**DEPARTMENT OF METALLURGY & MATERIALS ENGINEERING**

**INDIAN INSTITUTE OF ENGINEERING SCIENCE & TECHNOLOGY, SHIBPUR**

**HOWRAH-711 103**

**COURSE STRUCTURE (W.E.F. JULY 2017)**

**B. Tech. course structure with syllabus and suggested reading (In module form)**

**(7th and 8th Semesters)**

**7th Semester:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Course code | Class Load/Week | | | Credit | Class load/  week |
| L | T | P |
| 1. | Joining of Materials | MT701 | 2 | 1 | 0 | 3 | 3 |
| 2. | Degradation of Materials & Their Prevention | MT702 | 2 | 1 | 0 | 3 | 3 |
| 3. | Composites and Ceramic Materials | MT703 | 2 | 1 | 0 | 3 | 3 |
| 4. | Accounts & Financial Mgmt | HU 7------ | 2 | 0 | 0 | 2 | 2 |
| 5. | EL II (OE):- | MT731/1 | 2/2 | 1/1 | 0 | 3/3 | 3/3 |
|  | Theory Sub-total |  | 10/10 | 4/4 | NIL | 14/14 | 14/14 |
|  |  |  |  |  |  |  |  |
| 6. | Joining of Materials Lab | MT751 | 0 | 0 | 3 | 2 | 3 |
| 7. | Degradation of Materials & Their Prevention Lab | MT752 | 0 | 0 | 3 | 2 | 3 |
| 8. | Composites and Ceramic Materials Lab | MT753 | 0 | 0 | 3 | 2 | 3 |
| 9. | Project & Thesis I | MT754 | 0 | 0 | 2 | 1 | 2 |
|  | Sessional Sub-total : |  | NIL | NIL | 11 | 7 | 11 |
|  | 7th Semester Total |  |  |  |  | 21/21 | 25/25 |

EL II (OE):

(i) Selection of Engineering Materials MT731/1 (OE) - to be offered for other departments ( All ).

**MT 701: Joining of Materials 2-1-0 [F.M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Basic Welding Processes, their principles and applications - Gas Welding, Arc Welding, Thermit Welding, Resistance Welding, Spot Welding, Pressure Welding etc. | 06 |
| 2. | Advanced Material Joining Techniques - TIG, MIG, Submerged Arc Welding, Electro-slag Welding, Plasma Arc. Welding, Electron Beam Welding, Laser Beam Welding, Ultrasonic Welding, Explosive Welding, Atomic Hydrogen Welding, Under Water Welding, Diffusion Bonding, Friction Stir Welding etc.  Principles of Brazing, Soldering and joining of dissimilar materials. | 10 |
| 3. | Selection of Joining Process; Classification of Electrodes & Weld Joints, Welding Codes, Weld ability of different Materials and their Metallurgical and Mechanical aspects. | 08 |
| 4. | Physics of Welding - Welding Arc and their types, structure, mechanism, stability and characteristics, Mechanism of Arc blow, its effect and remedies. Types of metal transfer and forces affecting it. | 10 |
| 5. | Defects: Residual stresses and distortion in welded joints and their remedies. Design, Inspection & Testing of weld joints, Economics of joining processes. | 06 |
|  | Total | 40 |

**MT702: Degradation of Materials & Their Prevention 2-1-0 [F.M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Introduction: Technical and economic aspect of the study of corrosion; review of the electrochemical principles of corrosion cell; exchange current density; electrode potential and standard cells, EMF series and galvanic series— their applications; Polarization: types, factors involved, effect on corrosion rate; application of Faraday’s law in corrosion. | 10 |
| 2. | Mixed Potential theory; Tafel equation, construction and interpretation of Polarization diagrams, different forms of corrosion-uniform attack, galvanic, crevice, pitting, intergranular, selective leaching, erosion corrosion and stress corrosion cracking, Hydrogen effect, corrosion fatigue and liquid metal embrittlement-their characteristic features, causes and remedial measures; corrosion testing methods and interpretation of results. | 16 |
| 3. | Oxidation — Oxide films, Pilling-Bedworth ratio, and their effects on kinetics, oxide defect structures, rate laws, types of oxidation, materials for use at elevated temperatures. | 6 |
| 4. | Principles of corrosion prevention-material selection and design aspects; control of environment including inhibitors, cathodic and anodic protection, coatings and other surface protection techniques of metals and alloys. | 6 |
| 5. | Degradation by wear of materials; its characteristics, wear testing, Wear-resistant materials. | 4 |
|  | Total | 42 |

**MT 703: Composites and Ceramic Materials 2-1-0 [F.M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Composite Materials: Classification of composite materials. Dispersion strengthened, particle reinforced and fiber reinforced composites, Mechanics and strengthening mechanisms in composite materials. Properties of composites: Elastic Properties, Strength and toughness. | 6 |
| 2. | Design of composites; In-situ and ex-situ composites; Interfaces between reinforcements and matrices in composites; Bonding Mechanisms, Bond Strength, Interfacial Toughness. | 6 |
| 3. | Polymer Matrix Composites: Polymer Matrices, Processing Techniques, Glass Reinforced Plastics, Carbon Fiber Composites; Metal matrix Composites; Metal Matrices, Processing Techniques, Interfacial Controls, Discontinuously Reinforced Composites, Fiber Composites; Ceramic Matrix Composites: Ceramic Matrices, Processing Techniques, Alumina Matrix Composites, Glass Matrix Composites, Nanocomposites and its usefulness. | 8 |
| 4. | Ceramic Materials: Introduction to ceramics as engineering materials, Common crystal structures in ceramics; Silicates, clay, minerals, graphite and carbides, structure of glasses. Imperfections in ceramics, Classification of ceramics and their applications; Ceramic raw materials and their characterization, Raw material preparation and processing of ceramics, Casting processes like drain casting, tape casting etc. Properties of ceramic powder particle-size, shape and surface properties. Flocculation and rheology. | 8 |
| 5. | Phase diagrams and phase transformation in ceramic material. Forming Processes: Extrusion, Pressing, Injection Moulding. | 4 |
| 6. | Mechanical behavior of structural ceramics-brittleness and its improvement, Different toughness measuring techniques. Significance of Fracture toughness, elastic modulus and strength of structural ceramics.  Electrical, magnetic and optical properties of important ceramic systems. | 6 |
| 7. | Functional ceramics diverse application in cutting tool, mobile phone microwave devices polycrystalline diamond and solid oxides for fuel cells, Introduction to electro active ceramics and bio-ceramics. | 6 |
|  | Total | 44 |

**MT731/1: Selection of Engineering Materials (OE II) 2-1-0[F.M.:100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Relationship between processing— structure-properties of various engineering materials, Materials selection criteria-shape, micro structural factors, performance criteria in service and other strategic requirements of engineering components to be designed. Economic considerations. | 14 |
| 2. | Technologically important material properties-physical, mechanical, chemical, thermal optical and electrical properties, Materials used in important engineering sectors. | 12 |
| 3. | Types of design, materials data and design tools, Methodology for selection of materials for the components, selection of processes to meet the design requirements, Systematic selection process-pertinent case studies, Multiple constraints; its handling strategies. | 14 |
|  | Total | 40 |

**MT 751: Joining of Materials Lab 0-0-3 [F. M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Contact hours |
| 1. | Visit to the lab and acquaintance with the equipment | 3 |
| 2. | Soldering & brazing with on hand practice | 6 |
| 3. | Gas cutting and welding | 6 |
| 4. | Resistance spot welding | 3 |
| 5. | Manual Metal Arc Welding (MMAW) with on hand practice and spatter loss calculation | 6 |
| 6. | TIG and MIG welding with on hand practice | 9 |
| 7. | Submerged Arc Welding | 3 |
| 8. | Plasma arc cutting for stainless steel and non-ferrous metals and alloys | 3 |
| 9. | Repeat process | 3 |
| 10. | Laboratory Viva-voce | 3 |
|  | Total | 45 hours |

**MT 752: Degradation of Materials & Their Prevention Lab 0-0-3 [F. M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of contact hours |
| 1. | Visit to the lab and acquaintance with the equipment | 3 |
| 2. | Immersion test in various solutions with analysis | 12 |
| 3. | Potentiodynamic polarisation studies in various electrolytes with analysis | 9 |
| 4. | [Electrochemical Impedance Spectroscopy](https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0ahUKEwiox6vc9uTSAhUFN48KHT1pDZQQFggrMAI&url=https%3A%2F%2Fwww.hindawi.com%2Fjournals%2Fijms%2F2014%2F124065%2F&usg=AFQjCNE2siuW4cQXbEVDHxS_BuOJfkYqjQ&bvm=bv.149760088,d.c2I) with analysis | 6 |
| 5. | Examination, analysis and interpretation of corroded surfaces and products | 6 |
| 6. | Repeat process | 3 |
| 7. | Laboratory Viva-voce | 3 |
|  | Total | 42 hours |

**MT 753: Composites and Ceramic Materials Lab 0-0-3[F. M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of contact hours |
| 1. | Visit to the lab and acquaintance with the equipment | 3 |
| 2. | Preparation of metal matrix composite | 3 |
| 3. | Metallographic and mechanical properties study of different composite materials | 18 |
| 4. | Metallographic and mechanical properties study of different ceramic materials | 12 |
| 5. | Repeat process | 3 |
| 6. | Laboratory Viva-voce | 3 |
|  | Total | 40 |

**MT754: Project Thesis I 0-0-2 [F.M.:50]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of contact hours |
| 1. | Selection of topic, literature review, work plan, report submission and its presentation by each student, question-answer session by the fellow students and faculty members. | 26-30 hours |
|  | Total | 26-30 hours |

**8th Semester:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Course code | Class Load/Week | | | Credit | Class load/  week |
| L | T | P |
| 1. | Materials Processing | MT801 | 3 | 1 | 0 | 4 | 4 |
| 2. | Materials Characterisation | MT802 | 2 | 1 | 0 | 3 | 3 |
| 3. | Design and Selection of Materials | MT803 | 2 | 1 | 0 | 3 | 3 |
|  |  |  |  |  |  |  |  |
| 4. | Elective II (DE):- | MT821/1  MT821/2 | 3 | 0 | 0 | 3 | 3 |
| 5. | Elective III (DE):- | MT822/1  MT822/2 | 2 | 1 | 0 | 3 | 3 |
|  | Theory Sub-total |  | 12 | 4 | 0 | 16 | 16 |
|  |  |  |  |  |  |  |  |
| 6. | Materials Processing Lab | MT851 | 0 | 0 | 3 | 2 | 3 |
| 7. | Materials Characterisation Lab | MT852 | 0 | 0 | 3 | 2 | 3 |
| 8. | Project Thesis II | MT853 | 0 | 0 | 4 | 2 | 4 |
| 9. | Project Thesis II Viva-voce | MT854 | 0 | 0 | 0 | 1 | 0 |
| 10. | Comprehensive Viva-Voce II | MT871 | 0 | 0 | 0 | 2 | 0 |
|  | Sessional Sub-total |  | NIL | NIL | 10 | 9 | 10 |
|  | 8th Semester Total |  |  |  |  | 25 | 26 |

1) Elective II (DE):-

(i) Nano-structured and functionally graded materials ( MT821/1 )

(ii) Principles of Thin Films and Coatings ( MT821/2 )

2) Elective III (DE):-

i) Fracture Mechanics and Failure Analysis ( MT822/1 )

ii) Transportation Phenomena in Metallurgical Industries ( MT822/2 )

**MT 801: Materials Processing 3-1-0[F.M.:100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Fundamental of metal working: Classification of forming processes, mechanics of metal working, temperature in metal working - hot working vs. cold working, strain rate effects, sliding and sticking friction, lubrication, residual stress. | 8 |
| 2. | Forging: general aspects, closed-die and open-die forging, different types of forging equipment; forging in plane strain, forging loads, forging defects. | 6 |
| 3. | Rolling: terminology of rolled products, different types of rolling mills; deformation zone, neutral point, angle of bite, draft in rolling; forward slip and backward slip, derivation of rolling load, friction hill, roll flattening, rolling variables; problem and defects in rolled products. | 10 |
| 4. | Extrusion: direct and indirect extrusion, hydrostatic extrusion, extrusion equipment, derivation of extrusion pressure, deformation, lubrication and defects in extrusion. | 6 |
| 5. | Drawing: process and equipments, hydrodynamic lubrication, maximum possible reduction in a pass under ideal condition, draw stress with friction and back tension; common defects, production of tubes including seamless tubes by extrusion and rolling. | 6 |
| 6 | Sheet metal forming: different forming methods, forming limit criteria, defects in formed parts; Automation and recent advances in metal working technology. | 6 |
|  | Total | 42 |

**MT802: Materials Characterisation 2-1-0 [F.M.:100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Fundamentals of crystallography, reciprocal lattice and structure analysis in materials. Determination of grain size and lattice strain from X-ray diffraction patterns. | 6 |
| 2. | Fundamentals of electron microscopy - possible interactions between specimen and the incident electron beam. Construction and application of transmission and scanning electron microscopes in materials characterization. Electron probe micro analyzer; Principles and application of Auger electron spectroscopy, Scanning tunneling microscopy; Atomic force microscopy. | 16 |
| 3. | Thermal analyses as tools for materials characterization. Dilatometry, resistivity and magnetic measurements in materials characterization. | 8 |
| 4. | Advances in characterization techniques. | 10 |
|  | Total | 40 |

**MT 803: Design and Selection of Materials 2-1-0 [F. M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Relationship between processing-structure-properties of various engineering materials, Materials selection criteria-shape, micro structural factors, performance criteria in service and other strategic requirements of engineering components to be designed. Economic considerations. | 14 |
| 2. | Technologically important material properties: physical, mechanical, chemical, thermal optical and electrical properties, Materials used in important engineering sectors. | 12 |
| 3. | Types of design, materials data and design tools, Methodology for selection of materials for the components, selection of processes to meet the design requirements, Systematic selection process-pertinent case studies, Multiple constraints; its handling strategies. | 14 |
|  | Total | 40 |

**MT 821/1 (DE II): Nano-structured and functionally graded materials 3-0-0 [F. M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Introduction to Nanoscience and Nanotechnology. Underlying physical principles of nanotechnology: Nanostructured Materials, Fundamental physicochemical principles underlying the size dependence of the properties of nanostructured matter. | 10 |
| 2. | Quantum confinement, single electron charging, Synthesis of nanostructured materials. Top down and bottom up approaches to building nanostructured materials. Properties of nanomaterials. Overview of self-assembly. | 12 |
| 3. | The basic tools of nanotechnology, scanning probe microscopy and near-field optics; electron and ion-based microscopy and manipulation. | 8 |
| 4. | Introduction to functionally graded materials, classification of functionally graded materials, properties and preparation techniques. Areas of application. | 10 |
|  | Total | 40 |

**MT 821/2 (DE II): Principles of Thin Films and Coatings 3-0-0 [F.M.:100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Introduction to thin films, Environment and molecular and plasma processes in thin film deposition; Cold and thermal plasma; Requirement for substrate: Substrate cleaning; Formation of thin films Sticking coefficient, Formation of thermodynamically stable cluster – nucleation and Growth process; Properties of thin films: Microstructure. Single crystalline films. Polycrystalline films. | 10 |
| 2. | Nanocrystalline thin film. Amorphous films, Metastable films, Surface morphology, Film density, Stress in thin films, Adhesion. Stoichiometry. | 8 |
| 3. | Mechanical, electrical, thermal, chemical, and optical properties of thin films. | 4 |
| 4. | Thermal evaporation Resistance evaporation. Electron beam evaporation. Molecular beam epitaxy; Laser ablation. Synthesis of nanomaterials (nanowires, nanoribbons); Electrical discharges used in thin film deposition Mechanism of electrical discharges. I-V characteristic of electrical discharges. Townsend discharge. Glow discharge Arc. | 10 |
| 5. | Practical electric discharge configuration for deposition of thin films, Direct current electric discharges. Radio-frequency discharges, Microwave discharges, Electron cyclotron resonance plasma, Matching units, Floating potential, Bias potential, Plasma potential, Effective bias, Self-bias. | 8 |
|  | Total | 40 |

**MT 822/1 (DE III): Fracture Mechanics and Failure Analysis 2-1-0[F.M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Introduction; Continuum Mechanics: stress, strain; Linear Elasticity; beam theory, constitutive laws; | 4 |
| 2. | Linear Elastic Fracture Mechanics: K1 singularity, plasticity considerations, KIC, CTOD, resistance curves, plane-stress analyses; | 6 |
| 3. | Interfacial Fracture Mechanics: theory, crack-path considerations; sub critical crack growth; Plasticity; yield criteria, deformation and flow theories, constitutive laws, Prandtl-Reuss equations, limit analysis. | 8 |
| 4. | Nonlinear Elastic Fracture Mechanics: HRR singularity, JIC, JR (Δa) resistance curves, TR, CTOA, non-stationary crack-growth analysis. | 8 |
| 5. | Environmentally-Assisted Fracture; stress corrosion, hydrogen embrittlement, corrosion fatigue, Cyclic Fatigue Failure: mechanistic aspects, crack propagation, damage-tolerant analysis, variable amplitude loading small cracks, crack closure, stress-strain/ life analysis. | 10 |
| 6. | Physical Basis of Toughness: intrinsic toughening - metals, extrinsic toughening - ceramics, composites, Fracture statistics. | 6 |
|  | Total | 42 |

**MT 822/2 (DE III): Transportation Phenomena in Metallurgical Industries 2-1-0[F.M.:100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of Lectures |
| 1. | Review of the basic concepts in heat, mass and momentum transfer. | 6 |
| 2. | Empirical treatment of reaction rates, activated state. | 6 |
| 3. | Various expressions for reaction velocity and rate equations, rate controlling mechanisms: Reduced time plots. | 9 |
| 4. | Phenomena in heterogeneous kinetics of transformation of single particles and particulate beds by fluids. | 12 |
| 5. | Some kinetic models. Selected examples from metallurgical engineering. | 9 |
|  | Total | 42 |

**MT851: Materials Processing Lab 0-0-3[F.M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of contact hours |
| 1. | Visit to the lab and acquaintance with the equipment | 3 |
| 2. | Characterisation of powder using optical microscope (OM) | 6 |
| 3. | Green compaction of powder using hydraulic press | 3 |
| 4. | Measurement of green density | 3 |
| 5. | Sintering of green compacted powder sample | 6 |
| 6. | Hardness measurement and microstructural study of sintered samples | 6 |
| 7. | Hot forging and cold and hot rolling practices | 6 |
| 8. | Repeat process | 3 |
| 9. | Laboratory Viva-voce | 3 |
|  | Total | 39 hours |

**MT852: Materials Characterisation Lab 0-0-3[F.M.: 100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of contact hours |
| 1. | Visit to the lab and acquaintance with the equipment | 3 |
| 2. | Determination of grain size using Scherrer formula in X-ray diffraction | 6 |
| 3. | Measurement of lattice strain using single line profile (SLP) analysis | 6 |
| 4. | Study of surface topography and determination of chemical composition of precipitate particles using SEM and EDS facilities. | 6 |
| 5. | Study of thin foil and powder sample using TEM | 6 |
| 6. | Study of phase transformation using DSC | 6 |
| 7. | Repeat process | 3 |
| 8. | Laboratory Viva-voce | 3 |
|  | Total | 39 hours |

**MT853: Project Thesis II 0-0-4 [F.M.:100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of contact hours |
| 1. | Literature review on selected topic, work done, report submission and its presentation by each student, question-answer session by the fellow students and faculty members. | 52-60 hours |
|  | Total | 52-60 hours |

**MT854: Project & Thesis II Viva-Voce 0-0-0[F.M.:50]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of contact hours |
| 1. | Viva-voce examination pertaining to project work done | 0 |
|  | Total | 0 |

**MT871: Comprehensive Viva-Voce II 0-0-0[F.M.:100]**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module Name and Topics | No. of contact hours |
| 1. | Viva-voce examination pertaining to theory subjects of 7th and 8th semesters | 0 |
|  | Total | 0 |