MATERIAL SCIENCE AND METALLURGICAL ENGINEERING DEPARTMENT

B.Tech.

in

MATERIAL SCIENCE AND METALLURGICAL ENGINEERING

Course of Study & Scheme of Examination

(Revised Syllabus w.e.f. 2011-12 session)

Maulana Azad National Institute of Technology, Bhopal

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SEMESTER

3	4	5	6	7	8
Theory					
Maths - III	Electronic and Magnetic Properties of Materials (Phy-3)	Iron Making	Powder Metallurgy	Surface Engineering	Industrial Management (H-4)
Thermodynamics	Chemical Characterization of Materials (CH-3)	Numerical Methods & Computer Applications (MTH-4)	Metal Forming Processes	Casting and Welding	Manufacturing process: Selection and their Design
Introduction to Manufacturing Processes	Metallurgical Kinetics	Non Ferrous Extraction	Heat Treatment	Elective-I	Elective-III
Basic Material Science	Material Testing	Phase Equilibrium in Materials	Steel Making	Elective-II	Elective-IV
Mechanical Behavior of Materials	Fuel, Furnace and Refractory	Characterization of Materials	Humanities (H-3)	Open Elective	-
Humanities (H-2)	Polymeric Materials	Ceramics Materials	Manufacturing Process- I Lab	-	-
Material Science Lab.	Material Testing Lab	Process Metallurgy Lab.	Heat Treatment Lab	Manufacturing Process- II Iab	Major Project
Manufacturing Processes Lab.	Physical Met. Lab	Characterization of Material Lab	Minor Project	Surface Engineering Lab	-
-	-	Ceramics and polymers Lab.	---	Major Project & seminar	-
-	General Proficiency	-	General Proficiency	-	General Proficiency

COURSE OF STUDY AND SCHEME OF EXAMINATION (proposed w.e.f. July 2008)

B. Tech. (MATERIALS AND METALLURGICAL ENGINEERING)

III-SEMESTER

Course No.	Subject	Scheme of studies periods per week			No. & duration of Theory papers		Credits			Total Credits
		L	T	P	No.	Hrs.	L	T	P	
MTH-208	Numerical Analysis	3	1	-	1	3	3	1	-	4
ME-208	Thermodynamics	3	1	-	1	3	3	1	-	4
ME-209	Introduction to Manufacturing Processes	3	1	-	1	3	3	1	-	4
MSME - 201	Basic Material Science	3	1	-	1	3	3	1	-	4
MSME - 202	Mechanical Behavior of Materials	3	1	-	1	3	3	1	-	4
H-208	Humanities (H-2)	3	1	-	1	3	3	1	-	4
MSME - 241	Material Science Lab.	-	-	4	-	-	-	-	4	4
ME-248	Manufacturing Processes Lab.	-	-	4	-	-	-	-	4	4
	Total	**18**	**06**	**08**			**18**	**06**	**08**	**32**

IV-SEMESTER

Course No.	Subject	Scheme of studies periods per week			No. & duration of Theory papers		Credits			Total Credits
		L	T	P	No.	Hrs.	L	T	P	
PHY-258	Electronic and Magnetic Properties of Materials (Phy-3)	3	1	-	1	3	3	1	-	4
CH-258	Chemical Characterization of Materials (CH-3)	3	1	-	1	3	3	1	-	4
MSME -251	Metallurgical Kinetics	3	1	-	1	3	3	1	-	4
MSME - 252	Material Testing	3	1	-	1	3	3	1	-	4
MSME - 253	Fuel Furnace and Refractory	3	1	-	1	3	3	1	-	4
MSME - 254	Polymeric Materials	3	1	-	1	3	3	1	-	4
MSME - 291	Material Testing Lab	-	-	4	-	-	-	-	4	4
MSME - 292	Physical Metallurgy Lab	-	-	4	-	-	-	-	4	4
MSME - 299	General Proficiency	-	-	-	-	-	-	-	4	4
	Total	**18**	**06**	**08**			**18**	**06**	**10**	**36**

V-SEMESTER

Course No.	Subject	Scheme of studies periods per week			No. & duration of Theory papers		Credits			Total Credits
		L	T	P	No.	Hrs.	L	T	P	
MSME-301	Iron Making	3	1	-	1	3	3	1	-	4
MTH-308	Numerical Methods & Computer Applications (MTH-4)	3	1	-	1	3	3	1	-	4
MSME-302	Non Ferrous Extraction	3	1	-	1	3	3	1	-	4
MSME-303	Phase Equilibria in Materials	3	1	-	1	3	3	1	-	4
MSME-304	Characterization of Materials	3	-	-	1	3	3	-	-	3
MSME-305	Ceramics Materials	3	1	-	1	3	3	1	-	4
MSME-341	Process Metallurgy Lab.	-	-	3	-	-	-	-	3	3
MSME-342	Characterization of Materials Lab	-	-	3	-	-	-	-	3	3
MSME-343	Ceramics and polymers Lab.			3					3	3
Total		**18**	**05**	**09**			**18**	**05**	**09**	**32**

VI-SEMESTER

Course No.	Subject	Scheme of studies periods per week			No. & duration of Theory papers		Credits			Total Credits
		L	T	P	No.	Hrs.	L	T	P	
MSME-351	Powder Metallurgy	3	1	-	1	3	3	1	-	4
MSME-353	Metal Forming	3	1	-	1	3	3	1	-	4
MSME-354	Heat Treatment	3	1	-	1	3	3	1	-	4
MSME-355	Steel Making	3	1	-	1	3	3	1	-	4
H-358	Humanities (H-3)	3	1		1	3	-	1		3
MSME-391	Manufacturing Processes - I Lab.	-	-	3	-	-	-		3	3
MSME-392	Heat Treatment Lab	-	-	2	-	-	--	-	2	2
MSME-398	Minor Project		1	4	-	-	-	1	4	5
MSME-399	General Proficiency	-	-	-	-	-	-	-	4	4
Total		**15**	**07**	**09**	**-**	**-**	**15**	**07**	**13**	**38**

VII-SEMESTER

Course No.	Subject	Scheme of studies periods per week			No. & duration of Theory papers		Credits			Total Credits
		L	T	P	No.	Hrs.	L	T	P	
MSME-401	Surface Engineering	3	1	-	1	3	3	1	-	4
MSME-402	Casting and Welding	3	1	-	1	3	3	1	-	4
MSME -423	Open Elective	3	1	-	1	3	3	1	-	4
MSME-431-39	Elective-II	3	1	-	1	3	3	1	-	4
MSME-422-29	Elective-I	3	1	-	1	3	3	1	-	4
MSME-441	Manufacturing Processes - II Lab.	-	-	2	-	-	-	-	2	2
MSME-442	Surface Engineering LAB.	-	-	2	-	-	-	-	2	2
MSME-498	Major Project & Seminar	-	2	6	-	-	-	2	6	8
MSME-449	Education Tour and Training								2	2
Total		**15**	**07**	**10**			**15**	**07**	**12**	**34**

VIII-SEMESTER

Course No.	Subject	Scheme of studies periods per week			No. & duration of Theory papers		Credits			Total Credits
		L	T	P	No.	Hrs.	L	T	P	
H	Humanities (H-4)	3	1	-	1	3	3	1	-	3
MSME-451	Manufacturing process: Selection and their Design	3	1	-	1	3	3	1	-	3
MSME-461-469	Elective-III	3	1	-	1	3	3	1	-	3
MSME-471-479	Elective-IV	3	1	-	1	3	3	1	-	3
MSME-498	Major Project	-	2	12	-	-	-	2	12	14
MSME-499	General Proficiency	-	-		-	-	-	-	4	4
Total		**12**	**6**	**12**			**12**	**6**	**16**	**34**

COMPULSORY PROFESSIONAL COURSES

FOR

UNDER GRADUATE STUDENTS

Course syllabus of IInd Year
(Odd Semester)

MTH-203 NUMERICAL ANALYSIS

UNIT – I

Algorithm and its basic properties like effectiveness and efficiency. Examples of polynomial evaluation Searching Largest number in a set etc., Iterative and recursive loops in a flow chart, Types of errors, Sources of errors Problems in computation, safe Guards against errors.

UNIT – II

Simultaneous Equations: Partial and complete pivoting, Triangularization, Gauss elimination and Pivoting Gauss-Siedel and Gauss-Jacobi, iteration techniques. Inversion of Matrix by Crout's method and Cholesky's method.

UNIT -III

Solution of Equations: Newton Raphson method, False position method, Secant, Method, Bairstow's and Graffee's methods of complex roots, Numerical solution of nonlinear, simultaneons equations. Newtons and Kizner's method.

UNIT –IV

Interpolation: Newton forward and backward formulae, Central Differences Everett and Bessel Interpolation formulae, Lagrange's, Hermite and spline Interpolation. Numerical Differentiation and Integration: Weddle, Gauss-Legendre, methods of integration.

UNIT –V

Numerical solution of Differential, Equations: Modified Euler, Runge-Kutta methods, Predictor-Corrector methods- Milne Adams-Bashforth methods, Accuracy of Runge-Kutta and Milen's methods. Solution of Second order differential equations. Solution of Simultaneous differential equations

Books:

(i) Numerical Analysis by Hildebrand, Mcgraw Hill.
(ii) Numerical Analysis by Scarborough, Oxford.
(iii) Numerical Methods by E .Balaguruswamy, TMH
(iv) Numerical Methods for scientific and Engineering by M.K.Jain, New Age
(v) Numerical Algorithms by E.V. Krishnamurthy and S.K.Sen, East West Press.

M-208 THERMODYNAMICS

Heterogeneous and homogeneous systems, extensive and intensive properties, simple equilibrium; First Law of thermodynamics, constant volume and constant pressure processes; Spontaneous processes, entropy and quantification of irrversibility, properties of heat engines, thermodynamic temperature scale,

Second Law of thermodynamics, criterion for equilibrium, Entropy and disorder, most probable microstate, configurational entropy and thermal entropy; auxiliary functions, Maxwell's relations, Gibbs-Helmholtz equation;

Third Law of thermodynamics; variation of Gibbs energy with temperature and pressure, Clausius-Clapeyron equation; thermodynamic properties of mixtures of ideal and imperfect gases; reactions in gas mixtures; reactions of pure condensed phases with gas mixtures -standard Gibbs energy of reactions, Ellingham diagrams;

Raoulfs and Henry's Law, activity of a component, Gibbs-Duhem equation, non-ideal solutions, regular solutions, quasi-chemical model of solution, activity and alternative standard states; reaction equilibrium in condensed system,

Gibbs phase rule, binary systems involving compound formation, solubility of gases in metals, formation of oxide phases of variable composition; relation between chemical and electrical driving forces, Nernst equation, concentration and formation cells, Pourbaix diagrams; thermodynamics of Point Defects.

M-209 INTRODUCTION TO MANUFACTURING PROCESSES

UNIT – I

Lathe: Turning and related operations, geometry of a single point cutting tools, speed, feed and depth of cut, classification of lathes, lathe mechanisms, lathe centers, mandrels, chucks, collects, face plates, steady and follow rests, tool holders their study and use. Lathe Operations, lathe attachments, taper turning, thread cutting and their calculations, lathe specifications. Introduction to CNC lathes.

UNIT –II

Drilling: Geometry of twist drills, drill chucks, feeds in drilling, machine types and specifications, boring, reaming, spot facing, counter sinking and counter boring. Shaping: Shaping and planning processes, type of shapers and their mechanisms, types of planers and their mechanism, principal tools, specifications of shaper and planer. Introduction CNC Drilling. Single & Multi-spindle

UNIT –III

Foundry: Molding sand testing, molding methods and machines, casting processes, gray Cast Iron, white cast iron and malleable Cast Iron. Iron castings. Melting furnaces : Cupola and electric furnaces, oil fired, air furnaces, cupola design and operation, design of casting, casting solidification, casting defects & remedies, gates, runners & risers.

UNIT –IV

Welding: Resistance welding, weldability of metals, submerged, electroslag, inert gas (TIG, MIG and CO2) carbon arc welding, cold welding, thermite welding, friction welding, plasma arc welding, electron beam welding, laser beam welding, pre–heating, post heating and stress relieving, welding defects and remedies, brazing and soldering, welding symbols, welding consumables, classification, use and specifications.

UNIT – V

Cold working of metals: Press working equipment and operations, cutting action in a die, clearance, classifications, shearing, drawing, spinning, stretch forming, wire drawing, embossing, squeezing, swaging, coining and bending operations, calculation of press capacity. Quality assessment.

Books and References:

1. Workshop Technology I & II by Hazra Chowdhary
2. Workshop Technology I & II by Raghuwanshi

MSME-201 BASIC MATERIAL SCIENCE

Crystalline and amorphous materials, Bonding, Element of Crystallography, Crystal Structure of Metals, Crystallographic notation of atomic planes and directions, Imperfection in metal crystals, Allotropy in metals, Single crystal and polycrystalline aggregates.

Solidification of metals and alloys, Cooling curves, Concepts of nucleation and growth, Heat transfer associated in nucleation and growth, Homogeneous and Heterogeneous nucleation, Structure of metals ingots, Dendritic and other growth processes.

Construction of binary alloys, Formation of alloy phases, viz. Solid solution- substitutional and interstitial, Intermetallic compounds, Phase mixtures etc. Binary equilibrium diagrams of various system, system with partial solid solubilities involving eutectic and peritectic and other reactions. Binary equilibrium diagrams involving monotectic, eutectoid and peritectoid reactions, Lever and Phase rule and its applications, Solid state transformations, Ternary diagrams, Order disorders transformations.

Detailed study of Fe-C, Cu-Zn, Cu-Sn, Al- Si, Al-Cu, Al-Li, and other nonferrous alloys, Babbit metals and their equilibrium diagrams, discussion on structures, properties and uses of some industrially important alloys based on the above systems.

Selections and preparation of specimens for metallurgical examination, Macro and microscopic examinations, Etching reagents, Metallurgical Microscope, Properties of objectives viz. Numerical aperture, resolving power, depth of focus etc. Empty magnifications, Bright and dark field illumination,Principals and use of polarized microscope, Phase contrast microscope and high temperature microscope.

Books:

1. Callister's Material Science and Engineering: R. Balasubramaniam
2. Introduction to Physical Metallurgy: S. H. Avnor.
3. Physical Metallurgy (Vol. I & II): Dr. P. R. Khangaonkar.
4. Principals of Metallographic Practice: R. Kehl.
5. Engineering Metallurgy (Vol. I & II): R. A. Higgins.
6. The Science and Engineering of Materials: D. R. Askeland and P.P. Phule

MSME-202 MECHANICAL BEHAVIOUR OF MATERIALS

Stress tensor and stress transformation equations, Principal stresses; Strain tensor and strain transformation equations; Isotropic and anisotropic elasticity, elastic strain energy; Yield criteria and constitutive relationships;

Work hardening, plastic instability and its significance; Crystallographic aspects of plastic deformation; Dislocation theory - edge, screw and mixed dislocations, resistance to dislocation motion and elastic properties of dislocations, dislocation interactions, multiplication and dissociation; strengthening mechanisms;

Creep –characteristics of creep curve and steady-state creep, mechanisms and creep mechanism maps, creep under complex stress-states, prediction of long- time properties;

Fracture toughness and fatigue -Griffith's crack theory, energy release rate analysis, modes of loading, stress analysis of cracks, fracture toughness,

Low- and High-cycle fatigue, Fatigue crack initiation and propagation, structural aspects of fatigue, fatigue under complex stress-states, environmental assisted cracking and fatigue; some case studies related to design.

H-208 ENGINEERING ECONOMICS & BUSINESS ORGANIZATION

Unit I: Introduction to Economics

Introduction to economics, its Importance, Principals, Approaches, and use of study, Engineering and economics, Economic problems, economic good and wealth, Demand and supply, Competition, Monopoly, theory of firm, Money and its function, theory of money and choice, the bank and its functions, employment and income, Gross National Product, Net National Product Consumption, Savings and investment

Unit II: Features of Indian Economy-I

Broad features of Indian Economy, Natural resources and economic development, Infrastructure in the Indian Economy, Agriculture development, Green revolution, Population, Population theories, Unemployment, Poverty, and Balance Regional Development. Economic Growth and Economic Development, Indian Industries, Industrial Policy, Industrialization in India, role, plan and pattern of Industrialization, Public vs Private Sectors, Economic reforms in India, India's Five Year Plans.

Unit III: Features of Indian Economy-II

The indigenous and modern banking system in India, Reserve Bank of India, Monetary and Fiscal Policies, Financial Institutions and SEBI, Free trade and protection, India's Foreign Trade and WTO, Balance of Payments, Indian Currency System and Foreign exchange, Foreign Capital Investment, Foreign Aid, and FEMA.

Unit IV: Introduction to Business Organization-I

Concept, nature and scope of business, business and its environment, Profit maximization vs social responsibility of business, business ethics, business enterprise, entrepreneurship, Promoters, types and functions, stages in company formation, concept of business growth, rationale and types of growth strategies, joint venture-definition, scope, role and problems of small business, concepts and features of public enterprise, multinationals.

Unit V: Introduction to Business Organization-II

Time value for money, Simple and compound interest, annuity, Depreciation, definitions, characteristics, Life and Salvage value, Method of providing for depreciation, relationship between depreciation, repairs, renewals, Depletion cost, Replacement, amortization, and Present worth.

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Books:

Indian Economy	Dutt & Sundaram
Engineering Economics	Tarachand
A text book of economic theory	Stonner & Hague
Business Organization	M C Shukla

MSME-241 BASIC MATERIAL SCIENCE LAB

Temperature measurement : calibration of thermocouple, use of optical and radiation pyrometer, metallography, study of metallurgical microscope, specimen preparation for metallography, etching technique, image analyzer, quantitative metallography, phase dilagram by cooling curve, phase transformation study by dilatometer, diffusion studies of solidification structure.

Course syllabus of IInd Year
(Even Semester)

PHY-258 ELECTRONIC AND MAGNETIC PROPERTIES OF MATERIALS

DC conductivity of metals, Hall effect and magnetoresistance, AC conductivity of metals, thermal conductivity and specific heat of metals, Thermopower of metals;

Review of quantum mechanics and free electron theory, failures of free electron theory and introduction to the role of lattice; Review of reciprocal lattice, Brilouin zone, Free electron band diagrams, potential in a crystal, electron dynamics and concept of holes, conductivity in relation to band structure, band structures of metals and semiconductors; empirical estimates of conductivity in metals and alloys;

Semiconductors -band diagrams, direct and indirect band gap, applications of semiconductors; Degenerate and non- degenerate semiconductors, intrinsic and extrinsic semiconductors, determination of dopant levels and mobility measurements; Ionic conduction -review of defect equilibrium and diffusion mechanisms, theory of ionic conduction, conduction in glasses, effect of stoichiometric and extrinsic defects on conduction, applications in sensors and batteries;

Dielectric Materials -Dielectric constant and polarization, linear dielectric materials, capacitors and insulators, polarization mechanisms, non-linear dielectrics pyro-, piezo- and ferro-electric properties, hysterisis and ferroelectric domains and applications; Optical Materials -electron-hole recombination, solid-state LED's, lasers and IR detectors, band gap engineering;

Light interaction with materials -transparency, translucency and opacity, refraction and refractive index, reflection, absorption and transmission; Magnetic field, flux density, susceptibility and permeability; Orbital and spin, permanent magnetic moment of atoms, diamagnetism, paramagnetism and Pauliparamagnetism, ferro, anti-ferro and ferri magnetism, Fe, Co and Ni and alloy additions, ferrites, magnetic hysterisis, soft and hard magnet materials.

CH-258 CHEMICAL CHARACTERIZATION OF MATERIALS

Classification of various methods of analysis-Gravimetric, Volumetric, Gas Analysis, Calorimetric, Nephelometric electro – chemical methods; preparation of substances for analysis, error in quantitative analysis, Calculation of Gravimetric and Volumetric analysis results.

Principals of Gravimetric analysis, requirement for precipitates, choice and amount of percipient, salt effect of temperature, hydrogen ion concentration and complex formation on completeness of preparation; formation of amorphous and crystalline precipitates co-precipitation, washing of precipitates.

Principles of volumetric analysis, classification of methods, requirements of reactions, preparation of standard solutions

Neutralization method: principle, theory of indicators, titration curves for titration of strong acid with strong alkali, weak acid with strong alkali, weak bases with strong acids, buffer action, indicator errors in titration.

Oxidation- Reduction methods, oxidation potentials, direction of reactions, equilibrium constants, titration cures and indicators, rate of reaction and side reaction.

Principles of redix titration- Permangnometry, dichrometry, idometry, bromatometry, etc., standard solutions and indicators.

Precipitation and complex forming methods, principles, titration curves, methods of determining the equivalence point etc. EDTA titrations

Books:

1. Quantitative Analysis: V. Alexeyev
2. Qualitative Analysis: V. Alexeyev
3. Text book of Metallurgical Analysis: Jain & Agrawal
4. Standard methods of Chemical Analysis: W.V. Soot.
5. Text book of Quantitative inorganic Analysis: A.I.Vogel.

MSME-251 METALLURGICAL KINETICS

Thermodynamics vs. kinetics, homogeneous and heterogeneous reactions; Chemical Reaction Control-rate equation, reaction rate constant, reaction order, non-elementary reactions;

Solid State Diffusion - Fick's Law, mechanism of diffusion, uphill diffusion, Kirkendall effect, steady and transient diffusion;

External Mass Transfer -fluid flow and its relevance to mass transfer, general mass transport equation, concept of mass transfer coefficient, models of mass transfer -film theory and Higbie's penetration theory; Internal Mass Transfer- Ordinary and Knudsen diffusion, Mass transfer with reaction;

Adsorption – hysical adsorption vs. chemisorption, adsorption isotherms; Langmuir, BET, adsorption as the rate limiting step; gasification of C by CO2, dissolution of N2 in molten steel, porous solids, specific surface area and pore size distribution; Reactor Design -batch vs. continuous reactors, ideal stirred tank and plug flow reactors, mass balance in ideal reactors, residence time distribution; models of industrial reactors;

Electrochemical Kinetics - concept of polarization, activation over potential, Butler-Volmer and Tafel's equation, applications in electro-deposition and corrosion, concentration over-potential, limiting current; electro-winning and corrosion.

MSME-252 MATERIAL TESTING

Introduction: Type of engineering materials and their applications, testing of materials for evaluation, characterization and selection of various applications. Types of testing systems, significance of measurement of properties and test conditions, interpretation of test results.

Tensile Testing: Scope of tensile testing and significance of parameters measured in the test Necking during tension test, instability in tension, diffuse necking, stress distribution at the neck, ductility measurement in tensible testing – effect of gauge length,

Effect of strain rate and temperature on flow properties. Machine stiffness in tensile testing system, measuring instrument computerization.

Torsion Test: Mechanical properties in torsion. Torsional stresses for large plastic deformation, torsional failure, torsion Vs, tension test.

Hardness Test: Hardness testing system, elastic and plastic behavior during hardness testing. General consideration such as indenter size, shape, friction type of loading etc. in hardness testing. Concept of micro-hardness. Major hardness testing systems such as Rockewll, Brinell, Vickers. Special hardness tests suchas superficial, micro and shore.

Elements of brittle fracture elliptical crack and Griffith theory of Brittle fracture. Ductile to brittle transition. Notch effective in fracture.

Fatigue Tests: Stress cycles and SN curve statistical nature of fatigue. Effect of mean strain concentration, size and surface conditions on fatigue. Fatigue testing machines and equipments. Creep stress rupture tests. Creep curve and its analysis. Stress rupture test. Presentation of engineering creep data. Equipment test set up in creep testing.

Non- destructive Testing: Methods and classification. Elements and instruments in visual magnetic, radiographic, ultrasonic, electromagnetic, penetrant tests, their applications in quality control and inspection.

Books:

1. Mechanical Metallurgy by George E. Dieter: McGraw Hill Publication – London.
2. Practical Non – Destructive Testing by – Baldev Raj, T. Jayakumar & M. Thavasimuthu Narosa Publisher, New Delhi.
3. Annual book of A.S.T.M. Standards Vol. 3.01, ASTM Philadelphia

MSME-253 FUEL FURNACE AND REFRACTORY (IV Semester)

Unit: 1 Definition and classification of furnace, metallic and non metallic heating elements. Furnace construction materials; Manufacture and use of different types of refractories and insulator, critical insulation thickness, Criteria of section of refractory material, heat balance of a furnace and thermal efficiency, waste heat recovery systems and their designs, atmosphere in Furnace

Unit: 2 Conventional and newer source of energy, energy management problems in metallurgical industries, role of high temperature systems and materials; Deposits, manufacturing, properties and testing of solids, liquid and gaseous fuels;

Unit: 3 principle of fuel combustion and burner design; classification of refractories manufacturing and properties of common refractories such as silica fire clay, high alumina, dolomite, magnsite and chrome refractories

Unit: 4 Design of high temperature furnace, waste heat utilization, heat recuperatuors and regenerators, stack design, gas cleaning, heat balance diagrams; furnace dynamics and fluid and heat flow calculation; fuel fired furnaces, electric arc furnace, vacuum, electron beam, plasma, laser furnace

MSME-254 POLYMERIC MATERIALS

Electronic Structure of atoms, atomic bonding, bonding energy, atomic arrangements, crystalline and amorphous materials. General classification of materials, structure property- processing relationship, non metallic material.

Introduction to polymer- Classification for polymer- Polymerization- Polymer structure- Physical Characteristics of polymer- Mol.wt., Tg etc., Engg and specially polymers- Elastomer. Structure and properties of polymer- morphology, mechanical, thermal and Rheological behavior of polymers.

Chemical characterization of polymers- IR, NMR, GC etc. techniques- Analysis of result.

Polymer blend and composites- De-gradation and re-cycling of polymer, application of polymers.

Characteristics of some important thermoplastics and thermo-set system- processing of polymer- additives, molding, extrusion, forming etc.

Books:

1. Polymer Science- W. Billmerycr, Jr.
2. Structure & Properties of Polymeic materials- D.W. Clegg & A. A. Collyer (Instt. of Matls. Publn. Lenton)
3. Engineering Materials Vol. I/ II- Jones.
4. Science & Engineering Materials- D.R. Askeland.
5. Materials Science & Engineering- W. D. Callister.
6. POLYMER Science & Technology- J. Fried

Course syllabus of IIIrd Year
(Odd Semester)

MSME-301 IRON MAKING

History of iron making. Raw materials for iron making viz. Iron ores, metallurgical coal and coke, limestone, dolomite etc. Their characteristics, availability, etc. Beneficiation and up-gradation of raw materials.

Burden distribution, charging techniques and their influence on B. F. efficiency, burden preparation and agglomeration techniques, such as sintering, pelletisation. Mechanism of sinter and pellet formation and industrial practice. Use of prepared burdon on blast furnace efficiency.

Detail of B. F. layout and its accessories, constructional details of iron blast furnace, construction and working of B. F. stoves, B. F. product handling and processing systems, cleaning of the B. F. gas.

Physico- chemical- thermal principal of iron making in general and B. F. in particular. Quality of hot metal. External hot metal treatment.

Modern trends in B.F. practice. Comparison of Indian BFs with those from others countries, BF efficiency.

Alternate methods of iron production viz. charcoal blast furnace, small shaft furnace, electro thermal smelting. Sponge iron production-coal and gas based processes. Raw materials for sponge iron production, evaluation of sponge iron quality.

Books:

1. Modern Iron making- Dr. R. H. Tupkary.
2. Manufacture of Iron & Steel – R.W. Backforth- Vol.I
3. Physical Chemistry of Iron & Steel- R.G. Word
4. Principals of Blast furnace Ironmaking by A.K. Biswas

MTH - 308
MATHEMATICS-IV

UNIT – I

Laplace Transform: Laplace Transformation of Elementary Functions, Inverse Transform, Solution of Ordinary Differential Equations by using Laplace Transform Techniques.

UNIT – II

Boolean Algebra: Basic Postulates, Simplification of Boolean Function using these Postulates. Application in Switching Circuits

Fuzzy Sets Operations on Fuzzy sets I-V. Fuzzy Sets, Operation on I-V. Fuzzy Sets Discrete and Continuous cases. Membership Function, Fuzzy Relation, Operations on Fuzzy Relation.

UNIT – III

Calculus of Varition: Euler Lagrange's Equations, Approximate Solution of Boundary value Problems-Rayleigh-Ritz Method. Weighted Residual Method- Galerkin's method.

UNIT –IV

Introduction to Optimization by Linear Programming, Solution by Graphical and Simplex Method, Concept of Degeneracy and Duality, Artificial variable techniques-Big-M-Method Two phase method.

UNIT –V

Solution of a Transportation Problem by North-West Corner Method, Lowest Cost Entry Method, Vogel's Approximation Method (VAM) Non-Degenerate Basic Feasible Solution, Assignment Model, Mathematical Formulation of Assignment Problem. Hungarian Method for the Assignment Problem.

Books:

(i) Advanced Engineering Mathematics by Erwin Kreyszig, Wiley.
(ii) Advanced Engineering Mathematics by Peter V.O'Neil, Thomson Learning.
(iii) Higher Engineering Mathematics by John Bird, Elsevier.
(iv) Numerical Methods for scientific and Engineering by M.K.Jain, New Age
(v) Operation research by S.D.Sharma, Kedar Nath & Sons.

MSME-302 NON FERROUS EXTRACTION

- **Principles of Mineral Processing:** Introduction to minerals, ores and their resources, Ore preparation: Comminution: Crushing and grinding, sizing of comminuted particles, Concentration techniques: Gravity concentration, Magnetic and electrostatic separation, Froth floatation
- **Pyro-metallurgical Process:** Role of Ellingham diagrams in Extraction of metals, Calcination, Roasting, Predominance Area Diagrams, Reduction and matte smelting using blast furnace and electric arc furnace, Flash smelting, converting, principals of metallothermic reduction. Refining, distillation and vacuum refining.
- **Hydrometallurgical Process:** leaching methods such as insitu, heap and percolation leaching, pressure leaching and bacterial leaching, Mechanical and pneumatic vats. Solution purification methods such as chemical, ion exchange and solvent extraction, cementation, Extraction of.
- **Electrometallurgical Process:** Faraday's laws; Review of properties of aqueous electrolytes, ionic mobilities, transport number and conductivity in electrolytes, Debye-Huckle limiting law. Mean activity coefficient of ions in electrolytes. Electrode potential, polarization, gas and metal over voltage, E.M.F. of cells. Elementary idea of electro deposition, electro winning and electro refining.
- **Typical Extraction and Refining Processes:** Extraction of Aluminium: Bayer Process, Hall-Heroult Process, Extraction of Copper, Extraction of Titanium: Kroll's process, Extraction of Zinc, Gold and Nickel.

References:

1. H. S. Ray, R. Sridhar, K. P. Abraham- Extraction of Non-ferrous Metals, Affiliated East-West Press Pvt. Ltd., New Delhi-1985
2. A. Ghosh & H. S. Ray, Principals of Extractive Metallurgy, Wiley Eastern, 1991.
3. T. Rosenquist; Principals of Extractive Metallurgy, McGraw hill, 1974.
4. R. D. Pehike; Unit Processes of Extractive Metallurgy, American Elsevier, N.Y., 1968.

5. W. H. Dennis, Metallurgy of Non-Ferrous Metals, pitman, 1961.
6. N. Servykov at al; General Metallurgy, Mir Publishers, Moscow, 1960
7. J. Newton; Extractive Mtallurgy, John Wiley, 1959.

MSME-303 PHASE EQUILIBRIA IN MATERIALS

Phase rule, lever rule and Free energy of phase mixtures; Binary isomorphous systems -Equilibrium solidification, non-equilibrium, Cu-Ni alloys and Zone refining; Thermodynamic order of transformations; Theory of nucleation -Kinetics of homogeneous, transient and heterogeneous nucleation; Theory of Thermally Activated Growth: Interface controlled growth, Diffusion controlled growth, Interface instability and Widmanstatten growth,

Solidification -Nature and growth of solid-liquid interfaces, Rapid solidification, Glass transition, metallic glasses; Precipitation and Particle Coarsening; Binary Eutectic and Peritectic Systems - solidification of eutectic, hypo-eutectic, and hyper- eutectic alloys; solidification of peritectic, hypo-peritectic, and hyper-peritectic alloys; morphologies of eutectic systems, Binary Monotectic and Syntectic Systems; Stability of regular solution and miscibility gap, intrinsic stability of solution and spinodal;

Hume-Rothery rules and intermediate phases e.g., lave, sigma, electron compounds; Iron-carbon phase diagram and microstructures of plain carbon steel and cast iron: non-equilibrium structures;

Ternary phase diagrams -Gibbs triangle, isothermal and vertical sections, polythermal projections, two-phase equilibrium, concept of tie lines, rules for construction of tie lines, three phase equilibrium, concept of tie-triangle, four phase equilibria; Eutectoid growth, Discontinuous precipitation, Massive transformation; Transformation Kinetics -Johnson-Mehl equation, Avrami model, Transformation kinetics in diffusion-controlled transformations, Isothermal and continuous cooling transformation diagrams;

Kinetics of recrystallization, Theory of grain growth, Effect of second phase particles; Martensitic transformation - Nature of martensitic transformations, Bain distortion, Nucleation, and growth of martensite, Athermal, isothermal and burst transformations, Thermoeleastic martensitie; Spinodal Decomposition -Diffusion equation in spinodal region, Effect of gradient energy and elastic strain energy;

MSME-304 CHARACTERIZATION OF MATERIALS

UNIT-1

Characteristics of different materials group- Metal, Composites, polymers and ceramics, correlation of structure with properties, importance of characterization of materials.

UNIT-2

Techniques of materials characterization: Structural/ optical constants, electron microscopy - Transmission and scanning electron microscopy – electron optics principle, scope of applications – failure analysis, studies on defect and precipitates, LEED, spectroscopic ellipsometry, SEM techniques for characterization of semiconductors, EPMA.

UNIT-3

X-ray Diffraction Techniques: Principles & applications; Indexing of X-Ray diffraction patterns for cubic system, Texture, Resided stress Analysis, EDX. X-Ray Fluorescence Spectroscopy: Applications; EDXRF & WDXRF.

UNIT-4

Thermal characterization of Materials: TGA/DTA/DSC Measurement: Techniques, Applications, Dilatometric technique, Thermal conductivity measurements, Thermal expansion measurement.

UNIT-5

Elements of quantitative metallography: Image processing and analysis of the data provided by optical and electron microscopy, X-ray, etc. Characterization for materials selection and design case studies.

Practicals : Set of experiments based on the above syllabus.

Books:

1.Materials Characterization – ASM Metal Hand Book Vol. 11
2.Chemical Characterization - B. M. Rao
3.Metallographic Lab. Practices – G. L. Kehl
4.Thermal analysis – T. Hatakyama & FX Quinn
5.Introduction of Materials Science – Wolf & Rallis

Books:

1.Selection and use of engineering materials : F. Cranes & J. Charles
2.Engineering Materials : M. Ashby, Vol II & III
3.Mechanical Metallurgy : G Dieter

MSME-305 CERAMICS MATERIALS

Ceramic Materials – Crystalline structure, silicate structures and silica, glasses and other non crystalline ceramics, mechanical behaviour of ceramics, effect of temperature on mechanical behaviour.

Properties and applications of engineering ceramic materials, various phase diagrams in ceramic materials, imperfection in ceramic materials – Kroger Vink notation, Advance ceramic materials.

Processing of ceramic materials – glass forming processes (pressing, blowing, drawing and fiber forming), particulate forming process (powder pressing, hydro-plastic forming, slip casting and tape forming) Sol-gel process.

Classification of a refractory material into Acidic, basic, neutral, rarer refractories Requirements of a refractory. General processing of refractory bricks from natural raw materials. Properties of refractories such as True/ Apparent density, True/ Apparent porosity, cold crushing strength, pyrometric cone equivalent, refractoriness under load, reheat shrinkage, resistance to slag attack, spalling and thermal resistance, permeability ti air/ gas etc.

Drying, firing cycles of following refractory materials – Silica bricks, Magnesite bricks, Dolomite, Forsterite, Chromite bricks, Carbon/ graphite refractory, Insulating bricks, classification of fireclays and fireclay bricks.

High alumina bricks; metal case bricks low temperature and high temperature insulation bricks; refractory hard metal carbides/ borides/ nitrides/ sillicides etc. Refractory application in Iron/ Steel making furnaces, Cupola, Coke ovens, Calcinatin kilns, Rotary kilns for cement, Arc/ Induction furnaces.

Books:

1. Introduction to Ceramic Materials – W. D. Kingery.
2. Refectories & Ceramics – Norton.
3. Engineering Materials Vol I/ II – Jones.
4. Science & Engineering of Materials _ D. R. Askeland.
5. Material Science & Engineering – W. D. Callistor.
6. Refectories: Production & Properties – Chester.

PROCESS METALLURGY LABORATORY

Laboratory techniques of temperature and flow rate measurement and calibration: Experiments on Mineral Engineering, Metallurgical Thermodynamics and Kinetics, Fuels and Furnaces, Iron making, steelmaking, pyro-, hydro-, electro-metallurgy in extraction of non-ferrous metals and metallurgical analysis

CERAMICS AND POLYMERS LAB

Ceramics : thermal spelling resistance, tensile properties of ceramics, specific gravity of ceramics, coefficient of thermal conductivity, specific heat, porosity and bulk density, preparation of glazed tiles and their property determination, thermal conductivity measurement, polymers : molecular weight and identification using chromatography, melt flow index , viscosity using viscometer, glass transition temperature determination, molecular weight – viscometric/ end group analysis method, softening point determination , refractive index of liquid polymer, estimation of free phenol and formaldehyde in phenol formaldehyde resin.

Course syllabus of III[rd] year
(Even Semester)

MSME-351 POWDER METALLURGY

Production of metal and alloy powder, particle size & shape, microstructure, specific surface, density, flow rate, compatibility sinterability , alloying techniques pressure less shaping, two and three particle models, sintering diagram, special sintering procedures, sintering furnaces, bearing materials, friction materials, tool materials, ferrite, cermets, dispersion strengthened materials, computer applications in powder metallurgy, numerical problems in powder metallurgy, design aspects in powder metallurgy.

A. K. Sinha Powder Metallurgy, Dhanpat Rai and sons, New Delhi 1998.

C.G. Goetzel, Treatise on powder Metallurgy Vol. I, II, III 1950, Interscience publishers, Newyork.

M. Yu. Balshin and S.S. Kiparisov, General Principles of Powder Metallurgy, Mir Publishers, Moscow 1980.

V. S. Arunachalam and O.V. Roman, Powder Metallurgy, (Recent Advances), 1989, Oxford and IBH

MSME-353 METAL FORMING

Introduction to Metallurgical Processing, Steps involved in processing and their scope. Elastic and Plastic behaviour of Materials, Engineering Stress-strain curve. True stress strain and flow curve, important relations of flow curve. Concept of stress and strain in two dimensions, principal stresses, Mohr's circle, Yield Criteria.

Crystal cells and transnational symmetry, plastic deformation by slip and Twining, Edge and screw Dislocation of single crystals, Strain hardening mechanisms, Cross slip. Flow cure for FCC single crystals, Grain boundaries, sub grain boundaries, solute atom and second phase particle, effects on plastic deformation, annealing cycles, re-crystallization and variables of annealing cycles.

Fundamentals of Metal Working, Classification of processes, Metal working system. Mechanics of metal working, Deformation energy and slab analysis approach. Temperature Effects, Hot working, Strain rate effects. Effects of metallurgical structure. Friction and lubrication in working. Workability, Residual stresses, Experimental techniques in working. Computer aided working.

Rolling Processes, Definition, Classification products and processing sequences in hot and cold rolling mills. Rolling mill types layouts, Mill line equipments, accessories for flat and shape rolling. Analytical aspects of rolling. Rolling load torque and power calculations, variables of rolling. Rolling mill controls. Defects in rolled products causes and remedies. Metallurgical aspects related to heating, re-heating, deformation during rolling and post rolling practices.

Forging process, Main forging operation, Open and closed die forging. Forging equipments, hammers process, special forging equipments for isothermal ring rolling, near net shape. Analytical aspect of open die forging and design aspects of closed die forging, Forging defects. Forget shape classification and study of forged components for various industrial applications with respect to forging practices.

Extrusion processes, Direct and Indirect Extrusion tooling, Analysis of simple extrusion, variables of extrusion. Products and materials suitable for extrusion. Process like impact, hookers and other based on extrusion principle, tube drawing operations and their analysis. Wire rod drawing operations, Analysis of wore rod drawing. Drawing load and energy calculations. Elementary

concepts wire rod processing with new techniques of controlled cooling, Metallurgical aspacts. Sheet Metal Forging operation, Formability concepts. Drawing or stratching deep drawing, analysis of basic process, LDR, diffuse necking and formability limit diagram. Anisotropy and its effects, drivability tests.

Books:

1. Mechanical Metallurgy: Dieter.
2. Principal of industrial Metal Working : G.W. Rowe
3. Metal Forming Mechanics and Metallurgy: Hosford and Caddell.

Reference:

1. ASM Handbook Vol. 14
2. Hot Rolling and Steels : Roberts.

MSME-354 HEAT TREATMENT

Recapitulation of Fe-C equilibrium diagram, solidification of cast iron, factors governing the structure, correlation of structure and properties, graphite flake, size and type, inoculation, malleable and nodular cast iron.

Eutectoid transformation in steel, and its significance, Time- Temperature Transformation diagrams, characteristics of pearlite and bainite transformations, Continuous cooling transformations, Characteristics of martensite transformation, Cooling rate, Concept of Hardenability. Methods of determining Hardenability, effect of various parameters on hardenability, Correlation of hardenability data.

Technology of Heat Treatment, Annealing, Normalizing, Hardening, Quenching media and their evaluation, Sub-zero treatment. Tempering, changes in structure and properties of steels during tempering, Temper embitterment, Austempering, Martempering, Patenting.

Principals, Techniques and applications of surface hardening treatments, Carburizing, Nitriding, Cyaniding, Flame and Induction Hardening, Heat Treatment of surface hardened components.

Heat Treatment Atmospheres, Protective atmospheres, Defects due to heat treatment, causes and prevention, case studies, Quenching stresses and defects.

Non-ferrous alloys – study of structure and properties, heat- treatment and uses of industrially important alloys:, Aluminum base wrought and cast alloys, Aluminum and Beryllium bronzes, Die casting alloys –Zn base and Mg base

Books:

1. Engineering Physical Metallurgy & Heat Treatment by Prof. Y. Lakhtin
2. Physical Metallurgy for Engineers by D. S. Clark & W. R. Varney
3. Material Science & Metallurgy by Prof. V. D. Khodgire
4. Handbook of Heat Treatment of Steels by K. H. Prabhudeva
5. Heat Treatment- Principals & Techniques- TV Rajan, CP Sharma, A Sharma
6. Physical Metallurgy Principles , R.E. Reed Hill, Van Nostrand, East West Press, New York, New Delhi, 7. Introduction to Physical Metallurgy, S.H. Avner, McGraw Hill,
8. Physical Metallurgy for engineers, D.S Clark & W.R. varney, East West Press, New Delhi,
9. Heat treatment (Principles & Techniques), T.V Rajan and G.P. Sharma, Prentice Hall of India,

MSME-355 STEEL MAKING

History of steel making, raw materials for steel making. Physico-chemical principles of steel making reactions.

Reaction kinetics, decarburization, dephorisation, deoxidation, desulphurization, alloying etc. efficiency of steel making processes.

Bessemer process, open hearth process, modified open hearth process, EOF process. design, construction and operation details. Advantages and limitations.

Oxygen steel making. Design, construction and operation of L.D., Q-BOP, hybrid process. Rotary vessels, modified oxygen steel malting, advantages and limitations.

Electric steel making and secondary steel making.

Pit side practice, ingote defects. Continuous casting principals. Plant design and operation. Steel quality in continuous casting, modern trends in continuous casting.

Books:

1. Modern Steel making – Dr. R.H. Tupkary.
2. Fundamentals of steel making by E.T. Tukdogan
3. Secondary processing and casting of liquid steels- A. Ghosh
4. Steelmaking – Kurdin.

H-358 HUMANITIES-3

UNIT-I: Fundamentals of Management – I:

Management: Evolution, development, characteristics, principles, philosophy, Nature and function, (MBO), (MBE) their importance characteristics and applications.

UNIT-II: Fundamentals of Management – II:

Organizational Behavior, Human behavior, group dynamics. Leadership theories, styles and modern philosophies, motivation approaches and theories, communication, barriers and breakdowns, management information system, use of Computer in Management.

UNIT-III: Introduction to Personnel Management:

Employees, Personnel Management practices, methods, recruitment, selection, interviews, group discussions, training, placement and employees development, wages and incentives, labour welfare, conflict, Negotiations, best practices.

UNIT-IV: Introduction to Marketing and Sales Management:

Marketing concept, principles, functions, market survey and research, concepts of sales and distribution, channels of distribution, salesmanship, sales promotions, methods of advertising, copy right, sales management practices.

UNIT-V: Introduction to Financial Management

Nature and scope of Financial Management, goals of financial management, Sources of finance, Permanent long term, Short term Sources, Interest rates, annuity cost of capital, capital structure, decisions, Break-even Analysis, Financial Planning.

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Reference Books:

1.	Management	Stonner & Freeman
2.	Principle of Marketing	Philip Kotler
3.	Industrial Management	K.K. Ahuja
4.	Financial Management	S.K. Banerjee

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MSME-391 MANUFACTURING PROCESS-I LAB

Powder Metallurgy: powder production, powder characterization, sieve analysis, optical microscopy, particle microstructure, flow rate, apparent density; powder compaction : determination of compressibility curve, porosity determination, specimen preparation for tensile test, sintering of green compacts, tests for sintered properties : shrinkage/ growth, sintered density porosity, tensile strength, hardness using Housefeild tensometer, microstructure; welding : welded specimens by shielded metal arc welding, oxy fuel gas welding, TIG welding and MIG welding, testing and examination of welded specimens Rockwell hardness, tensile strength (transverse and reduced section), yield strength (transverse and reduced section), nick break test, microstructures of weld zone, heat affected zone and parent metal, deposition efficiency in shielded metal arc welding, welder qualification tests

MSME-392 HEAT TREATMENT LAB

Microstructures of cast irons, plain carbon steels, alloys steels, brasses, bronzes. Babbits, aluminum-silicon alloys, aluminum copper alloys, photomicrography; heat treatments, full annealing, normalizing, hardening and tempering of plain carbon steels, jominy end quench test, pack carburizing , precipitation hardening, diffusion studies, recrystallization and grain growth, heat treatment of high speed steels and stainless steels, macro-micro structure study of forged, rolled, cast and welded structures.

Course syllabus of IVth Year
(Odd Semester)

MSME-401 SURFACE ENGINEERING

- Philosophy of surface engineering, general applications and requirements.
- Basic principles of electrochemistry and aqueous corrosion processes. Corrosion problems in the aerospace industry. General corrosion, pitting corrosion, crevice corrosion, influence of deposits and anaerobic conditions. Exfoliation corrosion. Corrosion control. High temperature oxidation and hot corrosion. Corrosion/mechanical property interactions. Friction and Wear: Abrasive, erosive and sliding wears. The interaction between wear and corrosion.
- Analytical Techniques: X-ray diffraction, TEM, SEM and EDX, WDX analysis, surface analysis by AES, XPS and SIMS, overview of other techniques. Data interpretation and approaches to materials analysis.
- Surface engineering as part of a manufacturing process. Integrating coating systems into the design process. Coating manufacturing processes. Electro deposition. Flame Spraying. Plasma spray. Physical vapour deposition. Chemical vapour deposition. HIP surface treatments. Paint and paint systems.
- Coating systems for corrosion and wear protection. Coating systems for gas turbines. New coating concepts including multi-layer structures, functionally gradient materials, inter-metallic barrier coatings and thermal barrier coatings.

MSME402 CASTING AND WELDING

Unit - 1

Introduction to casting: Casting as a process of Manufacturing. A brief idea about patterns.Moulding processes, Equipments and Mechanisation; Mould re-enforecement, Mould factors in metal flow, Moulding factors in casting design. Brief introduction to various types of binders for mould and core-making.

Liquid Metals: Properties of Liquid Metals**:** Thermal properties, Viscosity, Surface tension and Density and role of these properties in foundry. Melting Practices for Casting: A brief idea about the various melting units and their operations; Melting and post-melting treatments; industrial melting practices as adopted to a few Metals and Alloys, such as Cast Iron, Steel, Copper, Aluminium etc.

Unit - 2

Principles of Gating and Risering: Solidification of Casting, Types of gates and risers; chowrinov rule; Wlodawer system of determining feeder-head repairements; various measures for improving casting yield.

Unit - 3

Special Casting Methods: Investment Casting, Die Casting, CENTIFUGAL Casting, Full Mould Casting,; Vacuum Sealed Casting, etc.

Casting Defects and their Remedies: The various casting defects; their causes and remedial measures.

Unit - 4

Welding Processes Welding versus other joining/ process. Theory and classification of welding process. Manual metal arc, submerged arc, Gas teengsten arc (TIG), Gas metal arc, Plasma arc,

and flux-cored arc welding, electron beam, laser and electroslag welding, pressure welding, friction, diffusion and ultrasonic welding, resistance welding, brazing soldering and spraying.

Unit - 5

Welding metallurgy: Thermal cycle in welding, use of oron-carbon, TTT, and CCT diagrams, welding of mild an low alloy steels, carbon equivalent, cold cracking, the hydrogen problem, pheheating and last heating, welding of austenite stainless steel, cast irons and cast steels, welding metallurgy of AI, Cu and Ti alloys, Joining of dissimilar materials.

Weld defects. Testing of weld and weldabilety.

Elective-I MSME 421-424
Elective-II MSME 431-434
OPEN ELECTIVE (OUT OF THESE TWO)

Course syllabus of IVth Year
(Odd Semester)

H-408 HUMANITIES-IV
Syllabus to be in incorporated here

MSME-451 MANUFACTURING PROCESSES: SELECTION & DESIGN

Overview of manufacturing systems; role of traditional and near-net shape processes in manufacturing industry; Basic attributes of manufactured products -size and shape complexity,

machining requirement and machining losses, dimensional tolerances, surface condition, mechanical properties and manufacturing costs, expendable mold and permanent mold shape casting processes;

Open die and closed die forging processes and design considerations; Manufacturing processes for making products such as sheets, round/sectioned bars, seamless tubes/rings and wires;

Criteria for selection of metal and ceramic powder production processes for a given application; Powder processing equipments and their selection;
Joining processes, selection and design; Case studies with CAD/ CAM aspects.

Elective-III MSME 461-464
Elective-IV MSME 471-474

Dated: 21/07/2010

List and syllabi of elective courses offered in B.Tech MSME Program w.e.f 2010-11 session:

Elective-I MSME 421-424
Elective-II MSME 431-434
Elective-III MSME 461-464
Elective-IV MSME 471-474
Open Elective (OE) will consist of all the courses listed in Elective I & II.

Sl. No.	Course No.	Title of the course	Syllabus
1	MSME 421	Advances in Powder Metallurgy	Advances in metal powder production methods, Characterization of metal powders: Chemical composition and structure: Particle size and their shape and their determination: Powder flow, compressibility and porosity measurements: Treatment of metal powders: Behaviour of powder during compaction: Die compaction: Types of presses: Tooling and design: Modern methods of powder consolidation, Isotactic pressing: Roll compaction, Powder extrusion and forging, Slip casting, evaluation of sintered products.
2	MSME 422	Special Steels and Cast Iron	Mechanical Behaviour of steels: Iron-carbon phase equilibria: Structure and property relationship in steels: High strength low alloy structural steels: Medium high carbon ferrite-pearlite steels: Tool steels, stainless steels, surface hardening of steels, welding of steels. Mareging and TRIP steels, Cast Iron and ADI
3	MSME 423	Composite Materials	Classification of composite materials, Dispersion strengthened, particle-reinforced and fiber-reinforced composites, laminates, properties of matrix and reinforcement materials: Micromechanics and principle of strengthening, elastic properties, stress-strain relations, fracture be-haviour, Fabrication methods and structural applications of different types of composite materials.
4	MSME 424	Hydro Metallurgy	Thermodynamic and kinetic principles involving solid solution equilibria: Various unit operations in Hydrometallurgy, such as, pretreatment of raw materials, leaching, solvent extraction, ion exchange, gaseous reduction, cementation, precipitation, electro-winning, etc.: Technological aspect of typical hydrometallurgical plants.
5	MSME 431	Sintering and Sintered Products	Stages of sintering, driving forces for sintering, mechanism of sintering, liquid phase sintering,

			hot processing: Sintering furnaces and atmosphere: Iron, copper and aluminium base P/M alloys: Porous materials: Friction and Antifriction materials: Brushes, Heavy alloys, Cemented carbides: Cermets, Electrical contact materials.
6	MSME 432	Deformation Phenomena	Stress and strain tensors: Anisotropic and isotropic elastic stress-strain relations: Dynamic elasticity: Anelasticity, visco-elasticity: Phenomenological aspects of plastic deformation in crystalline materials: Creep and Fatigue: Types of Fracture: Griffith theory of brittle fracture and its modification: Ductile fracture: Notch effect in fracture: Fracture mechanics.
7	MSME 433	Nano Materials: Processing and Properties	Definition and Classification of Nanomaterials, Fundamental Properties of various primary material classes (Metals, ceramics and Polymers), Size dependent properties and various characterization techniques of Nanomaterials, Synthesis / Consolidation routes to produce Nanomaterials, Mechanochemical synthesis to produce nanosized precursor powders, Various routes to produce Nanometallic alloys (Rapid solidification), Challenges in processing bulk ceramic nanomaterials, Various densification routes for nanoceramics and nanoceramic composites, Processing- structure-properties of important bulk nanomaterials, Mechanical Properties, Thermal properties, Tribological Properties, Biological Properties (Biomedical applications), Applications of bulk nanomaterials, Critical issues related to understanding properties of nanomaterials.
8	MSME 434	Quantitative Microscopy	Mathematical treatment of prediction of microstructure: Estimation of size distribution of inclusions from measurements on a two dimensional section: Image analysis through computers.
9	MSME 461	Processing and Applications of Refractory Metals and Alloys	Characteristics of Pure Refractory Metals-crystal structure, Physical, chemical, mechanical and thermal properties of refractory metals; Alloys of Refractory Metals, Powder processing of refractory metals and alloys; Structure and Properties of Refractory Alloys- substitutional alloy, doped Wand Mo, dispersion-strengthening alloys, tungsten heavy alloys, composites reinforced with refractory metal-fibers, refractory-metal cermets, amorphous refractory alloys; Application of Refractory Metals & Alloys: general applications,

			requirements for special applications, porous metals, refractory alloy for electrical contacts, refractory metals for superconductors, requirements of use in themo-nuclear reactors, refractory alloys for thermal-management applications, refractory alloys for wear-resistant applications; case studies; Novel Processing Techniques
10	MSME 462	Modern Trends in Metal Forming Processes	Limitation of conventional metal forming methods: Powder rolling and its various variants, spray rolling, direct strip process: Powder, spray, rotary and isothermal forging: Hydrostatic and powder extrusion: Conform process: Applications of these processes for making conventional and speciality products.
11	MSME 463	Heat and Mass Transfer	Review of the basic concepts in heat, mass and momentum transfer: Advanced topics in convective heat and heat transfer: Radiative heat transmission: Simultaneous heat and mass transfer: Selected topics in metallurgical engineering, Reaction kinetics.
12	MSME 464	Non-Equilibrium Processing of Materials	Introduction to non-equilibrium processing Thermodynamics and kinetics of metastable phase formation; Rapid solidification: Undercooling. Phase diagram of metastable states, Methods of rapid solidification, Application for rapid solidification ; Mechanical alloying: Process of mechanical alloying, Mechanism of alloying Energy criteria for mechanical alloying, Synthesis of non-equilibrium phases, Application of mechanical alloying, Metallic glass : Understanding of glass formation, thermal stability and glass forming ability, structure of metallic glass, crystallization behavior, properties of metallic glass, application, Special non-equilibrium processing and phase transformations.
13	MSME 471	Sintered Tool Materials	Classification of cutting materials-tools steels, cemented carbides, ceramic tools and diamond tools: Production method of raw materials powder steel, tungsten carbide, cobalt, Al_2O_3, Si_3N_4 etc.: Consolidation of shaped products, sintering mechanism liquid phase sintering, cold and hot isostatic pressing: Reclamation of tool materials, Evaluation of sintered tool material.
14	MSME 472	Engineering Application of Dislocation in Materials	Introduction to dislocation, disclinations, dispirations: Isotropic and anisotropic stress fields and energies of dislocations: Stability of dislocation in crystal structure: Interaction between dislocations, impurities, microparticles and related topics in deformation and relation of

			properties to microstructure.
15	MSME 473	Theory of Alloys	Structure and physical properties of elements: Alloys formation: primary solid solution, intermetallic compounds, concept of atomic size factor, normal valance compounds, electron compounds in noble metals and transition metal systems, size compounds, borides, carbides and silicides of metals: Experimental methods for the study of alloying behaviour of metals
16	MSME 474	Failure Analysis	Type of failures, buckling, fracture in brittle and ductile materials, fractography, mixed mode, and fatigue failures environmental effects, wear, creep, and yielding phenomena, high strain rate failures, case histories of component failures.