Contents

Category:**Basic Science Course** Subject code:**MA1101**

Linear Algebra and Calculus

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 4-0-0-4

Course Objectives:

- Types of matrices and their properties and concept of a rank of the matrix and applying this concept to know the consistency and solving the system of linear equations.
- Concept of Eigen values, Eigen vectors and to reduce the quadratic form to canonical form.
- Concept of Sequence and nature of series and geometrical approach to the mean values theorems and their application to the mathematical problems.
- Evaluation of surface areas, volumes of revolutions of curves and improper integrals using Beta and Gamma functions.
- Partial differentiation, concept of total derivative and finding maxima and minima of function of two and more variables.

Unit-1 Matrix Theory:
Types of Matrices, Symmetric, Hermitian, Skew-Symmetry, Skew-Hermitian, Orthogonal matrices, Unitary matrices; Elementary row and column operations on a matrix, Rank of a matrix by Echelon form and Normal form, Inverse of a Non-singular matrix by Gauss-Jordan method; Consistency and solutions of system of linear equations using elementary operations, Gauss elimination method; Gauss Seidel Iteration method.

Unit-2 Eigen values and Eigen vectors:
Linear Transformation and Orthogonal Transformation; Characteristic roots and vectors of a matrix; Diagonalization of a matrix; Cayley-Hamilton theorem (without proof); finding inverse and power of a matrix by Caylay-Hamilton Theorem; Quadratic forms and Nature of the Quadratic forms; Reduction of quadratic form to canonical form by Orthogonal transformation.

Unit-3 Sequences & Series:
Definition of a sequence, limit; Convergent, Divergent and Oscillatory sequences. Convergent, Divergent and Oscillatory Series; Series of positive terms; Comparison test, p-test, D-Alembert's ratio test; Raabe's test; Cauchys Integral test; Cauchys root test; Logarithmic test. Alternating series; Leibnitz test; Alternating Convergent series; Absolute and conditionally convergence.

Unit-4 Calculus:
Mean value theorems: Roll's theorem, Lagrange's mean value theorem, Cauchy's Mean value theorem;

Taylor's and Macaurin's series with remainders, Expansions; Applications of definite integrals to evaluate surface area and volumes of revolutions of curves (Only in Cartesian coordinates): Definition of Improper Integrals and their convergence, Beta and Gamma functions and their applications.

Unit-5 Multivariable Calculus (Partial Differentiation and applications):
Definitions of Limits and continuity. Partial Differentiation; Euler's theorem; Total Derivative; Jacobian; Functional dependence and independence; Maxima and minima of functions of several variables (two and three variables) using Lagrange multipliers.

Course outcomes: The student shall at the end of the course should be able to

- Write the matrix representation of set of linear equations and to analyze the solution of the system of equations.
- Find the Eigen values and Eigen vectors and reduce the quadratic form to canonical form using orthogonal transformations.
- Analyze the nature of sequence and series and solve the applications on the mean value theorems.
- Evaluate the improper integrals using Beta and Gamma functions.
- Find the extreme values of functions of two variables with/without constraints.

Textbooks:

- "Advanced Engineering Mathematics", Erwin Kreyszig, John Wiley and Sons, 10th Edition, 2011.
- "Advanced Engineering Mathematics", R.K.Jain and S.R.K.Iyengar Narosa Publications House, 2008.
- "Higher Engineering Mathematics", B.S. Grewal, Khanna Publications, 2009.

References:

- "Calculus and Analytic geometry", G.B. Thomas and R.L. Finney, 9th Edition, Pearson, Reprint, 2002.
- "Higher Engineering Mathematics", Ramana B.V., Tata McGraw Hill New Delhi, 11th Reprint, 2010.
- "A Text Book of Engineering Mathematics", N.P. bail and Manish Goyal, Laxmi Publications, Reprint,2008.

Category:**Basic Science Course** Subject code:**PH1101**

Engineering Physics

Externals: 60Marks **L-T-P-C***
Internals: 40Marks 3-0-0-3

Course Objectives:

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Unit 1 Vectors and Mathematical Physics(6)
Gradient, divergence, curl and its applications, line, surface and volume integrals, stokes and gauss theorem: applications, curvilinear coordinates: polar, cylindrical and spherical co-ordinates, problems.

Unit 2 Electrodynamics (12)
Electrodynamics before maxwell, fixing of ampere's law, Maxwell equations in matter, boundary conditions, continuity equation, Poynting theorem, wave equation for E and B, monochromatic plane waves, energy and momentum in EM waves. Propagation in linear media, reflection and transmission at normal incidence. EM waves in conductors, reflection at conducting surface.

Unit 3 Quantum Mechanics (8)
Introduction to quantum mechanics, De-Broglie's waves and uncertainty principle, significance of wave Function, time dependent Schrodinger wave equation, time independent Schrodinger wave equation, particle in a box – problems.

Unit 4 Electron Structure of Solids (10)
Introduction to crystallography, bravais lattices and crystal systems, atomic packing, atomic radii, crystal structures (sc, bcc and fcc), Miller indices, classical free electron theory, Kronig Penny model (e vs k), band theory of solids.

Semiconductor Physics (8)
Intrinsic and extrinsic semiconductors, Fermi level and carrier-concentration, effect of temperature on Fermi level. Mobility of charge carriers and effect of temperature on mobility, Hall Effect, energy band gap determination of semiconductors by four probe method, direct and indirect band gap semiconductors.

Course outcomes:

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Textbooks:

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References:

- Engineering Physics by Malik and Singh
- Electrodynamics by David.J.Griffiths
- Quantum Mechanics by Aruldhas
- Solid State Physics by C. Kittel

Category:**Humanities and Social Sciences course** Subject code:**HS1101**

English

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 2-0-0-2

Course Objectives:

- Improve the language proficiency of students in English with an emphasis on vocabulary, grammar, reading and writing skills.
- Equip students to study academic subjects more effectively and critically using the theoretical and practical components of English syllabus.
- Develop study skills and communication skills in formal and informal situations.

Unit-1
'The Raman Effect' from the prescribed textbook 'English for Engineers' published by Cambridge University Press.
Vocabulary Building: The Concept of Word Formation –The Use of Prefixes and Suffixes.
Grammar: Identifying Common Errors in Writing with Reference to Articles and Prepositions.
Reading: Reading and Its Importance- Techniques for Effective Reading.
Basic Writing Skills: 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-2
'Ancient Architecture in India' from the prescribed textbook 'English for Engineers' published by Cambridge University Press.
Vocabulary: synonyms and antonyms.
Grammar: identifying common errors in writing with reference to noun-pronoun agreement and subject-verb agreement.
Reading: improving comprehension skills techniques for good comprehension
Writing: format of a formal letter-Writing Formal Letters e.g., letter of complaint, letter of requisition, job application with resume.

Unit-3
'Blue Jeans' from the prescribed textbook 'English for Engineers' published by Cambridge University Press.
Vocabulary: acquaintance with prefixes and suffixes from foreign languages in english to form derivatives-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- skimming and scanning
Writing: nature and style of sensible writing- Defining- Describing objects, places and events Classifying- providing examples or evidence

Unit-4
'What Should You Be Eating' from the prescribed textbook 'English for Engineers' published by Cambridge University Press.
Vocabulary: standard abbreviations in English
Grammar: redundancies and clichs in oral and written communication.
Reading: comprehension- intensive reading and extensive reading
Writing: Writing Practices–writing introduction and conclusion - essay writing-precis writing.

Unit-5
'How a Chinese Billionaire Built Her Fortune' from the prescribed textbook 'English for Engineers' published by Cambridge University Press.
Vocabulary: technical vocabulary and their usage
Grammar: common errors in English
Reading: reading comprehension-exercises for practice
Writing: Technical Reports- introduction characteristics of a report categories of reports formats- structure of reports (manuscript format) -types of reports - writing a report.

Course outcomes:

- Use English language effectively in spoken and written forms.
- Comprehend the given texts and respond appropriately.
- Communicate confidently in various contexts.
- Acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

Textbooks:

- "English for Engineers", Sudarshana, N.P. and Savitha, C. Cambridge University Press, (2018).

References:

- "Practical English Usage", Swan, M, Oxford University Press, (2016)
- "Communication Skills", Kumar, S and Lata, P, Oxford University Press, (2018).
- "Remedial English Grammar", Wood, F.T. Macmillan, (2007).

- "On Writing Well Zinsser", William, Harper Resource Book, (2001).
- "Study Writing", Hamp-Lyons, L Cambridge University Press, (2006).
- Exercises in Spoken English. Parts I III. CIEFL, Hyderabad. Oxford University Press.

Category:**Program Core Course** Subject code:**MM1101**

Introduction to Materials Engineering

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To give the students a broad overview to various aspects of Materials Science and Engineering.
- To understand the basic concepts of crystal structures and geometry of different materials

Unit-1
Crystal structures: Co-ordination number, effective number atoms, lattice parameter an radius relation, Atomic packing factor, Indexing of lattice planes and directions: Miller Indices, density calculations: Linear and planar density.

Unit-2
Mechanical properties of materials: Plastic deformation of metals,stress-strain diagram, types of mechanical loads, Introduction to Mechanical working of metals processes: Rolling, Forging, Extrusion, pilgering, wire drawing, tube drawing

Unit-3
Defects in solids: point defects, line defects: dislocations, area and volume defects classification, dislocation theory

Unit-4
Electrical properties: Electrical conductors and insulators, semi-conductors: extrinsic and intrinsic, direct and indirect semi-conductors, super conductors: type-1, type-2 and high temperature super conductors; Thermal properties: Thermal conductivity, heat capacity and thermal expansion; Magnetic properties: Hysteresis loop, soft and hard magnetic materials, and its application in material science

Unit-5
Materials classification and Heat treatment: Classification of Metals, ceramics and polymers, their properties and applications. Heat treatment processes: Annealing, normalising, hardening and tempering

Course outcomes: The student should be able to

- Have a broad knowledge of the discipline
- Have an exposure to methods and techniques used in the discipline

- Understand the flow of courses through the rest of their undergraduate education
- Develop a preliminary understanding of which courses address which topics in the discipline.

Textbooks:

- "Physical metallurgy principles", R. E. Reed Hill, CL Engineering, 1991.
- "Physical Metallurgy: Principles and practices", V. Raghavan, Prentice Hall India Learning Private Limited; 2 edition (2006)

References:

- "Material Science and Engineering", William Callister , Wiley, 1985.
- "Physical metallurgy principles" , Reza Abbaschian, Cengage; 4 edition (2013)
- "Fundamentals of Physical Metallurgy", John D. Verhoeven
- "Physical Metallurgy", Robert W. Cahn and Peter Haasen, Vol. I, II and III

Category:**Engineering Science Course** Subject code:**EE1101**

Basic Electrical and Electronics Engineering

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-3

Course Objectives: This course introduces

- Electrical DC and AC circuits, basic law's of electricity and methods to solve the electrical networks
- Construction operational features of energy conversion devices i.e. transformers, DC motors and induction motors.
- Basics of electronics, semiconductor devices and their characteristics and operational features.

Unit-1:Circuits Analysis (10)
Electrical circuit elements: R-L-C Parameters, V-I relationship for passive elements, diode, voltage and current Independent and dependent sources
Circuit analysis: Kirchoff's Laws, network reduction techniques series, parallel, series parallel, starto-delta, delta-to-star transformation, source Transformation, mesh Analysis and nodal Analysis
Network Theorems – Thevenin's, Norton's maximum power transfer, superposition
Step response of RL,RC and RLC circuits

Unit-2: AC Circuit Analysis (10)
Single Phase AC Circuits – R.M.S. and average values, form Factor, steady state analysis of series, parallel and series parallel combinations of R, L and C with sinusoidal excitation, concept of reactance, impedance, susceptance and admittance phase and phase difference, concept of power factor, j-notation, complex and polar forms of representation.
Resonance – Series resonance and parallel resonance circuits

Unit-3: Three Phase AC Circuits (6)
Three phase EMF generation, delta and Y connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits

Unit-4: Basic Electronics (10)
Introduction to electronics and electronic systems, diode and rectifier circuits (Half and Full wave), BJT, transistor biasing. Small signal transistor amplifiers (CE), operational amplifiers and their basic application, introduction to digital circuits

Unit-5: Electrical Machines (12)
Transformers :Construction, EMF equation, ratings, phasor diagram on no load and full load, equivalent circuit, regulation and efficiency calculations, open and short circuit test, applications
DC machines: Construction, EMF and Torque equations, Characteristics of DC generators and motors, applications
Induction motors: The revolving magnetic field, principle of orientation, ratings, equivalent circuit, Torque-speed characteristics, applications

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

- Understand the basic concept of electrical circuits under DC and AC excitation and solve basic electrical circuit problems
- Understand basic concept and performance of transformers and motors used as various industrial drives

Textbooks:

- "Electrical Technology", Hughes Prentice Hall, 7th edition
- "Problems In Electrical Engineering", S. Parker Smith, 9th edition
- "Electronic Devices and Circuits", R.L. Boylestad and Louis Nashelsky, PEI/PHI, 9th edition, 2006.
- "Millman's Electronic Devices and Circuits", J.Millman and C.C.Halkias, Satyabratajit, TMH, 2/e, 1998.
- "Engineering circuit analysis", by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6th edition.
- "Electric Machines", I.J.Nagrath & D.P.Kothari, TataMcGraw Hill, 7th edition, 2005

References:

- "Electronic Devices and Circuits", K. Lal Kishore, B.S. Publications, 2nd Edition, 2005.
- "Electronic Devices and Circuits", Anil K. Maini, VarshaAgarwal Wiley India Pvt. Ltd., 2009.
- "Network Theory", N.C.Jagan & C.Lakshminarayana, B.S. Publications.
- "Network Theory", Sudhakar, Shyam Mohan Palli, TMH.
- "Electrical machines", PS Bhimbra, Khanna Publishers.

Category:**Humanities and Social Sciences course Lab** Subject code:**HS1701**

English Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-2-1

Course Objectives:

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

Unit-1
*Understand:*Understand: Listening Skill- Its importance Purpose- Process- Types- Barriers of Listening -Communication at Work Place- Spoken vs. Written language. *Practice:* Introduction to Phonetics Speech Sounds Vowels and Consonants -Ice-Breaking Activity and JAM Session- Situational Dialogues Greetings Taking Leave Introducing Oneself and Others.

Unit-2
Understand: Structure of Syllables Word Stress and Rhythm Weak Forms and Strong Forms in Context-Features of Good Conversation Non-verbal Communication. *Practice:* Basic Rules of Word Accent - Stress Shift - Weak Forms and Strong Forms in Context-Situational Dialogues Role-Play- Expressions in Various Situations Making Requests and Seeking Permissions - Telephone Etiquette.

Unit-3
Understand: Intonation-Errors in Pronunciation-the Influence of Mother Tongue (MTI)- How to make Formal Presentations. *Practice:* Common Indian Variants in Pronunciation Differences in British and American Pronunciation- Formal Presentations.

Unit-4
Understand: Listening for General Details-Public Speaking Exposure to Structured Talks. *Practice:* Listening Comprehension Tests- Making a Short Speech Extempore

Unit-5
Understand: Listening for Specific Details- Interview Skills.

Practice: Listening Comprehension Tests- Mock Interviews.

Course outcomes: The students will have

- Better understanding of nuances of English language through audio- visual experience and group activities
- Neutralization of accent for intelligibility
- Speaking skills with clarity and confidence which in turn enhances their employability skills

References:

- Clarity English Success - Software
- Connected Speech- Software
- Issues in English 2- Software
- http://www.clarityenglish.com/program/practicalwriting/
- http://www.clarityenglish.com/program/roadtoielts/
- http://www.clarityenglish.com/program/clearpronunciation1/
- http://www.clarityenglish.com/program/resultsmanager/

Category:**Basic Science Course Lab** Subject code:**PH1701**

Engineering Physics Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives: The objective of this course is

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The list of experiments are:

- Photoelectric effect
- Hall effect
- Ultrasonic interferometer
- Melde's experiment
- Four probe method
- Frank hertz experiment
- Seebeck and Peltier effect
- Solar cell
- Coupled pendulum

Course outcomes: Students will be able to

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References:

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Category:**Engineering Science Course** Subject code:**CE1701**

Computer Aided Graphics

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-1-4-3

Course Objectives:

- To introduce the students to the "Universal Language of Engineers" for effective communication through drawing.
- To understand the basic concepts of drawing through modern techniques.
- To impart knowledge about standard principles of projection of objects.
- To provide the visual aspects of Engineering drawing using Auto-CAD.

Unit-1
Introduction to Engineering Drawing: Principles of engineering graphics and their significance, usage of drawing instruments, lettering, types of lines and dimensioning. Overview of auto-cad: the menu system, tool bars, drawing area, dialogue boxes, short cut menu, the command lines, select and erase objects, introduction to layers etc., drawing simple figures-lines, planes, solids.

Unit-2
Geometrical constructions: Construction of regular polygons. Conic sections: construction of ellipse, parabola, hyperbola (general method only), cycloid, epicycloids, hypocycloid and involutes. Scales: construction of plain, diagonal and vernier scales.

Unit-3
Orthographic projections: Principles of orthographic projections. Projections of points: projections of points placed in different quadrants. Projection of lines: lines parallel and inclined to both the planes (determination of true lengths and true inclinations and traces). Projection of planes: planes inclined to both the reference planes

Unit-4
Projection of Solids: Projection of solids whose axis is parallel to one of the reference planes and inclined to the other plane, axis inclined to both the planes projection of sectioned solids: sectioning of simple solids like prism, pyramid, cylinder and cone in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the otherobtaining true shape of section.

Unit-5
Development of surfaces: development of surfaces of right regular solids-prism, pyramid, cylinder and

cone
Isometric projections: principles of isometric projectionisometric scale, isometric views of planes and simple solids
Perspective projections: basic concepts of perspective views.

Course outcomes: The student should be able to

- Use Engineering principles and techniques to understand and interpret engineeringdrawings.
- Understand the concepts of Auto-CAD.
- Draw orthographic projections oflines, planes and solids using Auto-CAD.
- Use the techniques, skils and modern engineering tools necessary for engineering practices.

Textbooks:

- "Engineering Drawing", Bhat N.D., Panchal V.M. & Ingle P.R., Charotar Publishing House, (2014).
- "EngineeringDrawing" Gopala krishna K.R., (Vol.I & II combined), Subhas Stores, Bangalore, 2007.
- "Engineering Drawing and Computer Graphics", Shah, M.B. & Rana B.C, Pearson Education, (2008).

References:

- "EngineeringGraphics", Venugopal K. and Prabhu Raja V., New Age publications
- "Engineering Graphics", Agrawal B. & Agrawal C.M, TMH Publication, (2012).
- "Text book on Engineering Drawing", Narayana, K.L. & P Kannaiah, Scitech Publishers, (2008).
- Auto CAD Software Theory and User Manuals

Category:**Engineering Science Course Lab** Subject code:**EE1701**

Basic Electrical and Electronics Engineering Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-2-1

Course Objectives: To provide practical exposure to

- To expose the students to the concepts of electrical and electronics circuits and their applications
- To expose the students to the operation of dc machines and transformer and give them experimental skills.

List of Laboratory Experiments/Demonstrations (any eight of the following):

- Introduction to lab:
  - Basic safety precautions. Introduction and use of measuring instruments voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
  - Demonstration of cut-out sections of machines: dc motor (commutator-brush arrangement), induction motor (squirrel cage rotor), synchronous motor (field winging - slip ring arrangement) and single-phase induction motor.
  - Demonstration of Components of LT switchgear.
- Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
- Transformers: Observation of the no-load current waveform on an oscilloscope (non sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
- Open circuit & short circuit test on single phase transformer.
- Verification of KCL & KVL.
- Characteristic of the lamps (Tungsten, Fluorescent and Compact Fluorescent Lamps)
- Verification of network theorems.
- V-I characteristics of Diodes and BJT

- Half-wave and full-wave rectifiers, rectification with capacitive filters, zener diode
- Studies on logic gates

Course outcomes: Student will be able to

- Understand principles of measuring instruments of voltage, current and power
- Analyze the characteristics of semiconductor devices and understand their applications
- Analyze the characteristics and evaluate performance of DC machines and transformers

Textbooks:

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References:

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Category:**Basic Science Course** Subject code:**MA1201**

Differential Equations and Vector Calculus

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 4-0-0-4

Course Objectives:

- To study the Methods of solving the differential equations of first and higher order.
- To study the methods of solving improper integrals and the concepts of multiple integrals
- The basic properties of vector valued functions and their applications to line, surface and volume integral.
- To study numerical methods to analyze an experimental data.

Unit-1
Ordinary Differential Equations of first order: Exact first order differential equation, finding integrating factors, linear differential equations, Bernoulli's , Riccati , Clairautss differential equations, finding orthogonal trajectory of family of curves, Newtons Law of Cooling, Law of Natural growth or decay.

Unit-2
Ordinary Differential Equations of higher order: Linear dependence and independence of functions, Wronskian of n- functions to determine Linear Independence and dependence of functions, Solutions of Second and higher order differential equations (homogeneous & non-homogeneous) with constant coefficients, Method of variation of parameters, Euler-Cauchy equation.

Unit-3
Integral Calculus : Convergence of improper integrals, tests of convergence, Beta and Gamma functions - elementary properties, differentiation under integral sign, differentiation of integrals with variable limits - Leibnitz rule. Rectification, double and triple integrals, computations of surface and volumes, change of variables in double integrals - Jacobians of transformations, integrals dependent on parameters applications.

Unit-4
Vector Differentiation: Vector point functions and scalar point functions. Gradient, Divergence and Curl. Directional derivatives, Tangent plane and normal line. Vector Identities. Scalar potential functions. Solenoidal and Irrotational vectors.

Unit-5
Vector Integration: Line, Surface and Volume Integrals. Theorems of Green, Gauss and Stokes (without

proofs) and their applications.

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

- Solve first order linear differential equations and special non linear first order equations like Bernouli , Riccati & Clairauts equations
- Compute double integrals over rectangles and type I and II" regions in the plane
- Explain the concept of a vector field and make sketches of simple vector fields in the plane.
- Explain concept of a conservative vector field, state and apply theorems that give necessary and sufficient conditions for when a vector field is conservative, and describe applications to physics.
- Recognize the statements of Stokes' Theorem and the Divergence Theorem and understand how they are generalizations of the Fundamental Theorem of Calculus.
- Able to solve the problems in diverse fields in engineering science using numerical Methods.

Textbooks:

- Advanced Engineering Mathematics (3rd Edition) by R. K. Jain and S. R. K. Iyengar, Narosa Publishing House, New Delhi

References:

- Advanced Engineering Mathematics (8th Edition) by Erwin Kreyszig, Wiley-India.
- Dr. M.D. Rai singh ania, Ordinary and Partial differential equations, S.CHAND, 17thEdition 2014.

Category:**Basic Science Course** Subject code:**CY1201**

Engineering Chemistry

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-3

Course Objectives:

- To understand the importance of the spectroscopy in determining the structures of chemical compounds
- To understand the importance of electrochemistry in technical field
- To understand the rates of some of the reactions and derivation of their rate laws
- To understand the phase rule with some examples
- To understand the importance of materials in the technical field

Unit-1 Electrochemistry
Introduction to electrochemistry: Galvanic cell (Daniel cell), Nernst equation. Types of electrodes: metal-metal ion electrodes, metal-insoluble salt-anion electrodes, calomel electrode, gas-ion electrodes, hydrogen and chlorine electrodes, oxidation-reduction electrodes (quinhydrone electrode), amalgam electrodes and ion exchange electrode (glass electrode). EMF and applications of EMF: determination of pH of the solution, potentiometric titrations, determination of the valency of the ions, solubility product of sparingly soluble salts. Thermodynamic data: enthalpy and entropy of cell reactions, Gibbs-Helmholtz equation and applications. Classification of commercial cells - primary cells (dry cell) and secondary cells (Lithium ion battery, Pb-acid storage battery). Fuel cells: $H_2 - O_2$ fuel cell, Methanol-oxygen fuel cell, Phosphoric acid fuel cell.

Unit-2 Corrosion and water treatment
Dry and wet corrosion and their mechanisms. Pilling - Bedworth Rule. Types of corrosion: galvanic corrosion, concentration cell corrosion, pitting corrosion and stress corrosion. Factors influencing the rate of corrosion: Temperature, pH and dissolved oxygen. Corrosion Prevention methods: cathodic protection sacrificial anodic method and impressed current method. Metallic coatings: galvanization and tinning methods.
Water: Hardness of water, degrees of hardness. Calculation of hardness by EDTA method. Disadvantages of hard water in boilers: priming, foaming, scales, sludges and caustic embrittlement. Treatment of boiler feed water: Zeolite process, Ion exchange process.

Unit-3 Energy sources
Introduction. Definition and classification of fuels. Calorific value of a fuel, Characteristics of a good fuel. Coal, types of coal. Analysis of Coal: proximate and ultimate analysis. Bomb calorimeter and

Junkers gas calorimeter. Problems on calculation of calorific value. Liquid fuels petroleum Extraction fractional distillation. Synthetic Petrol: Bergius process and Fisher Tropsch process. Bio-fuels: bio-diesel, bio-gas.

Unit-4 Chemical kinetics
Introduction to rate of reaction and rate constant determination. Factors influencing rate of reaction. Complex reactions: definition and classification of complex reactions, definition of reversible reactions with examples, rate law derivation for reversible reactions. Consecutive reactions: definition, rate law derivation and examples of consecutive reactions. Parallel reactions: definition, rate law derivation and examples of parallel reactions. Steady-state approximation: introduction, kinetic rate law derivation by applying steady state approximation in case of the oxidation of NO and pyrolysis of methane.

Unit-5 Nanochemistry
Introduction to nanomaterials, classification: Carbon based nanomaterials, metallic nanoparticles, metal oxide nanoparticles. Properties at nanoscale. Synthetic approaches: Top-Down (Lithography, spray pyrolysis, FIB, ball milling) and Bottom-Up (Sol-gel, Hydrothermal, CVD, PVD). Brief overview on characterization of nanomaterials: UV, X-ray, SEM and TEM. Applications of nanomaterials.

References:

- Engineering Chemistry, Jain & Jain
- Engineering Chemistry, Shashi Chawla
- Chemistry for Engineers, B. K. Ambasta
- Engineering Chemistry, H. C. Srivastava
- Fundamentals of Engineering Chemistry, Shikha Agarwal

Category:**Engineering Science Course** Subject code:**CS1201**

Programming for Problem Solving

Externals: 60Marks **L-T-P-C***
Internals: 40Marks 3-0-0-3

Course Objectives:

- To introduce the basic concepts of Computing environment, number systems and flowchart.
- To familiarize the basic constructs of C language data types, operators and expressions
- To understand modular and structured programming constructs in C
- To learn the usage of structured data types and memory management using pointers
- To learn the concepts of data handling using pointers

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

Unit-2
Conditional Branching , Loops & Arrays:
Writing and evaluation of conditionals and consequent branching, Iteration and loops Arrays (1-D, 2-D), Character arrays and Strings

Unit-3
Function & Basic Algorithms:
Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Unit-4
Recursion & Structure:
Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort. Structures, Defining structures and

Array of Structures

Unit-5
Pointers & File handling:
Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation) File handling (only if time is available, otherwise should be done as part of the lab)

Course outcomes:

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

Textbooks:

- Schaum's Outline of Programming with C, Byron Gottfried, McGraw-Hill, 2017
- Programming in ANSI C, E. Balaguruswamy, Tata McGraw-Hill 8th edition, 2019

References:

- The C Programming Language, Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall of India, 1978.

Category: **Mandatory Course** Subject code:**BM1201**

Constitution of India

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-0

Course Objectives:

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Unit-1 Introduction to Indian Constitution:
Meaning of the term Constitution, historical background of Indian constitution, making of Indian constitution, constituent assembly
Unit-2 Features of Indian Constitution:
Preamble of the Constitution , Importance, Scope, Relevance, The Salient Features of Indian Constitution , Importance, Scope, Relevance

Unit-3 Fundamental Rights:
Fundamental Rights, Importance and scope of fundamental rights, Categorization of Fundamental Rights

Unit-4 Fundamental Duties & The Directive Principles of State Policy:
Fundamental Duties, importance and scope of fundamental Duties, the Directive Principles of State Policy, Importance, Scope, Relevance

Unit-5 Union/Central Government:
Union Government , Union Legislature (Parliament), Lok Sabha and Rajya Sabha (with Powers and Functions), Union Executive, President of India (with Powers and Functions), Prime Minister of India (with Powers and Functions)

Course outcomes:

- Understand the formation and principles of Indian Constitution.
- Understand Fundamental Rights and its implications in life
- Understand Fundamental Duties of Individual toward country and society
- Understand Directive principles to govern the policy formation
- Understand the Way of running the Government and basic Governance

Textbooks:

- ‘Indian Polity’, Laxmikanth
- ‘Indian Administration’, Subhash Kashyap
- ‘Indian Constitution’, D.D. Basu
- ‘Indian Administration’, Avasti and Avasti

Category:**Program Core Course** Subject code:**MM1201**

Physics of Materials

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-3

Course Objectives:

- To understand the science behind the properties exhibited by materials. To recognize the size scale from which the property originates and hence the impact of various material constituents on the properties of the materials.

Unit-1
Overview of properties of materials, thermal expansion, electrical conductivity, measuring electrical conductivity, free electron gas, ideal gas.

Unit-2
Free electron theory of metals, Wiedemann-Franz law, Drude model, successes and limitations of Drude model, source of limitations of Drude model, large systems and statistical mechanics, Maxwell Boltzmann statistics, classical Particles, quantum particles, history of quantum mechanics, Drude-Sommerfeld model.

Unit-3
Fermi-Dirac statistics, features of Fermi-Dirac distributions, comparison with Maxwell-Boltzmann statistics, anisotropy and periodic potential, confinement and quantization, density of states, Fermi Energy, Fermi Surface, Fermi Temperature, electronic contribution to specific heat at constant volume.

Unit-4
Reciprocal space, Wigner Seitz cells, Brillouin zones, allowed energy levels, and the origin of bands, calculating allowed and forbidden energy levels, free electron approximation, tight binding approximation.

Unit-5
Electron compounds, semiconductors, optoelectronic properties, magnetic properties, phonons, superconductivity, Bose-Einstein statistics, Meissner effect, BCS theory, physics of nanoscale materials.

Course outcomes: The student should be able to

- Explain the origin of the various properties of materials
- Indicate the phenomena that impact specific properties
- Use quantum mechanical approach to explain material properties

- Utilize reciprocal space
- Explain the similarities and differences between classical particles, Fermions, and Bosons.

Textbooks:

- "Physics of Materials", Essential concepts of Solid State Physics. Prathap Haridoss, Wiley 2015.

References:

- "Solid State Physics", Ashcroft and Mermin, Cengage 2003.

Category:**Basic Science Course Lab** Subject code:**CY1801**

Engineering Chemistry Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

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The list of experiments are:

1. Determination of the strength of weak acid (CH_3COOH) by pH metry.
2. Conductometric titration (strong acid (HCl) vs strong base (NaOH)).
3. Throwing power of Copper.
4. Estimation of alkalinity of water.
5. Determination of total hardness of water by complexometric method using EDTA.
6. Preparation of bio-diesel from palm oil by trans esterification method.
7. The rate constant and order of the reaction of the hydrolysis of an ester catalyzed by an acid (dil.HCl).
8. Preparation of Nano particle (ZnO).

Course outcomes:

References:

- Essentials of experimental engineering chemistry, Shashi chawla.
- Practical chemistry, Dr.O.P.Pandey, S.Chand publication.
- A textbook of engineering chemistry, Shashi chawla.
- College practical chemistry, VK Ahluwalia.
- Practical engineering chemistry, K. Mukkanti.
- Laboratory manual, R. Kulakarni, Adil.

Category:**Engineering Science Course Lab** Subject code:**CS1801**

Programming for Problem Solving Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

- Able to have fundamental concept on basics commands in Linux.
- Able to write, compile and debug programs in C language.
- Able to formulate problems and implement algorithms in C.
- Able to effectively choose programming components that efficiently solve computing problems in real-world

[The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.]

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
Tutorial 7: Functions, call by value:
Lab 7: Simple functions
Tutorial 8 and 9: Numerical methods (Root finding, numerical differentiation, numerical integration):
Lab 8 and 9: Programming for solving Numerical methods problems
Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions
Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures
Tutorial 12: File handling
Lab 12: File operations

Course outcomes: Student will be able

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

Category:**Engineering Science Course** Subject code:**ME1001**

Engineering Workshop

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-1-2-2

Course Objectives:

- To understand the basic manufacturing process of producing a component by casting, forming plastic molding, joining processes, machining of a component either by conventional or by unconventional processes.
- To understand the advanced manufacturing process of additive manufacturing process.

The list of experiments:

Fitting

- Step fitting
- V fitting

Carpentry

- Half lap joint
- Dove tail joint

House wiring

- Series and parallel wiring
- Staircase and godown wiring

Tin Smithy

- Tray and Cylinder

Welding

- Bead formation
- Butt and lab joining of mild steel plates

Foundry

- Mold preparation for single piece pattern

- Mold preparation for split piece pattern

Machining

- Plain turning
- Facing and taper turning

Plastic Molding

Wire EDM, CNC, 3D Printer

Course Outcome:
Students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Category:**Basic Science Course** Subject code:**MA2101**

Probability and Numerical Methods

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 4-0-0-4

Course Objectives:

- To Solve the Differential & integral equations using Laplace Transform
- To understand the Applications of Laplace Transforms
- To understand the concepts of random variables, expectation, Variance.
- To learn various distributions and their applications
- To know the basic concepts of statistics applicable in estimation and testing.

Unit-1
Basic concepts of Probability:[Review] Random experiment, Sample space, Mutually exclusive events, Properties based on axiomatic definition of probability. Conditional probability. Independent events.
Random Variables: Definition of random variables. Properties of discrete and continuous random variable. Definition and properties of probability mass function and probability density function. Definition of cumulative distribution function and its properties for discrete and continuous distributions.
Sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Discrete Distributions: Properties of various discrete distributions: Binomial, Poisson, distributions, Negative Binomial and Discrete uniform distributions.

Unit-2
Continuous Distributions: Properties of various continuous distributions: Uniform, Exponential, Normal, Gamma distributions.
Bivariate Distributions: Definition and properties of bivariate distribution (continuous and discrete). Joint probability distributions. Marginal probability distributions. Conditional probability distributions. Distributions of sums and quotients of random variables.

Unit-3
Basic Statistics: Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression Rank correlation

Unit-4
Laplace Transform: Definition of Laplace Transform, linearity property, conditions for existence of

Laplace Transform. First and second shifting properties, Laplace Transform of derivatives and integrals, unit step functions, Dirac delta-function, error function. Differentiation and integration of transforms, convolution theorem

Unit-5
Finding Inverse Laplace Transform using various methods, Evaluation of integrals by Laplace Transform. Solving initial and boundary value problems, Differential Equations & Partial differential equations, Integral Equations using Laplace Transforms.

Numerical Methods: Introduction and motivation about numerical methods, True value, approximate value, error, error percentage, algebraic equations, transcendental equations, Newton-Raphson method, Bisection method.

Course outcomes: The student should be able to

- Use shift theorems to compute the Laplace transform and inverse Laplace transform
- Use the Laplace transform to compute solutions of equations involving impulse functions
- Compute conditional probabilities directly and using Bayes' theorem, and check for independence of events.
- Set up and work with discrete random variables. In particular, understand the binomial Poisson Negative Binomial and uniform distributions
- Work with continuous random variables. In particular, know the properties of uniform, normal exponential and gamma distributions.

Textbooks:

- Sheldon Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
- Gupta, S.C., Kapoor V.K., Fundamentals of Mathematical Statistics (11th Edition), Sultan Chand & Sons, 2002.
- W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed.,Wiley, 1968.
- Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition,
- R.K.Jain and S.R.K.Iyengar Advanced Engineering Mathematics, Narosa Publications House.2008.

References:

- Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11thReprint, 2010.

- B.S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2009.
- P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).

Category: **Mandatory Course** Subject code:**BS2101**

Environmental Science

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-0

Course Objectives:

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Unit-1 MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES
Definition, scope and importance, need for public awareness.

Unit-2 NATURAL RESOURCES
Renewable and non-renewable resources : Natural resources and associated problems.

- **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
- **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
- **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
- **Food resources:** World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
- **Energy resources:** Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources.
- **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.
  - Role of an individual in conservation of natural resources.
  - Equitable use of resources for sustainable lifestyles.

Unit-3 ECOSYSTEMS & BIODIVERSITY
Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems:-

- Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

- Biodiversity- Definition : genetic, species and ecosystem diversity. Biogeographical classification of India Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values.
- Biodiversity at global, National and local levels. Inida as a mega-diversity nation Hot-sports of biodiversity.
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit-4 ENVIRONMENTAL POLLUTION

Definition, Cause, effects and control measures of :- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards

- Solid waste Management: Causes, effect s and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies.
- Disaster management: floods, earthquake, cyclone and landslides.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.
- Environment Protection Act., Air (Prevention and Control of Pollution) Act. Water Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act .

Unit-5 SOCIAL ISSUES & THE ENVIRONMENT

Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health.
Field work : Visit to a local area to document t environmental assets river/ forest/grassland/hill/mountain Visit to a local polluted site-Urban/Rural/Industrial/Agricultural . Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.

Course outcomes: The student should be able to

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References:

- Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.

- Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad- 380 013, India, Email:mapin@icenet.net (R)
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
- Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
- Cunningham, W.P. Cooper, T.H. Gorhan i, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p .

Category:**Program Core Course** Subject code:**MM2101**

Physical Metallurgy

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To learn about the principles of alloy design, phase diagram and strengthening mechanisms in different metals and alloys.
- To study the fundamental aspects of heat treatment and its influence on properties and applications
- To obtain knowledge about the physical metallurgy of specific and important engineering materials such as ferrous and non-ferrous alloys

Unit-1
Structure of metals: Interstitial and substitutional solid solutions, Hume-Rothery's rules, electron compounds and Size packing phases: laves phases, Frank-Kasper phases and Nowotny phases, intermetallic compounds, super lattice.

Unit-2
Binary phase diagrams: Phase rule, Isomorphous phase diagram, peritectic, eutectic, eutectoid, monotectitc, monotectoid, metatectic, syntectic phase diagrams; lever rule; ternary phase diagram.

Unit-3
Iron Iron carbide equilibrium diagram; solidification in pure metals, alloy solidification; dendritic growth, coring and segregation in alloys; as cast micro and macro structures.

Unit-4
Time Temperature Transformation (TTT) diagrams, continuous cooling transformation (CCT) diagrams; pearlitic transformation, bainitic transformation and martensitic transformation in steels; microstructure property changes produced when hardened steels are tempered.

Recovery, recrystallization and grain growth; heat Treatments: annealing and its types, normalizing, hardening and tempering.

Unit-5
Point defects, dislocation, edge, screw and mixed dislocation, dislocation interaction, dislocation multiplication, dislocation jogs and steps, shockely partial dislocations, stair rod dislocation, intrinsic and

extrinsic dislocations, planer defects: grainboundaries.

Mode of plastic deformation: crystallographic slip, slip systems, critical resolved shear stress, strain; Invariant plane strain, Deformation twinning, crystallographic theory of twinning.

Course outcomes: The student should be able to

- The ability to identify the concepts of alloy design, phase diagrams and strengthening mechanisms and apply them to materials systems
- The knowledge of heat treatment and the resulting microstructure in materials
- The knowledge of physical metallurgical aspects of important engineering alloys
- Theoretical and problematic understanding can be developed.

Textbooks:

- "Physical metallurgy principles", R. E. Reed Hill.
- "Physical Metallurgy", V. Raghavan
- "Material Science and Engineering", Callister
- "Physical metallurgy principles", Reza Abbaschian

Category:**Program Core Course** Subject code:**MM2102**

Metallurgical Thermodynamics

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To understand the basics of thermodynamics
- To study and understand different laws of thermodynamics
- To enable the students to solve the necessary thermodynamic derivations and related problems

Unit-1
Importance of thermodynamics, definition of thermodynamic terms; concept of states, systems equilibrium. Equation of states, extensive and intensive properties, homogeneous and heterogeneous systems. Phase diagram of a single component system. Internal energy, heat capacity, enthalpy, isothermal and adiabatic processes.

Unit-2
The Second law of thermodynamics, entropy and free energy, degree of reversibility and irreversibility, criteria of equilibrium, auxiliary functions, combined statements, Maxwell's relations, Cp-Cv relations, transformation formula, Gibbs- Helmoltz equation.

Unit-3
Concept of Third law, temperature dependence of entropy, statistical interpretation of entropy, Debye and Einstein concept of heat capacity, consequences of third law, fugacity, activity, thermodynamics of point defects, equilibrium constant, chemical potential, use of Potential- functions, controlled atmospheres, homogeneous and heterogeneous equilibria.

Unit-4
Ellingham diagrams, E-pH diagram. Solution thermodynamics, Solutions, partial molar quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, quasi-chemical approach to solution, statistical treatment. Change of standard state. Phase relations and phase rule-its applications. Free energy composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines.

Unit-5
Thermodynamics of electrochemical cells, solid electrolytes. Thermodynamic applications in extraction, refining of metals and materials processing.

Course outcomes:

- Students will be able to understand the concepts of thermodynamics and its kinetics, and apply the knowledge in various extractive metallurgical operations.
- A reasonable clarity on the concept of phase and its stability can be arrived at and the pupil should be able to apply Gibbs phase rule to predict the number of phases that can coexist for a given set of components for a given set of variables.
- Drawing the concept of enthalpy from the first law of thermodynamics and introduce the concept of entropy and free energy of the system. Apply the relation between free energy, entropy and free energy to describe stability.
- The pupil is able to determine the possibility of reduction of a compound by determining suitable reducing agent and temperature of reduction using the Ellingham diagrams. Application of carbon as a reducing agent can be understood for different compounds.
- Kinetic of electrochemical and galvanic cells and their kinetics is to be understood. By the end of the course, the student is expected to be able to understand the feasibility and kinetics of a metallurgical reaction along with its nature. Problem solving ability of the student will be improved along with analytical and logical skills.

Textbooks:

- "Introduction to Metallurgical Thermodynamics", D.R. Gaskel
- "Text Book of Materials and Metallurgical Thermodynamics", Ahindra Ghosh (PHI)

References:

- "Problems in Metallurgical Thermodynamics and Kinetics", G. S. Upadhyaya and R. K. Dube
- "Physical chemistry for Metallurgists", J. Mackowick
- "Thermodynamics of solids", R.S.Swalin
- "Physical chemistry of metals", L.S.Darken & Gurry
- "Fundamentals of thermodynamics", Sonntag *et al.*

Category:**Program Core Course** Subject code:**MM2103**

Mechanics of Solids

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- Tounderstandtheresolutionofforces,equilibriumandcompatibilityconditionsof staticloads.
- To understand the basic concepts of the stresses and strains for different materials
- To analyze and understand principal stresses due to the combination of two dimensional stresses on an element and failure mechanisms in materials.

Unit-1
Resultant of two forces, resolution of a force into components, unit vectors, equilibrium of a particle, free-body diagrams, vector product of two vectors, moment of a force about a point, rectangular components of the moment of a force, scalar product of two vectors, mixed triple product of three vectors, moment of a force about a given axis.

Unit-2
Equilibrium of rigid bodies: reactions at supports and connections for a two and three dimensional structure, equilibrium of a rigid body in two and three dimensions.

Unit-3
Elastic and plastic behaviour, engineering stress and strain, tensile deformation of ductile material, ductile vs. brittle behaviour, concept of stress and types of stresses, concept of strain and types of strains. Flow curve, true stress and true strain. True versus engineering strain, advantages of true strain over engineering strain, Poisson's ratio and volume strain, relationship between true and engineering stresses during plastic deformation

Unit-4
Description of stress at a point, state of stress in two dimensions (plane stress), Mohr's circle of stress - two dimensions (plane stress), state of stress in three dimensions, stress tensor, Mohr's circle - three dimensions, description of strain at a point, Mohr's circle of strain, hydrostatic and deviator components of stress, elastic stress-strain relations.

Unit-5
Yielding criteria for ductile metals, the yield locus, octahedral shear stress and shear strain, invariants of stress and strain, types af stress – strain curves.

Course outcomes:

- Ability to solve engineering problems dealing with force.
- Understand the basic concept of simple stress and strain, theory of flexure and torsion, springs and strain energy.
- Will be able to understand the complex state of stresses.
- Have understanding about failure modes of materials and response to fatigue.

Textbooks:

- Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Phillip J. Cornwell, Brian Self, "Vector Mechanics for Engineers: Statics and Dynamics", McGraw-Hill.
- Dieter, G, E., "Mechanical metallurgy (SI metric edition)", McGraw-Hill book company, 1988.

References:

- Ferdinand L. Singer (1975). "Engineering Mechanic" Collins, Singapore.
- Amit Bhaduri, "Mechanical Properties and Working of Metals and Alloys", Springer Series in Material Science.

Category:**Program Core Course** Subject code:**MM2104**

Non Metallic Materials

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To introduce the student to the range of non-metallic materials available for Engineering.
- To get an exposure to the techniques associated with the synthesis, processing and characterization of these materials and to become aware of the applications where these materials are preferred

Unit-1: Polymer Materials
Classification and applications of non-metallic materials, understanding on polymer structures, classification of Polymers: Thermosetting, thermoplastic, defects in polymers, mechanical behaviour of polymers, Characteristics of polymers and advanced polymeric materials, Processing of polymers vulcanization, polymer additives, forming techniques for plastics and elastomers.

Unit-2: Ceramic Materials
Understanding on ceramic structures, classification of ceramics, traditional ceramics advanced ceramics, refractories, defects in ceramics, phase equilibrium, mechanical behaviour of ceramics, thermal, magnetic, dielectric and superconducting behavior of ceramics, characteristics of ceramics and advanced ceramic materials, processing of ceramics

Unit-3: Glasses Materials
Understanding on glass structures, classification of glasses, major composition of glasses, glass former, characteristics of glass and advanced glass materials annealed glass, toughened glass and processing of glass, preparation, melting, forming and finishing. Glass fibers glass tubing

Unit-4: Carbonaceous Materials
Understanding on carbonaceous materials structures, defects in carbonaceous materials, classification of carbonaceous materials, carbon nanotubes, graphite, graphene, characteristics of carbonaceous Materials, processing of carbonaceous materials CVD, laser ablation, arc discharge

Unit-5: Composite Materials
Understanding on Composite Materials structures, classification of composite materials, characteristics of composite Materials, processing of composite materials, particle - reinforced composites, and fiber reinforced composites, structural composite preparation of ceramic powders: auto - combustion, sol - gel synthesis, microwave assisted hydrothermal synthesis

Course outcomes: After completing this course the student can:

- list the prominent non-metallic materials available for engineering applications
- indicate the uses for which these materials are preferred
- indicate the structure property relations in these materials
- indicate the synthesis and processing steps associated with these materials.

Textbooks:

- "Textbook of Polymer Science"", Fred W. Billmeyer, Wiley 2007
- "Introduction to Ceramics", Kingery, Bowen, Uhlman. Wiley India Pvt Limited, 2012
- "Composite Materials: Science and Engineering", Krishan K. Chawla, Springer, 2012.

Category:**Program Core Course Lab** Subject code:**MM2701**

Physical Metallurgy Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

- To provide hands on experience of different metallographic operations.
- To study and understand microstructures of different metals.
- To analyze results and draw conclusions from the results of the tests

List of experiments

- Study of metallurgical microscope, its ray diagram, resolution, magnification
- Metallography sample preparation of ferrous materials
  - Steels (low, medium and high carbon steels)
  - EN8, EN24 steel
  - Dual phase steel
  - Stainless steel
  - Cast irons (gray, white and nodular cast irons)
  - Heat treated and deformed steels
- Metallography sample preparation of non ferrous materials
  - Aluminium
  - Copper
  - Brass
- Qualitative and quantitative analysis (grain size measurement and use of Image J software)

Course outcomes: The student should be able to

- Students will be able to understand the metallographic operations and apply the knowledge in quality assessment and control of any metal or alloy produced.
- An understanding of phases and their differentiation.
- Skill in metallographic operations will be developed.
- An understanding on working principles of different Instruments.

Category:**Humanities and Social Sciences course** Subject code:**BM2201**

Managerial Economics and Financial Analysis

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-3

Course Objectives:

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Unit-1 Introduction to Managerial Economics
Definition, nature and scope, basic economic principles, the concept of opportunity cost, marginalism, incremental concept, time perspective, discounting principle, risk and uncertainty.

Unit-2 Theory of Demand and Supply
Demand analysis, demand function, law of demand, determinants of demand and types of demand, elasticity of demand, types, demand forecasting, need for demand forecasting, methods of demand forecasting, supply – law of supply.

Unit-3 Theory of production & cost analysis
Production-meaning, production function, production function with one variable, production function with two variables, isoquants and isocosts, marginal rate of technical substitution, returns to scale, cost concepts: meaning of costs, types of costs.

Unit-4 Market Structure and Pricing Practices
Classification of market structures, features, competitive situations, price-output determination under perfect competition, monopoly, features of monopolistic competition and oligopoly, pricing strategies.

Unit-5
Capital and capital budgeting: introduction of capital, definition of capital, sources of capital.
Capital budgeting: significance of capital budgeting, need for capital budgeting decisions, capital budgeting decisions, kinds of capital budgeting decisions, methods of capital budgeting, traditional methods-payback period and accounting rate of return methods, discounted cash flow methods, net present value method.

Course outcomes: The student should be able to

- Understand the nature and scope of managerial economics and the concepts of demand analysis.
- Understand the significance of demand elasticity and the concepts of demand forecasting.
- Understand the concepts of production and cost analysis

- Understand the concepts of production and cost analysis different market structures and their competitive situations.
- Understand the concept and significance of capital budgeting.

Textbooks:

- A.R. Aryasri, "Managerial Economics and Financial Analysis", McGraw Hill Education
- Varshiney and Maheswari, "Managerial Economics", Sultan Chand & Co, New Delhi

References:

- Vanita Agarwal, "Managerial Economics", Pearson Education
- Domnick Salvatore, "Managerial Economics in a Global Economy", 4th Edition, Thomson
- S.P. Jain and K.L. Narang, "Financial Accounting"

Category:**Humanities and Social Sciences course** Subject code:**HS2201**

Essence of Indian Traditional Knowledge

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-0

Unit-1 Basic Structure of Indian Knowledge System:
Veda Definition Kinds Upavedas (Ayurveda, Gandhra veda, Shilpa veda, Artha veda)- Vedangas (Shiksha, Kalapa, Chhanda, Niruktha, Vyakarana, Jyothishya), Dharma Shastra, Mimansa, Purana, Tarka Shastra

Unit-2
Modern Science and Indian Knowledge System
Yoga Holistic Health Care

Unit-3 Indian Philosophical Tradition:
A) Orthodox School: Samkya, Yoga, Nyaya, Vaisheshika, Purva Mimansa, Vedantha
B) Heterodox School: Jainism, Buddhism, Ajivika, Anjana, Charvaka

Unit-4
Indian Linguistic Tradition

Unit-5 Indian Artistic Tradition:
Chithra Kala (Painting), Sangeetha Kala (Music), Nruthya Kala (Dance)

Category:**Program Core Course** Subject code:**MM2201**

Mechanical Properties of Materials

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- Emphasize on the importance of the basic phenomenon and mechanical relationships of materials.
- To understand the description of stress and strain.
- To introduce the concept of defects (1, 2 and 3 dimensional), dislocations, stacking faults etc., with special influence on dislocations, their interactions and energies between them.
- To analyze the influence of defects and their concentration on the mechanical properties and flow relations of materials.
- To familiarize different mechanisms of deformation like slip, twinning etc., and to describe the effects of different strengthening mechanisms on the deformation behavior of materials.
- To study major mechanical property tests.
- To make the student bridge the gap between theoretical and problematic understanding by introducing different numerical and research problems.

Unit-1 Tension:
Stress and strain relationships for elastic behaviour, elements of the theory of plasticity, plastic deformation of single crystals.

Unit-2 Dislocation theory:
Defects in crystalline materials, observation of dislocations, movement of dislocations, elastic properties of dislocations, jogs and the intersection of dislocations, origin and multiplication of dislocations, strengthening mechanisms.

Unit-3 Mechanical Testing:
Compression: Elastic and plastic range, Baushinger effect, buckling, barreling, bending and torsion.
Hardness: Classification of hardness, Moh's scale, Brinell hardness, Rockwell hardness, Vicker's hardness, microhardness.
Impact testing: Notched-bar impact tests, instrumented Charpy test, significance of transition-temperature curve and factors affecting it

Unit-4 Fracture:
Theoretical cohesive strength, stress concentration factor, Griffith theory of brittle fracture, elastic

strain energy release rate, stress intensity factor.

Unit-5 Creep and stress rupture:
Introduction, long time loading at high temperature, creep curve, strain-time relationship, creep rate-stress-temperature relationship, creep deformation mechanism. Materials for high temperature use. Fatigue: Fatigue failure, stress cycles, standard fatigue test, the S–N diagram and fatigue properties, fatigue crack nucleation and growth

Course outcomes: The student should be able to

- Studying of the different types of stress-strain relations and their importance in material deformation.
- Understanding about the influence of dislocations and their interactions on the flow behavior of materials and to visualize the importance of dislocations in phenomenon like strain hardening, solid solution strengthening, cold working etc.,
- Student should be able to distinguish between different deformation mechanisms and reason with them.
- To be able to theoretically understand different mechanical testing processes and identifying the necessary conditions and possible deformation mechanisms associated. In addition a correlation between different mechanical properties is established.
- Predicting the manner of component failure and preventing it.
- Problem solving ability of the student will be improved along with analytical and logical skills.

Textbooks:

- "Mechanical metallurgy (SI metric edition)", Dieter, G. E., McGraw-Hill book company, 1988.

References:

- "Deformation and fracture mechanics of engineering materials (3rd edition)", Hertzberg, R. W., John Wiley & sons, 1997
- "Introduction to dislocations (4th edition)", Hull. D and Bacon, D. J., Butterworth-Heinmann, 2001.
- "Mechanical properties and working of metals and alloys", Bhaduri, A. K., Springer series in materials science, 2018

Category:**Program Core Course** Subject code:**MM2202**

Metal Casting and Welding

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To study and understand the basic concepts of casting and Welding.
- To study and design the gating system and riser
- To study about the arc and resistance welding processes
- To study and understand various other casting and welding processes suiting various Applications.
- To study and understand the metallurgy of welding welding
- To study and identify the defects of casting and welding

Casting:

Unit-1 Introduction

Introduction and classification of casting techniques, melting, solidification, sand casting: tools of sand casting, moulding sands, moulding sand properties and testing, core and and core sands, pattern colors, pattern materials, pattern allowances, types of patterns, making of moulding sand, design of riser and gating system, sand casting defects.

Unit-2 Casting processes and operations

Permanent mould and special casting process: die casting, investment casting, vacuum sealed moulding and squeeze casting, centrifugal casting, evaporative pattern casting and plaster moulding, continuous casting, finishing and inspection: shakeout, fettling and finishing, testing and quality control.

Welding:

Unit-3 Introduction

Introduction, applications, classification, welding positions, welding joints, arc welding processes, arc characteristics, shielded metal arc welding (SMAW), features of SMAW, V-I characteristics, electrodes used in SMAW.

Unit-4 Welding processes

Metal inert gas welding (MIG), submerged arc welding (SAW), gas metal arc welding (GMAW), electro slag welding (ESW), electrogas welding (EGW), tungsten inert-gas welding (TIG), plasma arc welding (PAW); Resistance welding advantages, applications. Thermo chemical welding and atomic hydrogen welding; laser beam and electron beam welding; solid state welding diffusion, ultrasonic, explosive,

friction and forge welding; gas welding; oxy acetylene welding, types of oxy acetylene welding;

Unit-5 Weldment properties and defects
Weldability, welding Metallurgy, welding defects, inspection and testing of weldments destructive and non destructive testing.

Course outcomes: The student should be able to

- will be able understand the fundamentals concepts of metal casting and welding operations and apply the knowledge in solving various operational problems arise during metal casting and welding.
- understand on the process and problems involved in casting and welding is achieved.
- understand different types of tools and equipments can be identified.
- design gating systems and identify the importance of pressurized and un-pressurized gating systems in casting process.
- understand the advantages and limitations of different materials joining and casting operations.
- evaluation of different modes of testing (destructive and non-destructive) the casted and welded parts.

Textbooks:

- "Metal casting Technology", P. N. Rao
- "Foundary Technology", O. P. Khanna
- "Manufacturing Technology", P. N. Rao
- "Production Engineering", Dr. Swadesh Kumar Singh
- "Manufacturing Processes", J. P. Kaushish
- "Welding process and technology", R. S. Parmar
- "Welding and Welding technology", Richard Little
- "Welding Metallurgy", Sindo Kou
- "Morden Arc Welding Technology", S.V. Nadkarni
- "Manufacturing Processes", J.P. Kaushish

Category:**Program Core Course** Subject code:**MM2203**

Phase Transformations

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- to revise the basics of thermodynamics and stability concept of phase transformations.
- to understand the principles of solidification.
- to analyze the mechanisms and phenomenon associated with diffusion.
- to study pearlitic and bainitic transformations.
- to know the diffusionless transformations

Unit-1 Introduction:
Phase equilibrium: Introduction, thermodynamics and stability of phases, classification of phase transformations, order of transformation, Gibbs rule and application, phase diagrams, construction and interpretation.

Unit-2 Liquid-Solid Transformation:
Nucleation: homogeneous and heterogeneous, growth: continuous and lateral, interface stability; alloy solidification: cellular and dendritic, eutectic, off-eutectic, peritectic solidification, welding, casting and rapid solidification.

Unit-3 Diffusion:
Atomic mechanism, interstitial and substitutional diffusion, atomic mobility, tracer diffusion in binary alloys and diffusion in multiphase binary systems. Solid state diffusive transformation: classification, nucleation and growth - homogeneous and heterogeneous mechanism, precipitate growth under different conditions, age hardening, spinodal decomposition, precipitate coarsening, transformation with start range diffusion, recrystallization, grain growth, eutectoid transformation, discontinuous reactions.

Unit-4 Pearlitic And Bainitic Transformation:
Factors influencing pearlitic transformation, mechanism of transformation, nucleation and growth, orientation relationship, degenerate pearlite. Bainite: mechanism of transformation, nucleation and growth, orientation relationships, surface relief, classical and non-classical morphology, effect of alloying elements.

Unit-5 Non-Diffusive Transformation:
Characteristics of transformation, thermodynamics and kinetics, nucleation and growth, morphology,

crystallography, stabilization, strengthening mechanisms, non-ferrous martensite, shape memory effect/alloys and glass transition concept.

Course outcomes:

- A pragmatic understanding on the concept of phase and the relationship between thermodynamics of materials and the transformations occurring in them.
- Understanding the concept of nucleation and growth of solid phases from the liquid to obtain different grain morphologies.
- A complete idea of the formation of different phase like peritectic or eutectic mixtures along with their free energies to be deduced.
- Analyzing the conditions and transformations associated with solidification of metals.
- Study of the effect of diffusion on the phase shift along with their kinetics.

Textbooks:

- "Phase Transformations In Metals And Alloys", Porter, D, A And Easterling, K. E., 2 nd Edition, CRC Press, 1992.
- "Physical Metallurgy Principles", Reed-Hill, R, E And Abbaschian, R., 3rd Edition, PWS-Kent Publishing Company, 1994.

Category:**Program Core Course** Subject code:**MM2204**

Iron and Steel Making

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To study history of iron production and methods of producing iron from its ores.
- To study the physical chemistry during iron production from its ores at higher temperatures
- To study and understand iron production by sponge iron making process.
- To study past present and future of steel making
- To study and understand thermodynamics and kinetics of the reactions during steel making
- To study and understand primary steel making operations

Unit-1
History of Iron; occurrence and distribution of iron ore, limestone and coke in India; raw materials for blast furnace pig iron production; Coke production: Properties of coke, recoverable and nonrecoverable coke ovens process; Agglomeration of Iron ore fines: sintering; Dwight-Lloyd (DL) sintering, fluidized bed sintering; pelletisation: disc and drum pelletization processes.

Unit-2
Blast furnace (B/F) profile and design considerations; physical chemistry of iron making; furnace zones: combustion zone, RAFT zone, cohesive zone, thermal reserve zone, chemically inactive zone, B/F refractory lining, gas cleaning system, B/F gas storage stoves.

Unit-3
Blast furnace blow-in process, blow-out/shut down processes; blast furnace operation and its irregularities: deadman's zone, hanging, scaffold, pillering; limitations of blast furnace iron production; sponge iron productions: using gases as reducing agent: Midrex process, HYL, using solid as reducing agent process: SL/RN process; smelt iron reduction methods: COREX, INRED, ELRED; burden/charge/ mass balance calculations.

Unit-4
Pre-treatment; role of slag; steel making reactions; Linz-Donawitz (LD) convertor steel making: LD design, raw material, chemical reactions in LD: Thermodynamics of O, S, P, C removal; modren developments in LD convertor.

Unit-5
Electric arc furnace steel making (EAF-SM): EAF design, raw materials, EAF steel making process; modern developments in EAF-SM.
Continuous casting process (CCP): cast into semi-finished products; grain structure; heat transfer zones in CCP; mould making; casting defects; modern developments in CCP; burden/charge/mass balance calculations.

Course outcomes: The student should be able to

- aware about history of iron and steel making methods
- understood the physical chemistry iron and steel making
- understood the sponge iron making process
- received exposure of integrated steel plant
- understood the process of continuous casting of steel

Textbooks:

- "Iron making and Steel making", Ahindra Ghosh & Amit Chaterjee, Prentice Hall India Learning Private Limited; 1St Edition edition (2008)
- "Manufacture of Iron and Steel", Bashforth G.R, Volumes I - IV, Asia Publ., 1996
- "Secondary Steel Making: Principles and applications", Ahindra Ghosh, CRC Press; 1 edition (13 December 2000).

References:

- "Steel Making", A. K. Chakrabarthi (PHI) 2007
- "Modern Steelmaking", Dr. R.H. Tupkary and V.H. Tupkary
- "Steel Making", V. A. Kudrin
- "Fundamentals of Steel Making practice", Brahma Deo & Rob Boom
- "Physical Chemistry of Iron & Steel", Boodsworth
- "Steel making", Turkdogen
- "Metallurgical Thermodynamics Kinetics and Numericals", Dutta S.K., Lele A.B.

Category:**Program Core Course Lab** Subject code:**MM2801**

Mechanical Properties of Materials Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

- To provide hands on experience of different mechanical testing procedures
- To understand the mechanisms of deformation
- To be able to identify the difference in ferrous and non-ferrous materials in terms of mechanical properties.
- To correlate the different mechanical testing processes to understand the behavior of a metal under different loading conditions.
- To analyze results and draw conclusions from the results of the tests

The list of experiments are:

Hardness Test

- To determine the Brinell Hardness values of ferrous and non-ferrous samples.
- To determine the Rockwell hardness values of heat treated steels.
- To find the microhardness of phases by using Vickers hardness tester.

Tension Test

- To determine the elastic modulus, ultimate tensile strength, breaking stress, percentage elongation, percentage reduction in area of the given specimen.
- To determine the strain distribution along the gauge length.
- Compression test
- Three point bend test
- Erichson cupping test

Impact Testing

- To determine the Charpy and Izod (V & U Groove notch) values of a given material at room temperature.

- To establish the ductile - brittle transition temperature of the material.
- Creep test
- Fatigue test

Course outcomes: The student should be able to

- Experience in designing and conducting tests to devaluate the mechanical properties of different materials.
- Differentiating the materials based on their strength, ductility, toughness etc.
- Exposure to different testing machines
- Skill development in the areas of analyzing results and suggesting preventive measures for material failure.
- Hands on approach for the testing of materials.

Textbooks:

- Dieter, G, E., "Mechanical metallurgy (SI metric edition)", McGraw-Hill book company, 1988.
- Hertzberg, R, W.," Deformation and fracture mechanics of engineering materials (3rd edition)", John Wiley & sons, 1997

Category:**Program Core Course Lab** Subject code:**MM2802**

Metal Casting and Welding Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

- To provide hands on experience of casting and welding operations
- To understand and analyse different Casting and Welding defects.

List of experiments:

- To prepare a sand mold and produce an aluminum casted product.
- To determine the permeability number of the sand specimen.
- To determine the green, dry and shear strength of the sand mold.
- To determine the moisture content in the sand mold.
- To determine the hardness of the mold.
- To weld the mild steel samples by manual metal arc welding process and visually inspect the defects along with the microstructure variations.
- To weld the mild steel samples by metal inert gas welding process and visually inspect the defects along with the microstructure variations.
- To weld the mild steel samples by oxy acetylene gas welding process and visually inspect the defects along with the microstructure variations.
- To weld the aluminum samples by tungsten inert gas welding process and visually inspect the defects along with the microstructure variations.
- To weld two similar metals by friction stir welding process and visually inspect the defects along with the microstructure variations

Course outcomes:

- Students will be able to understand various steps involved in producing a casting and welded joint.
- They can also perform various quality assessment operations to identify the defects produced after casting as well as welding and apply the knowledge in preventing the defects.

Category:**Humanities and Social Sciences course** Subject code:**HS3101**

Communication Skills

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-2-1

Course Objectives:

- To make the students efficient communicators via experiential learning.
- To enhance learners' analytical and creative skills, so that they will be capable to address a wide variety of challenges in their professional lives.
- To help learners to improve the leadership qualities and professional etiquette
- To expose learners to an effective communicative environments.

Unit-1 Introduction to Communication
Introduction, importance of communication skills, definition, scope and nature, verbal and nonverbal communication

Unit-2 Reading Skills
Reading comprehension of unseen passage, prose, news paper reading and analysis (editorial), novels, different research articles, crack the answers in the unseen paragraphs in the competitive exams etc ...

Unit-3 Functional Grammar

- Parts of speech (functional usage)
- Subject and predicate (useful at workstations)
- Conjunctions-gap fillers (linkers; connectors; cohesive devices)
- Verbs & verb patterns (transitive and intransitive - finite and infinite - regular and irregular models)
- Tenses (various applications)
- Prepositions/ prepositional verbs (idiomatic expressions, one word substitutions, phrasal verbs)
- Adjectives (describing, narrating, effective presentation)

Unit-4 Enhancing Vocabulary
Developing professional vocabulary, different forms of verbs (verb forms: v1, v2, v3)
Using Dictionary: Spelling - jargon specific vocabulary, context specific vocabulary, right choice of vocabulary etc ...

Unit-5 Composition
Paragraph essay - expansion - describing the pictures - giving directions - situational dialogue writing - social and professional etiquette - telephone etiquette, email etiquettes, role plays, jam, and elocution etc ...

Course outcomes:

- Develop interpersonal communication, small group interactions and public speaking.
- Develop confidence and skills related reading comprehension.
- Improve a logical framework for the critical analysis of spoken, written, visual and mediated messages upon diverse platforms.
- Demonstrate the ability to apply vocabulary in practical situations.

References:

- Joseph Mylal Biswas book of English Grammar
- R. Murphy -Cambridge Press
- Wren and Martin
- The Good Grammar book by OUP
- Communication skills by M. Raman and Sangeeta Sharma
- How to Win Friends and Influence people by Dale Carnigie
- How to Read and Write Better by Norman Lewis
- Better English by Norman Lewis
- Use of English Collocations by OUP
- www.humptiesgrammar.com
- www.bbcenglisgh.com
- www.gingersoftware.com
- www.pintest.com

Category:**Program Core Course** Subject code:**MM3101**

Heat Treatment

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To introduce the concept of heat treatment and its classification
- To understand nucleation and growth kinetics, precipitation in age-hardening alloys, austenitic, eutectoid, pearlitic and bainitic transformations in steel.
- To analyze diffusionless transformations and hardenability
- To study different surface treatments
- To note different ferrous and non-ferrous heat treatments.

Unit 1: Introduction
Introduction, time-temperature parameters of a heat treatment process, classification of heat treatment processes, heat treatment as applied to the products of steel-making industry, machine building and automobile industry, tool making industry, etc.

Unit 2: Diffusional transformation and principles of heat treatment
Homogeneous nucleation in solids, heterogeneous nucleation, precipitate growth, overall transformation kinetics -TTT diagram, precipitation in age-hardening alloys, austenitic transformation, eutectoid transformation, pearlitic and Bainitic transformations in steel, continuous cooling diagrams, massive transformations, and order-disorder transformation.

Unit 3: Diffusionless transformations and hardenability
Introduction to diffusionless transformation, martensitic transformation, martempering, concept of critical diameter, joining-endquench test, effect of parameters viz: alloying elements, carbon content, austenic grain size, retained austenite, section size and quenching media.

Unit 4: Surface treatments
Surface heat treatment, carburizing, cyaniding, flame and induction hardening, residual stresses, deep freezing, thermo mechanical treatments: HTMT, LTMT, ausforming, isoforming, cryoformy.

Unit 5: Heat treatment of metals
Heat treatments of some important steels, cast irons (along with their classifications), heat treatment of non-ferrous alloys: precipitation hardening, aging treatment, study of copper and its alloys, aluminum

and its alloys, nickel and its alloys.

Textbooks:

- Rajan, T. V and Sharma, C. P., "Heat treatment principles and techniques (2nd edition)", Prentice hall of India, 1994.
- Reed-Hill, R, E and Abbaschian, R., "Physical Metallurgy Principles (3rd edition)", PWS-Kent publishing company, 1994.
- Raghavan, V., "Physical metallurgy: principles and practice (2nd edition)", Prentice hall of India, 1994.

Category:**Program Core Course** Subject code:**MM3102**

Non Ferrous Extractive Metallurgy

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To understand the methods of metal extraction and sources of non ferrous metals.
- To study the thermodynamics principles involved in metal extraction.
- To study the methods of extracting non ferrous metals from their ores.
- To study various methods of refining the extracted metals.

Unit-1 Introduction
History of non ferrous Metals: Early developments in metal extraction (introduction, discovery of metals and their importance, important landmarks, nonferrous metals in Indian history, uses of nonferrous metals), sources of non-ferrous metals (sources in land and sea, exploration methods, methods of beneficiation, nonferrous metals wealth in India).

Unit-2 Basic principles of extraction
Principles of metals extraction, (thermodynamic principles, homogeneous and heterogeneous reactions, Ellingham diagrams, kinetic principles, principles of electro-chemistry), general methods of extraction, (pyro-metallurgy calcinations, roasting and smelting, hydrometallurgy - leaching, solvent extraction, ion exchange, precipitation, and electrometallurgy - electrolysis and electro - refining), general methods of refining, (basic approaches, preparation of pure compounds, purification of crude metal produced in bulk).

Unit-3 Extraction of metals from oxides
Extraction of metals from oxide sources: Extraction of metals such as magnesium, aluminum, tin.

Unit-4 Extraction of metals from sulphides
Extraction of metals from sulphide ores: Pyro - metallurgy and hydro - metallurgy of sulphides, production of metals such as copper, lead, zinc, gold, silver)

Unit-5 Extraction of metals from halides
Production of halides and refining methods, production of reactive and reactor metals. Methods of extraction of metals such as titanium, rare earths, uranium, thorium, plutonium, beryllium, zirconium

Course outcomes:

- Students will be able to identify various resources of non ferrous metals and understand their extraction and refining methods by applying thermodynamic concepts for extraction.
- Students shall be able to understand the engineering aspects of prevalent extraction process of major non-ferrous metals.

Textbooks:

- "Extraction of Non-Ferrous Metals", HS Ray, KP Abraham and R. Sridhar.
- "Non Ferrous Extractive Metallurgy", G B Gill John Wiley & Sons.

Category:**Program Core Course** Subject code:**MM3103**

Mechanical Working of Metals

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To the basic concepts of the stress and strain for different materials
- To study about the cold, warm and hot deformation processes
- To analyze the parameters affecting the deformation processes such as forging, rolling, extrusion and drawing
- To study and analyze various sheet metal forming processes like bending, deep drawing, etc

Unit-1
Stress-strain relations in elastic and plastic deformation, concept of flow stress, deformation mechanisms, basic metal working concepts and plasticity, yield criterion, slip line fields, role of temperature and friction in metal working.

Unit-2
Hot and cold working, forging, rolling - types, analysis, parameters affecting the process, defects, their causes and remedial measures.

Unit-3
Extrusion, wire and tube drawing - types, analysis, parameters affecting the process, defects, their causes and remedial measures.

Unit-4
Sheet metal working processes - Classification of metal forming processes, estimation of force and energy requirements; Metals used in press working, Lubrication, press, theory of shearing, shearing operations, blanking, piercing, bending and stretch forming

Unit-5
Deep drawing, hydro forming, coining and embossing - types, parameters affecting the process, lubrication in metal forming processes, defects in various sheet metal forming processes, their causes and remedial measures

Course outcomes:

- Students can classify the metal working processes .

- Students can explain principle of forging, determination of forging load & its application.
- Understand the manufacturing of tubes and pipe by extrusion method..
- Describe the manufacturing of wire and rods and able to analyze the variable affecting it.
- Acquainted with sheet metal working.
- elect the material for die manufacturing and software utilize for designing of it
- Students will gain knowledge on various conventional and advanced deformation operations.
- Students will be able to identify appropriate deformation operation for a particular material.
- Students will be able to apply the concepts of stress-strain in the design of various deformation processes.

Textbooks:

- "Mechanical Metallurgy", Dieter
- "Production Engineering", Dr. Swadesh Kumar Singh
- "Manufacturing processes", J.P. Kaushish

Category:**Program Elective Course** Subject code:**MM3104**

Transport Phenomena

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To study and understand the heat and mass transfer
- To understand the kinetics of various metallurgical processes

Unit-1 Introduction
Balance of quantities using elemental volume approach, continuity equation.

Unit-2 Kinetics
Newton's law of viscosity, Navier - Stokes equation, laminar flow problems, exact solutions in rectangular, cylindrical and spherical coordinate systems. Friction factors, correlations for turbulent regime, Darcy's law, flow through porous media.

Unit-3 Heat transfer
Fundamentals of heat conduction, convection, radiation and their combined effect; steady and unsteady heat transfer, exact analytical solutions, correlations for conjugate heat transfer.

Unit-4 Mass transfer
Diffusion and its application in solid state, convective mass transfer, unsteady diffusion in finite and infinite bodies, diffusion and chemical reactions.

Unit-5 Other phenomena
Coupled phenomena in transport, non-dimensional numbers and their correlations of different regimes and analogies.

Course outcomes: The student should be able to

- pose a problem in transport phenomena as a balance equation
- make suitable assumptions to make the problem a well defined one
- identify suitable geometry and boundary conditions for the problem
- solve simple partial differential equations relevant to transport phenomena
- plot different parameters and interpret the solutions

Textbooks:

- "Transport phenomena", 2nd Edition R. Byron Bird, Warren E. Stewart and Edwin N Lightfoot; John Wiley & Sons
- "Fundamentals of Momentum, Heat and Mass Transfer", 4th Edition, James R. Welty, Charles E. Wicks, Robert E. Wilson and Gregory Rorrer; John Wiley & Sons

References:

- "Transport phenomena in materials processing", D.R. Poirier and G.H. Geiger, TMS
- "Introduction to Fluid Mechanics", 5th Edition, Robert W. Fox & Alan T. McDonald: John Wiley & Sons

Category:**Program Core Course Lab** Subject code:**MM3701**

Heat Treatment Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

- To introduce various kinds of heat treatment operations to the students
- To study the effect of heat treatment on the microstructure of the metals
- To study the effect of heat treatment on the mechanical properties of the metals

List of experiments:

- Annealing of medium carbon steels (AISI C105, EN8, EN24) and observation of microstructure.
- Normalizing of medium carbon steels (AISI C105, EN8, EN24) and observation of microstructure.
- Hardening of medium carbon steels (AISI C105, EN8, EN24) and observation of microstructure.
- Study of tempering characteristics of water quenched steel.
- Study of age hardening phenomena in duralumin.
- Spheroidizing of a given high carbon steel.
- Determination of hardenability of medium carbon steel by Jominy end quench Test.
- Effect of hardening heat treatment on the hardness of cast iron (Grey and Ductile Cast iron)

Category:**Program Core Course Lab** Subject code:**MM3702**

Extractive Metallurgy Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

- To understand the extraction methods of ferrous metals and non ferrous metals.
- To demonstrate physical and chemical beneficiation of metals from their ores.
- To compare different extraction processes and deduce the most effective one.
- To correlate laboratory and industrial extractions.

List of Experiments:

- Solvent extraction
- Ion exchange
- Preparation of iron by reaction of iron (III) oxide with aluminum (thermite reaction)
- Calcination of lime: to study the kinetics
- Extraction copper from electrolytic bath
- Electro refining
- Leaching of chalcopyrite by NaOH+Na_2CO_3 mixture
- Decomposition of metallic components
- Purification of leach liquor
- Single step and multistep leaching

Course outcomes: The student should be able to

- Students will gain the knowledge and experience on some of the mineral beneficiation and extraction operations of minerals.
- Understanding the different unit operations like crushing, grinding and classification.
- To study roasting, calcination and smelting of ores.

- Electroplating and electro - chemical refining of metal.
- The student is able to visualize industrial operations which are a part of the extraction of ferrous and non-ferrous metals.

Textbooks:

- "Extraction of Non-Ferrous Metals", HS Ray, KP Abraham and R. Sridhar.
- "Non Ferrous Extractive Metallurgy", G B Gill John Wiley & Sons.

Category:**Humanities and Social Sciences course** Subject code:**HS3201**

Soft Skills

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-2-1

Course Objectives:

- To enable students speak effectively in formal and informal situations
- To equip the students with necessary writing skills in order to face the corporate world
- To strengthen the writing skills of the students and help them in documentation
- To enable students sharpen their communication skills towards writing a persuasive resume and effective job application letters
- To equip students with pre - presentation steps, to understand the structure of a good presentation, and devise various techniques for delivering a successful presentation
- To make students understand the importance of team work and group presentations and group discussions

Unit-1 Activities on Fundamentals of Inter-personal Communication
Starting a conversation - responding appropriately and relevantly - using the right body language - role play in different situations & discourse skills using visuals.

Unit-2 Activities on Reading Comprehension
General Vs local comprehension - reading for facts - guessing meanings from context - scanning - skimming - inferring meaning - critical reading surfing Internet

Unit-3 Activities on Writing Skills
Structure and presentation of different types of writing- resume writing / e- correspondence / technical report writing - planning for writing - improving one's writing.

Unit-4 Activities on Presentation Skills
Oral presentations (individual and group) through JAM sessions / seminars / PPTs and written presentations

Unit-5 Activities on Group Discussion, Debate 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 - conferencing - Mock Interviews.

Course outcomes:

- communicate effectively in formal and informal situations
- understand the structure and mechanics of writing resumes, reports, documents and e-mails
- present effectively in academic and professional contexts
- develop communication in writing for a variety of purposes
- identify areas of evaluation in Group Discussions conducted by organizations as part of the selection procedure
- overcome stage fear and tackle questions

References:

- "Soft Skills Training: A workbook to Develop Skills for Employment", Frederick H. Wentz
- "Everyone Communicates, Few People Connect: What the Most Effective People do Differently", John C. Maxwell
- "How to Talk to Anyone: 92 Little Tricks to Have Big success in Relationships", Leil Lowndes
- "Teamwork101: What Every Leader Needs to Know ", John C. Maxwell
- "AdaptAbility: How to Survive Change You Didn't Ask For", M.J. Ryan
- "Conflict Communication: A New Paradigm in Conscious Communication", Rory Miller

Category:**Program Core Course** Subject code:**MM3201**

Materials Characterization

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To understand the basic concept of different characterization techniques
- To know the working principles of materials characterization techniques.
- To analyze and understand the behavior of materials from characterization techniques.
- To study crystal structure, chemical composition, phase, residual stress and texture of materials.
- To study the microstructure of materials from optical and electron microscopes.
- To understand the spectroscopic, thermal and electrical characterization techniques.

Unit-I: Introduction
Introduction, scope of subject, classification of techniques for characterization, macro & micro-characterization structure of solids

Unit-II: XRD
Diffraction methods: X - ray diffraction, crystal systems and space groups, Bravais lattices, direct and reciprocal lattice, Braggs law, powder diffraction and phase identification, single crystal diffraction, structure factor, X-ray crystal structure determination.

Unit-III: Microscopic Techniques
Metallographic techniques: Optical metallography, image analysis, quantitative phase estimation. Electron optical methods: Scanning electron microscopy and image formation in the SEM, Transmission electron microscopy (TEM), Scanning tunneling microscopy (STM), Atomic force microscopy (AFM) and scanning transmission electron microscopy (STEM).

Unit-IV: Spectroscopic Techniques
Optical & X -ray spectroscopy: Atomic absorption spectroscopy, X -ray spectrometry, infrared spectroscopy, Raman spectroscopy, EDS and WDS.

Unit-V: Thermal characterization Techniques
Bulk averaging techniques: Thermal analysis, DTA, DSC, TGA, TMA, dilatometry, resistivity/ conductivity.

Course outcomes: The student should be able to

- understand and characterize different systems from their X -ray data.
- understand different microscopic techniques can be studied. Difference between optical and electron microscopic techniques is established.
- Spectroscopic techniques and their application in identifying the chemical characteristics of different systems.

Textbooks:

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References:

- Spencer, Michael, "Fundamentals of Light Microscopy", Cambridge University Press,1982.
- David B. Williams, C. Barry Carter, "Transmission Electron Microscopy: A Textbook for Materials Science", Springer, pub. 2009.
- Joseph I Goldstein, Dale E Newbury, Patrick Echlin and David C Joy, "Scanning Electron Microscopy and X-Ray Microanalysis", 3rd Edition, 2005.
- B.D.Cullity and S.R.Stock, "Elements of X-Ray Diffraction", Third edition, Prentice Hall, NJ, 2001.
- G.W.H. Hohne, W.F. Hemminger, H.-J. Flammersheim, "Differential Scanning Calorimetry", Springer, 2nd ed., 2003.
- "Fundamentals of light microscopy and electronic imaging", Douglas B. Murphy, 2001, Wiley-Liss, Inc. USA
- "Electron optical applications in materials science (McGraw-Hill series in materials science and engineering)", Lawrence Eugene Murr.

Category:**Program Core Course** Subject code:**MM3202**

Corrosion Engineering

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-1-0-4

Course Objectives:

- To understand the technological importance of corrosion studies
- To study types and basic concepts of corrosion
- To study and understand the kinetics of corrosion
- To study and understand the preventive measures of corrosion

Unit -1: Introduction
Technological importance of corrosion study - introduction to corrosion, definition, learning objectives, degradation process-mechanical and chemical process. Dry corrosion and wet corrosion. Local and uniform corrosion. Cost of corrosion-direct loss and indirect loss, cost of corrosion in various industries.

Unit -2: Basic Concepts of Corrosion
Electochemical principles of corrosion - cell analogy, cathode, anode, electrolyte, cathodic and anodic reactions, types of corrosion cell. Concept of free energy (driving force of corrosion based on thermodynamical studies), cell potential and emf, Nernst equation and their application on corrosion. Concept of single electrode potential, reference electrodes, half cell reaction, types of reference electrode-SHE, Ag-AgCl, SCE, Cu-$CuSO_4$. Emf and galvanic series-their uses in corrosion studies. Eh-pH diagrams-fundamental aspects. Construction of Eh-pH diagrams.

Unit -3: Corrosion Kinetics
Corrosion rate expressions-Faraday's law, area effect, weight loss, thickness loss. Electrode - solution interface - overpotential, definition and types of polarization-factors affecting them. Exchange current density-polarization relationships. Mixed potentials-concepts and basics. Mixed potential theory-mixed electrodes (bimetallic couples), activation and diffusion controlled processes. Application of mixed potential theory. Corrosion rate measurements (determination). Passivity-definitions and influencing parameters. Passivity-design of corrosion resistant alloys, factors affecting passivity.

Unit -4: Types Of Corrosion
Different forms of corrosion Mechanism, characteristic features, causes and remedial measures of uniform corrosion, galvanic corrosion, crevice corrosion. Pitting corrosion, intergranular corrosion (including weld decay & knife-line attack). Erosion corrosion, selective leaching and stress corrosion cracking. Hydrogen damage-types, characteristics, mechanism and preventive measures.

Unit -5: Cathodic Protection And Coating
Principles of corrosion prevention-material selection, control of environment including inhibitors. Cathodic protection-principle, classification, influencing factors and design aspects. Anodic protection-principle, influencing factors and design aspects. Coatings and design considerations (corrosion prevention).

Course outcomes: The student should be able to

- understand electrochemical fundamentals
- understand corrosion preventing methods
- understand environmental induced corrosion
- solve corrosion problems

Textbooks:

- "Corrosion Engineering", Fontana.

References:

- "Principles of Corrosion engineering and corrosion control", Zaki Ahmad.
- "Handbook of Corrosion Engineering", Pierre R. Roberge.

Category:**Program Core Course** Subject code:**MM3203**

Powder Metallurgy and Additive Manufacturing

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-3

Course Objectives:

- To understand the basic introduction and overview of powder metallurgy
- To study various powder production methods and analyzing its characteristics
- To understand various cold and hot compacting methods
- To study various sintering and post sintering processes.
- To study various Additive manufacturing processes.

Unit-1
Introduction to powder metallurgy, steps in powder metallurgy, advantages of powder metallurgy process, applications of powder metallurgy, limitations of powder metallurgy, recent trends.

Unit-2
Powder production methods: Mechanical, Chemical, and Physical methods, Powder treatment and handling, Metal powder characteristics: sampling, metal powder characterization, packing and flow characteristics of powders, density and compressibility of metal powder

Unit-3
Compaction of metal powders: powder compaction methods, classification of powder metallurgy parts; cold isostatic, High temperature compaction uniaxial hot pressing, hot extrusion, spark sintering, hot isostatic pressing, injection moulding.

Unit-4
Sintering: types of sintering, sintering theory, sintering mechanisms, variables, effects of, sintering atmospheres, Post sintering operations.

Unit-5
Introduction to Additive Manufacturing: Introduction to AM, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM. Types of AM processes.

Course outcomes:

- Students will be able to produce powders of different materials by optimizing the operational parameters.
- Students will understand different powder characterizing techniques.
- Students will understand the operational limitations in converting powders into bulk materials by compaction and sintering.
- Students will be able to optimize process parameters of the powder making operations.
- Students will be having a basic knowledge of Additive manufacturing.

Textbooks:

- Powder Metallurgy Technology by G. S. Upadhyaya.

References:

- Powder Metallurgy Science by Randall M. German

Category:**Program Core Course Lab** Subject code:**MM3801**

Materials Characterization Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

- To provide hands on experience of XRD, FESEM, and EDX
- To study and analyse the peaks of XRD of materials
- To analyse quantitatively the chemical composition of material
- To analyse the microscopic images of materials produced by FESEM

List of experiments:

- Index and calculate the lattice parameter of cubic systems by analytical method.
- Index and calculate the lattice parameter of cubic systems by mathematical method.
- Calculate the precise lattice parameter by mathematical method.
- Calculate the precise lattice parameter by graphical method.
- Calculate the crystalline size from given XRD data.
- Calculate the residual strain from given XRD data.
- Calculate the residual stress from given XRD data.
- Phase identification from given XRD data.
- Demonstration on FESEM image formation.
- Demonstration on EDX.
- Demonstration on powder XRD.
- Demonstration on thin film XRD.

Course outcomes:

- Students can estimate the crystal structure and chemical composition of the given material by XRD and FESEM data.

- Students can analyze the phases present in a metal by image analysis using FESEM.
- Identifying the different crystal structures of materials by observing and analyzing XRD data
- Carrying out lattice parameter calculations by mathematical and graphical methods and their comparisons and residual stress calculations
- Micro-structural and chemical understanding of the materials by FESEM and EDS analyses.
- Student gets a flavor of operation and usage of high end equipment like XRD and FESEM.

Category:**Program Core Course Lab** Subject code:**MM3802**

Corrosion Engineering Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-3-1.5

Course Objectives:

- to measure the corrosion rate of two different metals and to show the effectiveness of the use of inhibitors to protect metals from corrosion
- Establishing corrosion mechanisms.
- Defining corrosion resistance of materials and how to develop new corrosion resistant alloys.
- Estimating service life of equipment.
- Developing corrosion protection processes.
- Defining the critical potential values for materials in various environments.

The list of experiments could be

- Weight loss - corrosion rate measurement (2 experiments)
- Effect of inhibitor on rate of corrosion (inorganic inhibitor or organic inhibitor)
- Crevice & Pitting corrosion testing
- Corrosion protective coatings
- Corrosion prevention Protective coatings (hardness test by pencil test)
- Corrosion prevention Protective coatings (immersion test)
- Corrosion prevention Protective coatings (salt spray test)
- Corrosion rate measurement Electrochemical work station or potentiostate
- Construction and interpretation of E-Ph diagram

References:

- **ASTM G1** — Standard practice for preparing, standard practice for preparing, test specimens.
- **ASTM G 31 -72** — Standard practice for laboratory immersion corrosion testing of metals.

- **ASTM G48 - 11** — Standard test methods for pitting and crevice corrosion resistance of stainless steels and related alloys by use of ferric chloride solution.
- **ASTM D_3363-05** — ASTM_D_3363 05 Standard test method for film hardness by pencil test.
- **ASTM D 6943 03**— Standard practice for immersion testing of industrial protective coatings
- **ASTM G 36 94** — Standard practice for evaluating stress-corrosion-cracking resistance of metals and alloys in a boiling magnesium chloride solution
- **ASTM G3-14** — Standard practice for conventions applicable to electrochemical measurements in corrosion testing.
- **ASTM A262-15** — Standard practices for detecting susceptibility to intergranular attack in austenitic stainless steels
- **ASTM G5 14** — Standard reference test method for making potentiostat anodic polarization measurements.
- **ASTM G59 - 97** — Standard test method for conducting potentiostat polarization resistance measurements.

Category:**Humanities and Social Sciences course** Subject code:**BM4101**

Fundamentals of Management for Engineers

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 3-0-0-3

Course Objectives:

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Unit-I:
Nature of management, importance, functions of management, role of manager, evolution of management thoughts

Unit-II:
Planning: nature, importance, types, steps, limitations, decision making, types, process of rational decision making, techniques of decision making

Unit-III:
Organixzing: concept, nature, process, purpose and significance, authority and responsibility, delegation of authority, centralization and decentralization, departmentalisation

Unit-IV:
Staffing and directin: meaning, importance of recruitment and selection, training and development; Motivation: meaning, nature; Leadership: meaning and styles; Communication: nature, process and barriers

Unit-V:
Controlling: Need, importance and process, effective control systems, techniques, traditional and modern coordination, need and importance

Course outcomes: The student should be able to

- Identify and apply appropriate management techniques for managing business
- Have a conceptual knowledge about the planning and decision making
- Apply the concept of organizing for the effective functioning of a management
- Evaluate the concepts of Staffing & Directing
- Demonstrate the techniques for controlling and coordination

References:

- PagareDinkar, "Principles of Management"
- L M Prasad, "Principles and Practice of Management"
- Satya Narayan and Raw VSP, "Principles and Practice of Management"
- Srivastava and Chunawalla, "Management Principles and Practice"

Category:**Program Core Course** Subject code:**MM4101**

Computational Materials Engineering Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks 0-0-2-1

Course Objectives: To make the students familiarize with

- various kinds of models used in computational materials engineering
- application of various numerical techniques to solve the equations in the models
- coding and simulation tools

The list of experiments could be

- Introduction to the programming using C/Python
- Analysis of data using linear regression for one/multi dimensional data
- Solving the given set of linear and nonlinear equations
- Find the derivative of the given numerical data using appropriate numerical methods
- Find the integral of the given data using appropriate numerical methods
- Simple engineering drawing using CAD tools (2-3 experiments)
- Analysis of microstructure using software tools (2-3 experiments)
- Solving the Laplace equation using finite divided differences
- Solving the diffusion equation using finite divided differences
- Various visualization tools for the numerical data
- Analyzing the cohesive strength using script code
- Ring compression test using finite elemental method

Course outcomes: The student should be able to

- Develop a simple model for metallurgical problems
- Use appropriate techniques to solve the model developed
- Implement simple codes/ programs in one of the programming languages

- Analyze the data generated

Suggested **Textbooks** and **References:**

- Chapra, S. C., & Canale, R. P. (2016). "Numerical Methods for Engineers", McGraw-Hill Education.
- Press, W. H., Teukolsky, S. A., Vetterling, W. T., & Flannery, B. P. (2007). "Numerical Recipes: The Art of Scientific Computing (3rd ed.)", Cambridge University Press.
- Lee, J. G. (2011). "Computational Materials Science: An Introduction", CRC Press.
- Ohno, K., Esfarjani, K., & Kawazoe, Y. (2018). "Computational Materials Science", Springer Berlin Heidelberg.