

BE METALLURGICAL ENGINEERING

SEMESTER - 1

19Y101 CALCULUS AND ITS APPLICATIONS

3 1 0 4

DIFFERENTIAL CALCULUS : Function of two variables, limits and continuity, partial derivatives, chain rule, extreme values and saddle points, Lagrange multipliers, Taylor's formula for two variables. (9 + 3)

INTEGRAL CALCULUS : Double integrals – double and iterated integrals over rectangles, double integrals over general regions, Fubini's theorem, area and volume by double integration, reversing the order of integration, polar form. (9 + 3)

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS : Basic concepts, separable differential equations, exact differential equations, integrating factors, linear differential equations, modeling - mixing problems, Newton's law of cooling. (9 + 3)

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS : Homogeneous linear equations of second order, homogeneous linear ODEs with constant coefficients, Euler–Cauchy equations, solution by variation of parameters, free oscillations of mass-spring systems. (9 + 3)

VECTOR CALCULUS : Gradient and directional derivative of a scalar field, divergence and curl of a vector field. Integration in vector field – line integrals, path independence of line integrals, Green's theorem in the plane, divergence theorem of Gauss and Stokes's theorems. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir , "Thomas' Calculus", Pearson, New Delhi, 2018.
2. Erwin Kreyszig , "Advanced Engineering Mathematics", Wiley India, New Delhi, 2015.

REFERENCES:

1. Howard Anton, Irl Bivens, Stephen Davis , "Calculus", John Wiley & Sons, INC, USA, 2016.
2. Wylie C R and Barrett L C , "Advanced Engineering Mathematics", Tata McGraw Hill, New Delhi, 2019.
3. Michael D.Greenberg , "Foundations of Applied Mathematics", Dover Publications, INC, New York, 2013.
4. Gilbert Strang , "Calculus", Wellesley Cambridge Press, USA, 2017.

19Y102 PHYSICS

3 0 0 3

CRYSTAL STRUCTURE : Solids :Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-central Elements. Unit Cell. Reciprocal Lattice. Atomic Packing factor-Types of Bonds. Ionic Bond. Covalent Bond. Van der Waals Bond. Diffraction of X-rays by Crystals. Bragg's Law. Powder diffraction method. Rotating crystal method. (9)

BEHAVIOUR OF MATERIALS : Behaviour of materials: Elastic behavior - atomic model - concept of stress and strain - Hooke's law - moduli of elasticity - inter-relationship between elastic moduli - applications to engineering design; Anelastic behavior and relaxation process - visco-elastic behavior - spring and dashpot model - applications to engineering design. (9)

QUANTUM MECHANICS : Wave particle duality, de Broglie waves- Heisenberg's uncertainty principle. Wave function-normalization. The wave equation. Schrodinger's equation of motion: Time dependent form, steady-state form. Particle in a box. Quantum Tunneling and applications to Scanning Tunneling Microscope. (9)

PROPERTIES OF FLUIDS: Surface tension: molecular forces-intermolecular range. Excess pressure, capillarity. Viscosity - viscous force-coefficient of viscosity. Equation of continuity. Adhesion, cohesion, wettability. Fluid Motion- Newtonian and non-newtonian fluids - Kinematics of Moving Fluids: Poiseuille's Equation for flow of a Liquid through a capillary tube. (9)

HEAT : Specific heat capacity, thermal capacity. Coefficient of linear thermal expansion. Methods of measurement of thermal expansion. Thermal stresses in composite structures due to non-homogeneous thermal expansion. Applications - The bimetallic strip. Expansion gaps and rollers in engineering structures. Thermal conductivity: differential equation of heat flow. Lee's disc apparatus for determination of thermal conductivity. Thermal Insulation. Convection and radiation. Applications to refrigeration and power electronic devices. (9)

Total L: 45

TEXT BOOKS:

1. Arthur Beiser, "Concepts of Modern Physics", 6th Edition, Tata McGraw Hill, 2009.
2. Wendelin J Wright, Donald R Askeland , "Essentials of Materials Science and Engineering", 3rd Edition, Essentials of Materials Science and Engineering", 2013.

REFERENCES:

1. Roger A. Freedman, Lewis Ford A., Hugh D. Young, "University Physics with Modern Physics", Pearson Education, India, 2008.
2. Raghavan V., "Materials Science and Engineering, A First Course", 6th Edition, PHI, 2015.
3. Mathur D. S., "Elements of Properties of Matter", S Chand and Co, 2013.
4. Gaur R K, Gupta S L, "Engineering Physics", Dhanpat Rai Publications, 2013.

19Y103 CHEMISTRY**3 0 0 3**

THERMODYNAMICS : Review of first law, variation of heat of reaction with temperature, adiabatic flame temperature; Joule Thomson effect and its significance- inversion temperature-liquefaction of gases; Second law- statements- entropy and spontaneity-free energy and spontaneity; Gibbs-Helmholtz equation; Concept of chemical potential-variation of chemical potential with T and P, Gibbs-Duhem equation, Clausius Clapeyron equation; Concept of fugacity and activity. (9)

PHASE EQUILIBRIA : Definitions, one component system (water), two component systems-Cu-Ni and Pb-Ag systems- lever rule; Solubility of gas in liquids- distribution law, principle of extraction, applications; Binary liquid systems-fractional distillation, azeotropic mixtures. (9)

KINETICS : Review of Integrated rate laws; Complex reactions: Opposing, parallel and consecutive reactions, steady state approximation- branched chain reactions, mechanism and kinetics of combustion of hydrogen and hydrocarbons. (9)

SURFACE CHEMISTRY : Adsorption: Freundlich and Langmuir adsorption isotherms, application of BET isotherm, applications of adsorption-abatement of air and water pollution, automobile catalytic converter; Surface active agents: Surfactants, detergents, emulsifiers, properties-critical micellar concentration, contact angle, wetting and water repellency. superhydrophobic surfaces. (9)

ELECTROCHEMISTRY : Electrode potential, emf series, standard and reference electrodes -SHE, calomel, Ag/AgCl; Nernst equation, galvanic and concentration cells, Ion selective electrodes-glass electrode-applications; Potentiometric and conductometric titrations; Applied Electrochemistry: Electroplating, electropolishing, electrochemical machining, electrophoretic painting, anodization of aluminium. (9)

Total L: 45**TEXT BOOKS:**

1. Peter Atkins, Julio de Paula, "Elements of Physical Chemistry", 6th Edition, Oxford university press, UK, 2013.
2. B.R. Puri, L.R. Sharma, M.S. Pathania, "Principles of Physical Chemistry", 47th Edition, Vishal Publishing Company, India, 2017.

REFERENCES:

1. Donald A. McQuarrie, John D. Simon, "Physical Chemistry: A Molecular Approach", 1st Edition, University Science Books, USA, 1997.
2. Derek Pletcher, Frank C. Walsh, "Industrial Electrochemistry", 2nd Edition, Chapman and Hall, London, 1990.
3. J. Rajaram, J. C. Kuriakose, "Thermodynamics for Students of Chemistry", 1st Edition, Shobanlal Nagin Chand Company, India, 1986.

19Y104 INTRODUCTION TO METALS AND MINERALS**3 0 0 3**

METALS AND METAL PROCESSING METHODS : Brief history and evolution of metals; Wootz's steel, archeometallurgy, contribution of metals in civilization and industrial revolution, metal industries in India, metallic elements in periodic table, general classification of metals – processing methods: casting, welding, forming, heat treatment, powder metallurgy: general principles, their merits & demerits. (12)

FERROUS AND NONFERROUS METALS : Cast irons, alloy cast irons, plain carbon steels, alloy steels: different grades, composition, general properties and applications – aluminium alloys, copper alloys, nickel alloys, titanium alloys, magnesium alloys: different grades, composition, general properties and applications. (10)

ORES AND MINERALS : Mineral resources of India: deposits of iron, copper, manganese, lead, zinc, aluminum, nickel – physical, chemical characteristics and uses of ores: hematite, magnetite, bauxite, pentlandite, chalcopyrite, galena – objectives and advantages of mineral processing – choice of mineral processing methods – steps in mineral processing – flow charts for mineral beneficiation of iron, aluminium and copper ores. (9)

COMMUNITION METHODS : Laws of crushing and work index – recovery, ratio of concentration and separation efficiency – jaw, gyratory and roll crushers, ball mills and rod mills: capacities and reduction ratios – hammer mills, gravity stamps – grinding: dry and wet grinding, open and closed circuit grinding – screening, sizing and sampling. (7)

CONCENTRATION TECHNIQUES : Theory of settling – practice of hydraulic and mechanical classification – working of thickeners, hydrocyclones – gravity concentration techniques, heavy media separation, jigging and tabling : working principle, process parameters and applications – froth floatation: use of various reagents – electrostatic separation, magnetic separation: principle, types, equipment and applications. (7)

Total L: 45

TEXT BOOKS:

1. Callister W.D , "Materials Science and Engineering", Wiley India Pvt Ltd, 2008.
2. Rajput R K , "Engineering Materials and Metallurgy", S. Chand and Co Publisher, New Delhi, 2006.
3. Wills B A , "Mineral Processing Technology", Butterworth-Heineman, 2006.

REFERENCES:

1. Srinivasan. S, Ranganathan. S , "India's Legendary Wootz steel", Universities Press, 2014.
2. Singh.P , "Engineering and General Geology", S.K.Kataria and Sons, Delhi, 2009.
3. Jain S.K , "Ore Processing", CBS Publisher, New Delhi, 2001.

19G105 ENGLISH LANGUAGE PROFICIENCY

2 1 0 3

LEARNING LANGUAGE THROUGH STANDARD LITERARY AND GENERAL TEXTS : Integrated tasks focusing on language skills ; Training based on Text based vocabulary, tone, register and Syntax features (12 + 0)

GRAMMAR IN CONTEXT : Word Order ; Subject Verb Concord ; Style features - Tenses, Conditionals, Prepositions, Active and Passive Voice, Modals, Cloze and Spotting Error exercises (10 + 0)

GUIDELINES FOR WRITTEN COMMUNICATION : Principles of clear writing, Paragraph writing, Essay writing, Emphasis Techniques, Summarizing and Paraphrasing, Analytical writing (8 + 0)

FOCUS ON SPOKEN ENGLISH : Task – based activities: Graded levels of difficulty and with focus on language functions - Level 1: Self – expression – Greetings in Conversation, Hobbies, Special interests, Daily routine - Level 2: General Awareness – Expression of Concepts, Opinions, Social Issues, Description of a process / picture/chart, news presentation / review - Level 3: Advanced Skills – Making Short Speeches and Participating in Role Plays (0 + 10)

LISTENING ACTIVITY : Task based activities using Language Laboratory (0 + 5)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Faculty Incharge , "Course Material on "English Language Proficiency", PSG College of Technology, Coimbatore, 2019.

REFERENCES:

1. Jill Singleton , "Writers at Work: The Paragraph", Cambridge University Press, New York, 2012.
2. Simon Haines, Mark Nettle and Martin Hewings , "Advanced Grammar In Use", Cambridge University Press, New Delhi, 2008.
3. Anne Laws , "Writing Skills", Orient Black Swan, Hyderabad, 2011.
4. Sinha DK , "Specimens of English Prose", Orient Black Swan, Hyderabad, 2012.

19Y110 ENGINEERING GRAPHICS

0 0 4 2

LIST OF EXPERIMENTS:

1. Introduction to Engineering Drawing. BIS. Principles of dimensioning, Basic dimensioning methods
2. Projection of lines
3. Projection of planes
4. Projection of solids
5. Section of solids
6. Development of surfaces
7. Orthographic views
8. Isometric views and perspective views

Total P: 60

TEXT BOOKS:

1. Venugopal K, Prabhu Raja V , "Engineering Graphics II", New Age International Publishers, 2010.

REFERENCES:

1. Bhatt N.D , "Engineering Drawing", 53rd Edition, Charotar Publishing House Pvt. Ltd, 2014.
2. Luzadder Duff , "Fundamentals of Engineering Drawing", Prentice Hall of India Pvt. Ltd, 2009.

19Y111 BASIC SCIENCES LABORATORY

0 0 4 2

PHYSICS LABORATORY (ANY EIGHT EXPERIMENTS) :

1. Determination of Young's Modulus of a wooden bar – Cantilever method
2. Determination of coefficient of viscosity of water – Poiseuille's method
3. Determination of surface tension of water – Capillary rise method
4. Determination of thermal conductivity of bad conductor using Lee's Disc method

5. Determination of Hysteresis loss of a ferromagnetic material
6. Study of I-V characteristics of solar cell and determination of its efficiency
7. Hall effect set up - Determination of Hall coefficient
8. Study of characteristics of PhotoDiode
9. Determination of lattice constant using X-ray powder photograph
10. Determination of thermal conductivity of good conductor – Forbe's method

(30)

CHEMISTRY (ANY EIGHT EXPERIMENTS) :

1. Metal finishing by electroplating
2. Anodizing of aluminium, determination of thickness of anodic film
3. Photocolorimetric estimation of iron
4. Estimation of iron in an industrial effluent using potentiometry
5. Conductometric estimation of an acid strength of an electroplating pickling bath
6. Construction of eutectic phase diagram
7. Determination of rate constant of acid hydrolysis of ester
8. Determination of molecular weight of polymers by Ostwald / Ubbelohde Viscometer
9. Estimation of hardness of water by EDTA method
10. Measurement of pH, conductivity, TDS of a water sample and determination of its hardness by ion-exchange method.

(30)

Total P: 60

REFERENCES:

1. Department of Chemistry , "Chemistry Laboratory Manual", 2019.
2. Department of Physics , "Physics Practicals", PSG College of Technology, 2019.
3. Wilson J. D. and Hernandez C. A. , "Physics Laboratory Experiments", 8th Edition, Cengage Learning, New York, 2014.

19Y112 ENGINEERING PRACTICES

0 0 2 1

1. Foundry: Study of tools; Preparation of molding sand using different types of patterns.
2. Welding: Study of arc welding tools and equipment; Exercises: Arc welding and MIG welding method
3. Fitting: Study of tools and operations; Exercises: Making of "L" Joint and "V" Joint
4. Carpentry: Study of tools and operations; Exercises: Making of "L" Joint and "T" Joint
5. Plumbing: Study of tools and operations; Exercises: External thread cutting and joining of PVC pipes
6. Sheet metal work and Soldering: Study of tools and operations; Exercises: Making a rectangular tray

Total P: 30

REFERENCES:

1. Department of Mechanical Engineering, "Engineering Practices Laboratory Manual", PSG College of Technology, Coimbatore, 2019.
2. Chapman W.A.J , "Workshop Technology", Edward Arnold, 2001.

19IP15 INDUCTION PROGRAMME

0 0 0 0

As per AICTE guidelines

SEMESTER - 2

19Y201 COMPLEX VARIABLES AND TRANSFORMS

3 1 0 4

COMPLEX DIFFERENTIATION : Derivative, analytic function, Cauchy-Riemann equations, Laplace's equation, linear fractional transformations. (9 + 3)

COMPLEX INTEGRATION : Cauchy's integral theorem, Cauchy's integral formula, Laurent series, singularities and zeros, residue integration method (Residue integration of complex integrals only). (9 + 3)

LAPLACE TRANSFORMS : Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, ODEs, unit step function, second shifting theorem, Dirac's delta function, periodic functions. (9 + 3)

FOURIER SERIES AND FOURIER TRANSFORMS : Fourier series – arbitrary period, even and odd functions, half range expansions. Fourier transforms, Fourier cosine and sine transforms. (9 + 3)

PARTIAL DIFFERENTIAL EQUATIONS : Basic concepts of PDEs, wave equation, heat equation, steady state two-dimensional heat problems, solution by separating variables and Fourier series. (9 + 3)

TEXT BOOKS:

1. Erwin Kreyszig , "Advanced Engineering Mathematics", Wiley India, New Delhi, 2015.
2. Wylie C R and Barret L C , "Advanced Engineering Mathematics", Tata McGraw Hill, New Delhi, 2019.

REFERENCES:

1. Dennis G Zill and Patrick D Shanahan , "A First Course in Complex Analysis with Applications", Jones and Bartlett Pvt Ltd, New Delhi, 2015.
2. Mathews J H and Howell R W , "Complex Analysis for Mathematics and Engineering", Narosa Publishing House, New Delhi, 2012.
3. Peter V.O Neil , "Advanced Engineering Mathematics", Cengage, New Delhi, 2016.
4. Dennis G Zill , "Advanced Engineering Mathematics", Jones & Bartlett Pvt Ltd, New Delhi, 2017.

19Y202 MATERIALS SCIENCE

3 0 0 3

SEMICONDUCTORS : Formation of energy bands-Band theory of solids: metals, semiconductors and insulators- intrinsic and extrinsic semiconductors- Fermi energy levels for doped, undoped semiconductors. Physics of PN junction, solar cell and LED. Hall effect- Hall sensors- Hall effect switches and commutators. (9)

MAGNETIC MATERIALS : Concepts of magnetic dipole, moment. Magnetic quantities -types of magnetic materials: Dia, Para, ferro, antiferro and ferrimagnetic materials. Domain and Heisenberg exchange interaction theory- Hysteresis- hard and soft materials. Magnetic multilayers- Magnetoresistance, Eddy current brakes. (9)

SUPERCONDUCTIVITY : Concepts and quantities of superconductivity -Meissner Effect, Type I and Type II Superconductors, BCS theory (Qualitative only), London's equation, properties of superconductors & applications- Magnetic levitation- SQUID. (9)

PHOTONIC MATERIALS : Basic Concepts - Electromagnetic Radiation, Light Interactions with Solids. Atomic and Electronic Interactions. Optical Properties of Metals-Reflection, Absorption, Transmission, Refraction. Applications of Optical phenomena - Luminescence, Photoconductivity. (8)

ADVANCED MATERIALS : Shape memory Alloys, Pseudo elastic materials-Self assembly mechanism of material-ferroelastic materials, Bio mimetic materials. Composites- physical properties and applications. Introduction to nanophase materials. (10)

Total L: 45

TEXT BOOKS:

1. William D Callister Jr , "Materials Science and Engineering - An Introduction", John Wiley and Sons Inc, New York, 2007.
2. Neil W Ashcroft, David N , "Solid State Physics", Brooks and Cole, Cengage Learning USA, 2003.

REFERENCES:

1. Arthur Beiser , "Concepts of Modern Physics", Tata McGraw Hill, India, 2002.
2. Van Vleck , "Elements of Material Science and Engineering", Pearson Education, India, 2008.
3. Donald R Askeland, Wendelin J Wright, "Essentials of Materials Science and Engineering", Cengage Learning, 2013.
4. James F Shackelford , "Introduction to Materials Science for Engineers", 7th Edition, Pearson Prentice Hall, 2009.

19Y203 CHEMISTRY OF ENGINEERING MATERIALS

3 0 0 3

FUELS & LUBRICANTS : Petroleum - refining, Cracked and polymer gasoline. Knocking in petrol and diesel engines – octane and cetane rating of fuels - reforming. Coal- coke manufacturing. Calorific value - calculation. Lubricants: Characteristics and Mechanism of lubricants - properties of lubricants. Semi-solid and solid lubricants (9)

MACROMOLECULES : Classification, molecular weight of polymer, mechanism of free radical polymerization. Structure property relationship. Glass transition (T_g) temperature – factors affecting (T_g). Compounding of plastics - polymer processing by compression, injection, extrusion and blow moulding techniques. Composite Materials: classification and constitutions of composites. Fibre and particle reinforced Composites – Particulate and structural composites. (9)

BATTERIES AND FUEL CELLS : Construction and working of lechlanche cell, lead-acid battery, nickel-cadmium battery, lithium ion battery. Outline of batteries for special application. Fuel cells – principles-proton exchange membrane and direct methanol fuel cell, super capacitors. (9)

PROTECTIVE COATINGS : Metallic coatings – Cu, Ni, Cr. Anodizing of aluminium. Organic coatings – paints – constituents and functions – surface conversion coatings, phosphating, chromating, vitrious enamel coatings, nature inspired coatings. Hot dipping calendaring, laminating, plastic lining concrete lining. (9)

CERAMICS AND REFRACTORY MATERIALS : Ceramics : Classification of ceramic materials, composition and application based materials. Abrasives: Characteristics- preparation, properties and applications. Refractories: General

characteristics, properties and measurements. SiC, high alumina and magnesite refractories- preparation, properties and applications. Glasses – types, composition, applications. (9)

Total L: 45

TEXT BOOKS:

1. Sharma B. K., "Engineering Chemistry", 1st Edition, Krishna Prakashan Media (P) Ltd, Meerut, 2005.
2. Jain P. C, Monica Jain , "Engineering Chemistry", 3rd Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2013.

REFERENCES:

1. Derek Pletcher, Frank C. Walsh , "Industrial Electrochemistry", 1st Edition, Chapman and Hall, New York, 1993.
2. Shashi Chawla , "A Text Book of Engineering Chemistry", 1st Edition, Dhanpat Rai & Co., New Delhi, 2005.
3. Samir S , "Fuels and Combustion", 1st Edition, University Press, Hyderabad, 1996.
4. Singer F and Singer S , "Industrial Ceramics", Oxford and IBH publishing Co.,, UK, 1991..

19Y204 APPLIED MECHANICS

3 1 0 4

INTRODUCTION TO MECHANICS AND RESOLUTION OF FORCES AND STATICS : Introduction to Engineering Mechanics –force - Laws of force- System of Forces- Resolution of a Force - Free body diagram - Problems involving the equilibrium of forces and free body diagram - Rigid bodies - moment of force about an axis - moment of a couple - equivalent systems of coplanar forces - Rigid body in equilibrium - Types of load, beams and supports – Problems involving equilibrium of rigid body (9)

ANALYSIS OF FRAMES AND CENTROID AND MOMENT OF INERTIA : Types of Frames – Stresses in frames - Analytical Methods for the Forces :Method of joints, Method of sections - Centroid of areas, composite areas, Determination of moment of inertia of plane figures, polar moment of inertia - radius of gyration (9)

STRESSES AND STRAINS : Types of stresses.- Stress and strain due to axial force - elastic limit - Hooke's law – Relationship between Modulus of Elasticity , shear modulus and poisson's ratio - Factor of safety, Stepped bars - Analysis of bars of varying sections - stresses in composite bar due to axial force . Introduction to principal stresses. (9)

SHEAR FORCE & BENDING MOMENT DIAGRAMS : Properties of shear and moment diagrams - sign conventions - Bending moment and shear force diagrams in simply supported, Overhanging and cantilevers subjected to concentrated loads, uniformly distributed loads and uniformly varying loads (9)

BENDING STRESSES IN BEAMS AND TORSION : Theory of simple bending and assumptions – Neutral axis – Moment of resistance - Bending equation. Section modulus - Problems in section modulus of beam sections. - Concept of torsion - shear stress in a shaft subjected to torsion – torsion formula- Power transmitted by a shaft (9)

Total L: 45

TEXT BOOKS:

1. Rajasekaran S, Sankarasubramanian G , "Engineering Mechanics - Statics and Dynamics", Vikas Publishing House Pvt. Ltd, New Delhi, 2011.
2. Bansal R.K , "A Textbook of Strength of Materials", Sixth edition, Laxmi Publication, 2018.

REFERENCES:

1. Hibbeler R. C , "Mechanics of Materials", Pearson Education, 2005.
2. Khurmi R.S , "A Textbook of Engineering Mechanics", 21st Edition, S Chand, 2007.
3. Pytel A, Singer F.L , "Strength of Materials", Harpercollins College Div, 1987.

19Y205 PROBLEM SOLVING AND C PROGRAMMING

2 0 0 2

INTRODUCTION TO PROBLEM SOLVING : Analyzing and Defining the Problem - Algorithm - Flow Chart – Program development steps -Types of programming language. C: The C character set - Identifiers and keywords – Data types – Constants - Variables - Declarations -input and output functions-preprocessor directives. (3)

OPERATORS AND EXPRESSIONS : Arithmetic operators - Unary operators - Relational operators - logical operators - Assignment operators - Conditional operators - comma operator - sizeof operator -precedence and associativity- Library functions. CONTROL STATEMENTS:simple if, if..else, nested if .. else, elseifladder , switch case - while -do while - for - Nested loops - break – continue – goto statements. (9)

ARRAYS : Defining an array - Processing an array - Multi dimensional arrays -strings. (6)

FUNCTIONS : Function prototype - Defining a function – function call - Passing arguments to a function –nested function – recursive function- Storage classes - auto - static - extern and register variables (4)

STRUCTURES : Definitions - Processing a structure – Array and structures – Nested structures - Structures and functions.POINTERS: Definition - Pointer Arithmetic – types of pointer - const pointer, pointer to a constant, void pointer, null pointer (8)

Total L: 30

TEXT BOOKS:

1. Deitel H. M. and Deitel P. J , "C: How To Program", Prentice Hall of India, New Delhi, 2015.
2. Ajay Mittal , "Programming in C - A Practical approach", Pearson, New Delhi, 2010.

REFERENCES:

1. Gottfried B , "Programming with C", McGraw Hill Education, New Delhi, 2018.
2. Herbert Schildt , "C: The Complete Reference", McGraw Hill, New Delhi, 2017.
3. Kernighan B. W. and Ritchie D. M , "Programming Language (ANSI C)", Prentice Hall of India, New Delhi, 2013.

19Y210 FUELS AND MINERAL DRESSING LABORATORY

0 0 4 2

LIST OF EXPERIMENTS IN FUELS LABORATORY:

1. Proximate analysis of coal
 2. Determination of flash and fire point, cloud and pour point of liquid fuels
 3. Determination of kinematic viscosity & viscosity index of oils using Redwood/ Saybolt viscometer
 4. Determination of calorific value using Bomb calorimeter and Boy's gas calorimeter
 5. Preparation and characterization of Biodiesel
- (30)

LIST OF EXPERIMENTS IN MINERAL DRESSING LABORATORY:

1. Sampling of ores by Jone riffler, coning and quartering methods
 2. Sieve analysis (Differential and cumulative)
 3. Petrological studies of metallic minerals using petrological microscope
 4. Determination of reduction ratio and crusher capacities of jaw crusher and double roll crusher
 5. Determination of size reduction of minerals by ball milling
- (30)

Total P: 60

REFERENCES:

1. Laboratory Manual prepared by Department of Chemistry, 2019.
2. Laboratory Manual prepared by Department of Metallurgical Engineering, 2019.

19Y211 PROBLEM SOLVING AND C PROGRAMMING LABORATORY

0 0 2 1

1. Working with RAPTOR Tool – Flowchart Interpreter
2. Operators
3. Decision making Statements
4. Loops : while , do..while,for
5. One dimensional array
6. Two dimensional array
7. Strings
8. Functions
9. Recursive functions
10. Structures
11. Structures and arrays
12. Nested Structures
13. Pointers

Total P: 30

REFERENCES:

1. Deitel H. M. and Deitel P , "C: How To Program", Prentice Hall of India, New Delhi, 2015.
2. Ajay Mittal , "Programming in C - A Practical approach", Pearson, New Delhi, 2010.
3. Gottfried B , "Programming with C", McGraw Hill Education, New Delhi, 2018.
4. Herbert Schildt , "C: The Complete Reference", McGraw Hill, New Delhi, 2017.

19Y212 INTERNSHIP

0 0 0 2

TRAINING IN METALLURGICAL TOOLS:

Temperature measurement, Metallography sample preparation practice

INDUSTRY ORIENTED ACTIVITIES:

Industrial visit to study the layout, organisational structure, and various sections / departments. Study of various material processes, equipment, tools and raw materials used.

Study of suitability of materials for different engineering applications.

REPORT PREPARATION

Preparation of a comprehensive report by the students for the industry oriented activities that will be assessed by a committee of faculty members.

TEXT BOOKS:

1. Avner S.H , "Introduction to Physical Metallurgy", Tata McGraw Hill Education (India) Private Limited, 2009.
2. Francis L.F , "Materials Processing", Elsevier, 2016.

SEMESTER - 3

19Y301 NUMERICAL METHODS

2 1 0 3

SYSTEM OF LINEAR EQUATIONS, EIGENVALUES AND EIGENVECTORS : Errors - approximations and round-off errors - truncation errors - system of linear equations-Gauss-elimination method, Crout's method, Gauss-Seidel method, eigenvalues and eigenvectors power method. (6 + 3)

NONLINEAR EQUATIONS : False - position method, Newton-Raphson method, modified Newton-Raphson method, Bairstow's method. (6 + 3)

INTERPOLATION, DIFFERENTIATION AND INTEGRATION : Lagrange interpolating polynomials, equally spaced data-Newton's forward and backward interpolating polynomials, numerical differentiation - evenly spaced data, numerical integration- Newton-Cotes formulae, Trapezoidal rule, Simpson's 1/3 rule. (6 + 3)

NUMERICAL SOLUTION TO ORDINARY DIFFERENTIAL EQUATIONS : Taylor-series method, Euler method, 4th order Runge-Kutta method, multi step method - Milne method. (6 + 3)

NUMERICAL SOLUTION TO PARTIAL DIFFERENTIAL EQUATIONS : Finite difference: elliptic equations - Laplace equation, Poisson equation - Liebmann method, parabolic equations - heat conduction equation - Crank. Nicolson's method, hyperbolic equations - vibrating string. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Steven C Chapra and Raymond P Canale , "Numerical Methods for Engineers", Tata McGraw Hill, New Delhi, 2017.
2. Curtis F Gerald and Patrick O Wheatly , "Applied Numerical Analysis", Pearson, New Delhi, 2017.

REFERENCES:

1. Richard L Burden and Douglas J Faires , "Numerical Analysis", Thomas Learning, New York, 2017.
2. G. Miller , "Numerical Analysis for Engineers and Scientists", Cambridge University Press, UK, 2014.
3. Amos Gilat and Vish Subramaniam , "Numerical Methods for Engineers and Scientists", Wiley India, New Delhi, 2014.
4. Ward Cheney and David Kincaid , "Numerical Mathematics and Computing", Cengage learning, USA, 2018.

19Y302 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

3 0 0 3

ELECTRIC CIRCUITS : Ohm's law, Kirchhoff's Laws, solving simple DC Circuits-single phase AC circuit, fundamentals-Power, Power factor-solving simple AC circuits- Introduction to three-phase AC circuits (8)

ELECTRICAL MACHINES : DC MOTORS: Principle of Operation-types-torque equation - speed-torque characteristics-losses and efficiency- speed control of DC motors-Electric Braking AC MACHINES: Single phase Transformers - Construction and working principle, 3 phase Induction Motor-construction-Principle of operation- types-torque equation-speed -torque characteristics-1 phase Induction Motor-Principle of operation-types - Industrial Applications. (12)

ELECTRONIC DEVICES : Operation of PN junction diodes, VI characteristics, zener diode, BJT, types-CB, CE, CC configurations, input and output characteristics, JFET - working principle and characteristics - Comparison of BJT and FET. MOSFET-types, principle of operation and characteristics, Opto Electronic Devices - Introduction, types, photo conductive cells, photo diode, phototransistor, Light emitting diode-Principles and Applications. (8)

ELECTRONIC CIRCUITS : (Qualitative analysis only) Half wave and full wave rectifier, capacitive filters, zener voltage regulator, RC- coupled amplifier, frequency response, RC phase shift oscillator. LINEAR INTEGRATED CIRCUITS: Operational amplifier, Ideal op-amp characteristics, Inverting and Non-inverting amplifier, Op-amp applications: Adder- Subtractor, integrator, differentiator, zero crossing detector. (10)

DIGITAL ELECTRONICS : Number systems-representation of signed numbers: 1's complement and 2's complement, logic gates, Half, full adder/subtractor, Flip flops, RS,JK,JK Master slave, D and T type, counters and shift registers. (7)

Total L: 45

TEXT BOOKS:

1. Mehta V K and Rohit Mehta , "Principles of Electrical Engineering and Electronics", 3rd Edition, S. Chand and Co., New Delhi, 2014.
2. Muthusubramanian R and and Salivahanan S , "Basic Electrical, Electronics and Computer Engineering", 2nd Edition, Tata McGraw Hill, New Delhi, 2012.

REFERENCES:

1. Bhattacharya S K , "Basic Electrical and Electronics Engineering", 2nd Edition, Pearson, New Delhi, 2012.
2. Rajput R K , "Basic Electrical and Electronics Engineering", 2nd Edition, University Science Press, New Delhi, 2012.
3. Gupta B R and Singhal Vandana , "Electrical and Electronics Engineering", 2nd Edition, S Chand and Co., New Delhi, 2010.

19Y303 DESIGN OF MACHINE ELEMENTS**3 1 0 4**

INTRODUCTION AND DESIGN OF SPRINGS : Introduction to machine elements and design, standards and codes, fatigue theory, design against fluctuating loads. Springs: Types of springs, Material for Helical Springs, Terms used in Compression Springs, Stresses in Helical Springs, Deflection of Helical Springs, Buckling of Compression Springs, design for static and fatigue loading, helical tension spring (9 + 3)

JOINTS : Introduction to bolted and riveted joints, Welded joints: types of welded joints, weld symbols, Strength of Transverse Fillet Welded Joints, Strength of Parallel Fillet Welded Joints, Special Cases of Fillet Welded Joints, Strength of Butt Joints. (9 + 3)

SHAFTS AND COUPLINGS : Types of Shafts, Stresses in Shafts, Shafts Subjected to Twisting Moment, Bending Moment, Combined Twisting Moment and Bending Moment. Shafts Subjected to Fluctuating Loads. Design of Shafts. Introduction to Keyways - Types of Keyways-Effect of Keyways . Couplings: Types of Shaft Couplings, Design of Rigid Couplings: Sleeve Coupling, Clamp Coupling, Flange Coupling, Design of Flexible Coupling: Bushed Pin Flexible Coupling, Oldham Coupling, and Universal Coupling, Selection of materials for shafts and couplings. (12 + 4)

BEARINGS : Classification of Bearings. Sliding Contact Bearings: Hydrodynamic Lubricated Bearings, Sommerfeld Number, Design Procedure for Journal Bearings. Rolling Contact Bearings: Types of Rolling Contact Bearings. Static Load Rating, Dynamic Load Rating, Reliability of a Bearing, Lubrication of Ball and Roller Bearings, Materials and Manufacture of Ball and Roller Bearings (9 + 3)

GEARS AND FLYWHEELS : Classification of Gears , Gear fundamentals ,Terms used in Gears. Law of Gearing. Causes of Gear Tooth Failure. Introduction to spur gear, helical gear, bevel gear, worm and worm wheel. Advantages and Disadvantages of Gear Drives. Introduction to flywheels, Coefficient of Fluctuation of Speed, Energy Stored in a Flywheel, Stresses in a Flywheel Rim and Flywheel Arms. Selection and treatment of materials for gears and Flywheels. (6 + 2)

Total L: 45 +T: 15 = 60**TEXT BOOKS:**

1. Khurmi R S, Gupta J K , "Machine Design", Eurasia Publishing House, 2005.
2. Robert L Mott , "Machine Elements in Mechanical Design", Pearson Prentice Hall, 2017.

REFERENCES:

1. Bhandari V B , "Design of Machine Elements", Tata McGraw Hill, New Delhi, 2017.
2. Shigley, Mischke , "Mechanical Engineering Design", Tata McGraw Hill, New Delhi, 2008.
3. Faculty of Mechanical Engineering , "Design Data Book", PSG College of Technology, Coimbatore, 2010.
4. Allen S Hall, Alfred R Holowenko, Herman G Laugblin , "Schaum's Outlines of Theory and Problems of Machine Design", Tata McGraw Hill, 2006.

19Y304 ELEMENTS OF PHYSICAL METALLURGY**3 0 0 3**

CRYSTAL STRUCTURES AND CRYSTAL DEFECTS : Crystal systems and Bravais lattices- principal metallic crystal systems- BCC, FCC, HCP-atomic planes and directions in cubic unit cells- Miller's indices for crystallographic planes in cubic unit cells - planar and linear atomic density calculations. Crystal Imperfections-point defects, vacancy dependence on temperature, line defects- edge, screw and mixed dislocations, Burger's vector, planar defects- grain boundaries, volume defects – numerical problems. (10)

SOLIDIFICATION OF METALS : Types of nucleation-homogeneous nucleation and heterogeneous nucleation, growth mechanism – planar and dendritic growth, nucleation rate, formation of grain structure-solidification behaviour of pure metals and alloys- defects – coring- hot tear and shrinkage.- factors affecting solidification- numerical problems. (9)

ATOMIC DIFFUSION IN SOLIDS : Diffusion mechanisms, steady state diffusion and non-steady state diffusion, Fick's first law and second law- modes of diffusion- Inter diffusion- Kirkendal effect . Darken's equation. Factors influencing diffusion, Industrial applications of diffusion processes- carburizing, sintering of powders and diffusion bonding-numerical problems. (8)

CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS : Solid solutions- types - formation of substitutional and interstitial solid solution. Gibb's phase rule and condensed phase rule- determination of binary phase diagrams- invariant reactions- discussion of binary isomorphous eutectic and peritectic systems - phase diagrams with intermediate phases and compounds- detailed discussion of Fe-C equilibrium diagram- basic concepts of ternary phase diagrams - numerical problems (9)

COLD WORKING AND ANNEALING : Cold working- structure and properties of cold worked metals. Annealing of cold worked metals and alloys- stages- recovery, recrystallization and grain growth- structure and property changes during annealing - secondary recrystallization (exaggerated grain growth). Driving forces for recrystallization and grain growth- recrystallization temperature- factors influencing recrystallization temperature- comparison of cold working and hot working- warm working- numerical problems. (9)

Total L: 45

TEXT BOOKS:

1. William D Callister, David G Rethwisch, Balasubramaniam R , "Callister's Materials Science and Engineering", Wiley India Pvt Ltd, New Delhi, 2014.
2. Avner S H , "Introduction to Physical Metallurgy", McGraw Hill, 2017.

REFERENCES:

1. Vernon B John , "Introduction to Engineering Materials", Fourth, Palgrave, New York, 2003.
2. William F Smith, Javad Hashemi, Ravi Prakash, "Materials Science and Engineering", Fourth, Tata Mc-Graw Hill, New Delhi, 2010.
3. Askeland D R, Wright W J , "Science and Engineering of Materials", Cengage Learning India Pvt Ltd, New Delhi, 2017.

190306 ECONOMICS FOR ENGINEERS

3 0 0 3

INTRODUCTION : Definition – Nature and Scope- Central Problems of an Economy – Positive and Normative Economics– Micro Economics and Macro Economics, Significance of Economics, Economic Assumptions. (9)

THEORY OF CONSUMER BEHAVIOR : Utility - Indifference Curve Analysis - Properties, Consumer's Budget Line - Demand Analysis: Demand Function and Law of Demand, Elasticity of Demand. Demand forecasting using Econometric Techniques. Supply—Factors Affecting Supply, Market Equilibrium Price, Consumer Surplus. (9)

PRODUCTION, COST AND REVENUE : Production Function, Total Product, Average Product and Marginal Product, Returns to Scale. Costs, Nature of Costs, Short-run and Long-run Cost Curves, Revenue concepts. (9)

MARKET STRUCTURE : Types of Markets - Perfect Competition — Characteristics — Imperfect Competition: Monopoly—Monopolistic Competition – Oligopoly and Duopoly - Price Discrimination and Product Differentiation under Different Markets — Price and Output Determination in Short run and Long run and profit maximization. (9)

PERFORMANCE OF AN ECONOMY (MACRO ECONOMICS) : Demand and Supply of Money — Quantity Theory of Money, Banking — Functions of Commercial Banks and Central Bank — Inflation — Causes — Control Measures — National Income — Concepts — Methods of Calculating National Income — Problems in Calculating National Income. (9)

Total L: 45

TEXT BOOKS:

1. Varian H.R. , "Intermediate Microeconomics", East– West Press, New Delhi, 2014.
2. Dewett.K.K, Navalur. M.H. , "Modern Economic Theory", S. Chand, New Delhi, 2015.

REFERENCES:

1. William A, McEachern, Simrit Kaur , "Micro ECON", Cengage Learning, Noida, 2013.
2. William A, McEachern, Indira A , "Macro ECON", Cengage Learning, Noida, 2014.
3. Deepashree , "Principles of Economics", Ane Books Pvt Ltd, New Delhi, 2010.
4. Dwivedi , "Essentials of Business Economics", Vikas Publishing House Pvt Ltd, New Delhi, 2010.

19Y310 METALLOGRAPHY LABORATORY

0 0 4 2

METALLOGRAPHY LABORATORY :

1. Study of metallurgical microscope Sample preparation and etching practices.
2. Microstructural study of grey cast iron, S.G.iron and malleable iron in unetched condition.
3. Microstructural study of grey iron, S.G.iron, white cast iron and malleable iron in etched condition.
4. Microstructural study of plain carbonsteels.
5. Microstructural study of hardened tempered steel and toolsteel.
6. Microstructural studyof cast and wrought stainless steels.

7. Microstructural study of Al and Cu alloys.
8. Microstructural study of Ni and Ti alloys.
9. Inclusion rating and grain size measurement.
10. In-situ Metallography Practice - Demonstration.

Total P: 60

REFERENCES:

1. Dept of Metallurgical Engineering, "Metallography Laboratory Manual", PSG College of Technology, 2019.
2. Kehl G L , "Metallographic Laboratory Practice", McGraw Hill , New York, 1994.

19Y311 METAL CUTTING PRACTICES & CIM LABORATORY

0 0 4 2

METAL CUTTING PRACTICES LABORATORY :

1. Facing and step turning
 2. Drilling and taper turning
 3. Grooving and Thread cutting
 4. Experiment in surface grinding
 - a. Experiment in pocket milling
- (30)

COMPUTER INTEGRATED MANUFACTURING LABORATORY :

1. CAD-Modeling and assembly of components
 2. CAD-Creation of bill of materials, extraction of 2D views and sections
 3. Exercise on CAE analysis
 4. CAM-NC code generation for cylindrical components
 - a. CAM-NC code generation for prismatic components
- (30)

Total P: 60

REFERENCES:

1. Laboratory Manual prepared by the Department of Mechanical Engineering, 2019.
2. Kalpakjian S , "Manufacturing Engineering and Technology", Prentice hall, 2007.

19Y312 ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. Verification of Ohm's and Kirchoff's Laws
2. Measurement of Power and Power Factor in Single Phase RLC Circuit
3. Mechanical Characteristics of DC Shunt and Compound Motor
4. Load Test on 3 Phase Induction Motor
5. Electric Braking of 3 Phase Induction Motor (Dynamic Braking / Plugging)
6. Study of Half Wave and Full Wave Rectifiers with and without Filters
7. RC Coupled Amplifier
8. Application of Operational Amplifier : Adder, Subtractor, Integrator, and Differentiator
9. Study of Logic Gates and Implementation of Binary Adder / Subtractor
 - a. Implementation of Modulo — 16 Counter

Total P: 30

19K312 ENVIRONMENTAL SCIENCE

2 0 0 0

INTRODUCTION TO ENVIRONMENT : Environment - Definition, scope and importance. Types and composition of atmosphere — particles, ions and radicals. Ozone layer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats - India as a mega-diversity nation — hotspots of biodiversity — endangered and endemic species of India conservation of biodiversity. (6)

ENERGY RESOURCES : Introduction — National and International status- exploitation - sustainable strategies- Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources - tidal –geothermal

hydroelectric. (6)

ENVIRONMENTAL POLLUTION : Definition — Sources, causes, impacts and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards (h) RF hazards Role of an individual in prevention of pollution. **DISASTER MANAGEMENT**: Floods, earthquake, cyclone and landslides — Case studies, consequences and rescue measures. (6)

WASTE MANAGEMENT : Wastewater - Characteristics of domestic and industrial wastewater - COD and BOD — Various stages of treatment — primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste management — Characteristics of municipal solid waste(MSW), biomedical, automobile and e-wastes and their management — landfills, incineration, pyrolysis, gasification and composting. (6)

SOCIAL ISSUES AND THE ENVIRONMENT : Environmentally Sustainable work practices- Rain water harvesting — Role of non-governmental organizations. Human ethics and rights- impact on environment and human health — role of information technology on environment and human kind. Green IT policies, Process of EIA - ISO 14000. Legislation- Environment protection act — Air (Prevention and Control of Pollution) act — Water (Prevention and control of Pollution) act—Wildlife protection act—Forest conservation act. (6)

Total L: 30

TEXT BOOKS:

1. Gilbert M. Masters , "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi, 2004.
2. De A K , "Environmental Chemistry", New Age International P Ltd, New Delhi, 2006.

REFERENCES:

1. Benny Joseph , "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. Koteswara Rao MVR , "Energy Resources: Conventional & Non-Conventional", BSP Publications, New Delhi, 2006.
3. Deswal S and Deswal A , "A Basic Course in Environmental Studies", Dhanpat Rai and Co, New Delhi, 2004.

SEMESTER – 4

19Y401 PROBABILITY AND STATISTICS

2 1 0 3

PROBABILITY AND DISCRETE RANDOM VARIABLES : Probability, axiomatic approach to probability, Baye's theorem, discrete random variables, probability distributions and probability mass functions, cumulative distribution functions, mean and variance, binomial, Poisson and geometric distributions. (6 + 3)

CONTINUOUS RANDOM VARIABLES : Continuous random variables, probability distributions and probability density functions, cumulative distribution functions, mean and variance, uniform, exponential, and normal distributions. (6 + 3)

JOINT PROBABILITY DISTRIBUTIONS : Two dimensional discrete and continuous random variables, marginal and conditional probability distributions, independence, covariance, correlation and linear regression. (6 + 3)

STATISTICAL INFERENCE: Point estimation - interval estimation — testing of hypotheses for means — large, small samples and matched pairs tests — testing of hypotheses for proportions, chi square test for goodness of fit and independence of attributes. (6 + 3)

VARIANCE TESTS AND ANALYSIS OF VARIANCE : Testing of Hypotheses for variances - analysis of variance - completely randomized design, randomized block design. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Douglas C. Montgomery and George C. Runger , "Applied Statistics and Probability for Engineers", Wiley India, New Delhi, 2018.
2. Richard A. Johnson , "Miller & Freund's, Probability and Statistics for Engineers", Prentice Hall, New Delhi, 2017.

REFERENCES:

1. Jay L. Devore , "Probability and Statistics for Engineering and the Sciences", Brooks/Cole, USA, 2015.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye , "Probability & Statistics for Engineers & Scientists", Pearson, New Delhi, 2016.
3. Robert V. Hogg, Elliot Tanis and Dale Zimmerman , "Probability and Statistical Inference", Pearson Education, USA, 2014.
4. Sheldon M Ross , "Introduction to Probability and Statistics for Engineers and Scientists", Academic press, USA, 2014.

19Y402 FLUID MECHANICS AND HEAT TRANSFER

3 1 0 4

FLUID MECHANICS AND ENERGY BALANCE IN FLUID FLOW : FLUID MECHANICS: Properties of fluids such as density, viscosity and specific weight - Fluid statics - Pressure at a point - Pressure variations in horizontal and vertical directions - Concept of gauge and absolute pressure - Use of manometer for pressure measurements - Forces on plates - Horizontal and inclined. ENERGY BALANCE IN FLUID FLOW: Types of flow - continuity equation- Application to one dimensional problems. Derivation of Bernoulli's equation and Euler's equation – Examples illustrating the use of energy equation in metallurgical processes. (9 + 3)

INTERNAL / EXTERNAL FLOW AND PRESSURE IN FLUID FLOW : INTERNAL AND EXTERNAL FLOW: Classification of flow - Reynolds number - Laminar flow between parallel plates and circular pipes - Simple problems. PRESSURE IN FLUID FLOW: Head loss due to friction -Darcy - Weisbach equation - flow through pipes - use of Moody diagram - Minor losses - Simple problems. (9 + 3)

STEADY HEAT CONDUCTION : Steady state heat conduction in plane wall, cylinder and sphere- simple examples, Composite Systems (9 + 3)

CONVECTIVE HEAT TRANSFER : Forced Heat transfer from flat plate, laminar and turbulent flow, cylinders and spheres, flow through tubes. Free convection, heat transfer from vertical and horizontal surfaces. Boundary layer concept — Simple problems on velocity and thermal boundary layers (no derivation) — problems on laminar and turbulent boundary layers (no derivation) (9 + 3)

RADIATION HEAT TRANSFER : Emissive power, grey body. Radiation heat transfer between surfaces, shape factor. Simple problems on Radiation heat transfer (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Kothandaraman C. P. and Rudramoorthy R, "Basic Fluid Mechanics", 2nd Edition, New Age International Publishers, Chennai, 2007.
2. Frank M. White, "Fluid Mechanics", 8th Edition, The Mc Graw Hill Companies, USA, 2015.

REFERENCES:

1. R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, "Transport Phenomena", John Wiley & Sons, 2006.
2. Kumar D. S, "Fluid Mechanics and Fluid Power Engineering", Kataria S. K. and Sons, New Delhi, 2013.
3. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "Introduction to Fluid Mechanics", 8th Edition, John Wiley & Sons, New York, USA, 2011.
4. Sachdeva R. C, "Fundamentals of Engineering Heat and Mass Transfer", 5th Edition, New Age International Publishers, New Delhi, 2017.

19Y403 METALLURGICAL THERMODYNAMICS AND KINETICS

3 1 0 4

INTRODUCTION : Review of Classical thermodynamics, Enthalpy, enthalpy changes in physical transformations and chemical reactions, Calorimetric studies, Heat capacity of solids; Dulong-Petit, Einstein and Debye models of heat capacity, concepts of heat, work and internal energy. First law of thermodynamics and its application in metallurgical processes; Hess's law, Kirchhoff's law and thermochemistry. (9 + 3)

PHASE EQUILIBRIUM : Concept of thermodynamic equilibrium, zeroth law of thermodynamics and its applications, concepts of heat engine and Carnot cycles. Statistical interpretation of entropy. Second law of thermodynamics and its applications; Entropy changes for metallurgical processes; Trouton's and Richard's rules, Criteria for thermodynamic equilibrium; Free energy and its significance in metallurgical reactions; Free energy change as a function of temperature; Third law of thermodynamics and its applications. (9 + 3)

PHASE STABILITY : Gibbs phase rule, phase stability of unary and binary systems, Clausius-Clayperon equation, Effect of pressure on the equilibrium temperatures for metallurgical systems, Gibbs-Helmholtz equation; Maxwell's equations; concepts of fugacity, activity, activity coefficient and equilibrium constant; Ellingham diagram ($\Delta G - T$ diagram) and its applications to metallurgical processes, Le Chatelier's principle, and Vant-Hoff's equation. (9 + 3)

SOLUTION THERMODYNAMICS : Concepts of partial molar and excess thermodynamic quantities; Gibbs-Duhem equation; Raoult's law; Henry's law and Sievert's law; Ideal, regular and real solution models for binary alloys and their thermodynamic properties; Gibbs free energy-composition diagrams for binary alloy systems, construction and evolution of binary phase diagrams, thermodynamics of surfaces, interfaces and defects, adsorption and segregation (9 + 3)

KINETICS OF MATERIALS : Basic kinetic laws, order of reactions, rate constants and rate limiting steps, Arrhenius rate equation and determination of activation energy; homogenous reactions, heterogeneous reactions, Fick's laws of diffusion and their applications; temperature dependence of diffusivity, diffusion in ideal and real solid solutions, driving force for phase transformation, nucleation and growth rates of phase transformation. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. David R Gaskell , "Introduction to the Thermodynamics of Materials", Taylor and Francis, 2003.
2. Hae-Geon Lee , "Chemical Thermodynamics for Metals and Materials", Imperial College Press, Reprinted, 2000.

REFERENCES:

1. Upadhyaya G S, Dube R K , "Problems in Metallurgical Thermodynamics and Kinetics", Pergamon,1977.
2. Eugene S. Machlin , "An Introduction to Aspects of Thermodynamics and Kinetics Relevant to Materials Science", Third Edition, Elsevier Science, 2007.
3. Dutta S K, Avinash B Lere , "Metallurgical Thermodynamics Kinetics and Numericals", S.Chand & Co, New Delhi, 2014.
4. Tupkary R H , "Essential of Metallurgical Thermodynamics", First Edition, Tupkary R H, 2016.

19Y404 MECHANICAL BEHAVIOR AND TESTING OF MATERIALS**3 0 0 3**

INTRODUCTION : Strength of materials-Basic assumptions-elastic and plastic behavior-concept of stress, strain and the types of stresses and strains- Average stress and strain - DISLOCATION THEORY: Theoretical cohesive strength, dislocation types, Burgers Vector and dislocation loop, dislocations in FCC, BCC and HCP, Stress fields and energies of dislocations forces on dislocations, between dislocation- Interaction of dislocations, dislocation intersection, dislocation multiplication, dislocation pileups, Interaction with points forces defects. (9)

PLASTIC DEFORMATION OF CRYSTALS : Deformation by slip, slip in a perfect lattice, slip by dislocation movement, critical resolved shear stress for slip, Deformation of single crystals, polycrystalline materials, Deformation by twinning, stacking faults, concept of strain hardening. (9)

STRENGTHENING MECHANISMS : Grain size strengthening-solid solution strengthening-factors affecting solid solution strengthening. Precipitation hardening-conditions for precipitation hardening-aging-formation of precipitates-coarsening of precipitates, mechanism of strengthening. Dispersion strengthening-factors for effective dispersion hardening, martensitic strengthening. Strain hardening. (9)

HARDNESS TESTING AND TENSION TESTING : ASTM standards. Brinell hardness testing, Rockwell hardness testing, Vickers hardness testing and knoop hardness testing, Nano indentation, Numerical problems. TENSION TESTING: ASTM Standards and specification, Engineering stress & strain, True stress strain curves, Holloman - Ludwig equation, Plastic Instability (Necking), Testing machines-types, testing procedures, properties measured, specimen dimensions, Numerical problems. (9)

IMPACT TEST, TORSION AND SHEAR TESTS : IMPACT TESTING: Principle, Izod and Charpy Impacts tests, ASTM Standards and specification. Introduction to fractures, type of fracture, Fractographic features of ductile and brittle fracture. Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT. Torsion testing & Shear testing: ASTM Standards and specifications, testing machines and procedures. (9)

Total L: 45**TEXT BOOKS:**

1. Dieter G E , "Mechanical Metallurgy", Third edition, McGraw Hill Education,2017.
2. Meyers M A, Chawla K K , "Mechanical Behaviour of Materials", Prentice Hall Inc, NY, 2017.

REFERENCES:

1. Hull D, Bacon D J , "Introduction to dislocations", Fourth Edition, Butterworth, 2001.
2. Courtney T H , "Mechanical Behaviour of Materials", Waveland press Inc, 2005.
3. Ed Kuhn H, Ed Medlin D , "ASM Handbook, Volume 8 Mechanical Testing and Evaluation", Second printing, ASM International, 2017.

19Y405 PRODUCTION OF IRON**3 0 0 3**

INTRODUCTION TO PRODUCTION OF IRON : Early history of iron - evolution of iron making technology - iron making in India - overview of blast furnace iron making - sponge iron making - smelting reduction processes – general physiochemical fundamentals. (9)

RAW MATERIALS AND THEIR PREPARATION : Characteristics of coal for coke making - selection of coals - assessment of coke quality - processes used for coke making: by - product coke ovens and non - recovery ovens - iron ores - iron ore reserves in India - beneficiation of iron ore - agglomeration methods - principle and mechanism of sintering - Dwight - Lloyd sintering technology - pelletisation - disc and drum pelletisers - physical & chemical characterization and metallurgical tests of lump ore / sinter / pellets - fluxes used in iron making. (9)

BLAST FURNACE AND ITS ACCESSORIES : plant layout - constructional features of the blast furnace - distribution of burden- charging equipment - bell type and bell less type - blast furnace gas cleaning and utilization - hot blast stoves (8)

BLAST FURNACE OPERATION : operation and process control - operational irregularities - physical chemistry of blast furnace reactions - carbon - oxygen reactions - gas - solid reaction equilibria - thermal and chemical features of the blast furnace - RAFT calculations - Reichardt's diagram - Rist diagrams - Internal zones and gas flow in blast furnaces - Blast furnace productivity - fuel efficiency - Modern developments - high top pressure - bell-less top - pulverized coal injection - humidification of blast. Blast furnace products and their utilization - Hot metal - slag & blast furnace gas - treatment of hot metal - modeling approaches to iron making (11)

ALTERNATE IRON MAKING PROCESSES : Sponge iron making - coal – based and gas - based - smelting reduction processes - fundamentals - categorisation - salient features of Corex- Hismelt - Finex - Fastmet - ITmk3 processes - Mini-blast furnace (8)

Total L: 45

TEXT BOOKS:

1. Ahindra Ghosh, Amit Chatterjee , "Iron Making and Steel Making - Theory and Practice", PHI Learning Private Ltd., New Delhi, 2011.
2. 2011.
3. Tupkary R H, Tupkary V R , "An Introduction to Modern Iron Making", Khanna Publishers, New Delhi, 2010.

REFERENCES:

1. Wakelin D H , "The Making, Shaping and Treating of Steel: Iron Making", The AISE Steel Foundation, 1999.", 1999.
2. Bashforth G R , "Manufacture of Iron and Steel Making: Vol 1 : Iron production", BI publications, 1973.
3. Dipak Mazumdar , "A First Course in Iron and Steel Making", Universities Press, 2015.
4. Biswas AK , "Principles of Blast furnace Iron making: Theory and Practice", Cootha, 1981.

19Y406 METAL CASTING

3 0 0 3

PATTERN AND MOULDING : Introduction to foundry processes, types of foundries, types of patterns- pattern materials- Pattern allowances-pattern layout, pattern making. Mould materials: Ingredients, properties. Testing of moulding sand- Strength permeability, moisture content, shatter Index, mouldability, compactability, loss on ignition, clay content and AFS grain fineness number. (9)

MOULDING PROCESSES : Introduction, Green sand moulding, dry sand moulding, CO₂ moulding, no bake moulding, shell moulding, investment casting, permanent moulding, die casting and centrifugal casting. Modern moulding methods like rheocasting, Thixo casting, Squeeze casting, magnetic moulding, Impulse moulding and high pressure moulding. Core and core making. (9)

GATING AND RISERING : Gating systems- functions of gating system, types, principles, design of gating system. Riser system- functions, principles, types of risers, methods to improve the riser efficiency, riser design for ferrous and non ferrous alloys. Simple problems in riser and gating design. (9)

MELTING : Construction and operation of crucible furnaces, cupola, rotary furnace-core type and coreless type Induction furnaces-arc furnace (direct and indirect arc furnaces), resistance furnaces. Simple problems in composition control for steels and cast irons. Casting Metallurgy- Solidification of Metals, Fluidity and its testing, Factors influencing castability of ferrous and non-ferrous alloys. (9)

FETTLING AND AUTOMATION : Knock out and finishing operations, checking the suitability and salvaging of castings. Sand reclamation, moulding machines, foundry layout, mechanization and automation, Use of softwares for foundry applications, Considerations, functional design, simplification of foundry practices - metallurgical design. (9)

Total L: 45

TEXT BOOKS:

1. Heine R W, Loper C R, Rosenthal, Rosenthal P C , "Principles of Metal Casting", Tata McGraw Hill, New Delhi, 2012.
2. Beeley P R , "Foundry Technology", Butterworths, London, 2001.

REFERENCES:

1. Ramana Rao T V , "Metal Casting: Principles and Practice", New Age International Publishers, New Delhi, 2006.
2. Jain P L , "Principles of Foundry Technology", Tata McGraw Hill, New Delhi, 2007.
3. Ed Moosbrugger, Ed DeGuire E , "ASM Handbook, Volume 15 - Casting", Third Printing, ASM International, 2013.

19Y410 MATERIALS TESTING LABORATORY

0 0 4 2

MATERIALS TESTING LABORATORY :

1. Tension test on metals: Stress-strain characteristics- determination of tensile properties

2. Hardness test on metals: Brinell, Vicker's, Rockwell and micro-hardness tests.
3. Cupping test on metal Sheets: Load deformation characteristics, cupping load, cupping number.
4. Impact test on rod: Charpy, Izod impact tests - Room temperature and Sub-zero temperature test
5. Tests on helical springs: Compression, tension springs - load deformation characteristics, stiffness, shear stress, modulus of rigidity, energy.
6. Torsion test on beams: Torque and angle of twist characteristics, shear stress, modulus of rigidity.
7. Shear test on metals: Direct shear strength, single shear, double shear.
8. High cycle fatigue testing.

Total P: 60

REFERENCES:

1. Dept of Metallurgical Engineering , "Materials Testing Laboratory Manual", PSG College of Technology, 2019

19Q412 INDIAN CONSTITUTION

2 0 0 0

INTRODUCTION : Evolution of Indian Constitution; Significance of Constitution; Composition; Preamble and its Philosophy. (4)

RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES : Fundamental Rights- Writs and Duties, Directive Principles of State Policy. (6)

COMPOSITION OF PARLIAMENT AND FEDERALISM : : Union Government, President and Vice President, Houses of the Parliament and their functions; Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States. (8)

BILLS AND CONSTITUTION AMENDMENT PROCEDURE : Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. (6)

JUDICIARY: Supreme Court and High Court; Functions and powers, Judicial Review (6)

Total L: 30

TEXT BOOKS:

1. Subash C. Kashyap , "Our Constitution", 5th Edition, NBT, India, New Delhi, 2015.
2. Basu D D , "Introduction to the Constitution of India", 20th Edition, Prentice Hall of India, New Delhi, 2011.

REFERENCES:

1. Brijji Kishore Sharma , "Introduction to the Constitution of India", 8th Edition, Prentice Hall of India, New Delhi, 2017.
2. Hoshiar Singh , "Indian Administration", 1st Edition, Pearson Education, New Delhi, 2011.
3. Jain M C , "The Constitution of India", 5th Edition, State Mutual Book & Periodical Service, Limited, New Delhi, 1988.
4. Shukla VN , "Constitution of India", 13th Edition, Eastern Book Company Limited, New Delhi, 2017.

19Q413 SOFT SKILLS DEVELOPMENT

0 0 2 1

SOFT SKILLS DEVELOPMENT :

1. Body Language and Professionalism
2. Interpersonal skills
3. Goal setting
4. Impression Management
5. Team Building
6. Time Management
7. Stress Management
8. Convincing Skills
9. Motivation
10. Change Management
11. Communication Confidence
12. Group discussion basics
13. Personal Interview basics
14. Resume writing

Total P: 30

REFERENCES:

1. Jeff Butterfield , "Soft Skills for Everyone", 6th Edition, Cengage Learning, Delhi, 2015.
2. Rao M S , "Soft Skills - Enhancing Employability", LK International Publishing House, New Delhi, 2011.

SEMESTER - 5

19Y501 PHASE TRANSFORMATIONS AND HEAT TREATMENT

3 1 0 4

SOLIDIFICATION : Introduction-types of nucleation-free energy change during solidification, thermodynamics of homogeneous nucleation –driving force, activation barrier, critical nucleus size and critical free energy change- extension to heterogeneous nucleation-growth considerations-overall transformation rate-example problems. Planar, cellular, equiaxed and dendritic solidification. Liquid to liquid- solid transformations, stability and criteria for phase equilibria in single and multi component systems. Phase changes in ceramics and polymers, concept of glass transition temperature. (9 + 3)

DIFFUSIONAL TRANSFORMATIONS IN SOLIDS : Types of solid state transformations, interface and diffusion controlled growth kinetics- continuous and discontinuous precipitations-Precipitate growth under different conditions, Transformation with short range and long range diffusion, Age hardening, Precipitate coarsening. Spinodal decomposition, moving boundary transformations, order and disorder transformations, eutectoid transformation, isothermal transformations, order-disorder transformations. (9 + 3)

DIFFUSIONLESS TRANSFORMATION : Characteristics of diffusionless transformation, classification, massive transformations, supersaturated solid solutions, martensitic transformation-morphological characteristics and crystallography, types-athermal, isothermal, burst, kinetics-characteristics of nonferrous martensite-shape memory phenomena-types, examples, applications. (9 + 3)

HEAT TREATMENT : Heat treatment furnaces - classification, construction, atmosphere, applications, fixtures. Transformations on heating and cooling. Influence of alloying elements, TTT & CCT diagrams. Annealing-types, Normalising, hardening & tempering, Hollomon Jaffe parameter, retained austenite - measurement and methods of elimination, Hardenability studies-Jominy end quench test, austempering and martempering. Heat treatment defects. Causes and remedies (9 + 3)

HEAT TREATMENT OF SPECIFIC ALLOYS : cast irons, plain carbon steels, stainless steels, tool steels, maraging steels, Heat treatable and non-heat treatable Aluminum alloys Copper alloys, Titanium alloys, Nickel base superalloys, thermo -mechanical treatments. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Porter D A, Easterling K E, Mohamed Youssef Abdelraouf Sherif , "Phase Transformations in Metals and Alloys", Third, CRC Press, 2009.
2. Rajan TV, Sharma CP, Ashok Sharma , "Heat Treatment: Principles and Techniques", PHI Learning Pvt Ltd, 2011.

REFERENCES:

1. Raghavan V , "Phase Transformations", Prentice Hall of India, New Delhi, 1990.
2. Smallman R E, Bishop R J , "Metals and Materials", Butterworth-Heinemann Ltd., New Delhi, 1995.
3. Reza Abbaschian, Lara Abbaschian, Reed Hill R E , "Physical Metallurgy Principles", 4th Edition, Cengage Learning, 2008.
4. Vijendra Singh, "Heat Treatment of Metals", Standard Publishers, Delhi, 2006.

19Y502 NONFERROUS EXTRACTION METALLURGY

2 0 0 2

INTRODUCTION : Availability of raw materials in India. Sources of metals, unit operations and unit processes of metal extraction. Pyrometallurgical Processes-Principles of drying, calcination, sintering, roasting-Roasting techniques, predominance area diagrams. Principles of smelting and converting. Ellingham diagrams, Carbothermic, Hydrothermic and Metallothermic reductions. (9)

HYDROMETALLURGY: Principles of hydrometallurgy, advantages, Leaching-properties of good solvent. preparation of ore for leaching, leaching methods, recovery of metal from liquor, solvent extraction, ion exchange, gaseous reduction of metals in aqueous solutions, cementation, recycling of leach liquor, bio leaching. (6)

ELECTROMETALLURGY : Aqueous and fused salt electrolysis, principles of electro refining and electro winning of metals. Purification of crude metals produced in bulk: Distillation, Liquefaction, Liquid-Liquid extraction, fire refining, electrolytic refining, zone refining, VAR, EBM and ESR- examples. (6)

EXTRACTION AND REFINING OF METALS FROM SULPHIDE ORES : Copper and Nickel. Extraction and refining of metals from oxide ores: Aluminium, Magnesium and Zinc. Recovery of by product metals and treatment of metallurgical waste, material and energy balance. (6)

EXTRACTION AND REFINING OF METALS FROM HALIDES : Titanium, Hafnium, Zirconium and Uranium. Extraction of precious metals: Gold and Platinum. (3)

TEXT BOOKS:

1. Ray H S, Sridhar R, Abraham K P , "Extraction of Non Ferrous Metals", East-West Press, New Delhi, 2008.
2. Raghavan R , "Extractive Metallurgy of Non Ferrous Metals", Vijay Nicole Imprints Private Limited, Chennai, 2017.

REFERENCES:

1. Ray H S, Ghosh A , "Principles of Non-ferrous Extractive Metallurgy", Prentice Hall of India, New Delhi, 2006.
2. Pehlke R D , "Unit Processes in Extractive Metallurgy", Elsevier, USA, 1993.
3. Terkel Rosenqvist , "Principles of Extractive Metallurgy", McGraw Hill, London, 2004.

19Y503 FRACTURE MECHANICS, FATIGUE AND CREEP**3 1 0 4**

INTRODUCTION TO FRACTURE MECHANICS : Theoretical cohesive strength, Griffith theory Brittle fracture. Modes of fracture, Irwin's approach to fracture toughness. Introduction to LEFM and EPFM, strain energy release rate and stress intensity factor. Relation between G and K. (9 + 3)

FRACTURE TOUGHNESS PARAMETERS : Plane strain fracture toughness, determination of plane strain fracture toughness, J-integral, CTOD and R curve. Failure Assessment Diagram, Mixed Mode Fracture, Crack Initiation and Life Estimation, Crack Arrest and Repair Methodologies. (9 + 3)

FATIGUE : S-N curve, Low cycle fatigue-Coffin-Manson law. High cycle fatigue-Basquin's law. Fatigue testing, Fractographic features of fatigue failure. Factors affecting fatigue life (surface finish, surface strength reducers, residual stresses, stress concentration, temperature and frequency (9 + 3)

MECHANISMS OF FATIGUE CRACK GROWTH : Fracture mechanics approach-Paris law. Cumulative damage and life prediction- Miner's rule-stages in fatigue crack growth. Methods to improve fatigue life. (9 + 3)

CREEP : Introduction to creep deformation, creep curve, creep mechanisms, Deformation mechanism maps, Effects of stress and temperature, Creep rate equation, steady-state creep parameter, creep resistant alloys, design and development of creep resistant alloys, creep testing, use of creep and stress rupture data for life prediction, Fatigue –creep interaction. (9 + 3)

Total L: 45 +T: 15 = 60**TEXT BOOKS:**

1. George E Dieter, "Mechanical Metallurgy", Third, McGraw Hill Education, 2017.
2. Richard W. Hertzberg, Richard P. Vinci, Jason L. Hertzberg , "Deformation and Fracture Mechanics of Engineering Materials", Fifth edition, John Wiley & Sons, Inc., 2012.

REFERENCES:

1. Broek D , "Elementary Engineering Fracture Mechanics", Kluwer Academic Publishers, Dordrecht, 1986.
2. Meyers M A, Chawla K K , "Mechanical Behaviour of Materials, NY, 2017", Prentice Hall Inc., New York, 2017.
3. Ed Lampman R S , "ASM Handbook, Volume 19 - Fatigue and Fracture", Seventh Printing, ASM International, 2012.

19Y504 PRODUCTION OF STEEL**3 0 0 3**

INTRODUCTION TO PRODUCTION OF STEEL : Early history of steel, evolution of steel making technology, steel making in India, present status of world steel industry, overview of modern steel making, general physiochemical fundamentals, general layout of integrated steel plants, raw materials for steel making, steel making refractories,. Overview of Bessemer converters, open hearth practice: furnace and operation, Basic open hearth steel making practice. Electric arc furnace steel making. (10)

PHYSICAL CHEMISTRY OF PRIMARY STEEL MAKING : Reactions and heat effects, primary steel making slags, the reaction equilibria — reactions of carbon, phosphorus, oxidation of iron, carbon. BOF plant practice : shop layout and basic operation, LD converter - vessel design, construction, steel refining, inputs for BOF steel making, pre- treatment of hot metal prior to steel making, Metallurgical features - interaction of oxygen jet with the surroundings and the bath, change in temperature and composition during the blow, carbon - oxygen reaction, slag - metal – gas interaction, bath agitated processes, oxygen bottom blown processes. (10)

SECONDARY STEEL MAKING : Ladle furnace, inert gas purging, deoxidation - thermodynamics and kinetics, decarburisation methods - AOD, VOD, degassing - thermodynamics and kinetics of degassing reactions, desulphurization - thermodynamics and kinetics, Injection metallurgy, clean steel technology, cleanliness control, Tundish metallurgy. (9)

RECENT STEEL MAKING METHODS : CONARC process, EOF process, recent trends in stainless steel making, manufacture of ultra - low carbon steel, alloy steel making, different slag practices in EAF steel making, direct steelmaking, Modeling approaches to steel making. (8)

CASTING OF LIQUID STEEL : Ingot casting of steel: Fundamentals of solidification, classification of steel ingots, ingot defects and their remedies. Continuous casting of steel: Heat transfer and solidification in continuous casting, continuous casting machines, current state of continuous casting technology, metallurgical defects and their remedies (8)

Total L: 45

TEXT BOOKS:

1. Ahindra Ghosh, Amit Chatterjee , "Iron Making and Steel Making - Theory and Practice", PHI Learning Private Ltd, New Delhi, 2011.
2. Tupkary R H, Tupkary V R , "An Introduction to Modern Steel Making", Khanna Publishers, New Delhi, 2010.

REFERENCES:

1. Fruehan R J , "The Making, Shaping and Treating of Steel: Steel Making and Refining", The AISE Steel Foundation, 1999.
2. Bashforth G R , "Manufacture of Iron and Steel Making: Vol 2 : Steel production", BI publications, 1996.
3. Dipak Mazumdar , "A First Course in Iron and Steel Making", Universities Press, Hyderabad, 2015.
4. Biswas A K , "Principles of Steel Making", Asia Publishing House, 1966.

19Y505 METAL JOINING

3 0 0 3

FUNDAMENTALS : Classification of joining processes. Energy Sources, Welding power sources, Arc Characteristics, Weld solidification, Slag metal reaction and gas metal reaction. Heat Flow in Welding, Quantitative Calculation of Heat Transfer in Fusion Welding, Calculation of HAZ width. Residual Stress and Distortion, Nature and Causes of Residual Stress, Effects of Residual Stress, Residual Stress Distribution Patterns, Effects of Welding Sequence, Weld Distortion, Reduction/control of Residual Stresses and Distortion. (10)

ARC WELDING PROCESSES : Arc Power Sources, Principles of Operation, Volt-Ampere Characteristics, Duty Cycle, Open-Circuit Voltage. Fusion Welding Processes: Shielded Metal Arc Welding, Gas Tungsten Arc Welding, Gas Metal Arc Welding, Flux Cored Arc Welding, Submerged Arc Welding, Stud Arc Welding: Fundamentals, Equipment, filler metals and its classifications, Materials weldable, Applications, Welding Variables, Weld Quality, Process Variations. (8)

OTHER WELDING PROCESSES : Electro Slag Welding, Gas Welding, Thermite Welding, Electron Beam Welding, Laser Welding and Resistance Welding Processes: Fundamentals, Equipment, Materials weldable, Applications, Welding Variables, Weld Quality, Process Variations. Solid State Processes: Ultrasonic welding, Explosion welding, Diffusion welding, Friction welding, Friction Stir Welding :fundamentals, equipment and applications. (9)

WELDING METALLURGY : Welding of carbon steels, Low alloy steels, Stainless steels, Cast irons, Aluminum and Aluminum alloys, Nickel and Nickel alloys, Titanium and Titanium alloys: Metallurgical Difficulties, Process selection, filler metal selection, safe welding procedures. (9)

TESTS, QUALIFICATIONS AND SAFETY : Overview of Welding defects, testing of weldments and Weldability testing, Mechanical tests. Welding procedure specifications (WPS), Sample WPSs for welding of carbon steels, low alloy steels and stainless steels, Procedure Qualification Records (PQR) and Welder Performance Qualifications (WPQ). Safety in welding, personal protective equipment, protection against fumes and gases, safe handling of compressed gases, protection against electromagnetic radiation, electrical safety, fire prevention and explosion prevention. (9)

Total L: 45

TEXT BOOKS:

1. Cary H B , "Modern Welding Technology", Prentice Hall, 2005.
2. Sindo Kou, "Welding Metallurgy", John Wiley and Sons, 2003.

REFERENCES:

1. AWS , "Welding hand books, Volume 1 to Volume 5", 9thEdition, American Welding Society, 2013.
2. Lancaster J F, "Metallurgy of welding", Woodhead Publishing Series, Elsevier, 1999.
3. Ed Zorc B T, "ASM Handbook, Volume 6 - Welding, Brazing and Soldering", Tenth printing, ASM International, 2013

19Y506 MATERIALS CHARACTERISATION

3 0 0 3

OPTICAL MICROSCOPY : Macro - examination and micro - examination, optical microscope, metallographic specimen preparation, theory of linear optics -magnification, numerical aperture, resolving power, depth of field, depth of focus, aberrations in lenses, bright field, dark field, phase-contrast, polarized light illuminations, interference microscopy, confocal microscopy, hot stage microscopy, color metallography, quantitative metallography and its applications. (10)

X-RAY DIFFRACTION : Nature and absorption of X-rays, Characteristic X-ray spectrum, Bragg's law, diffraction methods - Laue, rotating crystal and powder methods, reciprocal lattice and diffraction by crystals, X-ray diffractometers, X-ray filters and detectors, structure factor calculation for cubic systems, introduction of point groups and space groups, symmetry-crystallography, applications of X-ray diffraction studies - determination of crystal structure, lattice parameter, measurement

of stress, introduction to wide - angle and small - angle x-ray diffraction, fundamentals of preferred orientation and macro-textures, basics of stereographic projection, Laue patterns and pole figures. (10)

ELECTRON MICROSCOPY : Overview of electron optical instruments, electron - specimen interactions, signals used in electron optical instruments, Transmission Electron Microscopy (TEM) - electron optics, aberration correction, imaging modes, mass-density contrast, phase contrast, amplitude contrast, selected area diffraction, specimen preparation techniques, applications of TEM, HRTEM, Scanning Electron Microscopy (SEM) - principle, construction and working, operating modes, contrast formations, applications, Scanning Transmission Electron Microscopy (STEM) –principle and interpretations, Electron Microprobe Analysis - Energy Dispersive Spectroscopy, Wave Length Dispersive Spectroscopy, qualitative and quantitative analysis, principle and application of Electron Backscatter Diffraction (EBSD) technique (10)

ELECTRON SPECTROMETRY : Principle, instrumentation, working and applications of Electron Energy Loss Spectrometry(EELS), Auger electron spectroscopy (AES), X-ray photoelectron spectroscopy (XPS), Surface analysis methods - Secondary Ion Mass Spectroscopy Scanning Probe Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Field Ion Microscopy, Atom Probe Tomography - principles, instrumentation and applications (6)

OTHER SPECTROSCOPY TECHNIQUES : Optical Emission spectroscopy, X-ray Fluorescence Spectroscopy, Fourier Transform Infrared Spectroscopy, Raman Spectroscopy - principle, construction, working and applications. Thermal and Other Miscellaneous Methods: Principles and instrumentation of Differential Thermal Analysis, Differential Scanning Calorimetry and Thermo-Gravimetric Analysis - interpretation of results. Dilatometry. Electrical resistivity and magnetic measurements, An-elasticity measurements and electrochemical measurements. (9)

Total L: 45

TEXT BOOKS:

1. Angelo P C , "Materials Characterization", Cengage Learning India Private Limited, 2016.
2. Yang Leng , "Materials Characterization: Introduction to Microscopic and Spectroscopic Methods", John Wiley & Sons, 2013.

REFERENCES:

1. Cullity B D, Stock S R , "Elements of X-ray Diffraction", Pearson education Ltd, 2013.
2. Ramakanth Hebbar K R , "Basics of X-Ray Diffraction and Its Applications", I.K. International Publishing House Pvt, Ltd., 2011.
3. Whan R E , "ASM Handbook, Volume 10, "Materials Characterisation", ASM international, USA, 1992.
4. Khangaonkar P R , "An Introduction to Materials Characterization", Penram International Publishing (India) Pvt Ltd, 2010.

19Y510 FOUNDRY AND WELDING LABORATORY

0 0 4 2

FOUNDRY LABORATORY :

1. AFS grain fineness number
2. Moisture content determination and mould hardness test.
3. Sand strength tests.
4. Compactability test and mouldability test.
5. Permeability test and shatter index test. (30)

WELDING LABORATORY :

1. Welding practice on SMAW, GMAW and GTAW processes.
2. Microstructural study of low carbon steel weldments and stainless steel weldments.
3. Implant test to determine cold cracking susceptibility.
4. Vareststraint test to determine hot cracking susceptibility.
 - a.Practice for preparation of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR). (30)

Total P: 60

REFERENCES:

1. Dept of Metallurgical Engineering, "Foundry Laboratory Manual", PSG College of Technology, 2019.
2. Dept of Metallurgical Engineering, "Welding Laboratory Manual", PSG College of Technology, 2019.

19Y511 MATERIAL CHARACTERIZATION AND HEAT TREATMENT LABORATORY

0 0 4 2

MATERIAL CHARACTERIZATION LABORATORY :

1. Determination of phase fraction and grain size using image analyser.
2. Composition analysis of steels and cast irons using spectrometer (Demonstration).
3. X-ray diffraction analysis of bulk metal and powder samples.
4. Determination of crystal structure, lattice parameter and crystallite size using XRD.
5. Fractography and composition analysis using SEM / SEM-Energy Dispersive Spectroscopy.

6. Study of TEM imaging and SAD patterns. (30)

HEAT TREATMENT LABORATORY :

1. Annealing and normalizing - heat treatment practice and analysis.
2. Hardening and tempering - heat treatment practice and analysis.
3. Jominy end-quench hardenability evaluation test.
4. Heat treatment of stainless steels and cast irons.
5. Precipitation hardening of wrought aluminium alloys. (30)

Total P: 60

REFERENCES:

1. Dept of Metallurgical Engineering, "Material Characterization Laboratory Manual", PSG College of Technology, 2019.
2. Dept of Metallurgical Engineering, "Heat treatment Laboratory Manual", PSG College of Technology, 2019.

19Q513 BUSINESS AND MANAGERIAL COMMUNICATIONS

0 0 2 1

BUSINESS AND MANAGERIAL COMMUNICATIONS :

1. Advanced Group discussion
2. Advanced Resume writing
3. Mock Group discussion
4. Advanced Personal Interview
5. Mock Personal Interview
6. Cracking special Interviews
7. Essential Grammar for Placements
8. Vocabulary for Placements
9. Email writing
10. Paragraph writing
11. Essay writing

Total P: 30

REFERENCES:

1. Priyadarshi Patnaik , "Group Discussion and Interview Skills", Cambridge, New Delhi, 2011.
2. Hari Mohan Prasad , Rajnish Mohan , "How to Prepare for Group Discussion and Interview", 2nd Edition, Tata McGrawhill, New Delhi, 2009.

SEMESTER - 6

19Y601 CERAMICS AND COMPOSITES

3 0 0 3

INTRODUCTION TO CERAMIC STRUCTURES AND DEFECTS : Covalent and Ionic ceramics, Typical Ceramic crystal structures: Sodium chloride, cesium chloride, alumina, spinel and fluorite structures-examples. problems in crystal systems(Pauling's Rules), Silicate Structures, Structures of Glasses and properties . Simple problems involving Packing Fraction, critical radius ratio and density. Defects in Ceramics-Problems. (9)

PROPERTY PREDICTION OF ENGINEERING CERAMICS : Ceramics for mechanical functions — Electrical functions- Thermal properties-Optical Properties-Magnetic Properties of engineering ceramics –Simple problems - examples and applications. Mechanical behaviour of ceramics: Elasticity and brittle fracture- Toughening Mechanism, Glass — Mechanical behaviour of glass, Weibull Statistics and Design for brittle failure. Forming of ceramics: Brief description of slip and slurry casting, hot pressing, isostatic pressing, liquid phase sintering - applications. (9)

INTRODUCTION TO COMPOSITES : Classification — PMC, CMC, MMC — properties & applications — carbon — carbon composites, hybrid composites. Fiber composites: Constituents-functions of fiber and matrix- properties of fibers-critical fiber length-aligned and random fiber composites. property prediction-rule of mixtures-problems. Production of fibers- metallic, polymer and ceramic matrix materials-concept of interfaces and interfacial reactions in fiber composites. (9)

PARTICULATE COMPOSITES : Types-true particulate and dispersion strengthened composites-function and examples of dispersoids-particle size-interparticle spacing-simple problems-examples of particulate composites- brief idea of creep in dispersion strengthened composites (9)

LAMINAR COMPOSITES : Types - layered and honeycomb structures-examples manufacture and applications. Production techniques: Metal matrix composites (MMCs), polymer matrix composites (PMCs) and ceramic matrix composites (CMCs)-Directionally Solidified Eutectics (DSE's)-production. Selection of composites for specific application (Qualitative methods) (9)

TEXT BOOKS:

1. Kingery W D , "Introduction to Ceramics", John Wiley, USA, 2011.
2. Chawla K K , "Composite Materials", Springer, NewYork, 2006.

REFERENCES:

1. Broutman L J, Krock , "Modern Composite Materials", Addison Wesley Publishers, Massachusetts, 1967.
2. Michael Barsoum , "Fundamentals of Ceramics", Mc Graw Hill, 2002.
3. Daniel B Miracle, Donaldson S L , "ASM Handbook, Volume 21 - Composites", ASM International, 2008.
4. Matthews F L, Rawlings R D , "Composite Materials: Engineering and Science", Woodhead Publishing, 1999.

19Y602 CORROSION AND SURFACE ENGINEERING**3 0 0 3**

BASICS OF CORROSION : Introduction to corrosion, expressions for corrosion rate. Emf and galvanic series — merits and demerits — Pourbaix diagram. Exchange current density, polarization — concentration, activation and resistance, Tafel equation; passivity, electrochemical behaviour of active/passive metals, Flade potential, theories of passivity - Effect of oxidising agents. (9)

FORMS OF CORROSION : Uniform, pitting, intergranular, stress corrosion. corrosion fatigue. dezincification. erosion corrosion and crevice corrosion — causes and remedial measures — Pilling Bedworth ratio - High temperature oxidation-Hydrogen embrittlement - causes and remedial measures. (9)

CORROSION PROTECTION AND TESTING : Organic, inorganic and metallic coatings, electro and electroless plating and anodising — cathodic protection, corrosion inhibitors — principles and practice — inhibitors for acidic neutral and other media. Purpose of corrosion testing — Classification — susceptibility tests for intergranular corrosion- stress corrosion test. salt spray test, humidity and porosity tests, accelerated weathering tests — ASTM standards for corrosion testing. (9)

TRIBOLOGY : Introduction to wear, types of wear: adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication — Various methods of wear testing - ASTM standards for wear testing. (9)

SURFACE MODIFICATION TECHNIQUES : Definition of surface modification — classification-Introduction to surface preparation - diffusion techniques: Carburizing, nitriding, carbinitriding and cyaniding. Selective surface hardening methods such as flame hardening and induction hardening. Introduction to various types of coating methods. Electroforming: specimen preparation- electrolyte preparation- stages of operation and application. Friction stir processing: Definition, process variables, surface preparation, post FSP operations and applications. (9)

Total L: 45**TEXT BOOKS:**

1. Mars G Fontana , "Corrosion Engineering", Third, McGraw Hill, 2005.
2. Kenneth G Budinski , "Surface Engineering for Wear Resistance", Prentice Hall, 1988.

REFERENCES:

1. Denny A Jones , "Principles and Prevention of Corrosion", Second, Prentice Hall of India, 2013.
2. Uhlig H H , "Corrosion and Corrosion Control", Fifth, John Wiley & Sons, 2008.
3. Raj Narayan , "An Introduction to Metallic Corrosion and its Prevention", Oxford Press, New Delhi, 1983.
4. Ed Cramer D S, Ed Covino S B , "ASM Handbook, Volume 13A - Corrosion: Fundamentals, Testing, and Protection", Sixth Printing, ASM International, 2013

19Y603 METAL FORMING**3 1 0 4**

BASIC CONCEPTS OF YIELD CRITERIA : Components of stress, principal stresses in 2D and 3D state of stress, hydrostatic and deviatoric components of stress, Von Mises and Tresca yield criteria, comparison of yield criteria, Octahedral shear stress and shear strain. (7 + 2)

FUNDMENTALS OF METAL FORMING : Mechanics of metal forming, forming analysis- slab method, Flow stress determination -flow curve from true stress — strain curve, temperature in metal forming - Hot, cold and warm working - dynamic recovery and recrystallisation, strain rate effects, metallurgical structures, effect of friction in forming analysis, deformation zone geometry, workability, deformation mechanism maps - concept of softening mechanism (9 + 3)

FORGING, ROLLING AND EXTRUSION : Forging - classification, open die forging - closed die forging-die design, calculation of forging loads, friction hill diagram - defects, causes and remedies, applications, Rolling : types of rolling mills, flat and shape rolling, forces and geometrical relationship in rolling, analysis of rolling load, torque and power, rolling defects and applications. Extrusion: direct and indirect extrusion, co-extrusion, extrusion dies, hydrostatic extrusion, defects and remedies. Analysis of extrusion, tube extrusion and defects causes and remedies, application. concept of severe

plastic deformation.

(11 + 4)

DRAWING OF RODS, WIRES AND TUBES : Rod and wire drawing process, die and die materials, Simple analysis of wire drawing, defects in rod and wire drawing. Tube drawing processes- types, analysis of tube drawing, production of seamless pipe and tube, defects in tube drawing - residual stresses in drawing of rods, wires and tubes. (9 + 3)

SHEET METAL FORMING : Sheet metal characteristics, sheet metal forming materials, operations- shearing, bending, wrap forming, spinning, stretch forming, deep drawing, redrawing, drawability, practical considerations affecting drawability, forming limit diagram, defects and applications. Concept of super plasticity and superplastic forming (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Dieter G E , "Mechanical Metallurgy", Third edition, McGraw Hill Education, 2017.
2. Avitzur B , "Metal Forming - Processes and Analysis", Tata McGraw Hill, 2005.

REFERENCES:

1. Hertzberg R W , "Deformation and Fracture Mechanics of Engineering Materials", John Wiley & Sons, 1994.
2. Semiatin S L , "ASM Metals Handbook: Forming and Forging (Volume 14)", Ninth Edition, ASM International, 1989.
3. Rowe G W , "Principles Industrial Metalworking Processes", CBS Publishers & Distributors Pvt Ltd, New Delhi, 2005.
4. Hosford.W.F, Caddell.R.M , "Metal Forming -Mechanics and Metallurgy", Cambridge University Press, 2011.

19Y604 POWDER METALLURGY

3 0 0 3

PRODUCTION AND CONDITIONING : Basic operations in Powder Metallurgy. Classification of powder production methods, production of metal, alloy, intermetallic and nano crystalline powders. Rapid Solidification Processing (RSP) techniques; powder conditioning- powder annealing, calcinations, powder mixing and blending — principle, mechanism- equipment used. (9)

CHARACTERIZATION : Objectives of characterization- individual powder characteristics- morphology, topography, structure, surface area; bulk powder characteristics - density, flow rate, size distributions, angle of repose, compressibility- Powder handling - safety- pyrophrocity, toxicity and environmental issues. (9)

SHAPING AND CONSOLIDATION : Fundamentals of powder compaction, Pressureless shaping techniques — additives, processing steps, baking; Pressure compaction techniques: stages, densification mechanisms, Powder forming — rolling, forging, injection moulding, extrusion, explosive forming, powder coatings; Sintering — mechanisms, effect of process variables, sintering furnaces, types of sintering - solid state and liquid phase sintering, reactive, activated and supersolidus sintering; hot compaction techniques — principle, mechanisms; Advanced compaction techniques: isostatic pressing (cold and hot), spark plasma sintering, additive manufacturing; defects in sintered parts — blow out, blisters, slumping, lamination crack, surface roughness. (9)

TESTING AND FINISHING OPERATIONS : Determination of strength of green compacts and sintered parts, hardness factor, stability factor, abrasion resistance, permeability of powder compacts, standards, additional processes / treatments of sintered materials: to enhance the strength dimensional accuracy, wear and corrosion resistance and other properties. (9)

DESIGN CONSIDERATIONS AND SPECIFIC POWER METALLURGY PRODUCTS : Design aspects in powder metallurgy parts and dies, process variables, comparison with conventional manufacturing techniques; Production, properties and applications of self lubricating bearings, oxide dispersion strengthened alloys, friction materials, tungsten filaments, cermets, cemented carbide tool tips, magnets, contact materials, porous materials. (9)

Total L: 45

TEXT BOOKS:

1. Angelo P C, Subramanian R , "Powder Metallurgy: Science, Technology and Applications", PHI Learning Pvt Ltd, New Delhi, 2008.
2. Sinha AK, "Powder Metallurgy", Dhanpat Rai and Sons, New Delhi, 2016.

REFERENCES:

1. Ed Samal K P, Ed Newkirk W J, "ASM Handbook, Volume 7 - Powder Metallurgy", Third printing, ASM International, 2012.
2. Fritz V Lenel , "Powder Metallurgy Principles and Applications", Princeton, USA, 1980.
3. Randall M German, "Powder Metallurgy Science", Metal Powder Industries Federation, 1994.
4. Anish Upadhyaya, "Powder Metallurgy: Science, Technology and Materials", Universities Press, 2013.

19Y610 FORMING AND POWDER METALLURGY LABORATORY

0 0 4 2

FORMING LABORATORY :

1. Determination of n and K values using tension test.
2. Determination of friction co-efficient using ring compression test.
3. Cold working of low and high stacking fault energy materials
4. Determination of plastic strain ratio in sheet metals.
5. Determination of flow properties in forgings using simulation software. (30)

POWDER METALLURGY LABORATORY :

1. Powder production by top-down and bottom-up approaches.
2. Determination of bulk powder characteristics using Hall-flow meter and laser particle size analyser.
3. Determination of particle characteristics using SEM and XRD reports.
4. Cold compaction of powders and green compact strength measurement.
5. Determination of porosity, hardness and study on microstructure of sintered parts. (30)

Total P: 60

REFERENCES:

1. Dept of Metallurgical Engineering, "Forming Laboratory Manual", PSG College of Technology, 2019.
2. Dept of Metallurgical Engineering, "Powder Metallurgy Laboratory Manual", PSG College of Technology, 2019.

19Q613 QUANTITATIVE AND REASONING SKILLS

0 0 2 1

QUANTITATIVE AND REASONING SKILLS :

1. Number System, Time and Work
2. Percentages , Simple and Compound Interests
3. Time, Speed and Distance
4. Permutation, Combination and Probability
5. Ratio and Proportion
6. Profit, Loss and Partnership
7. Logarithms, Progressions, Geometry and Quadratic Equations
8. Coding and Decoding
9. Series, Analogy and Odd Man Out
10. Visual Reasoning
11. Data Arrangements
12. Blood Relations
13. Clocks, Calendars and Direction Sense
14. Cubes, Logical Connectives and Syllogisms
15. Venn Diagrams, Interpretations and solving

Total P: 30

REFERENCES:

1. Aggarwal R S , "Quantitative Aptitude for Competitive Examinations", 3rd Edition, S Chand Publishing, New Delhi, 2017.
2. ETHNUS , "Aptimithra", 1st Edition, McGraw-Hill Education Pvt Ltd, 2013.
3. FACE , "Aptipedia Aptitude Encyclopedia", 1st Edition, Wiley Publications, Delhi, 2016.

SEMESTER - 7

19Y701 NON-DESTRUCTIVE TESTING

3 0 0 3

BASIC CONCEPTS : Need for nondestructive testing, salient features of NDT, classification of NDT, Codes and standards for NDT, Training requirements for NDT professionals. - VISUAL TESTING (VT): Direct and remote visual inspection - visual aids, Weld Inspection by weld gauges. Acceptance Criteria. - PENETRANT TESTING (PT): Principle, Penetrants, developer and their types. Visible penetrant testing, Fluorescent penetrant testing (FPT) (9)

MAGNETIC PARTICLE INSPECTION (MT) : Principles, applications, magnetization methods, magnetic particles, dry technique and wet technique, demagnetization, advantages and limitations. - EDDY CURRENT TESTING (ET): Principle, instrumentation and procedure. Applications — Material sorting, thickness measurement, coating thickness measurement, heat treatment monitoring and corrosion damage evaluation. (9)

RADIOGRAPHY TESTING : Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography. Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, Film interpretation, RT of pipes and welds SWSI, DWSI, DWDI, Safety in radiography. (12)

ULTRASONIC TESTING (UT) : Types of ultrasonic waves, characteristics of ultrasonic waves, attenuation, couplants, Probes — Piezoelectric and EMAT. Inspection methods - pulse echo, transmission and phased array techniques, TOFD technique. (7)

TYPES OF ULTRASONIC TESTING : Types of scanning and displays, angle beam inspection of welds, Calibration: ASTM Test blocks, IIW-reference block. - ACOUSTIC EMISSION TESTING (AET): Principle, salient features, instrumentation, flaw location determination and applications. (8)

Total L: 45

TEXT BOOKS:

1. Barry Hull, Vernon John , "Nondestructive Testing", Revised, Springer, 2012.
2. Chuck Hellier , "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2013.

REFERENCES:

1. Louis Cartz , "Nondestructive Testing", ASM International, USA, 1995.
2. Davis R J , "ASM Handbook, Volume 17 - Nondestructive Evaluation and Quality Control", ASM International, 2001.

19Y710 NONDESTRUCTIVE TESTING AND SURFACE ENGINEERING LABORATORY

0 0 4 2

NON-DESTRUCTIVE TESTING LABORATORY :

1. Visual testing and weld inspection.
2. Penetrant testing.
3. Magnetic particle testing.
4. Ultrasonic thickness measurement and flaw detection.
5. Radiography test film interpretation. (30)

SURFACE ENGINEERING LABORATORY :

1. Estimation of corrosion rate of carbon steel by weight loss method and determination of inhibitor efficiency in acid and neutral media.
2. Oxalic acid etch test for intergranular corrosion (Streicher test) ASTM A262-practice A.
3. Study of passivation characteristics of MS and SS steels in acid media by potentiostatic/galvanostatic polarization techniques.
4. Adhesive wear testing using pin-on-disc wear tester.
5. (a) Abrasive wear testing in dry and wet conditions (b) Erosive wear testing using slurry erosion tester. (30)

Total P: 60

REFERENCES:

1. Dept of Metallurgical Engineering, "Nondestructive Testing Laboratory Manual", PSG College of Technology, 2019.
2. Dept of Metallurgical Engineering, "Surface Engineering Laboratory Manual", PSG College of Technology, 2019.

19Y720 PROJECT WORK I

0 0 4 2

- Identification of a real life problem in thrust areas.
- Developing a mathematical model for solving the above problem.
- Proposing different solutions for the problem based on literature survey.
- Future trends in providing alternate solutions.
- Experimental work done to validate.
- Characterization and testing of the samples.
- Discussion and finalisation of system requirements and specification.
- Consolidated report preparation of the above.

Total P:60

SEMESTER - 8

19Y820 PROJECT WORK II

0 0 8 4

REVIEW OF LITERATURES

- Detailed literature survey / review of patents.
- Identification of problems in the existing system.
- Need for current study and its feasibility.

PREPARATION OF PROJECT PROPOSAL AND CONTRIBUTION

- Formulation of methodology / time line to carry out the project work.
- Designing / planning / execution of experiments and file maintenance for progress monitoring.
- Testing and characterization of samples as per the requirement.
- Validation of the developed system/model.

REPORT PREPARATION/SUBMISSION AND PRESENTATION

- Introduction to the problem.
- Literature review and Identification of objectives.
- Experimental work and analysis / interpretation / consolidation of results.
- Summary of results.
- Presentation as an individual / team.

Total P: 120

PROFESSIONAL ELECTIVES

19Y001 METALLURGY OF STEELS AND NONFERROUS ALLOYS

3 0 0 3

LOW ALLOY STEELS : Introduction to carbon steels- effect of alloying elements, standards and specifications of steels. HSLA steels- melting, heat treatment, the effect of microalloy additions in HSLA steels, thermo mechanically controlled processed (TMCP) steels. Advanced high strength steels (AHSS)-DP steels, MP/ CP steels, TRIP steels, TWIP steels, MBIP steels. Steel for high temperature applications- C-Mo steels, Cr-Mo steels, Cr-Mo-V steels and Modified Cr-Mo-V steels, standards and specification requirements (9)

SPECIAL STEELS : Maraging steels- manufacture, structure, property, heat treatment and applications of maraging steels. Silicon steels- Composition, structure, properties and applications. High manganese steels- Composition, structure, properties and applications. Low density Fe-Al-Mn steels for automotive structural applications (9)

STAINLESS STEELS : Types of stainless steels; ferritic, martensitic, austenitic, precipitation hardening, duplex, heat resisting, their properties, structure and applications; nickel free stainless steels high nitrogen stainless steels-their manufacture, structure, properties and applications. Powder Metallurgy of stainless steels and high nitrogen stainless steels, Sensitization and remedial measures for austenitic stainless steel. (9)

LIGHT METAL ALLOYS : ALUMINIUM: Classification of aluminium alloys, wrought and cast alloys; heat treatable and non-heat treatable alloys; physical metallurgy of Al alloys, strengthening mechanisms in non-heat treatable alloys and heat treatable alloys. - MAGNESIUM: Properties and applications of magnesium and magnesium alloys; influence of alloying elements-Al, Mn, Zn, Si, Ag, Th, Zr; classification-cast alloys and wrought alloys. - TITANIUM: Introduction; effect of alloying elements in alpha stabilizers; beta stabilizers; alpha titanium alloys; beta titanium alloys; alpha-beta titanium alloys; structure-property correlations; melting, casting, welding of titanium alloys, applications of commercial titanium and titanium alloys. (9)

COPPER AND NICKEL ALLOYS : COPPER: Properties and applications of pure copper; influence of alloying elements-brasses-Cu-Zn alloys. Types of bronzes- tin bronze, phosphor bronze, Al bronze, Be bronze; compositions, properties and uses; copper-nickel alloys; properties and applications. - NICKEL: Metallurgy of nickel base alloys-alloying elements and their effects-nickel base super alloys composition; melting, forging; solid solution alloys, precipitation hardenable alloys, nickel-iron base alloys, heat treatment, properties and applications; Ni base soft magnetic alloys (9)

Total L: 45

TEXT BOOKS:

1. Balram Gupta , "Aerospace Materials: Vol.1-3", S.Chand and Co, New Delhi, 1996.
2. Angelo. P.C, Ravisankar. B "Non Ferrous Alloys: Structures, Properties, and Engineering Applications", First, Cengage Learning India Pvt Ltd, 2018.

REFERENCES:

1. Edgar C Bain, Paxton H.W , "Alloying Elements in Steel", ASM, 1966.
2. Clark.D.S, Varney.W.R , "Physical Metallurgy for Engineers", First Edition, CBS Publishers & Distributors, New Delhi,

- 2004.
- George Krauss , "Steels: Processing, Structure and Performance", ASM International, USA, 2005.
 - Angelo P.C, Ravisankar B , "Introduction to Steel - Processing, Properties and Applications", CRS Press, Florida, USA, 2019.

19Y002 METALLURGY OF TOOL MATERIALS

3 0 0 3

CLASSIFICATION OF TOOL STEELS : AISI system; selection of tool steels. Properties of tool steels. Testing of tool steels: Mechanical properties of tool steels, strength, hardness and toughness. Properties at elevated temperatures, microstructure-distribution of carbides-coating thickness. Micro hardness adhesives and crack resistance. (9)

METALLIC TOOL MATERIALS : Production techniques-problems in melting and refining methods like VAR, ESR, EBM. Powder Metallurgy route and forming of tool steels. Properties and applications of high carbon tool steels, high alloyed tool steels and maraging steels. (9)

HEAT TREATMENT OF TOOL STEELS : Selection of quenching and tempering. Parameters-precautions-effect or retained austenitic-Multiple tempering, sub-zero treatment and cyno treatment surface treatment- defects in tool steels- Over heated and burnt structure- decarburization. (9)

CERAMIC TOOL MATERIALS : Sintered tungsten carbide tools-ISO classification-Uses of P, M, K grade, cermet- ceramides. mixed and reinforced grades. Cubic Boron Nitride-Poly Crystalline Diamond tools. (9)

ADVANCED TRENDS IN SURFACE TREATMENT AND COATING FOR TOOL STEELS : Sulphidising of tool steels- TiN coating by PVD coating of carbide tools-mono and multilayer coatings TiC, TiN, Alumina & DCC by PVD and CVD processing, Plasma Nitriding, Ti and face coating. Surfacing. (9)

Total L: 45

TEXT BOOKS:

- Payson , "Metallurgy of Tool Steel", John Wiley and Sons, New York, 1982.
- Robert Wilson , "Metallurgy and Heat Treatment of Tool Steels", McGraw Hill, 1975.

REFERENCES:

- George Roberts, George Krauss, Richard Kennedy, "Tool Steels", ASM International, USA, 1998.
- Davis J R , "ASM Specialty Handbook-Tool Materials", ASM International, USA, 1995.
- Robert S, Haymaker, Johnson , "Tool Steels", ASM International, USA, 1992.

19Y003 STRUCTURE AND PROPERTIES OF POLYMERS

3 0 0 3

INTRODUCTION TO POLYMERS : Polymers-thermoplastics and thermosets- examples, structure, properties and applications of important engineering plastics (polyethylene, polypropylene, polystyrene, poly vinyl chloride, poly tetrafluoroethylene, poly oxymethylene, poly phenyleneoxide, poly ether ketone, poly urethane and poly methyl methacrylate. Elastomers: engineering rubber, natural rubber, styrene-butadiene rubber, nitrile rubbers, silicones - structure, properties and applications. (10)

BONDING IN POLYMERS : Basic concepts of macromolecules - Monomers- Functionality - Classification and nomenclature of polymers. Step growth polymerization- - Chain length and degree of Polymerisation-simple problems. (6)

STRUCTURE AND PROPERTY RELATIONSHIP : Structure and properties of polymers- Linear, branched, cross-linked, and network polymers-Homochain and hetero atomic chain polymers- Copolymers and its types- Linear and cyclic arrangement - Polymer properties estimation techniques, topological techniques- Volumetric properties - molar volume, density, Van der Waals volume - Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure Volume Temperature. (PVT) relationship. (11)

BEHAVIOUR OF POLYMERS : Transition temperature in polymers, glass transition (T_g), melt transition (T_m), relationship between T_g and T_m- viscoelasticity: concept of creep and stress relaxation in polymers. Introduction to yielding and fracture of polymers - crazing of polymers. Brief idea of fracture mechanics - problems. (6)

PROPERTIES OF POLYMERIC MATERIALS : Mechanical properties - Stress-strain curve for different classes of polymers - Effect of polymer structure on modulus of elasticity, tensile strength, flexural strength, impact strength, yield strength, fracture toughness- Optical properties -Effect of polymer structure on optical properties -clarity, transparency, haze, transmittance, absorbance, reflectance, and gloss- Chemical Properties - Cohesive energy, cohesive energy density, solubility parameter, determination of solubility parameter of polymers - Prediction of solubility parameter, Biodegradability of polymers Applications of Polymers-General, engineering, aerospace, biomedical sports and aggressive environments. (12)

Total L: 45

TEXT BOOKS:

1. Brent A Strong , "Plastics: Materials and Processing", 3rd Edition, Pearson Prentice Hall, 2006.
2. Callister W D , "Materials Science and Engineering - An Introduction", John Wiley and Sons, 2009.

REFERENCES:

1. Carreher C E , "Polymer Chemistry", 6th Edition, Marcked Decker, New York, 2005.
2. Charles A Harper , "Handbook of Plastics, Elastomers and Composites", McGraw Hill, USA, 2002.
3. McCrum N G, Buckley C P, Bucknall C B , "Principles of Polymer Engineering", Oxford University Press, 1997.

19Y004 NANOMATERIALS**3 0 0 3**

STRUCTURE AND PROPERTIES : Definition-classification of nano materials-structure of nano materials- comparison with conventional materials; basic concepts - relationship between grain size and properties - physical properties- color, conductivity, Thomson effect, optical properties - surface plasmon effect, chemical properties - reactivity, mechanical properties - strength, hardness of nano sized particles. (9)

SYNTHESIS : Basic approaches-top down and bottom up approaches-various methods for producing nano materials — zero, one, two and three dimensional materials, solid State (mechanical) methods: Mechanical Alloying (MA) and Mechanical Milling (MM) - Severe Plastic Deformation (SPD); chemical synthesis: sol-gel method, combustion synthesis and co-precipitation techniques, Chemical Vapor Deposition (CVD); physical methods: Electrolysis, microwave and plasma synthesis, condensation, Physical Vapor Deposition (PVD)-thermal spray processing. (9)

CHARACTERIZATION : Specific characterisation techniques for evaluation of microstructure, phases using SEM, TEM XRD, AFM - Physical , chemical and mechanical properties of nanomaterials (9)

CONSOLIDATION AND SPECIFIC NANOMATERIALS : Problems in consolidation, FAST– process variables, examples; High pressure shock consolidation-explosive forming, nano coatings-dip, plasma spray; assembly of nano structures, processing of semi conducting, metallic and magnetic nano particles, fullerenes, nano tubes, Quantum dots, nano TiO₂, nano ZnO - properties, applications and advantages (9)

APPLICATIONS : Structural — Continuous coatings for corrosive environments, electronic and optical applications- thin and multi layer capacitors, sensors and quantum dots, energy storage devices - inorganic membranes for gas separation, fuel cells, catalysts, solar cells, efficient micro batteries, biomedical- valves for artificial hearts, internal drug release devices. (9)

Total L: 45**TEXT BOOKS:**

1. Murthy B S, Shankar P, Baldev Raj , "Textbook of Nanoscience and Technology", Springer, 2012.
2. Parag Diwan, Ashish Bharadwaj , "Nanostructured Materials", Pentagon Press, 2006.

REFERENCES:

1. Charles P Poole, Frank J Owens , "Introduction to Nanotechnology", John Wiley and Sons, New York, 2003.
2. Michael Wilson, Kamali Kannagara, Geoff Smith , "Nanotechnology: Basic Science and Emerging Technology", Chapman and Hall, New York, 2002.
3. Pradeep T , "Nano: The Essentials", Tata Mc Graw Hill, New Delhi, 2007.
4. Ying J , "Nanostructured Materials", Academic Press, New York, 2001.

19Y005 BIOMATERIALS**3 0 0 3**

INTRODUCTION : Need for biomaterials, their composition and properties , Biocompatibility, bioactive, bioinert, corrosion resistance, strength and weight , metallic biomaterials: stainless steels, cobalt-chromium alloys, titanium alloys, noble metals, merits and demerits. Ceramic biomaterials: calcium phosphates, their forms, alumina, zirconia, titania, Polymeric biomaterials: methacrylates, lactic acid derivatives, silicone rubber. (9)

SYNTHESIS : Electrophoretic, Sol-gel, combustion synthesis, cathodic deposition, anodization, precipitation methods, Mechanical Alloying, Effect of alloying elements like Na, Mg, Sr, Ag, Carbonates on biocompatibility. (9)

BIOCOATINGS : Biomimetic, plasma spraying, sol-gel, electrochemical methods, laser, Ion-implantation, coating roughness, adhesion strength, wettability and contact angle measurements. (9)

CHARACTERIZATION OF BIOMATERIALS : Important characterization techniques- diffraction and electron microscopy, Atomic Force Microscopy (AFM) / STM, and XPS, FTIR and UV Spectroscopy, Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP - AES) techniques (9)

BIOLOGICAL STUDIES : Corrosion: leaching studies in SBF, Polarization, Impedance, Open circuit potential measurements. In vitro cell culture: Cell seeding, cytotoxicity, MTT assay, protein quantity measurements, In vivo studies: Surgical procedure,

removal torque measurement, pathological studies.

(9)

Total L: 45

TEXT BOOKS:

1. Sujatha V Bhat , "Biomaterials", Narosa Publishing House, New Delhi, 2002.
2. Seeram Ramakrishna, Murugan Ramalingam, Sampath Kumar T S, Winston O. Soboyejo , "Biomaterials: A Nano Approach", CRC Press, 2010.

REFERENCES:

1. Joon B Park, Joseph D Bronzino , "Biomaterials principles and Applications", CRC Press, London, 2003.
2. Ed Narayan J R , "ASM Handbook, Volume 23 - Materials for Medical Devices", Second Printing, ASM International, 2012.
3. Narayanan R , "Surface Modification of Titanium for Bio materials applications", Nova Publishers, New York, 2010.

19Y006 MATERIAL AND ENERGY BALANCE IN METALLURGY

3 0 0 3

BASICS OF MASS AND HEAT BALANCE : Law of conservation of mass and energy, Processes and their classification, Types of mass and heat balance, Mass and heat balance procedure-Basis and Units, Flowcharts, Degrees of Freedom analysis, Forming the materials balance equations, Numerical examples. (9)

EXTRACTION PROCESSES : Characterization of natural reserves of metal, Metal extraction requirements, Energy requirements for metal production, Sources of energy, Environmental issues. Slurry - Concentration of solids in slurry, Exercise Problems. Thermochemistry and Stoichiometry- Basics of stoichiometry, Ideal gas law, Excess and limiting reactants, Oxidation and reduction reactions, Exercise Problems. (9)

CALCINATION AND ROASTING : Calcination - Principles of calcination, Applications, Materials and heat balance in calcinations, Problems, Roasting —Introduction, Sources of energy, Determination of calorific value of gaseous fuel, Amount of air, Types of roasting, Basics of materials balance in roasting, Calculation procedure, Problems. Basics of heat balance in roasting, Calculation Procedure for Roasting Temperature, Illustration. (9)

NON FERROUS SMELTING : Matte smelting, Industrial copper smelting. Material balance and heat balance problems in matte smelting. Reduction smelting, Salient features of zinc and lead reduction smelting, Material balance in zinc and lead smelting, Material and heat balance in Imperial Smelting Process, Analysis of heat balance. (9)

IRON AND STEEL MAKING : : Materials Balance in Iron making, Blast furnace stoichiometry, Enthalpy balance in blast furnace, Illustration of the concept, Problems, Converting - Basics of converting operation, Illustrations, Material and heat balance in converting, Material and heat balance in steel making by L.D converters and open hearth furnace. (9)

Total L: 45

TEXT BOOKS:

1. Alan Fine H, Gordon H. Geiger , "Handbook on Material and Energy Balance Calculations in Metallurgical Processes", Second Revised Edition, Wiley, 1998.
2. Seetharaman S , "Fundamentals of Metallurgy", Woodhead Publish Limited, Cambridge, 2005.

REFERENCES:

1. Koria S C , "Materials and Heat Balance in Metallurgical Processes", Course Materials, NPTEL Online, 2017.
2. Schuhmann R , "Metallurgical Engineering Volume 1: Engineering Principles", Addison Wesley, 1952.

19Y007 METALLURGY OF CASTINGS

3 0 0 3

SOLIDIFICATION OF METALS AND ALLOYS : Solidification of castings. Effect of composition on freezing pattern. Effect of moulding materials and cooling rate on freezing pattern. Shrinkage of casting and directional solidification of castings. (9)

CAST IRONS : Introduction, Graphitization. . Effect of normal elements and alloying elements in cast Irons. Types and sizes of graphite for Grey Cast Iron and S.G.Iron. Production , compositional, properties and microstructure. Properties of austenitic cast irons, high silicon cast irons, high chrome cast Irons, Ni-Hard cast irons. Grey cast iron, S.G.Iron, Austempered S.G.Iron. C.G.Iron ad Malleable cast iron, composition control for cast irons simple problems in composition control. Specifications IS, BS, EN and ASTM standards, different inoculants and inoculation techniques. (9)

STEELS : Effect of normal elements and alloying elements in steels. Compositional aspects and properties of alloy steels. melting procedure and composition control for carbon steels, low alloy steels and stainless steels. Simple problems in composition control, slag-metal reactions-desulphurization-dephosphorisation, specifications for carbon steels, low alloy steels and stainless steels as per ASTM, BS, EN and standards, modification and grain refinement

of steels.

(9)

NON-FERROUS CAST ALLOYS : Specifications, composition, properties and phase diagrams of Copper, Aluminium, Magnesium, zinc and Nickel base alloys, melting Procedure and composition control for Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys, modification and grain refinement of Al alloys, problems in composition control, specifications IS, BS, EN and ASTM standards. Gases in metal- Various degassing techniques for metals and alloys. (9)

GASES IN METALS : Various degassing techniques for metals and alloys. **FLUIDITY**: Definition, factors affecting and measurement of fluidity. **RESIDUAL STRESSES**: Origin, effects and stress relieving operations.

DEFECTS IN CASTINGS: Identification, their causes and remedies. fish bone diagram, FMEA and WHY analysis. (9)

Total L: 45

TEXT BOOKS:

1. Richard W Heine, Carcl R L Loper , "Principles of Metal Casting", Second, Tata McGraw Hill, 2009.
2. Hasse Fredriksson, Ulla Åkerlind , "Materials Processing during Casting", John Wiley & Sons, 2012.

REFERENCES:

1. Ed Moosbrugger, Ed DeGuire E , "ASM Handbook, Volume 15 - Casting", Third Printing, ASM International, 2013.
2. Beeley P R , "Foundry Technology", Second Edition, Butterworth-Heinemann, London, 2001.

19Y008 SPECIAL FORMING PROCESSES

3 0 0 3

HIGH ENERGY RATE FORMING PROCESSES : High velocity forming — comparison with conventional forming — Explosive forming — types, explosives — detonation velocity of explosives —process parameters application of explosive forming, electro hydraulic forming — methods and applications, electromagnetic forming — methods and applications, Petro forge system —rubber pad forming — methods and applications. (9)

SUPER PLASTIC FORMING : Super plasticity — definition - materials — mechanism of super plastic deformation — deep drawing, blow and vacuum forming, vacuum thermo forming, mechanical thermo forming, diffusion bonding — superplasticforminganddiffusionbonding—methodsandapplicationsofsuperplasticforming. (9)

SEVERE PLASTIC DEFORMATION PROCESS : Metallurgical characteristics and structural changes during severe plastic deformation processes, —ECAP -types- microstructural variations with processing route —Cryo rolling — process-types —stress strain distribution, Accumulative roll bonding — methods, production of composite structures using ARB, applications, Repetitive corrugation and straightening — methods and applications, Asymmetric rolling — methods and applications. (11)

SEVERE PLASTIC DEFORMATION BY MECHANICAL ALLOYING : Severe plastic deformation by mechanical alloying —types —equipment —compaction —sintering —mechanism of sintering, powder forging, powder extrusion, deformation of porous performs, powder rolling — methods, materials and applications. (9)

ADVANCED FORMING PROCESSES : Ring rolling — parameters, methods and applications, Peen forming process, High Pressure Torsion, High-Pressure Tube Twisting, Twist Extrusion, Conshearing Process, Continuous Confined Strip Shearing, ultrasound plastic deformation. Electro forming. (7)

Total L: 45

TEXT BOOKS:

1. Hertzberg R W , "Deformation and Fracture Mechanics of Engineering Materials", John Wiley & Sons, 2012.
2. Padmanabhan K A, Davis G J , "Superplasticity", Springer Verlag, Berlin, 1980.

REFERENCES:

1. Hosford W.F, Caddell R M , "Metal Forming Mechanics and Metallurgy", 4th Edition, Cambridge University Press, 2011.
2. Suryanarayana C , "Mechanical Alloying and Milling", 1st Edition, Taylor & Francis, 2004

19Y009 WELDING METALLURGY

3 0 0 3

WELDING METALLURGY FUNDAMENTALS : Weld solidification, Absorption of gases, liquid metal reactions, solid state transformations in weldments, strengthening mechanisms in weld metals, heat affected zones, Weldability, Factors affecting weldability, Weldability tests: cold cracking tests, hot cracking tests, Mechanical tests — Weld tension tests, Weld bend tests. (9)

WELDING OF CARBON STEELS AND LOW ALLOY STEELS : Phase transformations, Hydrogen induced cracking, carbon equivalent, preheating and post heating, solidification cracking, lamellar cracking, reheat cracking. Welding of Cast Irons: Weld metal and HAZ microstructures, Defects and remedies, Filler metal selection (9)

WELDING OF STAINLESS STEELS : Welding of austenitic, ferritic, martensitic, duplex and precipitation hardenable stainless steels. General Welding characteristics, Weld microstructures, Weld cracking and other metallurgical problems, Use of Constitution diagrams (Schaeffler, Delong, WRC-1992). Filler metal selection. Dissimilar welds with stainless steels. (9)

WELDING OF ALUMINIUM ALLOYS : Oxide formation, Hydrogen solubility, Difficulties due to electrical and thermal characteristics, sensitivity to weld cracking. Filler metal selection. Weldability of heat treatable and non-heat-treatable aluminium alloys (9)

WELDING OF NICKEL ALLOYS : Metallurgical Difficulties, Solidification Cracking, Slag Detachability Problem, Porosity Issues. Welding of Titanium Alloys: Reactivity of Titanium, Embrittlement Cracking, Hydrogen Induced Cracking, Soft Zone Formation, Effect of Process Parameters, Material Parameters, Filler Metal Selection (9)

Total L: 45

TEXT BOOKS:

1. Sindo Kou , "Welding Metallurgy", John Wiley and Sons, 2003.
2. John C. Lippold , "Welding Metallurgy and Weldability", John wiley and sons, 2015.

REFERENCES:

1. American Welding Society, . ASM International, 2003.
2. Laucaster J F, "Metallurgy of welding", Woodhead Publishing Series, Elsevier, 1999.

19Y010 WELDING PROCEDURES AND QUALIFICATIONS

3 0 0 3

PROCESSES & WELDING METALLURGY: Overview of selected processes: SMAW, GTAW, GMAW, FCAW, SAW: AWS: Fundamentals, Equipments, Electrodes / Filler metals Classifications as per AWS. Review of welding metallurgy of selected metals — Carbon steels, low alloy steels, stainless steels, Ni alloys, Cu alloys, Al alloys, ASMEB&PV Code —Sections IIC and IX (9)

CODE PRACTICE : Familiarization of codes: Section IIC, Section IX of ASME B&PV Code, API 1100 and AWS D1.1 , Essential variables, non - essential variables, Supplementary essential variables.WPS formats, PQR formats and WPQ formats. Test requirements. Range qualified for varying values of essential values. Preparation of WPSs, PQRs and Range Qualified tables. Preparation of WPQs (9)

WELDING PROCEDURE SPECIFICATIONS (WPS) – FERRITIC STEELS : Preparation of WPS's for metal joining for Process variation: SMAW, GTAW, GTAW+SMAW, GMAW, SAW, SMAW+SAW, GTAW+SAW. Material variation: Carbon steels, Low Alloy Steels, Cr - Mo Steels.Post Weld Heat Treatment: No PWHT, Stress Relieving, Other Heat Treatments. (9)

WELDING PROCEDURE SPECIFICATIONS (WPS) – STAINLESS STEELS : Preparation of WPS's for metal joining for Process variation: SMAW, GTAW, GTAW+SMAW, GMAW, SAW, SMAW+SAW, GTAW+SAW. Material variation: Stainless steels. Preparation of WPS's for dissimilar metal joining for Process variation: SMAW, GTAW+SMAW. Preparation of WPS's for weld overlaying of Stainless steels over carbon steel. (9)

WELDING PROCEDURE SPECIFICATIONS (WPS) –NON-FERROUS ALLOYS : Preparation of WPS's for metal joining for Process variation: SMAW, GTAW, GTAW+SMAW, GMAW, SAW, SMAW+SAW, GTAW+SAW. Material variation: Nickel alloys, Copper alloys, Titanium alloys, Al Alloys. Preparation of WPS's for dissimilar metal joining for Process variation: SMAW, GTAW+SMAW. Preparation of WPS's for weld overlaying of Nickel alloys over carbon steels. Cu alloys over carbon steels, Stellite over carbon steels / stainless steels. (9)

Total L: 45

TEXT BOOKS:

1. Olson D L, Siewert T A, Liu S, Edwards G R , "ASM Metals Handbook, Vol 6,"Welding Brazing and Soldering", ASM International, 2003.
2. AWS, "AWS Welding Hand books: Volume 1 to Volume 5", American Welding Society, USA, 2001.

REFERENCES:

1. American Society of Mechanical Engineers, American Petroleum Institute, American Welding Society,

19Y011 SURFACE COATINGS AND MODIFICATIONS

3 0 0 3

SURFACE ENGINEERING : Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods: Chemical, Electrochemical and Mechanical methods(Sand Blasting, Shot peening, Shot blasting& Hydro-blasting) and Vapor Phase Degreasing. Introduction to diffusion techniques and Coating techniques. (9)

CHEMICAL CONVERSION COATING : Chromating, Phosphating, Anodizing, Thermochemical processes: Methodology

used, mechanisms, important reactions involved, Process parameters and applications. (9)

METALLIC COATING : Hot Dipping, Galvanizing, Electrolytic and Electro less plating: Methodology used, mechanisms, important reactions involved, Process parameters and applications. Testing/ evaluation of metallic coatings. (9)

VAPOUR PHASE COATINGS AND THERMAL SPRAY COATINGS : PVD and CVD: Various Methods used, mechanisms, Important reactions involved Process parameters and applications. Thermal spray processes, types of spray guns, comparison of typical thermal spray processes, cold spray methods, surface preparation, finishing treatment, structures properties and applications. (9)

ADVANCED SURFACE MODIFICATION TECHNIQUES : Surface modification by use of directed energy beams, Plasma, Sputtering & Ion Implantation. Surface modification by friction stir processing for surface composites preparation(9)

Total L: 45

TEXT BOOKS:

1. Murphy J A, "Surface Preparation and Finishes for Metal", McGraw-Hill, 1971.
2. Ashok Kumar , "Surface Engineering : Science and Technology II", Wiley, 2002.

REFERENCES:

1. P G Sheasby, R Pinner , "Surface treatment and finishing of Aluminium and its alloy : Volume-2", 6th Edition, ASM, 2001.
2. ASM International, 1994. ASM International, 2013.4. George J. Ruzdki , "Surface Finishing Systems., metal and non-metal finishing handbook-guide,", Metals Park ASM, 1983.

19Y012 ADDITIVE MANUFACTURING

3 0 0 3

INTRODUCTION : Overview, history, classification, Rapid Prototyping (RP) process chain - fundamental automated processes, process chain, additive manufacturing technology in product development, materials for additive manufacturing technology, tooling, advantages, disadvantages and applications. (8)

CAD & REVERSE ENGINEERING : Basic concepts, digitization techniques, model reconstruction, data processing for additive manufacturing technology - CAD model preparation, part orientation and support generation, model slicing, tool path generation, softwares for additive manufacturing technology - MIMICS, MAGICS. (9)

LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS : Classification - liquid based system - Stereolithography Apparatus (SLA) - Principle, process, advantages and applications, Binder jet technology - Principle, process, advantages and applications. Solid Ground Curing (SGC), solid based system - Fused Deposition Modeling (FDM) - Principle, Process, advantages and applications, Laminated Object Manufacturing (LOM), Case studies in SLA, SGC, FDM, LOM systems. (10)

POWDER BASED ADDITIVE MANUFACTURING SYSTEMS : Selective Laser Sintering (SLS) - principles, process, advantages and applications, three dimensional printing - principle, process, advantages and applications, Laser Engineered Net Shaping (LENS), electron beam melting, overview of direct rapid tooling and indirect rapid tooling (10)

RAPID PROTOTYPING APPLICATIONS : Applications - material relationship, application in design, engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, Rapid Prototyping in medical and bioengineering applications: planning and simulation of complex surgery, customized implants & prosthesis, design and production of medical devices, forensic science and anthropology, visualization of biomolecules. (8)

Total L: 45

TEXT BOOKS:

1. Chua C.K, Leong K.F, Lim C.S. , "Rapid prototyping: Principles and applications", Third Edition,, World Scientific Publishers, 2010.
2. Ian Gibson, David W. Rosen, Brent Stucker , "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping and Direct Digital Manufacturing", Springer, 2015.

REFERENCES:

1. Liou L W, Liou F W , "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Gebhardt A, "Rapid prototyping", Hanser Gardener Publications, 2003.
3. Kamrani A K, Nasr E A , "Rapid Prototyping: Theory and Practice", Springer, 2006.
4. Hilton P D, Jacobs P F , "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

19Y013 ADVANCED NON-DESTRUCTIVE TESTING

3 0 0 3

NEED FOR ADVANCED NDT METHODS : Global frame work: New and high critical applications, Product safety and reliability, In-line diagnostics, Security monitoring. Driving forces for advancements in NDT, future trends in NDT. Positive

material Identification (PMI): Introduction, Principle, Typical methods: X-ray fluorescence (XRF) and optical emission spectrometry (OES), relative merits, limitations and applications. Laser Shearography testing (LST): Principle, Speckle pattern and fringe patterns, Applications. (9)

ALTERNATIVE CURRENT FIELD MEASUREMENT (ACFM) : Principle, procedure and applications. Magnetic flux leakage (MFL): Principle, instrumentation and applications. Remote field testing (RFT): Principle, instrumentation and applications. Acoustic pulse reflectometry (APR): Principle and applications — heat exchanger tube inspection. (9)

MICROWAVE TESTING (MWT) : Principle, instrumentation and applications. Phased array ultrasonic testing (PAUT): Principle, wave sweeping, focusing, and steering. Phase array probes, Scanning and display, Result interpretation, Potential applications. Time of flight diffraction (TOFD): Principles of operation, flaw size determination, applications, reliability. (9)

GUIDED WAVE ULTRASONIC TESTING (GWUT) : Principle, procedure, advantages and applications. Laser-ultrasonic testing (LUT): Principle, procedure, advantages and applications. (9)

DIGITAL RADIOGRAPHY TESTING (DRT) : Computed Radiography (CR), Direct Radiography (DR), Real Time Radiography (RTR), Industrial Computed Radiography (ICT), X-Ray Back Scatter Technique (BSRT). Neutron radiography (NRT): Principle, Neutron sources, Neutron beam and collimation, detection of image, advantages and applications. Infra-red thermography (IRT): Principle, Image capturing, active and passive sources, detector types, applications (9)

Total L: 45

TEXT BOOKS:

1. Songling Huang, Shen Wang, "New Technologies in Electromagnetic Non-destructive Testing", Springer Series in Measurement Science and Technology, 2016.
2. Ed Lampman R S, Ed Zorc B T , "ASM Handbook, Volume 17 - Nondestructive Evaluation and Quality Control", Twelfth Printing, ASM International, 2014.

REFERENCES:

1. Zoughi R , "Microwave Non-Destructive Testing and Evaluation Principles - Volume 4", Springer, Netherlands, 2011.
2. Advanced Practical NDT Series , "Introduction to Phased Array Ultrasonic Technology Applications", Olympus, USA, 2004.

19Y014 METALLURGICAL FAILURE ANALYSIS

3 0 0 3

METHODOLOGY FOR FAILURE ANALYSIS : Fundamental sources of failures: Deficiency in design, manufacturing defects, overload and environmental factors; Types of failures; Stages in failure analysis, Tools and Techniques : fractography using micro, macro and SEM examinations, Chemical and mechanical testing. (9)

FAILURE OF CASTINGS AND HEATTREATED COMPONENTS : CASTINGS: Failures due to improper cast design, porosity, cold joints and inclusions, casting defects and remedies in cast irons and steels. Case studies; HEAT TREATMENT: failure of carburized and nitrided components, effects of quenching, tempering and isothermal heat treatment - case studies. (9)

FAILURE OF WELDED AND FORMED COMPONENTS : TWELDING: Effects of discontinuities, residual stress, hot cracking, and stress concentration. Welding defects and remedies, Case studies; FORMING: Causes and prevention of failures in forged /rolled components and extrusion tool dies. Case studies. (9)

CREEP AND FATIGUE FAILURES : CREEP: creep mechanisms, prediction of creep life time of a component, Elevated temperature failures: failure analysis of jet nozzle casing of aeroengine, turbine blades and boiler tubes. FATIGUE: Types of fatigue failures, metallurgical factors affecting fatigue properties, Causes and prevention of fatigue failures, determination of fatigue life of a component, failure of shafts, gears, wheels, failure analysis of wheel hub of aircraft and rotor shaft of aeroengine. (9)

CORROSION AND WEAR FAILURES : CORROSION: Types and mechanisms of corrosion, environmental factors affecting corrosion, examples of corrosion failures and their prevention, mechanism of stress corrosion cracking and case studies on analysis of stress corrosion cracking, failure analysis of condenser tubes in thermal power station, fuel pipe line; WEAR: Types and mechanisms of wear, factors affecting wear, failure analysis on bearings of aeroengine, super heater tube in thermal power station. (9)

Total L: 45

TEXT BOOKS:

1. Vito J. Colangelo, Francis A. Heiser , "Analysis of Metallurgical Failures", Second, Wiley Publisher, 1985.
2. Arthur J. McEvily, "Metal Failures: Mechanisms, Analysis, Prevention", First, John Wiley & Sons, Inc., 2013.

REFERENCES:

1. Becker W T, Shipley R J , "ASM Metals Hand Book: Failure Analysis and Prevention - Vol.11", Tenth, ASM International, 2002.
2. Balan K P , "Metallurgical Failure Analysis", Elsevier, 2018.

3. Das A K , "Metallurgy of Failure Analysis", McGraw-Hill Professional, 1997.
4. Hani M. Tawancy, Anwar Ul-Hamid, Nureddin M. Abbas , "Practical Engineering Failure Analysis", CRC Press, 2004.

19Y015 SELECTION OF MATERIALS

3 0 0 3

FACTORS OF MATERIAL SELECTION : Classes of engineering materials - Evolution of engineering materials- Definition of materials properties- Design strengths and weakness of various materials and their processes, Displaying material properties using materials selection charts- Forces for change in materials selection and design, Materials and the environment. (9)

ROLE OF DESIGN : Design process - types of design, design requirements, Technical Factors - Function, Material attributes. Shape and Manufacturing processes — Formulation of functional requirements, Constraints, Objectives and Free variable, Materials processing and their influence on design, process attributes, Non-Technical Factors — Local conditions, Cost, Availability, Reparability, Recyclability. Reliability, Environmental impact, Legal issues. (9)

MATERIAL SELECTION : Materials selection strategy and methods: Screening and Ranking- weighted ranking, performance indices- materials selection charts, deriving property limits and material indices, structural indices, Multiple constraints and multiple objectives, Role of local parameters, Post script on materials selection. (9)

PROCESS SELECTION : Process classification, Systematic process selection, process selection diagrams, process cost, energy consumption for production, material and shape link with process, availability and environmental consideration, Screening, Ranking – Process cost and Supporting information. (9)

MATERIAL SELECTION FOR INDUSTRIAL COMPONENTS : Introduction, materials for tie rods, columns, beams, oars, flywheels, springs, safe pressure vessels, heat exchangers, disk brake caliber, connecting rods, automobile body, nuclear reactors, boat hulls, etc (9)

Total L: 45

TEXT BOOKS:

1. Ashby M F , "Materials Selection in Mechanical Design", Butterworth- Heineman, New York,,2005.
2. Dieter G E , "Engineering Design: A Materials and Processing Approach", McGraw Hill,2002.

REFERENCES:

1. Ed Dieter E G , "ASM Handbook, Volume 20 - Material Selection and Design", Fourth printing, ASM International, 2014.
2. Charles J A and Crane F A , "Selection and Use of Engineering Materials", Butterworth-Heinemann Oxford, 2001.

19Y016 MATHEMATICAL MODELLING IN METALLURGICAL ENGINEERING

3 0 0 3

NUMERICAL METHODS FOR METALLURGICAL MODELLING : Solving system of linear and non linear equations- Numerical integration-Newton-Cotes integration formula, Trapezoidal rule, Simpson's rule, Ranberg's method and Gaussian quadrature. Solving ordinary differential equations, Euler method, Runge kutta 2nd and 4th order methods, and Predictor and corrector methods. Solving partial differential equations, Introduction to FEM. (9)

DISCRETIZATION TECHNIQUES IN METALLURGY : Fundamentals of finite difference, explicit, implicit schemes, stability criteria, Tri-Diagonal Matrix Algorithm (TDMA), finite volume method - fundamentals, convergence, numerical schemes in FVM, pressure velocity coupling. Applications to metallurgical problems like heat treatment, reheating furnace, carburizing, precipitation and dissolution kinetics, quenching, liquid degassing, casting and welding. (9)

MATERIALS MODELING FROM FIRST PRINCIPLES : Many-body Schrodinger equation, Density functional theory. Total energy of the electronic ground state. Kohn-Sham equations, The local density approximation. Self-consistent calculations. Equilibrium structures of materials: The adiabatic approximation, Atomic forces, Calculating atomic forces using classical electrostatics. Equilibrium configuration using calculated forces, Structure of crystals, Reciprocal lattice and Brillouin zone. (9)

MOLECULAR DYNAMICS SIMULATION OF MATERIALS : Introduction to classical statistical mechanics. Ergodicity, Ensembles, Interatomic potentials, Force calculation. Integration algorithms, boundary conditions Virial Theorem Equipartition Principle, Properties from equipartition principle, Caloric Curve , cohesive energy, bulk modulus, Thermal expansion coefficient, Structural information, Radial Distribution Function, Defect properties, Auto- correlation functions, Velocity Auto correlation function, Green-Kubo Equations, Mean Square displacement. (9)

MONTE CARLO METHODS : Importance Sampling ,Random Number generation ,Metropolis algorithm, Glauber Dynamics . Exchange Monte Carlo Monte -Kawasaki dynamics. Kinetic Monte Carlo-Gillespie algorithm. (9)

Total L: 45

TEXT BOOKS:

1. Feliciano Giustino , "Materials Modeling using Density Functional Theory", Oxford University Press, 2014.

2. June Gunn Lee , "Computational Materials Science: an Introduction", CRC Press, 2012.

REFERENCES:

1. Michel Rappaz, Michel Bellet, Michel Deville, "Numerical Modeling in Materials Science and Engineering", Springer series in Computational Mathematics, 2003.
2. Shlomo Mark , "Applications of Monte Carlo Method in Science and Engineering", InTech, 2011.
3. Richard Le Sar , "Introduction to Computational Materials Science", Cambridge University Press, 2013.
4. Sidney Yip , "Hand Book of Materials Modeling and Methods: Part A & B", Springer, 2005.

19Y017 COMPUTATIONS IN METALLURGICAL ENGINEERING

3 0 0 3

INTRODUCTION TO CALPHAD APPROACH : Thermodynamic parameters in binary systems — solution thermodynamics — ideal and regular solution models, chemical potential, free energy composition diagrams, evolution of phase diagrams based in regular solution models, quasi chemical theory - sub regular solution model. (9)

PHASE DIAGRAMS OF MULTI COMPONENT SYSTEM : Sub regular solution model for phase and precipitates of multi component system — Redlich-kister polynomial — Muggianu and Kohler extrapolation, crystallography in thermodynamics- order disorder structure, anti-site defects and vacancies, compound energy formalism, diffusion coupling technique. (9)

COMPUTATIONAL METHODS : Introduction to programming in MATLAB / OCTAVE software, programming for solving set of linear and non linear equations, ODE and PDE, construction of G Vs X curve and phase diagrams — binary systems, multi component systems, sub regular solution models, chemical potentials, calculation of stacking fault energy using CALPHAD approach. (9)

SOLIDIFICATION AND DIFFUSION MODELS : Solidification of pure metals and alloys — planar front and dendritic solidification, calculations of nucleation rate, concept of equilibrium. Solidification, Scheil solidification, Diffusion- Fick's laws for diffusion, solution for diffusion equations, boundary conditions, programming to solve the diffusion equations. (9)

CALPHAD SOFTWARE : Thermocalc software — introduction, construction of binary, ternary phase diagrams, analyzing thermodynamic parameters in unary systems, vertical sections of multi component phase diagrams, property diagram for multi component system, creation of user defined databases, introduction to PRISMA — Isothermal and non isothermal simulations for precipitation mechanisms, TTT and CCT diagram construction, Introduction to Dictra - diffusion single phase, moving phase boundary diffusion simulation, carburizing, nitriding, diffusion bonding. (9)

Total L: 45

TEXT BOOKS:

1. Saunders, Miodownik , "CALPHAD : A comprehensive guide", Pergamman Press, 1998.
2. Suzana G. Fries, Bo Sundman, "Computational Thermodynamics: the CALPHAD method, by Hans Lukas", Cambridge University Press, 2007.

REFERENCES:

1. Porter D A, Easterling K E , "Phase Transformations in Metals and Alloys", Third, CRC Press, 2017.
2. David R Gaskell , "Introduction to Thermodynamics of Materials", Taylor and Francis, 2003.
3. Ed Furrer D U, Ed Semiatin S L , "ASM Handbook, Volume 22A - Fundamentals of Modelling for Metals Processing", Fourth Printing, ASM International, 2013.

19Y018 MICROSTRUCTURAL SIMULATION

3 0 0 3

SOLUTION MODELS AND DIFFUSION EQUATION : Solution models — introduction, G vs X diagrams , phase diagrams, bond breaking model, chemical potential, Spinodal decomposition, stability, diffusion and mobility, chemical potential, diffusion equation for up-hill and down-hill diffusion. Non-dimensionalisation of diffusion equation, analytical solutions, error function solution, Fourier series solutions. (8)

NUMERICAL SOLUTIONS : Review of programming in high level languages such as Python and Octave. Numerical solutions — Ideal solution model, regular solution model, construction of phase diagrams, plotting spinodal, numerical solution for diffusion equation — finite difference method, Implicit and explicit methods, Periodic boundary condition, spectral techniques. Application of linear algebra towards solution to a system of linear and non linear equations; Numerical integration; Numerical solution of diffusion equation. (8)

WORKING WITH DATA : Use of VTK library to store multi-dimensional data, using Python to read and write files in different formats. Fitting and visualization of multidimensional data; Quantification of experimental microstructures using programs as well as software tools; synthetic microstructures using Dream-3D software. (8)

MICROSTRUCTURE SIMULATION TOOLS : Computational techniques such as phase field method, Diffusion limited aggregation, cellular automata and Monte Carlo towards evolution of microstructure. Programming cycle of problem statement, numerical implementation, initial and boundary conditions, time evolution of microstructure and storing output files in different formats. (10)

PHASE FIELD SIMULATIONS : Introduction to symmetry group theory, transformation laws, Neuman's principle, introduction to variational calculus, variational derivative, free energy functional, Cahn-Hilliard and Allen-Cahn equations, numerical solutions. Calculation of model parameters from physical parameters. 2D microstructure simulations - spinodal decomposition, Order-disorder Transformation, Gibbs-Thomson effect, Grain growth and Precipitate Growth. (11)

Total L: 45

TEXT BOOKS:

1. Richard Le Sar , "Introduction to Computational Materials Science", Cambridge University Press, 2013.
2. Biner S Bulent, "Programming Phase-Field Modeling", Springer, 2017.

REFERENCES:

1. Riley R F, Hobson M P, Bence S J, "Mathematical Methods for Physics and Engineering", Third edition, Cambridge University Press, 2012.
2. Georg J. Schmitz, Ulrich Prah , "Integrative Computational Materials Engineering: Concepts and Applications of a Modular Simulation Platform", Wiley-VCH Verlag GmbH & Co, 2012.

LANGUAGE ELECTIVES

19G001 COMMUNICATION SKILLS FOR ENGINEERS

0 0 4 2

COMMUNICATION CONCEPTS :

Process of Communication
Inter and Intrapersonal Communication
Inter and Intrapersonal Communication Activities

(9)

FOCUS ON SOFT SKILLS :

Etiquette — Work Place etiquette — Telephone etiquette
Body Language
Persuasive Communication
Public Speaking
Critical Reasoning and Conflict Management based on Case Studies
Group Communication
Meetings
Interview Techniques

(14)

TECHNICAL WRITING :

Technical Writing Principles
Style and Mechanics
Technical Definitions – Physical, Functional and Process Descriptions
Technical Report Writing
Preparing Instructions and Manuals
Interpretation of Technical Data

(15)

BUSINESS CORRESPONDENCE :

Writing Emails
Preparing Resumes
Memos
Technical and Business Proposals

(7)

TECHNICAL COMMUNICATION :

Seminars
Process Description and Group Discussions
Use of Visual Aids

(15)

Total P: 60

TEXT BOOKS:

1. Faculty Incharge "Course Material on "Communication Skills for Engineers"", PSG College of Technology., Coimbatore, 2019

REFERENCES:

1. Jeff Butterfield "Soft Skills for Everyone", Cengage Learning., New Delhi, 2013
2. Jean Naterop B and Rod Revell "Telephoning in English", Cambridge University Press., Cambridge, 2011
3. David A Mc Murrey and Joanne Buckley "Handbook for Technical Writing", Cengage Learning., New Delhi, 2011
4. Simon Sweeney "English for Business Communication", Cambridge University Press., New Delhi, 2012

19G002 GERMAN- LEVEL A1.1**0 0 4 2****GUTEN TAG! :**

1. To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages
2. Vocabulary: related to the topic
3. Grammar: W – Questions, Verbs & Personal pronouns I. (10)

FREUNDE, KOLLEGEN UND ICH :

1. To speak about hobbies, jobs, learn numbers from 20; build dialogues and frame simple questions & answers
2. Vocabulary: related to the topic
3. Grammar: Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural (10)

IN DER STADT :

1. To know places, buildings, question, know transport systems, understand international words; build dialogues and write short sentences
2. Vocabulary: related to the topic
3. Grammar: Definite & indefinite articles, Negotiation, Imperative with Sien verbs (12)

GUTEN APPETIT! :

1. To speak about food, shop, converse; Vocabulary: related to the topic; build dialogues and write short sentences
2. Grammar: Sentence position, Accusative, Accusative with verbs, personal pronouns & prepositions, Past tense of haben & sein verbs (13)

TAG FÜR TAG/ZEIT MIT FREUNDEN :

1. To learn time related expressions, speak about family, about birthdays, understand & write invitations, converse in the restaurant; ask excuse, fix appointments on phone
2. Vocabulary: related to the topic
3. Grammar: Time related prepositions, Possessive articles, Modalverbs (15)

Total P: 60**TEXT BOOKS:**

1. Dengler Stefanie "Netzwerk A1.1", Klett-Langenscheidt GmbH., München, 2013
2. Sandra Evans, Angela Pude "Menschen A1", Hueber Verlag., Germany, 2012

REFERENCES:

1. Stefanie Dengler "Netzwerk A1", Klett-Langenscheidt GmbH., München, 2013
2. Hermann Funk, Christina Kuhn "Studio d A1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009
3. Rosa-Maria Dallapiazza "Tangram Aktuell 1 (Deutsch als Fremdsprache)", Max Hueber Verlag., Munchen, 2004
4. Christiane Lemcke und Lutz Rohrmann "Grammatik Intensivtrainer A 1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2012

19G003 FRENCH LANGUAGE LEVEL 1**0 0 4 2****PARTS OF SPEECH :**

1. inviter et répondre à une invitation, Pronoms sujets
2. L'article définis, l'article indéfinis
3. Conjugation : présent, adjectifs possessifs
4. interrogation, décrire les personnes
5. La vie de quatre parisiens de professions différentes (12)

ELEMENTS OF GRAMMAR :

1. Exprimer l'ordre et l'obligation demander et commander
2. l'adjectif possessifs, l'article partitif, l'article démonstratif, négation ne
3. pas, l'article contracté
4. verbe pronominaux
5. prepositions (12)

SENTENCE STRUCTURE :

1. Raconter et reporter-donner son avis
2. Futur simple, pronom complètement d'objet direct, passé composé
3. plusieurs région de France, imparfait, pronom y/en, imparfait (12)

TENSES AND NUMBERS :

1. Demander l'autorisation-passé récent, futur proche
2. La vie administrative et régionale, Pluriel des noms, moyens de transport (12)

DISCOURSE :

1. le discours rapporté, décrire un lieu, exprimer ses préférences
2. décrire la carrière, discuter d'un système éducation de France
3. parler de la technologie de l'information (12)

Total P: 60**TEXT BOOKS:**

1. Christine Andant étal "À propos (livre de l'élève", LANGER., NEW DELHI, 2012
2. Myrna Bell Rochester "Easy French Step By Step", MCGrawhill Companies., USA, 2008

REFERENCES:

1. Michael D. Oates "Entre Amis: An Interactive Approach", Houghton Mifflin., 2005 , 5th
2. Bette Hirsch, Chantal Thompson "Moments Literaries : An Anthology for intermediate French", ..
3. Simone Renaud, Dominique van Hooff "En bonne forme", ..

19G004 BASIC JAPANESE**0 0 4 2****JAPANESE PEOPLE AND CULTURE :**

1. Basic greetings and responses
2. Basic script— Method of writing hiragana and katakana — Combination sounds and simple words
3. Selfintroductions: "Hajimemashite" -Demonstratives "Kore", "Sore", "Are"— Demonstrative "Kono", "Sono", "Ano"
4. Possessive noun particle "no"— Japanese apartments: Greeting your neighbor (12)

PARTICLE "NI (AT)" FOR TIME :

1. kara (from) ~ made(until) — Particle "to (and)"
2. Time periods: Days of the week, months, time of day –Verbs (Present / future and pasttense)
3. Telephone enquiry: Asking for a phone no. And business hours- Destination particle "e". (12)

LIKES AND DISLIKES :

1. Potential verbs (wakarimasu and dekimasu) — "Kara (~ because)"
2. Adverbs — Asking some one out over the phone-Verbs denoting presence
3. Introduction to Adjectives (na and ii type) -Verb groups — I, II and III — Exercises to group verbs- Please do (te kudasai)
4. Present continuous tenses (te imasu) — Shall I? (~ mashou ka) — Describing a natural phenomenon (It is raining) (12)

DIFFERENT USAGES OF ADJECTIVES :

1. Comparison — Likes and dislikes — Going to a trip- Need and desire (ga hoshii) — Wanting to . . . (Tabeti desu)- Going for a certain purpose (mi -ni ikimasu)
2. Choosing from a menu-Adjectives ("i" and "na" type) — Adjectives (Positive and negative useage) (12)

ROLE PLAYS IN JAPANESE :

1. Framing simple questions & answers
2. Writing Short paragraphs & Dialogues
3. A demonstration on usage of chopsticks and Japanese tea party (12)

Total P: 60**TEXT BOOKS:**

1. Minna no Nihongo, Honsatsu Roma "ji ban (Main Textbook Romanized Version)", . International publisher — 3A Corporation., Tokyo, 2012

REFERENCES:

1. Eri Banno et.al "Genki I: An Integrated Course in Elementary Japanese I -Workbook", .., 1999
2. Tae Kim "A Guide to Japanese Grammar: A Japanese Approach to Learning Japanese Grammar", .., 2014
3. Minna No Nihongo "Translation & Grammatical Notes In English Elementary", ..,

ONE-CREDIT COURSES

19YF01 BLAST FURNACE DESIGN AND CAST HOUSE PRACTICE

1 0 0 1

DESIGN OF BLAST FURNACE : Furnace proper, bustle pipe, tuyere, tap hole, hearth cooling, masses and compounds for tap hole, ladles and cast house runners. (5)

CHARGE CALCULATIONS AND ANALYSIS : Sinter chemistry calculations, charge calculations for steel making requirements, top gas analysis, peripheral and skin temperatures analysis, calculations for oxygen enrichment and fuel injection. (3)

FURNACE ACCESSORIES : Pump house, cooling system, blower, hot metal transport and utilization, water requirements, gases required, man power requirements, automation (3)

CAST HOUSE PRACTICE : Capital repairs - category 1, 2 and 3, modifications during repair, cast house equipment, runner design, runner making and maintenance, logistics, cast house related problems and remedies. (4)

Total L: 15

REFERENCES:

1. Ahindra Ghosh and Amit Chatterjee , "Iron Making and Steel Making-Theory and Practice", PHI Learning Private Ltd., New Delhi, 2010.
2. Wakelin D H , "The Making, Shaping and Treating of Steel: Iron Making", The AISE Steel Foundation, Pittsburgh, USA, 1999.
3. Bash forth G R , "The Manufacture of Iron and Steel Volume 1: Iron Production", Chapman Hall, London, 1964.
4. Geerdes M, Toxopeus H Van Der Vliet C , "Modern Blast Furnace Iron making", IOS press, The Netherlands, 2009.

19YF02 ADVANCED CAST IRONS AND FOUNDRY MANAGEMENT

1 0 0 1

SYSTEMATIC DEVELOPMENT OF CASTINGS : Understanding casting drawings - review of technical requirements, costing aspects, process design and control - gating and risering design through simulation techniques - validation of process and casting quality (4)

CAST IRONS FOR AUTOMOTIVE AND HYDRAULIC VALVES APPLICATIONS : Manufacturing of cast irons - material standards - design requirements - raw material selection- process design - gating system design – process controls and testing requirements as per standards (3)

SPECIAL CAST IRONS : Austempered Ductile Iron (ADI): international standards - different types and properties - production process - austempering heat treatment process - applications - Compacted Graphite Iron (CGI): international standards - properties - production process, applications - casting suitable for sub-zero applications: design requirements - material selection - microstructure and mechanical property requirements - process design, process controls and test requirements (4)

AUTOMATION AND MODERNIZATION OF FOUNDRY PROCESSES : Advanced foundry processes and casting inspection techniques - application of IoT - Foundry 4.0: need, concepts & benefits - challenges in foundry industry special moulding techniques: shell moulding, lost-wax process, lost-foam process, vacuum moulding process, foundry waste management - waste disposal and waste recycling methods. (4)

Total L: 15

REFERENCES:

1. ASM Handbook, Volume 1A, 2017.
2. Roy Elliott , "Cast Iron Technology", Butterworth-Heinemann, 1988.
3. John Campbell , "Complete Casting Handbook", Butterworth-Heinemann, 2015.

ENGLISH

19GF01 INTERPERSONAL AND ORGANIZATIONAL COMMUNICATION

1 0 0 1

INTRA ORGANIZATIONAL COMMUNICATION : Communication Networks in an Organization; Intra- organizational communication (2)

INTER ORGANIZATIONAL COMMUNICATION : Flow Nomenclature; Workplace diversity and intercultural aspects of communication (2)

COMMUNICATION FUNCTIONS IN ORGANIZATIONS : Teamwork and team dynamics; Conflict resolution strategies and styles; Leading and influencing others-facilitation skills (3)

WRITTEN COMMUNICATION : Email Writing, Professional Reports, and Memos (4)

INTERPERSONAL SKILLS : Nature and Dimensions of Interpersonal Communication; Personality and Communication styles; Active listening and intentional responding; Working with emotional intelligence (4)

Total L: 15

REFERENCES:

1. Bagchi Subroto , "The Professional", Penguin Publications, UK, 2011.
2. PMBOK guide , "A Guide to the Project Management Body of Knowledge", Project Management Institute Inc, USA, 2013.

19GF02 HUMAN VALUES THROUGH LITERATURE

1 0 0 1

PROSE : Kalam's vision of college education in Wings of fire - Emerson's advocacy of independence of Human will in Self-reliance - Harmony in Education-views of Betrand Russel (4)

POETRY : Maintaining Human relations in Robert Frost's Mending Wall - Quest for identity and freedom in Kamala Das's An Introduction (2)

DRAMA : Statesmanship and friendship in Girish Karnad's Tughlaq (3)

ONE-ACT PLAY : The theme of love in Chekhov's The Bear (3)

SHORT STORY : Empathy in Somerset maugham's Mr. Know-all - Family bond in Anita Desai's Devoted son (3)

Total L: 15

TEXT BOOKS:

1. Faculty - Department of English , "Course materials", PSG College of Technology, Coimbatore, 2019.

REFERENCES:

1. Abrams M .H, Harpham , "A Glossary of Literary Terms", Cengage, Boston, 2015.
2. Scholes R, et.al. , "Elements of Literature", IV, Indian Rpt. OUP, New Delhi, 2013.

HUMANITIES

19OFA1 EXPORT – IMPORT PRACTICES

1 0 0 1

INTRODUCTION : Export – Import Business – Preliminaries for starting Export – Import Business Registration. (3)

EXPORT PROCEDURES : : Obtaining an Export License – Export Credit Insurance – Procedures and Documentation (4)

FOREIGN EXCHANGE : Finance for Exports – Pricing - Understanding Foreign Exchange Rates. (3)

IMPORT PROCEDURES : Import Policy – License - Procedure and Documentation. (3)

EXPORT INCENTIVES : Incentives - Institutional support (2)

Total L: 15

REFERENCES:

1. Ramagopal C , "Export Import Procedures - Documentation and Logistics", New Age International, 2014.
2. Cherian and Parab , "Export Marketing", Himalaya Publishing House, New Delhi, 2008.
3. Parul Gupta , "Export Import Management", MC-Graw Hill, 2017.
4. Justin Paul, Rajiv Aserkar , "Export Import Management", Oxford, 2013.

190FA2 INSURANCE - CONCEPTS AND PRACTICES

1 0 0 1

INTRODUCTION TO INSURANCE AND RISK MANAGEMENT : Origin, History, Nature and Scope of insurance – Meaning, types and significance of risk. (3)

INSURANCE LAWS AND REGULATIONS : Insurance Act, IRDA Act, Consumer Protection Act, Ombudsman Scheme. (2)

INSURANCE UNDERWRITING AND RISK MANAGEMENT : Meaning of underwriting and underwriter, guidelines and steps in the process of underwriting – characteristics, significance and principles of risk management. (4)

FINANCIAL ASPECTS OF INSURANCE MANAGEMENT : Role and functions of financial institutions, determination of premium for various insurance products. (3)

SETTLEMENT OF INSURANCE CLAIMS : Documents needed during various claims, Factors affecting insurance claims (3)

Total L: 15

REFERENCES:

1. Scott Harrington, Gregory Niehaus , "Risk Management and Insurance", McGraw Hill Education, 2017.
2. George E Rejda , "Principles of Risk Management & Insurance", Pearson Education, 2017.
3. John Hull , "Risk Management & Financial Institution", John Wiley and Sons, 2018.
4. Arjun Mittal, D D Chaturvedi , "Insurance and Risk Management", Scholar Tech Press, 2017.

190FA3 PUBLIC FINANCE

1 0 0 1

INTRODUCTION: Nature and Scope of public finance – Principles of taxation. (2)

PUBLIC REVENUE AND TAXATION: Sources of Revenue – Tax and non-tax revenue – Classification of Taxes, GST. (4)

PUBLIC EXPENDITURE: Importance – Types – Causes of increase in public expenditure – Effects of public expenditure in India. (3)

DEFICIT FINANCING AND BUDGET: Sources of public debt – Debt redemption – Budget – Types – Preparation of Budget in India. (3)

FEDERAL FINANCE: Centre-State financial relations – Finance commissions. (3)

TOTAL: 15

REFERENCE BOOKS:

1. Richard A Musgrave and Peggy B Musgrave, "Public Finance in Theory and Practice" – Tata McGraw Hill Education, New Delhi, 2004.
2. Bhatia H.L, "Public Finance" – Vikas Publishing House, 29th Edition, New Delhi, 2012.
3. David N Hyman, "Public Finance: A contemporary application of theory and policy", Cengage Publication, 11th Edition, Noida, 2014.
4. Santhosh Dalvi and Krishnan Venkatasubramanian, "An introduction to Goods and Service Tax: The biggest tax reform in India", CCH Publisher, New Delhi, 2015.

190FA4 SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT

1 0 0 1

INVESTMENT ENVIRONMENT : Financial Markets - Classification - Financial Instruments – Security Trading. (2)

TYPES OF SECURITIES : Trading – Orders, Margin Trading – Clearing and Settlement Procedures. (5)

SECURITY ANALYSIS I : Industry Analysis –Estimation of Rates of Return. (2)

SECURITY ANALYSIS II : Company Analysis — Estimation of Rates of Return. (2)

PORTFOLIO MANAGEMENT : Measuring Risk and Returns and Treatment in Portfolio Management. (4)

Total L: 15

REFERENCES:

1. William F Sharpe, Gordon J. Alexander, Jeffery V Bailey , "Investments", Prentice Hall, 2012.

2. Prasanna Chandra , "Investment Analysis and Portfolio Management", TATA McGraw Hill Publishing, 2011.
3. Ranganathan , "Investment Analysis and Portfolio Management", Pearson, 2004.
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190FA5SOCIAL ENTREPRENEURSHIP

1 0 0 1

INTRODUCTION TO SOCIAL ENTREPRENEURSHIP: Social Entrepreneur - Meaning, qualities and skills. Social Entrepreneurship – Characteristics, process and ecosystem – Case Studies. (3)

SOURCES OF FUNDING FOR SOCIAL ENTREPRENEURSHIP: The Social Entrepreneurship Frame work. Start-ups and funding - Internal and External. Schemes for social entrepreneurship. (4)

STRATEGIES IN SOCIAL ENTREPRENEURSHIP:Industry and Market Analysis, Business planning, concepts of value creation,new ideas and risk taking. (4)

PROSPECTS AND PROBLEMSIN SOCIAL ENTREPRENEURSHIP: Opportunities for Social entrepreneurs, an overview of legal structure, tax structure and other liabilities. (4)

TOTAL: 15

REFERENCE BOOKS:

- 1.S.S.Khanka, "Creativity and Innovation in Entrepreneurship", Sultan Chand & Sons, 2021.
- 2.C. Paramasivan, "Social Entrepreneurship", New Century Publications, 2016.
- 3.Robert A. Philips Margret Bonefiel Ritesh Sharma, "Social entrepreneurship, the next big business opportunity", Global Vision Publishing House, 2011.
- 4.Drucker, Peter, "Innovation and Entrepreneurship", Harper Business, 2006.