**	**20**

IV YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1.	PEC – 5	**Professional Elective – V** 1. Solidification Processing 2. Non Metallic Materials 3. Functional Materials	3	0	0	3
2.	PEC – 6	**Professional Elective – VI** 1. Powder Metallurgy 2. Bio Materials 3. Transport Phenomena	3	0	0	3
3.	OEC - III	**Open Elective – III** 1. Alloy Steels 2. High Temperature Materials	3	0	0	3
4.	PROJ	Project Stage – II including seminar	0	0	22	9+2
		Total	**9**	**0**	**22**	**20**

***MC – Satisfactory / Unsatisfactory**

MATRICES AND CALCULUS

I Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-requisites: Mathematical Knowledge at pre-university level

Course Objectives: To learn

1. Types of matrices and their properties.
2. Concept of a rank of the matrix and applying this concept to know the consistency and solving the system of linear equations.
3. Concept of eigenvalues and eigenvectors and to reduce the quadratic form to canonical form.
4. Geometrical approach to the mean value theorems and their application to the mathematical Problems.
5. Evaluation of surface areas and volumes of revolutions of curves.
6. Evaluation of improper integrals using Beta and Gamma functions.
7. Partial differentiation, concept of total derivative
8. Finding maxima and minima of function of two and three variables.
9. Evaluation of multiple integrals and their applications

UNIT-I: Matrices **10 L**

Rank of a matrix by Echelon form and Normal form, 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: Eigen values and Eigen vectors **10 L**

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 **10 L**

Mean value theorems: Rolle's theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean value Theorem, Taylor's Series. Applications of definite integrals to evaluate surface areas and volumes of revolutions of curves (Only in Cartesian coordinates), Definition of Improper Integral: Beta and Gamma functions and their applications.

UNIT-IV: Multivariable Calculus (Partial Differentiation and applications) **10 L**

Definitions of Limit and continuity.

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

UNIT-V: Multivariable Calculus (Integration) 8 L

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

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5th Edition, 2016.

Reference Books:

1. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S Chand and Company Limited, New Delhi.

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

1. Write the matrix representation of a set of linear equations and to analyse the solution of the system of equations
2. Find the Eigenvalues and Eigen vectors
3. Reduce the quadratic form to canonical form using orthogonal transformations.
4. Solve the applications on the mean value theorems.
5. Evaluate the improper integrals using Beta and Gamma functions
6. Find the extreme values of functions of two variables with/ without constraints.
7. Evaluate the multiple integrals and apply the concept to find areas, volumes

APPLIED PHYSICS

B.Tech. I Year I Sem.

L	T	P	C
3	1	0	4

Pre-requisites: 10 + 2 Physics

Course Objectives: The objectives of this course for the student are to:

1. Understand the basic principles of quantum physics and band theory of solids.
2. Understand the underlying mechanism involved in construction and working principles of various semiconductor devices.
3. Study the fundamental concepts related to the dielectric, magnetic and energy materials.
4. Identify the importance of nanoscale, quantum confinement and various fabrications techniques.
5. Study the characteristics of lasers and optical fibres.

UNIT - I: QUANTUM PHYSICS AND SOLIDS

Quantum Mechanics: Introduction to quantum physics, blackbody radiation – Stefan-Boltzmann's law,Wein's and Rayleigh-Jean's law, Planck's radiation law - photoelectric effect - Davisson and Germer experiment –Heisenberg uncertainty principle - Born interpretation of the wave function – time independent Schrodinger wave equation - particle in one dimensional potential box.

Solids: Symmetry in solids, free electron theory (Drude & Lorentz, Sommerfeld) - Fermi-Dirac distribution - Bloch's theorem -Kronig-Penney model – E-K diagram- effective mass of electron-origin of energy bands- classification of solids.

UNIT - II: SEMICONDUCTORS AND DEVICES

Intrinsic and extrinsic semiconductors – Hall effect - direct and indirect band gap semiconductors -construction, principle of operation and characteristics of P-N Junction diode, Zener diode and bipolar junction transistor (BJT)–LED, PIN diode, avalanche photo diode (APD) and solar cells, their structure, materials, working principle and characteristics.

UNIT - III: DIELECTRIC, MAGNETIC AND ENERGY MATERIALS

Dielectric Materials: Basic definitions- types of polarizations (qualitative) - ferroelectric, piezoelectric, and pyroelectric materials – applications – liquid crystal displays (LCD) and crystal oscillators.Magnetic Materials: Hysteresis - soft and hard magnetic materials - magnetostriction, magnetoresistance - applications - bubble memory devices, magnetic field sensors and multiferroics.Energy Materials: Conductivity of liquid and solid electrolytes-superionic conductors - materials and electrolytes for super capacitors - rechargeable ion batteries, solid fuel cells.

UNIT - IV: NANOTECHNOLOGY

Nanoscale, quantum confinement, surface to volume ratio, bottom-up fabrication: sol-gel, precipitation, combustion methods – top-down fabrication: ball milling - physical vapor deposition (PVD) - chemical vapor deposition (CVD) - characterization techniques - XRD, SEM &TEM - applications of nanomaterials.

UNIT - V: LASER AND FIBER OPTICS

Lasers: Laser beam characteristics-three quantum processes-Einstein coefficients and their relations lasing action - pumping methods- ruby laser, $He-Ne$ laser, CO_2 laser, Argon ion Laser, Nd: YAG laser semiconductor laser-applications of laser.

Fiber Optics: Introduction to optical fiber- advantages of optical Fibers - total internal reflection-construction of optical fiber - acceptance angle - numerical aperture- classification of optical fibers-losses in optical fiber - optical fiber for communication system - applications.

Text Books:

1. M. N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy" A Text book of Engineering Physics"- S. Chand Publications, 11th Edition 2019.
2. Engineering Physics by Shatendra Sharma and Jyotsna Sharma, Pearson Publication, 2019
3. Semiconductor Physics and Devices- Basic Principle – Donald A, Neamen, Mc Graw Hill, 4th Edition, 2021.
4. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Learning, 2nd Edition,2022.
5. Essentials of Nanoscience & Nanotechnology by Narasimha Reddy Katta, Typical Creatives NANO DIGEST, 1st Edition, 2021.

Reference Books:

1. Quantum Physics, H.C. Verma, TBS Publication, 2nd Edition 2012.
2. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley &Sons,11th Edition, 2018.
3. Introduction to Solid State Physics, Charles Kittel, Wiley Eastern, 2019.
4. Elementary Solid State Physics, S.L. Gupta and V. Kumar, Pragathi Prakashan, 2019.
5. A.K. Bhandhopadhya - Nano Materials, New Age International, 1stEdition, 2007.
6. Energy Materials a Short Introduction to Functional Materials for Energy Conversion and Storage Aliaksandr S. Bandarenka, CRC Press Taylor & Francis Group Energy Materials Taylor & Francis Group, 1st Edition, 2022.

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

1. Understand physical world from fundamental point of view by the concepts of Quantum mechanics and visualize the difference between conductor, semiconductor, and an insulator by classification of solids.
2. Identify the role of semiconductor devices in science and engineering Applications.
3. Explore the fundamental properties of dielectric, magnetic materials and energy for their applications.
4. Appreciate the features and applications of Nanomaterials.
5. Understand various aspects of Lasers and Optical fiber and their applications in diverse fields.

C PROGRAMMING AND DATA STRUCTURES

B.Tech. I Year I Sem. **L T P C**
3 0 0 3

Course Objectives: Introduce the importance of programming, C language constructs, program development, data structures, searching and sorting.

UNIT - I

Introduction to Computers – Computer Systems, Computing Environments, Computer Languages, Creating and running programs, Software Development

Introduction to C Language – Background, Simple C programs, Identifiers, Basic data types, Variables, Constants, Input / OutputStructure of a C Program – Operators, Bit-wise operators, Expressions, Precedence and Associatively, Expression Evaluation, Type conversions, Statements.

UNIT - II

Statements – if and switch statements, Repetition statements – while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Recursion.

Designing Structured Programs- Functions, basics, user defined functions, inter function communication, standard functions.

Arrays – Concepts, using arrays in C, inter function communication, array applications, two – dimensional arrays, multidimensional arrays.

UNIT - III

Pointers – Introduction, Pointers for inter function communication, pointers to pointers, compatibility,

Pointer Applications – Passing an array to a function, Memory allocation functions, array of pointers.

Strings – Concepts, C Strings, String Input / Output functions, arrays of strings, string manipulation functions, string / data conversion.

UNIT - IV

Derived types – The Typedef, enumerated types, Structures – Declaration, definition and initialization of structures, accessing structures, operations on structures, complex structures. Unions – Referencing unions, initializers, unions and structures.

Input and Output – Text vs Binary streams, standard library functions for files, converting file types, File programs – copy, merge files.

UNIT – V

Sorting- selection sort, bubble sort, insertion sort,

Searching-linear and binary search methods.

Data Structures – Introduction to Data Structures, abstract data types, Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, Stacks - Operations, array and linked representations of stacks, stack applications, Queues-operations, array and linked representations.

Text Books:

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

Reference Books:

1. C & Data structures – P. Padmanabham, 3rd Edition, B.S. Publications.
2. C Programming with problem solving, J.A. Jones & K. Harrow, Dreamtech Press.
3. Programming in C – Stephen G. Kochan, III Edition, Pearson Education.
4. C for Engineers and Scientists, H. Cheng, McGraw-Hill International Edition.
5. Data Structures using C – A. M. Tanenbaum, Y. Langsam, and M.J. Augenstein, Pearson Education / PHI.
6. C Programming & Data Structures, E. Balagurusamy, TMH.
7. C Programming & Data Structures, P. Dey, M Ghosh R Thereja, Oxford University Press.
8. C & Data structures – E V Prasad and N B Venkateswarlu, S. Chand & Co.

Course Outcomes:

1. Understand the various steps in Program development.
2. Explore the basic concepts in C Programming Language.
3. Develop modular and readable C Programs
4. Understand the basic concepts such as Abstract Data Types, Linear and Non-Linear Data structures.
5. Apply data structures such as stacks, queues in problem solving
6. To understand and analyze various searching and sorting algorithms.

ENGINEERING WORKSHOP

B.Tech. I Year I Sem.

L	T	P	C
0	1	3	2.5

Pre-requisites: Practical skill

Course Objectives:

1. To Study of different hand operated power tools, uses and their demonstration.
2. To gain a good basic working knowledge required for the production of various engineering products.
3. To provide hands on experience about use of different engineering materials, tools, equipments
   and processes those are common in the engineering field.
4. To develop a right attitude, team working, precision and safety at work place.
5. It explains the construction, function, use and application of different working tools, equipment and machines.
6. To study commonly used carpentry joints.
7. To have practical exposure to various welding and joining processes.
8. Identify and use marking out tools, hand tools, measuring equipment and to work to prescribed tolerances.

1. TRADES FOR EXERCISES:

At least two exercises from each trade:

I. Carpentry – (T-Lap Joint, Dovetail Joint, Mortise & Tenon Joint)
II. Fitting – (V-Fit, Dovetail Fit & Semi-circular fit)
III. Tin-Smithy – (Square Tin, Rectangular Tray & Conical Funnel)
IV. Foundry – (Preparation of Green Sand Mould using Single Piece and Split Pattern)
V. Welding Practice – (Arc Welding & Gas Welding)
VI. House-wiring – (Parallel & Series, Two-way Switch and Tube Light)
VII. Black Smithy – (Round to Square, Fan Hook and S-Hook)

2. TRADES FOR DEMONSTRATION & EXPOSURE:

Plumbing, Machine Shop, Metal Cutting (Water Plasma), Power tools in construction and Wood Working.

Text Books:

1. Workshop Practice /B. L. Juneja / Cengage
2. Workshop Manual / K. Venugopal / Anuradha.

Reference Books:

1. Work shop Manual - P. Kannaiah/ K.L. Narayana/ Scitech
2. Workshop Manual / Venkat Reddy/ BSP.

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

1. Study and practice on machine tools and their operations
2. Practice on manufacturing of components using workshop trades including pluming, fitting, carpentry, foundry, house wiring and welding.
3. Identify and apply suitable tools for different trades of Engineering processes including drilling, material removing, measuring, chiseling.
4. Apply basic electrical engineering knowledge for house wiring practice.

ENGLISH FOR SKILL ENHANCEMENT

B.Tech. I Year I Sem.

L	T	P	C
2	0	0	2

Course Objectives: This course will enable the students to:

1. Improve the language proficiency of students in English with an emphasis on Vocabulary, Grammar, Reading and Writing skills.
2. Develop study skills and communication skills in various professional situations.
3. Equip students to study engineering subjects more effectively and critically using the theoretical and practical components of the syllabus.

UNIT - I

Chapter entitled ***'Toasted English' by R.K.Narayan*** from ***"English: Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.

Vocabulary: The Concept of Word Formation -The Use of Prefixes and Suffixes – Acquaintance with Prefixes and Suffixes from Foreign Languages to form Derivatives - Synonyms and Antonyms.

Grammar: Identifying Common Errors in Writing with Reference to Articles and Prepositions.

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

Writing: Sentence Structures -Use of Phrases and Clauses in Sentences- Importance of Proper Punctuation- Techniques for Writing precisely – Paragraph Writing – Types, Structures and Features of a Paragraph - Creating Coherence-Organizing Principles of Paragraphs in Documents.

UNIT - II

Chapter entitled ***'Appro JRD' by Sudha Murthy*** from ***"English: Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.

Vocabulary: Words Often Misspelt - Homophones, Homonyms and Homographs

Grammar: Identifying Common Errors in Writing with Reference to Noun-pronoun Agreement and Subject-verb Agreement.

Reading: Sub-Skills of Reading – Skimming and Scanning – Exercises for Practice

Writing: Nature and Style of Writing- Defining /Describing People, Objects, Places and Events – Classifying- Providing Examples or Evidence.

UNIT - III

Chapter entitled '***Lessons from Online Learning'*** by F.Haider Alvi, Deborah Hurst et al from ***"English: Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.

Vocabulary: Words Often Confused - Words from Foreign Languages and their Use in English.

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

Reading: Sub-Skills of Reading – Intensive Reading and Extensive Reading – Exercises for Practice.

Writing: Format of a Formal Letter-Writing Formal Letters E.g.., Letter of Complaint, Letter of Requisition, Email Etiquette, Job Application with CV/Resume.

UNIT - IV

Chapter entitled ***'Art and Literature'*** by Abdul Kalam from ***"English: Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.

Vocabulary: Standard Abbreviations in English

Grammar: Redundancies and Clichés in Oral and Written Communication.

Reading: Survey, Question, Read, Recite and Review (SQ3R Method) - Exercises for Practice

Writing: Writing Practices- Essay Writing-Writing Introduction and Conclusion -Précis Writing.

UNIT - V

Chapter entitled ***'Go, Kiss the World'*** by Subroto Bagchi from ***"English: Language, Context and Culture"*** published by Orient BlackSwan, Hyderabad.

Vocabulary: Technical Vocabulary and their Usage

Grammar: Common Errors in English (Covering all the other aspects of grammar which were not covered in the previous units)

Reading: Reading Comprehension-Exercises for Practice

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

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

- **Note: 1.** As the syllabus of English given in *AICTE Model Curriculum-2018 for B.Tech First Year is* ***Open-ended,*** besides following the prescribed textbook, it is required to prepare teaching/learning materials **by the teachers collectively** in the form of handouts based on the needs of the students in their respective colleges for effective teaching/learning in the class.
- **Note: 2**. Based on the recommendations of NEP2020, teachers are requested to be flexible to adopt Blended Learning in dealing with the course contents. They are advised to teach 40 percent of each topic from the syllabus in blended mode.

Text Book:

1. "English: Language, Context and Culture" by Orient BlackSwan Pvt. Ltd, Hyderabad. 2022. Print.

Reference Books:

1. Effective Academic Writing by Liss and Davis (OUP)
2. Richards, Jack C. (2022) Interchange Series. Introduction, 1,2,3. Cambridge University Press
3. Wood, F.T. (2007). Remedial English Grammar. Macmillan.
4. Chaudhuri, Santanu Sinha. (2018). Learn English: A Fun Book of Functional Language, Grammar and Vocabulary. (2nd ed.,). Sage Publications India Pvt. Ltd.
5. (2019). Technical Communication. Wiley India Pvt. Ltd.
6. Vishwamohan, Aysha. (2013). English for Technical Communication for Engineering Students. Mc Graw-Hill Education India Pvt. Ltd.
7. Swan, Michael. (2016). Practical English Usage. Oxford University Press. Fourth Edition.

Course Outcomes: Students will be able to:

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

ELEMENTS OF METALLURGICAL ENGINEERING

I Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Course Objectives:

1. The objective of this course is to give an overview of various Metallurgical Engineering Laboratory Processes.

List of Experiments:

1. Identification of various ores and minerals and their sampling methods for mineral beneficiation.
2. Study of different sizing techniques.
3. Preparation of crystal structure models.
4. Study of the constructional features of Metallurgical Microscope.
5. Metallographic sample preparation of Ferrous and Non-Ferrous Metals.
6. Study of heat treatment cycle and heat treatment processes. (Annealing, Normalising, Hardening and Tempering)
7. Study of various hardness measurement methods. (BHN, VHN, RHN)
8. Study of properties of different moulding sands and preparation of standard sample.
9. Study and preparation of weld joints (Butt & Lap joints).
10. Construction of electrochemical cells and understanding of principles of electrometallurgy.
11. Study of various types of corrosion.

Course Outcomes:

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

1. Gain knowledge in metallographic examination of metals using microscope.
2. Handle various hardness testing equipment.
3. Get exposure to casting and welding processes.
4. Get a basic knowledge in electrometallurgical processes.

APPLIED PHYSICS LAB

B.Tech. I Year I Sem.

L	T	P	C
0	0	3	1.5

Course Objectives: The objectives of this course for the student to

1. Capable of handling instruments related to the Hall effect and photoelectric effect experiments and their measurements.
2. Understand the characteristics of various devices such as PN junction diode, Zener diode, BJT, LED, solar cell, lasers and optical fiber and measurement of energy gap and resistivity of semiconductor materials.
3. Able to measure the characteristics of dielectric constant of a given material.
4. Study the behavior of B-H curve of ferromagnetic materials.
5. Understanding the method of least squares fitting.

List of Experiments:

1. Determination of work function and Planck's constant using photoelectric effect.
2. Determination of Hall co-efficient and carrier concentration of a given semiconductor.
3. Characteristics of series and parallel LCR circuits.
4. V-I characteristics of a p-n junction diode and Zener diode
5. Input and output characteristics of BJT (CE, CB & CC configurations)
6. a) V-I and L-I characteristics of light emitting diode (LED)
   b) V-I Characteristics of solar cell
7. Determination of Energy gap of a semiconductor.
8. Determination of the resistivity of semiconductor by two probe method.
9. Study B-H curve of a magnetic material.
10. Determination of dielectric constant of a given material
11. a) Determination of the beam divergence of the given LASER beam
    b) Determination of Acceptance Angle and Numerical Apertureof an optical fiber.
12. Understanding the method of least squares – torsional pendulum as an example.

Note: *Any 8 experiments are to be performed.*

Reference Book:

1. S. Balasubramanian, M.N. Srinivasan "A Text book of Practical Physics"- S Chand Publishers, 2017

Course Outcomes: The students will be able to:

1. Know the determination of the Planck's constant using Photo electric effect and identify the material whether it is n-type or p-type by Hall experiment.
2. Appreciate quantum physics in semiconductor devices and optoelectronics.
3. Gain the knowledge of applications of dielectric constant.
4. Understand the variation of magnetic field and behavior of hysteresis curve.
5. Carried out data analysis.

ENGLISH LANGUAGE AND COMMUNICATION SKILLS LAB

B.Tech. I Year I Sem.

L	T	P	C
0	0	2	1

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

Course Objectives:

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

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

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

Listening Skills:

Objectives

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

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

1. Listening for general content.
2. Listening to fill up information.
3. Intensive listening.
4. Listening for specific information.

Speaking Skills:

Objectives

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

contexts

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

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

Exercise – I
CALL Lab:
Understand: Listening Skill- Its importance – Purpose- Process- Types- Barriers- Effective Listening.
Practice: Introduction to Phonetics – Speech Sounds – Vowels and Consonants – Minimal Pairs- Consonant Clusters- Past Tense Marker and Plural Marker- Testing Exercises.
ICS Lab:
Understand: Spoken vs. Written language- Formal and Informal English.
Practice: Ice-Breaking Activity and JAM Session- Situational Dialogues – Greetings – Taking Leave –
Introducing Oneself and Others.

Exercise – II
CALL Lab:
Understand: Structure of Syllables – Word Stress– Weak Forms and Strong Forms – Stress pattern in
sentences – Intonation.
Practice: Basic Rules of Word Accent - Stress Shift - Weak Forms and Strong Forms- Stress pattern in
sentences – Intonation - Testing Exercises.
ICS Lab:
Understand: Features of Good Conversation – Strategies for Effective Communication.
Practice: Situational Dialogues – Role Play- Expressions in Various Situations –Making Requests and
Seeking Permissions - Telephone Etiquette.

Exercise - III
CALL Lab:
Understand: Errors in Pronunciation-Neutralising Mother Tongue Interference (MTI).
Practice: Common Indian Variants in Pronunciation – Differences between British and American Pronunciation -Testing Exercises
ICS Lab:
Understand: Descriptions- Narrations- Giving Directions and Guidelines – Blog Writing
Practice: Giving Instructions – Seeking Clarifications – Asking for and Giving Directions – Thanking and Responding – Agreeing and Disagreeing – Seeking and Giving Advice – Making Suggestions.

Exercise – IV
CALL Lab:
Understand: Listening for General Details.
Practice: Listening Comprehension Tests - Testing Exercises
ICS Lab:
Understand: Public Speaking – Exposure to Structured Talks - Non-verbal Communication- Presentation Skills.
Practice: Making a Short Speech – Extempore- Making a Presentation.

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

Minimum Requirement of infrastructural facilities for ELCS Lab:

1. Computer Assisted Language Learning (CALL) Lab:
The Computer Assisted Language Learning Lab has to accommodate 40 students with 40 systems,
with one Master Console, LAN facility and English language learning software for self- study by students.
System Requirement (Hardware component):
Computer network with LAN facility (minimum 40 systems with multimedia) with the following specifications:

i) Computers with Suitable Configuration
ii) High Fidelity Headphones

2. Interactive Communication Skills (ICS) Lab :
The Interactive Communication Skills Lab: A Spacious room with movable chairs and audio -visual aids with a Public Address System, a T. V. or LCD, a digital stereo –audio & video system and camcorder etc.
Source of Material (Master Copy):

1. Exercises in Spoken English. Part 1,2,3. CIEFL and Oxford University Press.

Note: Teachers are requested to make use of the master copy and get it tailor-made to suit the contents
of the syllabus.

Suggested Software:

1. Cambridge Advanced Learners' English Dictionary with CD.
2. Grammar Made Easy by Darling Kindersley.
3. Punctuation Made Easy by Darling Kindersley.
4. Oxford Advanced Learner's Compass, 10^{th} Edition.
5. English in Mind (Series 1-4), Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge.
6. English Pronunciation in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
7. English Vocabulary in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
8. TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS).
9. Digital All
10. Orell Digital Language Lab (Licensed Version)

Reference Books:

1. English Language Communication Skills – Lab Manual cum Workbook. Cengage Learning India Pvt. Ltd. (2022).
2. Shobha, KN & Rayen, J. Lourdes. (2019). Communicative English – A workbook. Cambridge University Press.
3. Kumar, Sanjay & Lata, Pushp. (2019). Communication Skills: A Workbook. Oxford University Press.
4. Board of Editors. (2016). ELCS Lab Manual: A Workbook for CALL and ICS Lab Activities. Orient Black Swan Pvt. Ltd.
5. Mishra, Veerendra et al. (2020). English Language Skills: A Practical Approach. Cambridge University Press.

Course Outcomes: Students will be able to:

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

C PROGRAMMING AND DATA STRUCTURES LAB

B.Tech. I Year I Sem.

L	T	P	C
0	0	2	1

Course Objectives: Introduce the importance of programming, C language constructs, program development, data structures, searching and sorting.

List of Experiments:

1. Write a C program to find the sum of individual digits of a positive integer.
2. Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence. Write a C program to generate the first n terms of the sequence.
3. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.
4. Write a C program to find the roots of a quadratic equation.
5. Write a C program to find the factorial of a given integer.
6. Write a C program to find the GCD (greatest common divisor) of two given integers.
7. Write a C program to solve Towers of Hanoi problem.
8. Write a C program, which takes two integer operands and one operator from the user, performs the operation and then prints the result. (Consider the operators +,-,*, /, % and use Switch Statement)
9. Write a C program to find both the largest and smallest number in a list of integers.
10. Write a C program that uses functions to perform the following:
    i) Addition of Two Matrices
    ii) Multiplication of Two Matrices
11. Write a C program that uses functions to perform the following operations:
    i) To insert a sub-string in to a given main string from a given position.
    ii) To delete n Characters from a given position in a given string.
12. Write a C program to determine if the given string is a palindrome or not
13. Write a C program that displays the position or index in the string S where the string T begins, or –1 if S doesn't contain T.
14. Write a C program to count the lines, words and characters in a given text.
15. Write a C program to generate Pascal's triangle.
16. Write a C program to construct a pyramid of numbers.
17. Write a C program that uses functions to perform the following operations:
    i) Reading a complex number
    ii) Writing a complex number
    iii) Addition of two complex numbers
    iv) Multiplication of two complex numbers
    (Note: represent complex number using a structure.)
18. i. Write a C program which copies one file to another.
    ii. Write a C program to reverse the first n characters in a file.
    (Note: The file name and n are specified on the command line.)
19. i. Write a C program to display the contents of a file.
    ii. Write a C program to merge two files into a third file (i.e., the contents of the first file followed by those of the second are put in the third file)

20. Write a C program that uses functions to perform the following operations on singly linked list.:
    i) Creation ii) Insertion iii) Deletion iv) Traversal
21. Write C programs that implement stack (its operations) using
    i) Arrays ii) Pointers
22. Write C programs that implement Queue (its operations) using
    i) Arrays ii) Pointers
23. Write a C program that implements the following sorting methods to sort a given list of integers in ascending order
    i) Bubble sort ii) Selection sort iii) Insertion sort
24. Write C programs that use both recursive and non-recursive functions to perform the following searching operations for a Key value in a given list of integers:
    i) Linear search ii) Binary search

Text Books:

1. C Programming & Data Structures, B.A. Forouzan and R. F. Gilberg, Third Edition, Cengage Learning.
2. Let us C, Yeswanth Kanitkar
3. C Programming, Balaguruswamy.

Course Outcomes:

1. Develop modular and readable C Programs
2. Solve problems using strings, functions
3. Handle data in files
4. Implement stacks, queues using arrays, linked lists.
5. To understand and analyze various searching and sorting algorithms.

ENVIRONMENTAL SCIENCE

B.Tech. I Year I Sem.

L	T	P	C
3	0	0	0

Course Objectives:

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

UNIT - I

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

UNIT - II

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

UNIT - III

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

UNIT - IV

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

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

UNIT - V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

ORDINARY DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

B.Tech. I Year II Sem.

L	T	P	C
3	1	0	4

Pre-requisites: Mathematical Knowledge at pre-university level

Course Objectives: To learn

1. Methods of solving the differential equations of first and higher order.
2. Concept, properties of Laplace transforms.
3. Solving ordinary differential equations using Laplace transforms techniques.
4. The physical quantities involved in engineering field related to vector valued functions.
5. The basic properties of vector valued functions and their applications to line, surface and volume integrals.

UNIT-I: First Order ODE **8 L**

Exact differential equations, Equations reducible to exact differential equations, linear and Bernoulli's
equations, Orthogonal Trajectories (only in Cartesian Coordinates). Applications: Newton's law of cooling, Law of natural growth and decay.

UNIT-II: Ordinary Differential Equations of Higher Order **10 L**

Second order linear differential equations with constant coefficients: Non-Homogeneous terms of the type e^{ax}, $sinax$, $cosax$,polynomials in $x, e^{ax}V[x] and\ xV[x]$,(method of variation of parameters, Equations reducible to linear ODE with constant coefficients: Legendre's equation, Cauchy-Euler equation. Applications: Electric Circuits

UNIT-III: Laplace transforms **10 L**

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

UNIT-IV: Vector Differentiation **10 L**

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

UNIT-V: Vector Integration **10 L**

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

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010
2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5^{th} Edition, 2016.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9^{th} Edition, Pearson, Reprint, 2002.
3. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S Chand and Company Limited, New Delhi.
4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

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

1. Identify whether the given differential equation of first order is exact or not.
2. Solve higher differential equation and apply the concept of differential equation to real world problems.
3. Use the Laplace transforms techniques for solving ODE's.
4. Evaluate the line, surface and volume integrals and converting them from one to another.

ENGINEERING CHEMISTRY

B.Tech. I Year II Sem.

L	T	P	C
3	1	0	4

Course Objectives:

1. To bring adaptability to new developments in Engineering Chemistry and to acquire the skills required to become a perfect engineer.
2. To include the importance of water in industrial usage, fundamental aspects of battery chemistry, significance of corrosion it's control to protect the structures.
3. To imbibe the basic concepts of petroleum and its products.
4. To acquire required knowledge about engineering materials like cement, smart materials and Lubricants.

UNIT - I: Water and its treatment: [8]

Introduction to hardness of water – Estimation of hardness of water by complexometric method and related numerical problems. Potable water and its specifications - Steps involved in the treatment of potable water - Disinfection of potable water by chlorination and break - point chlorination. Defluoridation - Determination of F- ion by ion-selective electrode method. Boiler troubles: Sludges, Scales and Caustic embrittlement. Internal treatment of Boiler feed water - Calgon conditioning - Phosphate conditioning - Colloidal conditioning, External treatment methods - Softening of water by ion- exchange processes. Desalination of water – Reverse osmosis.

UNIT – II Battery Chemistry & Corrosion [8]

Introduction to Electrochemistry- Galvanic cell, Electrode Potentials, Nernst equation, EMF of the cell, cell representation. Classification of batteries- primary, secondary and reserve batteries with examples. Basic requirements for commercial batteries. Construction, working and applications of: Zn-air and Lithium ion battery, Applications of Li-ion battery to electrical vehicles. Fuel Cells- Differences between battery and a fuel cell, Construction and applications of Methanol Oxygen fuel cell and Solid oxide fuel cell. Solar cells - Introduction and applications of Solar cells.

Corrosion: Causes and effects of corrosion – theories of chemical and electrochemical corrosion – mechanism of electrochemical corrosion, Types of corrosion: Galvanic, water-line and pitting corrosion. Factors affecting rate of corrosion, Corrosion control methods- Cathodic protection – Sacrificial anode and impressed current methods. Surface coatings – Metallic coatings – Hot dipping – Galvanisation, Tinning.

UNIT - III: Polymeric materials: [8]

Definition – Classification of polymers with examples – Types of polymerization – addition (free radical addition) and condensation polymerization with examples – Nylon 6:6, Terylene Plastics: Definition and characteristics- thermoplastic and thermosetting plastics, Preparation, Properties and engineering applications of PVC and Bakelite, Teflon, Fiber reinforced plastics (FRP).

Elastomers: Natural rubber and its vulcanization. Characteristics – preparation – properties and applications of Buna-S, Butyl and Thiokol rubber.

Conducting polymers: Characteristics and Classification with examples-mechanism of conduction in trans-polyacetylene and applications of conducting polymers.

Biodegradable polymers: Concept and advantages - Polylactic acid and poly vinyl alcohol and their applications.

UNIT - IV: Energy Sources: [8]

Introduction, Calorific value of fuel – HCV, LCV- Dulongs formula. Classification- solid fuels: coal analysis of coal – proximate and ultimate analysis and their significance. Liquid fuels – petroleum and its refining, cracking types – moving bed catalytic cracking. Knocking – octane and cetane rating, Gaseous fuels – composition and uses of natural gas, LPG and CNG, Biodiesel – Trans-esterification, advantages. Hydrogen as fuel – Production, storage and applications.

UNIT - V: Engineering Materials: [8]

Cement: Portland cement, its composition, setting and hardening, special cements – white cement, water proof cement, high-alumina cement

Smart materials and their engineering applications

Smart materials – classification – (Piezoelectric materials, Shape Memory Alloys (SMA's), Thermoresponse materials, magnetorhetoric materials, smart polymers) – Piezolelectric materials – Quartz, SMA's – Nitinol.

Lubricants: Classification of lubricants with examples-characteristics of a good lubricants – mechanism of lubrication (thick film, thin film and extreme pressure)- properties of lubricants: viscosity, cloud point, pour point, flash point and fire point.

Text Books:

1. Engineering Chemistry by P.C. Jain and M. Jain, Dhanpatrai Publishing Company, 2010
2. Engineering Chemistry by Rama Devi, Venkata Ramana Reddy and Rath, Cengage learning, 2016.
3. A text book of Engineering Chemistry by M. Thirumala Chary, E. Laxminarayana and K. Shashikala, Pearson Publications, 2021.
4. Textbook of Engineering Chemistry by Jaya Shree Anireddy, Wiley Publications.

Reference Books:

1. Engineering Chemistry by Shikha Agarwal, Cambridge University Press, Delhi (2015).
2. Engineering Chemistry by Shashi Chawla, Dhanpatrai and Company (P) Ltd. Delhi (2011)

Course Outcomes:

1. Students will acquire the basic knowledge of electrochemical procedures related to corrosion and its control.
2. The students are able to understand the basic properties of water and its usage in domestic and industrial purposes.
3. They can learn the fundamentals and general properties of polymers and other engineering materials.
4. They can predict potential applications of chemistry and practical utility in order to become good engineers and entrepreneurs.

COMPUTER AIDED ENGINEERING GRAPHICS

B.Tech. I Year II Sem.

L	T	P	C
1	0	4	3

Course Objectives:

1. To develop the ability of visualization of different objects through technical drawings
2. To acquire computer drafting skill for communication of concepts, ideas in the design of engineering products

UNIT – I

Introduction to Engineering Graphics: Principles of Engineering Graphics and their Significance, Scales – Plain & Diagonal, Conic Sections including the Rectangular Hyperbola – General method only. Cycloid, Epicycloid and Hypocycloid, Introduction to Computer aided drafting – views, commands and conics

UNIT- II

Orthographic Projections: Principles of Orthographic Projections – Conventions – Projections of Points and Lines, Projections of Plane regular geometric figures. Auxiliary Planes. Computer aided
orthographic projections – points, lines and planes

UNIT – III

Projections of Regular Solids – Auxiliary Views - Sections or Sectional views of Right Regular Solids –Prism, Cylinder, Pyramid, Cone – Auxiliary views, Computer aided projections of solids – sectional views

UNIT – IV

Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid and Cone, Development of surfaces using computer aided drafting

UNIT – V

Isometric Projections: Principles of Isometric Projection – Isometric Scale – Isometric Views –Conventions – Isometric Views of Lines, Plane Figures, Simple and Compound Solids – Isometric Projection of objects having non- isometric lines. Isometric Projection of Spherical Parts. Conversion of Isometric Views to Orthographic Views and Vice-versa –Conventions. Conversion of orthographic projection into isometric view using computer aided drafting.

Text Books:

1. Engineering Drawing N.D. Bhatt / Charotar
2. Engineering Drawing and graphics Using AutoCAD Third Edition, T. Jeyapoovan, Vikas: S. Chand and company Ltd.

Reference Books:

1. Engineering Drawing, Basant Agrawal and C M Agrawal, Third Edition McGraw Hill
2. Engineering Graphics and Design, WILEY, Edition 2020
3. Engineering Drawing, M. B. Shah, B.C. Rane / Pearson.
4. Engineering Drawing, N. S. Parthasarathy and Vela Murali, Oxford
5. Computer Aided Engineering Drawing – K Balaveera Reddy et al – CBS Publishers.

Note: - External examination is conducted in conventional mode and internal evaluation to be done by both conventional as well as using computer aided drafting.

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

1. Apply computer aided drafting tools to create 2D and 3D objects
2. sketch conics and different types of solids
3. Appreciate the need of Sectional views of solids and Development of surfaces of solids
4. Read and interpret engineering drawings
5. Conversion of orthographic projection into isometric view and vice versa manually and by using computer aided drafting

ENGINEERING MECHANICS

B.Tech. I Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are to

1. Explain the resolution of a system of forces, compute their resultant and solve problems using equations of equilibrium.
2. Perform analysis of bodies lying on rough surfaces.
3. Locate the centroid of a body and compute the area moment of inertia and mass moment of inertia of standard and composite sections.
4. Explain kinetics and kinematics of particles, projectiles, curvilinear motion, centroidal motion and plane motion of rigid bodies.
5. Explain the concepts of work-energy method and its applications to translation, rotation and plane motion and the concept of vibrations.

UNIT - I

Introduction to Engineering Mechanics - Force Systems: Basic concepts, Particle equilibrium in 2-D 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space - Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy.

UNIT - II

Friction: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, ladder friction Centroid and Centre of Gravity -Centroid of Lines, Areas and Volumes from first principle, centroid of composite sections; Centre of Gravity and its implications. – Theorem of Pappus.

UNIT - III

Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Product of Inertia, Parallel Axis Theorem, Perpendicular Axis Theorem.

Mass Moment of Inertia: Moment of Inertia of Masses - Transfer Formula for Mass Moments of Inertia – Mass moment of inertia of composite bodies.

UNIT - IV

Kinematics of Particles: Kinematics of particles – Rectilinear motion – Curvilinear motion – Projectiles. Kinetics of Particles: Kinetics of particles – Newton’s Second Law – Differential equations of rectilinear and curvilinear motion – Dynamic equilibrium – Inertia force – D. Alembert’s Principle applied for rectilinear and curvilinear motion.

UNIT - V

Work - Energy Principle: Equation of translation, principle of conservation of energy, work - energy principle applied to particle motion and connected systems, fixed axis rotation. Impulse – Momentum Principle: Introduction, linear impulse momentum, principle of conservation of linear momentum, elastic impact and types of impact, loss of kinetic energy, co efficient of restitution.

Text Books:

1. Shames and Rao (2006), Engineering Mechanics, Pearson Education
2. Reddy Vijay Kumar K. and J. Suresh Kumar (2010), Singer's Engineering Mechanics – Statics & Dynamics.

Reference Books:

1. Timoshenko S.P and Young D.H., "Engineering Mechanics", McGraw Hill International Edition, 1983.
2. Andrew Pytel, Jaan Kiusalaas, "Engineering Mechanics", Cengage Learning, 2014.
3. Beer F.P& Johnston E.R Jr. Vector, "Mechanics for Engineers", TMH, 2004.
4. Hibbeler R. C & Ashok Gupta, "Engineering Mechanics", Pearson Education, 2010.
5. Tayal A.K., "Engineering Mechanics – Statics & Dynamics", Umesh Publications, 2011.
6. Basudeb Bhattacharyya, "Engineering Mechanics", Oxford University Press, 2008.
7. Meriam. J. L., "Engineering Mechanics", Volume-II Dynamics, John Wiley & Sons, 2008.
8. P.C Dumir et al. "Engineering Mechanics", University press.

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

1. Determine resultant of forces acting on a body and analyse equilibrium of a body subjected to a system of forces.
2. Solve problem of bodies subjected to friction.
3. Find the location of centroid and calculate moment of inertia of a given section.
4. Understand the kinetics and kinematics of a body undergoing rectilinear, curvilinear, rotatory motion and rigid body motion.

INTRODUCTION TO ENGINEERING MATERIALS

I Year B.Tech. II-Sem

L	T	P	C
2	0	0	2

Course Objectives:

The objectives of this course are to

1. Provide basic understanding of engineering materials, their structure, classification and usage.
2. Introduce the testing methods for various material properties.
3. Understand the properties and applications of metals, ceramics, polymers and composite materials.

UNIT-I Introduction

Classification of Engineering Materials: Atomic structure and interatomic bonding; Crystallography: crystal systems, notations for lattice directions and planes, symmetry elements, common crystal structures, interstitial sites. Defects in materials: Point, line and surface defects.

UNIT –II Metallic Materials

Metals and Alloys: Ferrous alloys: classification, composition, properties and applications of steels and cast irons; Nonferrous Alloys: classification, composition, properties and applications of copper and aluminium alloys.

UNIT – III Ceramics and Polymers

Ceramics: Crystal Structure, classification, properties and applications of ceramics.
Polymers: Crystal Structure, classification, properties and applications of polymers.

UNIT –IV: Composite Materials

Introduction, Classification of Composite materials based on structure and matrix and reinforcements, Advantages and applications of composites, Functional requirements of reinforcement and matrix materials.

UNIT – V: Material Properties

Principle and testing methods for hardness, tensile, impact and creep properties of materials.
Principle, operation, advantages and limitations of liquid penetrant and magnetic particle testing methods.

Text Books:

1. Materials Science and Engineering – A First Course, V. Raghavan, Prentice Hall of India Private Limited, 2015, 6th Edition.
2. George Murray, Charles V. White, Wolfgang Weise, “Introduction to Engineering Materials”, CRC Press, 2007.
3. William. D. Callister, David G. Rethwisch, “Materials Science and Engineering: An Introduction”, John Wiley & Sons, 2018.

Reference Books:

1. E. Paul De Garmo, J.T. Black, R.A. Kohler. Materials and Processes in Manufacturing, John Wiley and Sons, Inc., NY, 11 the Edition, 2012.
2. Donald R Askland and Pradeep P Phule 2013. "Essentials of Materials Science and Engineering", by Pradeep P. Fulay (Author), Donald R. Askeland, 2013.
3. K. K. Chawala, Composite Materials, Kluwer Academic Publishers, 2002.

Course Outcomes:

At the end of the course student will be able to

1. Classify the various materials that will be essential for the Metallurgical engineering applications.
2. Work on various mechanical property testing equipment.
3. Gain the knowledge of usage of materials in different applications.

PYTHON PROGRAMMING LAB

B.Tech. I Year II Sem.

L	T	P	C
0	1	2	2

Course Objectives:

1. To install and run the Python interpreter
2. To learn control structures.
3. To Understand Lists, Dictionaries in python
4. To Handle Strings and Files in Python

Note: The lab experiments will be like the following experiment examples

Week -1:

1. i) Use a web browser to go to the Python website http://python.org. This page contains information about Python and links to Python-related pages, and it gives you the ability to search the Python documentation.
   ii) Start the Python interpreter and type help() to start the online help utility.
2. Start a Python interpreter and use it as a Calculator.
3. i) Write a program to calculate compound interest when principal, rate and number of periods are given.
   ii) Given coordinates (x1, y1), (x2, y2) find the distance between two points
4. Read name, address, email and phone number of a person through keyboard and print the details.

Week - 2:

1. Print the below triangle using for loop.

   5
   4 4
   3 3 3
   2 2 2 2
   1 1 1 1 1

2. Write a program to check whether the given input is digit or lowercase character or uppercase character or a special character (use 'if-else-if' ladder)
3. Python Program to Print the Fibonacci sequence using while loop
4. Python program to print all prime numbers in a given interval (use break)

Week - 3:

1. i) Write a program to convert a list and tuple into arrays.
   ii) Write a program to find common values between two arrays.
2. Write a function called gcd that takes parameters a and b and returns their greatest common divisor.
3. Write a function called palindrome that takes a string argument and returnsTrue if it is a palindrome and False otherwise. Remember that you can use the built-in function len to check the length of a string.

Week - 4:

1. Write a function called is_sorted that takes a list as a parameter and returns True if the list is sorted in ascending order and False otherwise.
2. Write a function called has_duplicates that takes a list and returns True if there is any element that appears more than once. It should not modify the original list.
   i). Write a function called remove_duplicates that takes a list and returns a new list with only the unique elements from the original. Hint: they don't have to be in the same order.
   ii). The wordlist I provided, words.txt, doesn't contain single letter words. So you might want to add "I", "a", and the empty string.
   iii). Write a python code to read dictionary values from the user. Construct a function to invert its content. i.e., keys should be values and values should be keys.
3. i) Add a comma between the characters. If the given word is 'Apple', it should become 'A,p,p,l,e'
   ii) Remove the given word in all the places in a string?
   iii) Write a function that takes a sentence as an input parameter and replaces the first letter of every word with the corresponding upper case letter and the rest of the letters in the word by corresponding letters in lower case without using a built-in function?
4. Writes a recursive function that generates all binary strings of n-bit length

Week - 5:

1. i) Write a python program that defines a matrix and prints
   ii) Write a python program to perform addition of two square matrices
   iii) Write a python program to perform multiplication of two square matrices
2. How do you make a module? Give an example of construction of a module using different geometrical shapes and operations on them as its functions.
3. Use the structure of exception handling all general purpose exceptions.

Week-6:

1. a. Write a function called draw_rectangle that takes a Canvas and a Rectangle as arguments and draws a representation of the Rectangle on the Canvas.
   b. Add an attribute named color to your Rectangle objects and modify draw_rectangle so that it uses the color attribute as the fill color.
   c. Write a function called draw_point that takes a Canvas and a Point as arguments and draws a representation of the Point on the Canvas.
   d. Define a new class called Circle with appropriate attributes and instantiate a few Circle objects.
   Write a function called draw_circle that draws circles on the canvas.
2. Write a Python program to demonstrate the usage of Method Resolution Order (MRO) in multiple levels of Inheritances.
3. Write a python code to read a phone number and email-id from the user and validate it for correctness.

Week- 7

1. Write a Python code to merge two given file contents into a third file.
2. Write a Python code to open a given file and construct a function to check for given words present in it and display on found.
3. Write a Python code to Read text from a text file, find the word with most number of occurrences
4. Write a function that reads a file file1 and displays the number of words, number of vowels, blank spaces, lower case letters and uppercase letters.

Week - 8:

1. Import numpy, Plotpy and Scipy and explore their functionalities.
2. a) Install NumPy package with pip and explore it.
3. Write a program to implement Digital Logic Gates – AND, OR, NOT, EX-OR
4. Write a program to implement Half Adder, Full Adder, and Parallel Adder
5. Write a GUI program to create a window wizard having two text labels, two text fields and two buttons as Submit and Reset.

Text Books:

1. Supercharged Python: Take your code to the next level, Overland
2. Learning Python, Mark Lutz, O'reilly

Reference Books:

1. Python Programming: A Modern Approach, Vamsi Kurama, Pearson.
2. Python Programming A Modular Approach with Graphics, Database, Mobile, and Web Applications, Sheetal Taneja, Naveen Kumar, Pearson.
3. Programming with Python, A User's Book, Michael Dawson, Cengage Learning, India Edition.
4. Think Python, Allen Downey, Green Tea Press.
5. Core Python Programming, W. Chun, Pearson.
6. Introduction to Python, Kenneth A. Lambert, Cengage.

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

1. Develop the application specific codes using python.
2. Understand Strings, Lists, Tuples and Dictionaries in Python.
3. Verify programs using modular approach, file I/O, Python standard library.
4. Implement Digital Systems using Python.

ENGINEERING CHEMISTRY LAB

B.Tech. I Year II Sem.

L	T	P	C
0	0	2	1

Course Objectives: The course consists of experiments related to the principles of chemistry required for engineering student. The student will learn:

1. Estimation of hardness of water to check its suitability for drinking purpose.
2. Students are able to perform estimations of acids and bases using conductometry, potentiometry and pH metry methods.
3. Students will learn to prepare polymers such as Bakelite and nylon-6 in the laboratory.
4. Students will learn skills related to the lubricant properties such as saponification value, surface tension and viscosity of oils.

List of Experiments:

I. Volumetric Analysis:
   1. Estimation of Hardness of water by EDTA Complexometry method.
   2. Estimation of Fe+2 by dichrometry.

II. Conductometry: Estimation of mixture of acids by a strong base.

III. Potentiometry: Estimation of the amount of Fe+2 by Permanganometry.

IV. pH Metry: Determination of the strength of acid using pH metry.

V. Preparations:
   1. Preparation of Bakelite.
   2. Preparation Nylon – 6.

VI. Lubricants:
   1. Estimation of acid value of given lubricant oil.
   2. Estimation of Viscosity of lubricant oil using Ostwald's Viscometer.

VII. Corrosion: Determination of rate of corrosion of mild steel by weight loss method.

VIII. Virtual lab experiments
   1. Construction of Fuel cell and its working.
   2. Smart materials for Biomedical applications
   3. Batteries for electrical vehicles.
   4. Functioning of solar cell and its applications.

Reference Books:

1. Lab manual for Engineering chemistry by B. Ramadevi and P. Aparna, S Chand Publications, New Delhi (2022)
2. Vogel's text book of practical organic chemistry 5th edition
3. Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications.
4. College Practical Chemistry by V.K. Ahluwalia, Narosa Publications Ltd. New Delhi (2007).

Course Outcomes: The experiments will make the student gain skills on:

1. Determination of parameters like hardness of water and rate of corrosion of mild steel in various conditions.
2. Able to perform methods such as conductometry, potentiometry and pH metry in order to find out the concentrations or equivalence points of acids and bases.
3. Students are able to prepare polymers like bakelite and nylon-6.
4. Estimations saponification value, surface tension and viscosity of lubricant oils.

ENGINEERING MATERIALS LAB

I Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Course Objective:

1. The objective of this course is to give hands on experience on testing of materials.

List of Experiments:

1. Construction of crystal structures – SC, BCC, FCC and HCP.
2. Study of grain size measurement methods.
3. Measurement of density of different materials using Archimedes Principle.
4. Determination of influence of temperature on viscosity of lubricating oils.
5. Determination of Rockwell hardness of Fe Alloys.
6. Determination of Rockwell hardness of Cu Alloys.
7. Determination of Rockwell hardness of Al Alloys.
8. Determination of surface defects of materials by Liquid Penetrant Test.
9. Determination of surface and sub - surface defects of materials by magnetic particle testing.
10. Study of electrical and optical properties of engineering materials

Course Outcomes:

At the end of the course student will be able to

1. Gain knowledge on atomic arrangements in different crystal structures and construct crystal structure models.
2. Conduct experiment using hardness testing machines, report, analyze and write the results obtained.
3. Conduct experiment using NDT equipment, report, analyze and write about the observations.

PROBABILITY, STATISTICS & COMPLEX VARIABLES

II Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Mathematics courses of first year of study

Course Objectives: To learn

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

UNIT-I: Basic Probability

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

UNIT-II: Probability distributions

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

UNIT-III: Estimation & Tests of Hypotheses

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

UNIT-IV: Complex Differentiation

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

UNIT-V: Complex Integration

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

Text Books

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

Reference Books

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

Course Outcomes:

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

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

MINERAL PROCESSING

II Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre- Requisites: Nil

Course Objectives:

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

UNIT–I

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

UNIT–II

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

UNIT–III

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

UNIT-IV

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

UNIT–V

Floatation: Principles of floatation. Factors affecting floatation. Classification of collectors and frothers. Regulators, factors affecting their efficiency. Floatation machines: Pneumatic and mechanical floatation cells.

Text Books:

1. Mineral Processing Technology - Barry A. Wills, James Finch Published by Butterworth-Heinemann, 2015.
2. Principles of Mineral Dressing - A.M. Gaudin, published by McGraw-Hill Inc., US, 1939.

References Books:

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

Course Outcomes:

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

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

METALLURGICAL ANALYSIS

II Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

METALLURGICAL THERMODYNAMICS –I

II Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

Fugacity, activity and equilibrium constant: Concepts of fugacity, activity and equilibrium constant variation of the equilibrium constant with temperature, sigma functions.

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

PHYSICAL METALLURGY

II Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Engineering Physics & Engineering Chemistry

Course Objectives:

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

UNIT–I

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

UNIT–II

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

UNIT–III

Types of nucleation, determination of the size of critical nucleus, equilibrium cooling and heating of alloys.

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

Equilibrium Diagrams: Construction, lever rule, phase rule.

UNIT–IV

Types of Phase diagrams: Binary Isomorphous alloy systems, non- equilibrium cooling.

Binary eutectic system, peritectic and monotectic reactions, miscibility gaps. Phase diagrams with intermediate phases and compounds Transformation in solid state: allotropy, eutectoid, peritectoid reactions and order-disorder transformations.

UNIT–V

Study of Fe-Fe_3 C phase diagram. Study of other important binary phase diagrams: Al-Cu, Cu-Zn, Cu-Sn, Pb-Sn, and complex phase diagrams. Strengthening mechanisms: strengthening of grain boundary, work hardening, solid solution strengthening, precipitation hardening and dispersion strengthening.

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

PHYSICAL METALLURGY LAB

II Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Physical Metallurgy

Course Objectives:

The laboratory course helps to:

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

List of Experiments:

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

Course Outcomes:

By completing this laboratory course, students:

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

MINERAL PROCESSING LAB

II Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre- Requisites: Mineral Dressing

Course Objectives:

This laboratory course is designed to

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

List of Experiments:

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

Course Outcomes:

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

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

METALLURGICAL ANALYSIS LAB

II Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre- Requisites: Metallurgical Analysis

Course Objectives:

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

List of Experiments:

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

Course Outcomes:

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

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

CONSTITUTION OF INDIA

II Year B.Tech. I-Sem

L	T	P	C
3	0	0	0

Course Objectives: Students will be able to:

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

UNIT – I

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

UNIT – II

Contours of Constitutional Rights & Duties - Fundamental Rights

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

UNIT – III

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

UNIT – IV

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

UNIT – V

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

Text Books:

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

Course Outcomes:

Students will be able to:

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

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Course Objectives:

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

UNIT - I:

D.C. Circuits: Electrical circuit elements (R, L and C), voltage and current sources, KVL&KCL, analysis of simple circuits with dc excitation.

A.C. Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits, Three-phase balanced circuits, voltage and current relations in star and delta connections.

UNIT - II:

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

UNIT - III:

Electrical Machines: Working principle of Single-phase transformer, equivalent circuit, losses in transformers, efficiency, Three-phase transformer connections. Construction and working principle of DC generators, EMF equation, working principle of DC motors, Torque equations and Speed control of DC motors, Construction and working principle of Three-phase Induction motor, Torques equations and Speed control of Three-phase induction motor. Construction and working principle of synchronous generators.

UNIT - IV:

P-N Junction and Zener Diode: Principle of Operation Diode equation, Volt-Ampere characteristics, Temperature dependence, Ideal versus practical, Static and dynamic resistances, Equivalent circuit, Zener diode characteristics and applications.

Rectifiers and Filters: P-N junction as a rectifier - Half Wave Rectifier, Ripple Factor - Full Wave Rectifier, Bridge Rectifier, Harmonic components in Rectifier Circuits, Filters – Inductor Filters, Capacitor Filters, L- section Filters, π- section Filters.

UNIT - V:

Bipolar Junction Transistor (BJT): Construction, Principle of Operation, Amplifying Action, Common Emitter, Common Base and Common Collector configurations, Comparison of CE, CB and CC configurations.

Field Effect Transistor (FET): Construction, Principle of Operation, Comparison of BJT and FET, Biasing FET.

Text Books:

1. Basic Electrical and electronics Engineering – M S Sukija TK Nagasarkar Oxford University.
2. Basic Electrical and electronics Engineering - D P Kothari. I J Nagarath, McGraw Hill Education.

Reference Books:

1. Electronic Devices and Circuits – R. L. Boylestad and Louis Nashelsky, PEI/PHI, 9th Ed, 2006.
2. Millman's Electronic Devices and Circuits – J. Millman and C. C. Halkias, Satyabrata Jit, TMH, 2/e, 1998.
3. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6^{th} edition.
4. Linear circuit analysis (time domain phasor and Laplace transform approaches) - 2^{nd} edition by Raymond A. De Carlo and Pen-Min-Lin, Oxford University Press-2004.
5. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
6. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Course Outcomes:

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

METALLURGICAL THERMODYNAMICS-II

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

This course is mainly intended to deals with

1. Interpret Ellingham diagrams
2. Identify metallurgical thermodynamics principles to be applied in phase diagrams.
3. Identify metallurgical thermodynamics principles to be applied in reversible cells.

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

Obtain the skill to use Metallurgical Thermodynamics concept for

1. Interpret Ellingham Diagram for oxides.
2. Knowledge of ideal and regular solutions and free energy of mixing.
3. Apply the phase rule on the metallurgical systems.
4. Understanding of the nature of polarized electrochemical reactions and an introduction of their application in corrosion behavior of metals.
5. Determine order of reaction. Explain the central concepts of chemical kinetics. Formulate and solve rate equations for various reactions.

PRINCIPLES OF EXTRACTIVE METALLURGY

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Mineral Processing and Metallurgical Thermodynamics-I

Course Objectives:

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

UNIT-I

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

UNIT-II

Pelletisation and Sintering, Smelting: Principles of reduction and matte smelting with examples. Smelting furnaces: Reverberatory, Blast Furnace and electric smelting. Flash smelting.
Slags: Classification, properties, Application of Ellingham diagrams for oxides and sulphides.

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

FUELS, FURNACES & REFRACTORIES

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT–I

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

Liquid fuels: Properties and applications.

UNIT –II

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

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

UNIT-III

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

UNIT-IV

Pyrometry: Thermo electric pyrometer - Peltier and Thomson e.m.f. Thermo-electric power of thermocouples. Required properties of thermocouples. Noble and base metal thermocouples. Principle, operation and applications of Thermometer, Optical and Radiation pyrometers.

UNIT – V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

IRON MAKING

II Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-requisites: Mineral Processing and Metallurgical Thermodynamics -I

Course Objectives:

1. Discuss the evolution of Iron making in chronological order.
2. Illustrate the applications of thermodynamics and kinetics in production of pig iron and refining it.
3. Outline the techniques for production and primary processing in Blast furnace.
4. Differentiate between past and present production methods and examine the modern trends in iron production.
5. Identify consists and effect for blast furnace irregularities and their remedial measures.

UNIT - I

Raw materials for Iron making. Occurrence and distribution of iron ores. Classification and factors affecting valuation of iron ores. Preparation of iron ores.

UNIT – II

Blast Furnace profile and design considerations. Furnace lining. Furnace cooling system. BF Stoves. BF gas cleaning system. Blast furnace operation and irregularities.

UNIT - III

Systems of importance in iron making, blast furnace reactions. Thermodynamics of iron oxide reduction by $CO + CO_2$ and H_2 and H_2O mixtures. Control of C, Si, S, P in metals and slags.

UNIT - IV

Modern trends in blast furnace: High top pressure, humidification of blast, Oxygen enrichment, hot blast temperature and top charging systems.

UNIT - V

Alternative routes of iron making: Sponge iron making: HYL and Rotary Kiln.
Smelting and reduction methods such as Corex process.

Text Books:

1. Iron making and steel making – Theory and practice Ahindra and Ghosh.
2. Hot metal production by smelting reduction of Iron ore - Amit Chatterjee, P & H publications, 2010.
3. An Introduction to Modern Iron Making - Dr. R.H. Tupkary, Khanna Publishers, 2004.

References Books:

1. Beyond the B.F – Amit Chatterjee.
2. Sponge Iron production by direct reduction of Iron ores - Amit Chatterjee, P & H, publications, 2010.

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

1. Describe the developments of Iron making and recognize the importance of processing raw materials for Iron making keeping in view of economics, safety and efficiency.
2. Identify the required parameters and design of a blast furnace and illustrate ancillary equipment and measures to be taken for starting and trouble shooting of Blast furnace process.
3. Predict the physico-chemical phenomena taking place in blast furnace. Able to perform simple mass balance and complex problems.
4. Identify and explain the modernization techniques to improve quantity, quality and minimization of waste.
5. Able to predict the possible alternative processes to be followed suitable to the local conditions in view of energy, environmental and efficiency considerations.
6. Able to undertake any technical assignment in R&D and production units with professional responsibility towards profession and society.

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LAB

II Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Pre-requisites: Basic Electrical and Electronics Engineering

Course Objectives:

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

List of Experiments / Demonstrations:

PART A : ELECTRICAL

1. Verification of KVL and KCL
2. (i) Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single-Phase Transformer
   (ii) Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Deltastar, Star-Star) in a Three Phase Transformer
3. Measurement of Active and Reactive Power in a balanced Three-phase circuit.
4. Performance Characteristics of a Separately Excited DC Shunt Motor
5. Performance Characteristics of a Three-phase Induction Motor
6. No-Load Characteristics of a Three-phase Alternator

PART B : ELECTRONICS

1. Study and operation of
   (i) Multi-meters (ii) Function Generator (iii) Regulated Power Supplies (iv) CRO.
2. PN Junction diode characteristics
3. Zener diode characteristics and Zener as voltage Regulator
4. Input & Output characteristics of Transistor in CB / CE configuration
5. Full Wave Rectifier with & without filters
6. Input and Output characteristics of FET in CS configuration

Text Books:

1. Basic Electrical and electronics Engineering –M S Sukija TK Nagasarkar Oxford University.
2. Basic Electrical and electronics Engineering-D P Kothari. I J Nagarath, McGraw Hill Education.

Reference Books:

1. Electronic Devices and Circuits – R. L. Boylestead and Louis Nashelsky, PEI/PHI, 9th Ed, 2006.
2. Millman's Electronic Devices and Circuits – J. Millman and C. C. Halkias, Satyabrata Jit, TMH, 2/e, 1998.
3. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6th edition.
4. Linear circuit analysis (time domain phasor and Laplace transform approaches) - 2nd edition by Raymond A. De Carlo and Pen-Min-Lin, Oxford University Press-2004.
5. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
6. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.

Course Outcomes:

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

PRINCIPLES OF EXTRACTIVE METALLURGY LAB

II Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Principles of Extractive Metallurgy

Course Objectives:

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

List of Experiments

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

Course Outcomes:

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

FUELS, FURNACES AND REFRACTORIES LAB

II Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Nil

Course Objectives:

This laboratory course deals with:

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

List of Experiments:

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

Course Outcomes:

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

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

REAL-TIME RESEARCH PROJECT / FIELD - BASED PROJECT

II Year B.Tech. II-Sem

L	T	P	C
0	0	4	2

GENDER SENSITIZATION LAB

II Year B.Tech. II-Sem

L	T	P	C
0	0	2	0

COURSE DESCRIPTION

This course offers an introduction to Gender Studies, an interdisciplinary field that asks critical questions about the meanings of sex and gender in society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary. It draws on multiple disciplines – such as literature, history, economics, psychology, sociology, philosophy, political science, anthropology and media studies – to examine cultural assumptions about sex, gender, and sexuality.

This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with race, class, caste, nationality and other social identities. This course also seeks to build an understanding and initiate and strengthen programmes combating gender-based violence and discrimination. The course also features several exercises and reflective activities designed to examine the concepts of gender, gender-based violence, sexuality, and rights. It will further explore the impact of gender-based violence on education, health and development.

Objectives of the Course

- To develop students' sensibility with regard to issues of gender in contemporary India.
- To provide a critical perspective on the socialization of men and women.
- To introduce students to information about some key biological aspects of genders.
- To expose the students to debates on the politics and economics of work.
- To help students reflect critically on gender violence.
- To expose students to more egalitarian interactions between men and women.

Learning Outcomes

- Students will have developed a better understanding of important issues related to gender in contemporary India.
- Students will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from research, facts, everyday life, literature and film.
- Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.
- Students will acquire insight into the gendered division of labor and its relation to politics and economics.
- Men and women students and professionals will be better equipped to work and live together as equals.
- Students will develop a sense of appreciation of women in all walks of life.
- Through providing accounts of studies and movements as well as the new laws that provide protection and relief to women, the textbook will empower students to understand and respond to gender violence.

Unit-I: UNDERSTANDING GENDER

Introduction: Definition of Gender-Basic Gender Concepts and Terminology-Exploring Attitudes towards Gender-Construction of Gender-Socialization: Making Women, Making Men - Preparing for Womanhood. Growing up Male. First lessons in Caste.

Unit – II: GENDER ROLES AND RELATIONS

Two or Many? -Struggles with Discrimination-Gender Roles and Relations-Types of Gender Roles- Gender Roles and Relationships Matrix-Missing Women-Sex Selection and Its Consequences- Declining Sex Ratio. Demographic Consequences-Gender Spectrum: Beyond the Binary

Unit – III: GENDER AND LABOUR

Division and Valuation of Labour-Housework: The Invisible Labor- "My Mother doesn't Work." "Share the Load." Work: Its Politics and Economics -Fact and Fiction. Unrecognized and Unaccounted work.

Gender Development Issues-Gender, Governance and Sustainable Development-Gender and Human Rights-Gender and Mainstreaming.

Unit – IV: GENDER - BASED VIOLENCE

The Concept of Violence - Types of Gender-based Violence-Gender-based Violence from a Human Rights Perspective-Sexual Harassment: Say No!-Sexual Harassment, not Eve-teasing-Coping with Everyday Harassment- Further Reading: "*Chupulu".*

Domestic Violence: Speaking OutIs Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Thinking about Sexual Violence Blaming the Victim-"I Fought for my Life…."

Unit – V: GENDER AND CULTURE

Gender and Film-Gender and Electronic Media-Gender and Advertisement-Gender and Popular Literature- Gender Development Issues-Gender Issues-Gender Sensitive Language-Gender and Popular Literature - Just Relationships: Being Together as Equals

Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Rosa Parks- The Brave Heart.

Note: **Since it is Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.**

- ***Classes will consist of a combination of activities: dialogue-based lectures, discussions, collaborative learning activities, group work and in-class assignments. Apart from the above prescribed book, Teachers can make use of any authentic materials related to the topics given in the syllabus on "Gender".***

- **ESSENTIAL READING**: The Textbook, "*Towards a World of Equals: A Bilingual Textbook on Gender"* written by A.Suneetha, Uma Bhrugubanda, DuggiralaVasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu **published by Telugu Akademi, Telangana Government in 2015.**

ASSESSMENT AND GRADING:

- Discussion & Classroom Participation: 20%
- Project/Assignment: 30%
- End Term Exam: 50%

BUSINESS ECONOMICS & FINANCIAL ANALYSIS

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Course Objective:

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

Unit- I:

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

Unit- II:

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

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UNIT- III:

Production, Cost, Market Structures & Pricing:

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

Unit- IV:

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

Unit- V:

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

Suggested Readings:

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

Course Outcome:

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

MECHANICAL METALLURGY

III Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT–II

Hardness Test: Brinell, Vickers, Rockwell, Microhardness test, relationship between hardness and other mechanical properties, Nanoindentation.

The Tension Test: Engineering stress-strain and True stress-strain curve. Tensile properties, conditions for necking, effect of temperature and strain rate on tensile properties.

Elastic and in-elastic action and properties in compression test.

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

UNIT-III

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

UNIT–IV

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

UNIT–V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

HEAT TREATMENT AND PHASE TRANSFORMATIONS

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Physical Metallurgy

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

Surface Hardening: Principles and Applications of Carburizing, Nitriding, Carbonitriding, Nitrocarburizing, Boronizing and Aluminizing; Flame, Induction and Laser surface hardening.

UNIT–IV

Thermo mechanical treatments: HTMT, LTMT, Ausforming, Isoforming, Cryoforming.
Heat-Treatment of Cast Irons.

UNIT-V

Heat-Treatment of Copper and its alloys and Aluminium and its alloys.
Heat treatment furnaces, types and applications, Atmospheres, Heat treatment defects and remedies.

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

METAL CASTING

III Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

This course is mainly intended to

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

UNIT - I

Introduction to Foundry, Types of foundries - Steps involved in casting. Pattern types, allowances for pattern, pattern materials.

Moulding methods and processes - materials, equipment, Moulding sand ingredients, sand preparation and control, testing, cores and core making - its types.

UNIT - II

Sand castings - Green and dry, pressure die casting, Gravity die casting, permanent mould casting, centrifugal casting, precision investment casting, shell Moulding, CO_2 Moulding. Continuous casting and squeeze casting.

UNIT - III

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

UNIT - IV

Solidification time and Chvorinov's rule, concept of progressive and directional solidifications, Metallurgical aspects of Casting. Types of Melting furnaces- crucibles, oil fired furnaces, electric furnaces and cupola, calculation of cupola charges, Degasification, inoculation, pouring techniques.

UNIT - V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

STEEL MAKING

III Year B.Tech. I-Sem

L	T	P	C
3	1	0	4

Pre-requisites: Iron Making, Metallurgical Thermodynamics - I

Course Objectives:

1. Discuss the evolution of steel making processes in chronological order.
2. Illustrate the applications of thermodynamics and kinetics in production of steel making.
3. Outline the techniques for production and primary processing in steel making.
4. Explain the casting processes for steel.

UNIT - I

Classification of Steel making Processes. Raw materials for steel making. Factors affecting the efficiency of steel making. Principles of Steel Making - Decarburisation, Desiliconization. Dephosphorisation and Desulphurisation. Deoxidation practice. Molecular and ionic theory of slags.

UNIT - II

Bessemer and open-hearth steel making processes, electric arc steel making.

UNIT - III

LD, LD - AC steel making processes. Bottom blown O_2 processes. Combined blow processes.

UNIT - IV

Casting pit side practice, Teeming methods. Solidification of steels – killed steels, semi killed steels and Rimming steels. Ingot defects and remedies.

UNIT - V

Secondary steel making processes - Vacuum treatment of steels**:** RH and DH process. Continuous casting of steels.

Text Book:

1. Iron Making and Steel Making – Theory and practice - Ahindra Ghosh and Amit Chatterjee published by Prentice Hall India Learning Pvt. Ltd, 2008.
2. An Introduction to Modern Steel Making, 7^{th} Edition – Dr. R. H. Tupkary and V. R. Tupkary, Khanna Publishers, 2000.

Reference Books:

1. Steel Making - A.K. Chakrabarti, published by Prentice Hall India Learning Pvt. Ltd, 2006.
2. Steel Making - V.A. Kudrin, Mir Publishers, 1985.

Course Outcomes:

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

1. Knowledge and analyze the effect of input variables on quantity and quality of steel production
2. Illustrate the constructional details of various furnaces used in steel making and design plant lay outs.
3. Judge the role of slag chemistry on quality of steel.
4. Know and apply principles of modern environmental friendly production techniques.
5. Able to undertake any technical assignment in R&D and production units with professional responsibility towards profession and society.

METAL CASTING LAB

III Year B.Tech. I - Sem

L	T	P	C
0	0	2	1

Pre-Requisites:

Course Objectives:

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

LIST OF EXPERIMENTS:

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

Course Outcomes:

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

HEAT TREATMENT AND PHASE TRANSFORMATIONS LAB

III Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Heat Treatment and Phase Transformations

Course Objectives:

This course is mainly designed to

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

List of Experiments:

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

Course Outcomes:

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

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

MECHANICAL METALLURGY LAB

III Year B.Tech. I - Sem

L	T	P	C
0	0	2	1

Pre-Requisites: Mechanical Metallurgy

Course Objectives:

Students will be able:

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

List of Experiments:

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

Course Outcomes:

After completing the course, the student will be able:

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

INTELLECTUAL PROPERTY RIGHTS

III Year B.Tech. I - Sem

L	T	P	C
3	0	0	0

UNIT – I

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT – III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT – IV

Trade Secrets: Trade secret law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

UNIT – V

New development of intellectual property: new developments in trade mark law; copy right law, patent law, intellectual property audits.

International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

Text & Reference Books:

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
2. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd.

NON-FERROUS EXTRACTIVE METALLURGY

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Mineral Dressing and Principles of Extractive Metallurgy

Course Objectives:

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

UNIT-I

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

UNIT-II

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

Lead: Blast furnace smelting, Refining of lead bullion.

UNIT-III

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

UNIT-IV

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

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

UNIT-V

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

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

METAL FORMING

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-requisites: Mechanical Metallurgy

Course Objective:

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

UNIT-I:

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

UNIT - II:

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

UNIT-III:

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

UNIT-IV:

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

UNIT-V:

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

METAL JOINING

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-requisites: None

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

Soldering and Brazing: Principles and practices.

UNIT-V

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

Inspection of Weld Joints. Non-destructive testing.

Weld defects- their causes and remedies.

Text Books:

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

Reference Books:

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

Course Outcomes:

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

CERAMICS AND COMPOSITE MATERIALS
(Professional Elective - I)

III Year B.Tech. II -Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

Introduction to Composite materials, Fibers: Fabrication, structures, properties and applications of glass fibers, boron fibers, carbon fibers, organic fibers, ceramic fibers and metallic fibers.

Matrix materials: Polymers, metals and ceramic matrix materials.

UNIT-IV

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

UNIT-V

Interfaces and bonding, strengthening and toughening mechanism, Testing of interfacial strength.

Text Books:

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

Reference Books:

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

Course Outcomes:

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

COMPUTATIONAL MATERIALS ENGINEERING
(Professional Elective – I)

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course objective:

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

UNIT- I

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

UNIT-II

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

UNIT- III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

FERRO ALLOY TECHNOLOGY
(Professional Elective – I)

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

The prime objective of the course is to

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

UNIT-I

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

UNIT-II

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

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

UNIT-III

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

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

UNIT-IV

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

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

UNIT-V

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

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

Text Books:

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

Reference Book:

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

Course Outcomes:

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

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

METALLURGY FOR NON METALLURGISTS
(Open Elective - I)

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

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

COMPOSITE MATERIALS
(Open Elective - I)

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. Describe the importance of composite materials and its constituents.
2. Familiarize the students with various types of fibers, their properties and processing techniques.
3. Introduce the various process techniques for composite materials.
4. To demonstrate the relationship among synthesis, processing and properties in composite materials.

UNIT-I

Introduction, Classification of Composite materials based on structure and matrix and reinforcements, Advantages and applications of composites, Functional requirements of reinforcement and matrix materials.

UNIT-II

Types of reinforcements and their properties: Glass, Carbon, Boron, Aramid, Al_2O_3 and SiC fibers. Nature and manufacture of glass, carbon and aramid fibres, Comparison of fibres. Role of interfaces: Wettability and Bonding, Tests for measuring Interfacial and bond strength.

UNIT-III

Fabrication of Polymeric Matrix Composites, Structure and properties of Polymeric Matrix Composites, Applications. Fabrication of Ceramic Matrix Composites, Toughness of Ceramic Matrix Composites, Properties and Applications of Ceramic Matrix Composites.

UNIT-IV

Fabrication of Metal Matrix Composites: Solid state fabrication, Liquid state fabrication and In-situ fabrication techniques. Mechanical bonding, Chemical bonding. Discontinuously reinforced Metal Matrix Composites: Properties and Applications. Fabrication of Carbon Fiber Composites, Properties and Applications of Carbon Fiber Composites.

UNIT -V

Micro Mechanics of Composites: Density, Mechanical Properties: Prediction of Elastic constants, Micro mechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties: Hygrothermal stresses and Mechanics of Load transfer from matrix to fiber.

Text Books:

1. Composite Materials – Science & Engineering, 3rd edition - K.K. Chawla, Springer-Verlag, New York, 2012.
2. An Introduction to Composite Materials, 3rd Edition - D. Hull, Cambridge, 2019.

Reference Books:

1. Composites, Engineered Materials Handbook, Vol.21, 18th Edition, ASM International, Ohio, 2017.
2. Structure and Properties of Composites, Materials Science and Technology, Vol. 13, VCH, Weinheim, Germany, 1993
3. Composite Materials: Engineering and Science, F.L. Matthews and R.D. Rawlings, Chapman & Hall, London, Woodhead Publishing; Reprint edition, 1999.

Course Outcomes:

1. Can classify the composites, know the required properties, reinforcements and matrix materials and uses of composites.
2. Able to explain how common fibers are produced and how the properties of the fibers are related to the internal structure and the interfaces obtained.
3. Knowledge of processing techniques for polymer matrix, ceramic matrix and metal matrix composites and list out their properties and applications.
4. Ability to arrive at different deformation and failure mechanisms of composite materials under different loading conditions in engineering applications.
5. Able to explain the elastic constants and strengths of the composite.
6. Able to undertake any technical assignment in R&D and production of newer and smarter materials.

METAL FORMING LAB

III Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Pre Requisites:

Course Objectives:

This lab course is designed to know

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

LIST OF EXPERIMENTS:

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

Course Outcomes:

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

METAL JOINING LAB

III Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

Pre Requisites:

Course Objectives:

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

LIST OF EXPERIMENTS:

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

Course Outcomes:

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

ADVANCED ENGLISH COMMUNICATION SKILLS LABORATORY

III Year B.Tech. II-Sem

L	T	P	C
0	0	2	1

1. INTRODUCTION:

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

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

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

2. OBJECTIVES:

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

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

3. SYLLABUS:

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

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

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

4. MINIMUM REQUIREMENT:

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

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

5. SUGGESTED SOFTWARE:

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

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

Text Books:

1. Effective Technical Communication by M Asharaf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition
2. Academic Writing: A Handbook for International Students by Stephen Bailey, Routledge, 5th Edition.

References:

1. Learn Correct English – A Book of Grammar, Usage and Composition by Shiv K. Kumar and Hemalatha Nagarajan. Pearson 2007
2. Professional Communication by ArunaKoneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
3. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
4. Technical Communication by Paul V. Anderson. 2007. Cengage Learning pvt. Ltd. New Delhi.

5. English Vocabulary in Use series, Cambridge University Press 2008.
6. Handbook for Technical Communication by David A. McMurrey& Joanne Buckley. 2012. Cengage Learning.
7. Communication Skills by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.
8. Job Hunting by Colm Downes, Cambridge University Press 2008.
9. English for Technical Communication for Engineering Students, AyshaVishwamohan, Tata Mc Graw-Hill 2009.

INDUSTRY ORIENTED MINI PROJECT/ INTERNSHIP

III Year B.Tech. II-Sem

L	T	P	C
0	0	4	2

Pre-Requisites: Nil

Course Objectives:

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

Course Outcomes:

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

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

ENVIRONMENTAL SCIENCE

III Year B.Tech. II-Sem

L	T	P	C
3	0	0	0

Course Objectives:

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

UNIT - I

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

UNIT - II

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

UNIT - III

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

UNIT - IV

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

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

UNIT - V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

INTRODUCTION TO INSTRUMENTATION

IV Year B.Tech. I-Sem

L	T	P	C
2	0	0	2

Pre- Requisites: Nil

Course Objectives:

To have a knowledge of:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT- V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

ENVIRONMENTAL DEGRADATION OF MATERIALS

IV Year B.Tech. I-Sem

L	T	P	C
2	0	0	2

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

Course Objectives:

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

UNIT-I

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

UNIT – II

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

UNIT - III

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

UNIT-IV

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

UNIT - V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

MATERIALS CHARACTERIZATION TECHNIQUES
(Professional Elective – II)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT – I

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

UNIT – II

(a) Scanning Electron Microscopy (SEM) - Introduction, instrumentation, Contrast formation, Operational variables, Specimen Preparation, Imaging Modes, Applications, and Limitations.
(b) Transmission Electron Microscopy (TEM**) -** Introduction, instrumentation, Specimen preparation –pre thinning, final thinning, Image modes-mass density contrast, diffraction contrast, Phase contrast, Applications, Limitations.

UNIT – III

X-Ray Diffraction (XRD) - Introduction, production and properties of X-ray, Absorption and diffraction, Instrumentation, determination of Structure, Crystallite size, phase diagram and residual stresses.

UNIT – IV

Thermal Analysis: Introduction, Differential thermal analysis, Differential Scanning Calorimetry, Thermogravimetry, Dilatometry, Dynamic Mechanical analysis.

UNIT – V

Scanning Probe Microscopy (SPM), Scanning Tunneling Microscopy-Basics, Probe Tips, Working environment, operational modes, Applications, Limitations.
Atomic Force Microscopy (AFM) – Basic Principles, instrumentation, operational modes, Applications, Limitations.

Text Books:

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

Reference Books:

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

Course Outcomes:

At the end of the course, student will be:

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

NUCLEAR METALLURGY
(Professional Elective – II)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre requisites: Nil

Course Objectives:

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

UNIT – I

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

UNIT - II

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

UNIT – III

Types of reactors and classification.

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

UNIT – IV

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

UNIT – V

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

Nuclear power production in India and its economics.

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

ELECTRONIC MATERIALS
(Professional Elective - II)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre- Requisites: Nil

Course Objectives:

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

UNIT- I

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

UNIT-II

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

UNIT- III

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

UNIT- IV

Ionic conductors and Dielectric materials: Ionic conduction – review of defect equilibrium and diffusion mechanisms; Theory of ionic conduction, conduction in glasses; Effect of stoichiometric and extrinsic defects on conduction, Applications in sensors and fuel cells.
Dielectric constants and polarization, linear dielectric materials, capacitors; Polarization mechanisms; Non-linear dielectrics, pyro-, piezo-, and ferro-electric properties, hysterisis and ferroelectric domains; Applications in sensors, actuators and memory devices.

UNIT -V

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

Text Books:

1. Electronic Properties of Materials: An Introduction for Engineers, Rolf E. Hummel, Springer Verlag, 1985
2. Physical Properties of Semiconductors, Charles M. Wolfe, Nick Holonyak and Gregory E. Stillman, Prentice Hall, 1989
3. Semiconductor Materials, Devices and Fabrication, Parasuraman Swaminathan, Wiley 2017

Reference Books:

1. Principles of Electronic Materials and Devices, S. O. Kasap, McGraw Hill Education, 2017.
2. Electronic Materials by Chelikowsky, James R., Franciosi, Alfonso (Eds.).
3. Electronic Materials and Processes Handbook by Charles Harper.

Course Outcomes:

After completing this course the student should be able to:

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

LIGHT METALS & ALLOYS
(Professional Elective – III)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

This course is mainly intended:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

1. Heat Treatment, structure and properties of Nonferrous Alloys - Charlie R. Brooks, Published by ASM International, 1982.
2. Engineering Physical Metallurgy, 1st Edition – Lakhtin published by CBS Publishers and Distributors Pvt. Ltd., 2005.
3. ASM Metals Handbook Vol-1 & 2, 1990.
4. Metallurgical Abstracts on Light Metals and Alloys, Volume – 32 - Keikinzoku Shōgakukai, published by Light Metal Educational Foundation, 1999.

Course Outcomes:

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

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

FATIGUE AND FRACTURE MECHANICS
(Professional Elective – III)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

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

Text Books:

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

Reference Books:

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

Course Outcomes:

After completing this course, the student will have:

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

FAILURE ANALYSIS
(Professional Elective– III)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

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

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

UNIT-III

Failure mechanisms. Embrittlement phenomena. Environmental effects.

UNIT-IV

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

UNIT-V

Case studies in failure analysis and prevention of failures.

Test Books:

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

Reference Books:

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

Course Outcomes:

After completing this course the student will have:

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

SURFACE ENGINEERING
(Professional Elective -IV)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Physical Metallurgy and Thermodynamics and Kinetics

Course Objectives:

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

UNIT-I

Introduction to surface modification, surface properties, need for surface modification, Classification of surface modification techniques.

UNIT-II

Plating and coating process: Concept of coating, types of coatings, properties of coatings, hot dipping hard facing, anodizing, physical vapour deposition, chemical vapour deposition, electro-deposition, electro-less deposition

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

ENERGY MATERIALS
(Professional Elective – IV)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To understand energy requirements on domestic and international scale.
2. To learn the operating principle of several environmentally friendly energy technologies.
3. To identify the material issues relevant to these technologies and to evaluate various operational aspects associated with these technologies.

UNIT-I

Energy requirements in a global scale and in the Indian context. Global context in terms of reducing greenhouse-gas emissions that contribute to climate change. Develop the infrastructure to meet the needs other energy- consuming sectors, the scale of India's energy resources and its energy production. Examples of coal-based DRI, pulp and paper making and small-scale cement kilns.

UNIT-II

Evaluation of energy sources from the perspective of clean energy. Carbon equivalent, The carbon footprint of various forms of energy. Renewable energy and carbon Credits. Life cycle assessment, Re-cycling.

UNIT-III

Introduction to different types of energy storage and conversion devices and technologies. Synthesis and characterization of materials used for these technologies, Properties desired in the materials, Techniques to evaluate the properties and performance, failure modes and analysis and environmental impact.

UNIT-IV

Technologies and function of Energy Storage devices, Batteries & Super Capacitors.

UNIT-V

Solar energy conversion devices, Wind & Mechanical Energy storages.

Text Books:

1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 2004.
2. Energy Materials by Duncan W. Bruce, Dermot O'Hare, Richard I. Walton.

Reference Books:

1. Materials Science in Energy Technology 1st Edition by G Libowitz.
2. Advanced Energy materials 1st Edition by Ashutosh Tiwari, Sergiy Valyukh.
3. Energy Storage & Conversion: Materials & Devices by A. Kumar, S. K. Das.

Course Outcomes:

After completing this course the student should be able to:

1. Evaluate an energy technology for environmental friendliness.
2. Explain the operating principle of several energy technologies.
3. Indicate the material requirements for these energy technologies.
4. Demonstrate the ability to understand the characterization, performance, and failure data related to these technologies.
5. Comprehend various energy storage, conversation devices and technologies.
6. Demonstrate the various renewable energy sources and characterize the materials which can be used.

NON DESTRUCTIVE TESTING
(Professional Elective – IV)

IV Year B.Tech. I-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

Electrical methods: Eddy current methods, potential-drop methods, applications.
Electromagnetic testing: Magnetism, Magnetic domains, Magnetization curves, Magnetic Hysteresis. Hysteresis-loop tests, comparator - bridge tests Absolute single-coil system, applications.

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

The end of the student gain will be:

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

TESTING OF MATERIALS
(Open Elective - II)

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

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Course Objectives:

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

UNIT–I

Introduction, Importance of testing.

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

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

UNIT-II

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

UNIT-III

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

UNIT–IV

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

UNIT–V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

CORROSION PROCESS AND CONTROL
(Open Elective – II)

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

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

1. To list out various atmospheres responsible for corrosion and understand the various corrosion combating techniques.
2. To determine corrosion rate/ resistance of metals and alloys.
3. To demonstrate electrometallurgy principles in deposition winning and the efficiency of the bath.
4. To explain corrosion protection methods and tests.

UNIT-I

Introduction, Electro Chemistry principles, Corrosion, Introduction and Definition, electrochemical reactions, Polarization, passivity, environmental effects (oxygen, oxidizers, velocity, temperature, corrosive concentration, Galvanic coupling).

UNIT-II

Forms of corrosion, uniform corrosion, Two metal corrosion: Sacrificial anode, EMF and Galvanic Series, Environmental effects, Pitting corrosion: Pit shape and growth, Autocatalytic Nature of pitting, Crevice corrosion.

UNIT-III

Intergranular corrosion: Sensitization, weld decay, Knife-Line attack, Stress corrosion cracking: crack morphology, stress effects, environmental factors, metallurgical factors, Erosion corrosion: cavitation damage, fretting corrosion, Corrosion fatigue.

UNIT-IV

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

UNIT-V

Modern theory and applications of corrosion: Introduction, free energy, cell potentials, emf series, applications of thermodynamics to corrosion, Corrosion rate expressions and measurements, corrosion testing.

Text Books:

1. Corrosion Engineering, M. G. Fontana, 3rd edition, McGraw-Hill, 1985.
2. Corrosion and Corrosion Control, H. H. Uhlig, Wiley, 1985.

Reference Books:

1. Theory of Corrosion and Protection of Metals, N. D. Tomashov, Macmillan, 1967.
2. Introduction to Electrometallurgy & Corrosion by Sharan – Narayan.
3. Corrosion Engineering 1st Edition Principles and Solved Problems by Branko Popov.
4. Handbook of Corrosion Engineering, Second Edition by: Pierre R. Roberge, Ph.D.

Course Outcomes:

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

1. Able to interpret electro chemical phenomenon.
2. Can explain different types of corrosion, their causes, effect and able to identify the different remedial measures to be taken.
3. Able to design corrosion resistant structures and materials.
4. Determine the thermodynamic causes of corrosion.
5. Conduct corrosion tests and able to quantify the corrosion processes.
6. Able to graphically represent and interpret Eh-pH, pourbiax extrapolation techniques.

ENVIRONMENTAL DEGRADATION OF MATERIALS LAB

IV Year B.Tech. I-Sem

L	T	P	C
0	0	2	1

Pre-Requisites: **NIL**

Course Objectives:

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

List of Experiments:

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

Course Outcomes:

Through this laboratory practice, the student will be able:

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

SOLIDIFICATION PROCESSING
(Professional Elective - V)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites : Physical Metallurgy and Material Processing-I

Course Objectives :

1. To inculcate the metallurgical aspects during solidification of metal and alloys.
2. To impart knowledge about solidification of casting with detail emphasis on calculation of gating/riser system.
3. To impart knowledge about solidification behaviour during welding and effect of microstructure in HAZ.

UNIT-I

Principles of solidification: Nucleation and growth of pure metals and alloys, Cooling curves, heat transfer associated in nucleation and growth, eutectic solidification; Homogeneous and Heterogeneous nucleation.

UNIT-II

Solidification of ingots and castings: formation of plane front columnar, equiaxed and dendritic structures, Effect of composition, moulding materials and cooling rate on solidification pattern.

UNIT-III

Segregation and shrinkage phenomena in castings, calculation of solidification time for casting, heat transfer calculations in metal casting, principles of chill design.

UNIT-IV

Heat transfer in weldments, dissipation of welding heat, cooling rates, weld metal cooling curves, peak temperature, calculating width of heat affected zones, solidification rate and affects of heat input.

UNIT-V

Heat conduction with and without phase change by finite element method, finite volume method and finite differences methods.

Text Books:

1. Physics of Welding – J. F. Lancaster, Pergamon press, 1986.
2. Principles of Metal Casting, 2nd Edition - Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, published by McGraw Hill Higher Education1976.

Reference Books:

1. Fundamentals of Solidification, 4th Edition - W. Kurz and D.J. Fisher, published by CRC Press, 1998.
2. Castings, 2nd Edition - John Campbell, published by Butterworth Heinemann, 2003.
3. Science and Engineering of Casting Solification, 2nd Edition - Doru Micheal stefanescu, published by Springer, 2009.
4. Solidification and Casting - Davies, Graeme John, Applied science publishers Ltd., 1973
5. Solidification Processing - M.C. Flemings, McGraw-Hill, N.Y., 1974
6. Solidification of Casting; Ruddle, R.W., Institute of Metals, 1957

Course Outcomes:

The student will be able to:

1. Explain the principles and practice of directional solidification.
2. Describe the procedures used for controlling porosity and shrinkage during solidification processing.
3. List out the microstructural differences between cast and wrought metallic alloy products.
4. Knowledge about the microstructural mechanisms associated with metals joining operations including heat affected zones.

NON METALLIC MATERIALS
(Professional Elective - V)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

After completing this course the student can:

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

FUNCTIONAL MATERIALS
(Professional Elective – V)

IV Year B.Tech. II-Semester

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

POWDER METALLURGY
(Professional Elective - VI)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil.

Course Objectives:

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

UNIT–I

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

UNIT–II

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

UNIT–III

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

UNIT–IV

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

UNIT –V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

BIO MATERIALS
(Professional Elective - VI)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre- Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT–III

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

UNIT–IV

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

UNIT-V

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

Text Books:

1. Introduction to Biomaterials: Basic Theory with Engineering Applications, 1st Edition - C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford and Gopinath Mani, published by Cambridge University Press, 2013.
2. Biomaterials Science: An introduction to Materials in Medicine, 3rd Edition - Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons - Academic Press, 2012.

Reference Books:

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

Course Outcomes:

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

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

TRANSPORT PHENOMENA
(Professional Elective - VI)

IV Year B.Tech. II-Sem

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

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

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

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

ALLOY STEELS
(Open Elective - III)

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

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course Objectives:

This course deals with:

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

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

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

UNIT- V

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

Text Books:

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

Reference Books:

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

Course Outcomes:

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

HIGH TEMPERATURE MATERIALS
(Open Elective – III)

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

L	T	P	C
3	0	0	3

Pre-Requisites: Nil

Course objectives:

1. To learn and design material's microstructure for high temperature applications.
2. To learn scientific issues related to high temperature such as creep, oxidation and material degradation.
3. To study the properties which improve high temperature resistance.

UNIT-I

Creep, Types of Creep, Testing methods, Creep data presentation, Creep Curve and stages of creep, Mechanisms of Creep and creep resistant steels.

UNIT-II

Fatigue, thermal fatigue, ageing, structural changes, material damage, crack propagation, damage mechanics, life time analysis, Creep-Fatigue interaction.

UNIT-III

Oxidation, Kinetics of oxidation, Factors controlling oxidation, Hot Corrosion, Testing methods, Mechanisms of hot corrosion, erosion, Hot corrosion properties of carbon steels and stainless steels.

UNIT-IV

Super alloys: their processing, high temperature mechanical properties, Corrosion behaviour, Ceramics for applications in refractory technology, Properties and applications of high temperature polymers.

UNIT-V

Refractory metals and alloys, Intermetallics, Carbon-Carbon composites, Ceramic matrix composites for refractory applications, Industrial, defence and nuclear applications.

Text Books:

1. Creep of metals and alloys - Evans, R.W and Wilshire, B., Institute of metals, London, 1985.
2. Heat- resistant materials - J.R. Davis, ASM Specialty Handbook: ASM, 1997.

Reference Books:

1. Introduction to the High Temperature Oxidation of Metals - Neil Birks, Gerald H. Meier, and Frederick S. Pettit, 2009.
2. The Super-alloys: Fundamentals and Applications, 1st edition - Roger C. Reed, Cambridge University Press, 2008.
3. High Temperature Coatings, 1st edition - Sudhansu Bose, Published by Butterworth-Heinemann, 2007.
4. Polyimides and Other High Temperature Polymers: Synthesis, Characterization and Applications - K. L. Mittal, Brill Academic Publications, 2009.

Course Outcomes:

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

1. Outline the different processes responsible for failure of materials at high temperature.
2. Able to relate the causes for creep failure and choice of creep resistant materials.
3. Able to interpret the structural changes taking place during fatigue and aging and carry out analysis of data.
4. Able to interpret the chemical causes for failure at high temperature.
5. Distinguish the role of ceramics, polymers, super alloys etc., at high temperature.
6. Analysis of data available for design and improve the existing materials.

PROJECT SATGE – II INCLUDING SEMINAR

IV B.Tech. Met. Engg. II-Semester	L	T	P	C
	0	0	22	9+2