

BE METALLURGICAL ENGINEERING
SEMESTER - VII
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 - VIII

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.
3. George Krauss , "Steels: Processing, Structure and Performance", ASM International, USA, 2005.
4. 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:

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

REFERENCES:

1. George Roberts, George Krauss, Richard Kennedy, "Tool Steels", ASM International, USA, 1998.
2. Davis J R , "ASM Specialty Handbook-Tool Materials", ASM International, USA, 1995.
3. 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, Carl 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, ASME B&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: Volume1 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. Rudzki , "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. Infrared 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 — Redlitch-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", Pergamon 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.

19OFA2 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.

19OFA3 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.

19OFA4 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.
4. Bhalla V K , "Investment Management", TATA McGraw Hill Publishing, 2011