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1 S. NO. COURSE NO. TITLE / SUBJECT ENGAGEMENT C R E D I T L T P TH. P TOTAL 1 MME-301  
Introduction to Metallurgy and Materials 3 1 - 4 - 4 2 CHM-03 CHM-03 P Metallurgical & Instrumental  
Analysis Laboratory Practice in Metallurgical & Instrumental Analysis 2 - 1 - - 2 3 - - 1 3 1 3. MTH-308  
Mathematics-III 3 1 - 4 - 4 4. CIV-307 CIV-308 P Geology and Mineralogy Laboratory Practice in Geology  
and Mineralogy 2 - 1 - - 2 3 - - 1 3 1 5. MEC-302 Mechanics of Solids 2 1 - 3 - 3 6. ELE-303 ELE-304P  
Electrical Technology Laboratory Practice in Electrical Technology 2 - 1 - - 2 3 - - 1 3 1 TOTAL 14 6 6 20 3  
23 SUBJECTS OFFERED BY THE DEPARTMENT OF METALLURGICAL AND MATERIALS ENGINEERING TO  
THE THIRD (3rd) SEMESTER STUDENTS OF SISTER DISCIPLINES 1. MME-302 Electrical Engineering  
Materials (For Electrical Engineering Department) 2 1 - 3 - 3 2. MME-303 Electronic Engineering  
Materials (For Electronics and Communication Department) 2 1 - 3 - 3 SEMESTER WISE COURSE  
STRUCTURE B. Tech. 3rd Semester L – Lecture T – Tutorial P – Practical TH – Theory METALLURGICAL  
AND MATERIALS ENGINEERING DEPARTMENT NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

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3 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials  
Engineering 1. Subject Code: MME-301 Course Title: Introduction to Metallurgy and Materials 2. Contact  
Hours: L: 3 ; T: 1 ; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I : M-II:  
ASM: ME: PRE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To familiarize the students with  
the fundamentals and other aspects of various metallurgical processes. 7. Details of the Course: S.No .  
Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. An introduction to Metallurgy and Classification of  
Metallurgical Processes. Classification of Engineering Materials based on Engineering properties. A  
general discussion on other engineering materials plastics, rubber, polymers, ceramics, refractories,  
glasses, composites etc. Introduction of Nano-technology; its importance and applications A brief  
discussion on important ferrous and non-ferrous materials and their production processes (flow sheets  
giving important parameters). General introduction to phase rule and phase diagrams (Binary systems).  
An overview of iron carbon equilibrium diagram and the critical phenomenon. Brief discussion on plastic  
deformation & Strain Hardening. Bonding in solids, crystal structure & imperfections. Plastic  
deformation in single crystals. Single crystals, polycrystalline materials and factors affecting their  
mechanical properties. Yield strength, tensile strength and rupture strength. Ductility and malleability,  
toughness and hardness of materials. 04 08 03 08 07 05 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 4 v

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4 8. Suggested Books: S.No. Name of Book Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. 8. 9.  
 Principles of Extractive Metallurgy Materials Science and Engineering Elements of Materials Science  
 Engineering Materials Science Structure and Properties of Materials Material Science Engineering  
 Materials II : An introduction to microstructures , processing & design Material Science Principles of  
 Material Science Engineering J. Newton V.Raghvan Van Valack Richards Wulff Series R. S. Khurmi & R. S.  
 Sedha Ashby, M.F.,& D.R.M. Jones Callister Smith J.Wiley PHI Addison Wesley Wadworth Pub. Co John  
 Wiley (New York) S. Chan Pergamum Press Willey McGraw Hill 1959 2008 1998 1961 1966 2005 2006  
 2008 1990

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5 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT : Metallurgical & Materials  
 Engineering 1. Subject Code: CHM-03 Course Title: Metallurgical and Instrumental Analysis 2. Contact  
 Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II:  
 ASM: ME: PRE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To acquire knowledge and become  
 familiar with the various metallurgical analysis techniques and the instruments involved therein. 7.  
 Details of the Course: S.No. Particulars Contact Hours 1 2. 3. 4. Principles of Volumetric, Gravimetric and  
 Fire assay methods. Electrogravimetry, potentiometry, polarography, colorimetry and conductometry.  
 Absorptimetry, Emission spectrophotometry, Atomic Absorption Spectrophotometry, flame  
 photometry, colorimetry and X-Ray fluorescence. Determination of gases in metal. Introduction to  
 Thermal Analysis (DTA, TMA, TGA, DSC, etc.) Chromatography, Radio-chemical analytical methods.  
 Applications of the above analytical methods to the assessment and evaluation of alloys, ores, slags,  
 ceramics, glass and refractories. 10 10 12 10 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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6 8. Suggested Books S.No. Name of the Book Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. 6. 7. 8.  
 Instrumental Methods of Analysis Standard Methods of Chemical Analysis, Vol: III A Instrumental  
 methods of Analysis Metallurgical Analysis Problems in Quantitative Analysis A brief introduction to  
 modern chemical Analysis Physico-chemical Analysis Williard H.H., Merritt L.L., and Dean J.A. Welcher  
 F.J. Ewing G.W. Jain and Agarwal, A. Masakin, D.G. Peters, J.H. Hayes and G.M. Hieftje YU Lyalikov  
 Wadsworth Van Nostrand McGraw- Hill Khanna Publishers, New Delhi Mir Saunders Mir 1981 1962 1985  
 1985 1984 1976 1974

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7 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT : Metallurgical & Materials  
 Engineering 1. Subject Code: CHM-03P Course Title: Laboratory Practice in Metallurgical and  
 Instrumental Analysis 2. Contact Hours: L: 0 ; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical:  
 4. Relative Weightage: MSLE: ESLE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To acquire  
 knowledge of equipment's and become familiar with the basic analytical methods. 7. List of  
 experiments: S.No. Experiments 1. 2. 3. 4. 5. 6. Determination of copper (II) as copper oxide Gravimetric  
 estimation of aluminium Determination of Iron (III) Determination of barium as barium sulphate.

Distribution coefficient of iodine between water & CCl<sub>4</sub> Determination of acid value of oil. De 0 0 0 2 2 5  
2 5 0 1 v

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9 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MTH-308 Course Title: Mathematics-III 2. Contact Hours: L: 3; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I M-II: ASM: ME: PRE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To understand and familiarize with the algebra of matrices and various aspects of statistics and probability. 7. Details of the Course: S. No. Particulars Contact Hours  
1 2. MATRICES: Definitions and algebra of matrices. Transverse of a matrix Symmetric, skew-symmetric, Hermitian, and Skew-Hermitian matrices inverse matrix, orthogonal and unitary matrices, Solution of simultaneous equations by matrix method. Triangular matrices, Rank of a matrix, equivalent matrices, elementary transformations, normal form, and Eigen vectors of a matrix, Caley-Hamilton theorem. Quadratic forms. STATISTICS AND PROBABILITY Measures of central tendency and Measures of variations (Dispersions), Moments, Measures of Skewness and kurtosis. Random experiment, sample space, events, classical, statistical and axiomatic definitions of probability. Statements and proof of theorems on addition and multiplication of probabilities. Simple problems. Bayes Theorem on conditional probability. Random variable, derivation of formula for mean, variance and moments of random variables for discrete and continuous cases. Laws of expectation, Binomial, Poisson and normal distributions, Beta and Gamma distribution. T-distribution, F- distribution, Chi-square distribution and their applications. Method of least squares, fitting a straight line and parabola of degree 'p'. Regression and correlation Multiple and partial correlation. 18 24 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 4 v

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10 8. Suggested Books: S. No. Name of the Book Author(s) Publisher Year of Publications 1. 2. 3.  
Fundamentals of Mathematical Statistics Statistical Theory and Methodology in Science & Engineering.  
Introduction to Mathematical Statistics, 3rdEd. S.C Gupta and V.K Kapoor Brownlee R.E. Walpole. Sultan  
Chan and Sons, N.Delhi John Wiley and Sons Prentice Hall 2000 1965 1987

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11 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: CIV-307 Course Title: Geology and Mineralogy 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To familiarize with the fundamentals and other aspects of rocks, minerals, crystals etc. 7. Details of the Course: S. No. Particulars Contact Hrs. 1. 2.  
Physical Geology: Introduction to Science of Geology. The crust of the earth and its composition.  
Minerals & rocks. The structure, hydrosphere, lithosphere and biosphere. Geological work of

atmosphere. Weathering. Erosion, transportation and deposition by wind, water and ice. Features developing due to crust and depositional processes. Introduction to geological structures. Mineralogy: Rock forming minerals and ore minerals. Processes of mineral formation. Physical properties of minerals. Study of minerals under microscope. Introduction to crystallography. Elements of crystal. The six crystal systems: Isometric, Tetragonal, Hexagonal, Orthorhombic and Monoclinic systems. Study of symmetry elements and common forms of the normal class of each of these systems. Introduction to ore mineral. Principle ore minerals of Aluminium, Copper, lead, zinc, antimony, nickel, tin, chromium, magnesium and iron. Their important properties, associations, impurities, mode of formation, mode of occurrence and distribution in India. Study of refractory minerals, coal and petroleum. Practicals to familiarize the students with minerals, study of crystal models and natural crystals, blow pipe analysis of a few common ores, and microscopic study of few important rock-forming and ore minerals. 12 30 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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12 8. Suggested Books: S. No. Name of Book/Author/Publisher Author(s) Publisher Year of Publications  
 1. 2. 3. 4. 5. 6. A Textbook Of Mineralogy with an extended Treatise on Crystallography & Physical Mineralogy Rutley's Elements Of Mineralogy Geology Of Industrial Rocks & Minerals Engineering & General Geology Prospecting for Minerals Physical Geology Dand & Ford H.H Read Bates Parbin Singh Y.D Kitaisky Skinner & Porter Asia Publishing House, Delhi Thomas Murray & Co., London Harper & Bros., New York S.K. Kataria & Sons, Delhi Foreign Languages Publishing House, Moscow John Wiley & Sons, New York 1966 1947 1960 2008 1976 1987

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13 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: CIV-308P Course Title: Laboratory Practice in Geology and Mineralogy 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 3rd Semester: Autumn Spring 6. Objectives: To familiarize with the identification and classification of different minerals, rocks and crystals. 7. List of Experiments: S. No. Experiments 1. 2. 3. 4. 5. 6. 7. The study of physical properties of minerals (form, lustre, fracture, cleavage, streak, hardness, specific gravity, colour etc). Determination of specific gravity by: a. Jolly's balance b. The beam balance c. The walkers steel yard balance. Study of rocks and their characteristics (Igneous - Granite & Basalt; Sedimentary- Sandstone and Limestone; and Metamorphic - Quartzite, Marble, slate, Gneiss and Schist). Study of some important minerals. Study and sketching of various types of structure faults (normal, reverse, dip, shake, non- plunging and plunging faults. Study of models of some crystal systems, class, form, elements of symmetry and general symbol etc. Determination of dip and strike with a clinometers compass. 0 0 0 2 0 1 v 2 5 2 5

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15 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT : Metallurgical & Materials Engineering 1. Subject Code: MEC-302 Course Title: Mechanics of Solids 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To familiarize with the fundamental principles of stress and strain, mechanical properties and to understand the response of members to flexural loads etc. 7. Details of the Course: S.No. Particulars Contact Hours 1. 2. 3. 4. Analysis of Stresses and Strains - Two dimensional state of stress and strain, Principle stresses/strains and principle planes/axes. The stress and strain circles. Measurement of techniques as applied to stresses, etc. Poisson's ratio, Hooke's Law, Surface and Volumetric strains, Elastic constants and their relationships. Mechanical Properties: Stress - Strain diagrams. Elastic and plastic behaviour under multi-axial stresses. Mechanical properties at high and low temperatures under static and cyclic stresses. Members in Bi-Axial State of Stresses: Stresses and strain in thin cylindrical and spherical shells subjected to internal pressures. Members subject to Flexural Loads: Theory of simple bending. Distribution of normal and shear stresses, principle stresses. Built-up and composite beams. Bending movements, slope and deflection. Various methods of deflection. Symmetrical and un-symmetrical bending. Fracture Mechanics. Columns: Short struts subjected to axial and multi-axial loads. Euler's theorem. Critical and Eccentric loading. 09 14 09 10 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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16 8. Suggested Books: S No. Name of Book Author(s) Publisher Year of Publications 1. 2. 3. Mechanics of Materials Mechanics of Materials Engineering Mechanics Timoshenko & Gere E.P.Popov Irwing and Shames Nelson Thornes Prentice - Hall Prentice Hall 2003 1959 2000

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17 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: ELE-303 Course Title: Electrical Technology 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To obtain sound knowledge in the basic concepts of electrical technology. 7. Details of the course: S. No. Particulars Contact Hours 1. 2. 3. Electric circuit laws and D.G. Circuits- super position principle. Thevenin's theorem. Maximum power transfer theorem. A.C. Circuits, Basic Definitions. Solution of R-L-G circuit, three phase balanced star and delta connection circuits. D.C generators and motors, and their characteristics, three phase alternators, synchronous and induction motors. 10 19 13 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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18 8. Suggested Books: S. No. Name of Book Author(s) Publisher Year of Publications 1. 2. 3. 4. Principles of Elect. Engineering Basic Elect. Engineering Electrical Machines Basic Circuit Analysis Vincent Deltoro Fitzgerald Nagraath/Kothari Schaum Series. Prentice-Hall McGraw- Hill McGraw- Hill McGraw- Hill 1972 1981 2006 1992

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19 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: ELE-304P Course Title: Laboratory Practice in Electrical Technology 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To provide practical knowledge about the working of various relevant laboratory equipments. 7. List of experiments: S. No. Experiments 1. 2. 3. 4. 5. 6. 7. 8. 9. Verification of KVL Verification of KCL Verification of Super position theorem. Verification of Thevenin's theorem Verification of Max. Power Transfer theorem Delta-star Transformation Obtaining resonance in RLC circuits Measurement of Power and Power factor for a 3  $\phi$  load Constructional details of a single phase transformer 0 0 0 2 0 1  $\sqrt{2}$  5 2 5

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21 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-302 Course Title: Electrical Engineering. Materials 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To familiarize with the basic principles related to the physics of materials relevant to electrical, magnetic and optical properties. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. Crystalline nature of solids. Transformation in alloys. Electrical conduction in metals and alloys. Applications of conductors. Some important resistor alloys. Di-electrical materials and their electrical properties. Semiconductors, their properties and applications. Magnetic properties of solids - types of magnetism, magnetic domain, soft magnetic materials - their characteristics, applications of iron- silicon, iron-nickel and iron-cobalt alloys. Hard magnetic materials, their properties and applications. Some important carbon steels and precipitation hardening type magnet alloys and their applications. Optical properties of materials. Super conducting theory and materials. 14 20 08 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3  $\sqrt{2}$

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22 8. Suggested Books: S. No. Name of Book Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. Introduction to solid state Physics Solid State Physics Physical Metallurgy Principles Theoretical Structural Metallurgy Electricity and Magnetism The Structure and Properties of Materials Vol.4 C. Kittel Dekker Reedhill Cottrell H.E. Duckworth Rose, Shepperd, Wulf. Wiley Prentice Hall Affiliated East West Press Pvt Ltd. Arnold Holt, Renihart, Winston John Wiley (New York) 1986 1965 2008 1962 1960 1966

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23 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-303 Course Title: Electronics Engineering Materials 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 3rd Semester: Autumn Spring 6. Objective: To familiarize with the basic principles

related to the physics of materials relevant to electrical, electronic, magnetic and optical properties. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. Crystal structure: crystalline state, Bravais lattices, Miller indices, reciprocal lattice. Common crystal structures. Interference phenomenon. Bragg's diffraction. Crystal imperfections. Free electron theory, conduction in Metal and alloys conductor, resistors. Growth of single crystal, zone refining technique. Semiconductors: their properties and applications. Magnetism: Magnetic Properties of materials, diamagnetism, paramagnetism, ferromagnetism, black wall, domain dimensions. Anti-ferromagnetism ferrimagnetism. Ferrites, Magnetic Materials: Fe, Si, Ni, Co. Hard magnetic materials. Dielectric materials, electric & optical properties, polarization in static and alternating field, piezoelectricity, polarizability and dielectric constant, optical transition in solids, absorption and emission of radiation, dielectrics, capacitors, inductors. Superconductivity and Superconductors. 06 06 03 03 10 14 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 2 0 0 3 v

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24 8. Suggested Books: S. No. Name of the Book Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. Introduction to solid state Physics Solid State Physics Physical Metallurgy Principles Theoretical Structural Metallurgy Electricity & Magnetism The Structure & Properties of Materials, Vol IV: Electronic Properties Material Science C. Kittel Dekker Reedhill Cottrell H.E. Duckworth Rose R M, Shephard L A, Wulff J Callister Wiley Prentice Hall Affiliated E-W Press Pvt Ltd. Arnold Hott, Renihart, Winston Wiley Eastern Ltd. Wiley 1986 1965 2008 1962 1960 1987 2008

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25 S. NO. COURSE NO. TITLE / SUBJECT ENGAGEMENT C R E D I T L T P TH. P TOTAL 1. MME-401 Thermodynamics of Materials 3 2 - 5 - 5 2. MME-402 Introduction to Manufacturing Processes 2 1 - 3 - 3 3. MTH-404 MTH-405 P Numerical Methods and Computer Programming Laboratory Practice in Numerical Methods and Computer Programming 2 - 2 - - 2 4 - - 1 4 1 4. MEC-412 MEC-413 P Heat Transfer and Fluid Flow Laboratory Practice in Heat Transfer and Fluid Flow 2 - 1 - - 2 3 - - 1 3 1 5. ECE-405 ECE-406 P Electronics & Metallurgical Industrial Instrumentation Laboratory Practice in Electronics & Metallurgical Industrial Instrumentation 2 - - - 2 2 - - 1 2 1 6. HSS-402 Industrial Economics and Management 2 2 - 4 - 4 TOTAL 13 8 6 21 3 24 B. Tech. 4th Semester SEMESTER WISE COURSE STRUCTURE L – Lecture T – Tutorial P – Practical TH – Theory METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

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27 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-401 Course Title: Thermodynamics of Materials 2. Contact Hours: L: 3; T: 2; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME:

PRE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To comprehend the laws of thermodynamics and their applications to metallurgical systems. 7. Details of the Course: S. No. Particulars Contact Hours  
 1. 2. 3. Introduction: Basic concepts, postulates, and basic problems of thermodynamics. Reversible and irreversible reactions. First law of thermodynamics: Enthalpy. Heat capacity. Thermo-chemistry. Hess's law. Flame temperature. Second law of Thermodynamics: Entropy and its change, Carnot cycle. Free energy and Gibb's Helmholtz equation. Third law. Fugacity, activity and equilibrium constant. Free energy calculations. Activity measurement. Ellingham diagram. Richardson diagram. Solutions: Introduction – Le Chatelier principle. Partial molal quantities. Gibb's Duham equation. Ideal, non-ideal and dilute solutions. Raoult's and Henry's laws. Alternative/standard states. Sieverts' law, mixing excess functions. Regular solutions. Classius-Clapeyron equation. Phase rule: liquid- vapour, solid-liquid, solid-vapour equilibria, Trouton's rule. The thermodynamics of electro-chemical reversible cells. Introduction to statistical thermodynamics. Thermodynamics of inter phases. 10 20 12 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 5 v

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28 8. Suggested Books: S. No. Name of the Book Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. Physical Chemistry of Metals Physical Chemistry of Iron and Steel making Introduction to Metallurgical Thermodynamics Problems in Metallurgical Thermodynamics & Kinetics Principles of Extractive Metallurgy Phy. Chemistry of Met. Processes Text Book of Materials and Metallurgical Thermodynamics Darken & Gurry C. Bodsworth David R Gaskell G.S Upadhyaye & R.K Dubey Rosenquist A.K. Biswas and G.R. Bashforth Ahindra Ghosh CBS English Longman's Books Society & Longman's Green & Company McGraw-Hill Pergamum Press McGraw-Hill Asia Publishing House, New Delhi PHI 2002 1972 1995 1985 1983 2005 2003

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29 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-402 Course Title: Introduction to Manufacturing Processes 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To provide the fundamentals of knowledge about various manufacturing processes. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. Historical perspective of manufacturing process, classification of Manufacturing processes, their advantages and disadvantages. Machining, casting, metal forming, powder metallurgy, Joining methods, important methods of each manufacturing process Plastic part manufacturing methods, injection moulding, blow moulding, compression moulding and transfer moulding. Thermoforming, rapid proto typing etc. 08 26 04 04 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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30 8. Suggested Books: S. No. Name of the Books/Publisher Author Publisher Year of Publications 1. 2. 3. 4. 5. 6. Forging & forming metals Theory of Metal forming & Metal Cutting Mechanical Metallurgy Manufacturing Processes for Engineering materials Manufacturing Processes Process & Materials Of Manufacturing S.E.Rusinoff S.K.Sinha S.C.Prasad G.E.Dieter Kalpakjian & Schmid B.H Amstead, Ostwald,



31 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MTH-404 Course Title: Numerical Methods and Computer programming 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To learn the principles of numerical solutions of equations and computer programming. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. NUMERICAL METHODS: Finite Differences: Difference table and its usage. The difference operators  $\Delta$ ,  $\nabla$  and the operator E. Interpolation: Interpolation with equal intervals. Newton's advancing difference formula. Newton's backward differences formula. Interpolation with unequal intervals. Newton's divided differences formula. Lagrange's interpolation formula. Spline functions. Central Differences: The central difference operator  $\delta$  and the averaging operator  $\mu$ , Relations between these operators. Gauss forward and backward interpolation formula, Sterling, Bessel's Laplace and Everett's formulae. Numerical Solution of Algebraic and Transcendental Equations. Graphic Method, Regula - Falsi Method, Balzano's Bisection Method, Newton - Raphson Method and its geometrical significance. Numerical Integration: Numerical integration. General Quadrature Formula, Trapezoidal rule. Simpson's one-third and three-eighth rules, Weddle's rule, Hardy's rule. Numerical solution of ordinary differential equations. Numerical solution of ordinary differential equations, Picard's method, Taylor's series methods, Euler's method, Runge-Kutta method. 02 05 06 06 06 04 0 3 0 0 2 0 2 0 1 0 5 0 0 0 3 v

32 7. COMPUTER PROGRAMMING: The application of Computer, Digital computer organization. Flow charts and decision tables. FORTRAN programming preliminaries. Fortran integer and real constants. Fortran variables and the names of variables. Fortran operations and expressions for addition, subtraction, multiplication, division and exponentiation. Mathematical functions. Arithmetic statements. Input-output statements. Format free statements. Simple computer programmes. Transfer of control: Control statements. The GoTo statements. The arithmetic IF statement. The logical IF statement. Relational operators. Elementary format specifications. Format description for PUNCH statement. The Do statement. Examples. C++ programming, simulation and modelling, Computing methods in Engineering problem solving in general and Metallurgical Engineering. Problem in particular, working principal of genetic algorithm, artificial neural networking, fuzzy logic techniques, soft computing technique like fuzzy regression, fuzzy neuron nets etc. 07 06 Total 42 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. Numerical Analysis for Scientists and Engineering Mathematical numerical analysis Numerical methods, software and analysis Numerical Methods in Science and Engineering. M.K Jain S.C. Scarborough. John R Rice S. Rajasekaran New Age International (P) Ltd. Oxford & IBH Publishing Co. McGraw-Hill S. Chan 1997 1966 1985 2003

33 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MTH-405P Course Title: Laboratory Practice in Numerical Methods and Computer programming 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To provide basic knowledge about the problem formulation and writing of computer programs to solve the same. 7. List of Experiments: S. No. Particulars 1. 2. 3. 4. 5. Given a set of N numbers A1, A2, A3..... AN, to write a program and arrange them in an ascending sequence. To draw a flow chart and to write a Computer Program to compute the Scalar Product of two vectors X and Y given by Scalar Product  $\sum_{i=1}^N X_i Y_i$  where the quantities  $X_i, Y_i$  ( $i=1, 2, \dots, 15$ ) are known. To write a Program and then compute the roots of the quadratic equation  $Ax^2 + Bx + C=0$  for different values of A, B and C. The formula for computing standard deviation ( ) of normal distribution is where  $x_i$  represents an individual number of group numbers,  $\bar{x}$ - the arithmetic mean of the group of numbers, and N the size of group of numbers. Draw a flow chart and compute the standard deviation of a given set of 500 numbers  $x_1, x_2, \dots, x_{500}$ . Program to find a real root of  $F(x) = 0$  by Newton Raphson Method. 0 1  $\sqrt{0}$  0 2 5 2 5 0 2

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34 6. 7. 8. 9. Program to evaluate the integral of  $F(x)$  between limits A and B using Simpson and Trapezoidal rule Program to solve an ordinary differential equation  $dy / dx = f(x,y)$  using Euler method. Program to compute the solution of  $dy / dx = f(x,y)$ ,  $y(x_0) = y_0$  using the classical Runge - Kutta Fourth order method. To write a program to compute and print the values of the safe loading S for  $R = 25(25)250$  where  $S = 17,000 - 0.485 R^2$  for  $R < 120$   $18,000/1 + R^2/18,000$  for  $R > 120$

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35 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT : Metallurgical & Materials Engineering 1. Subject Code: MEC-412 Course Title: Heat Transfer and Fluid Flow 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To understand the basic principles of heat transfer and fluid flow. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. Modes and Laws of heat transfer. CONDUCTION: Steady State and unsteady state. Heat flow through composite walls. Heating and cooling of plates, cylinders and spheres. CONVECTION: Free and forced convection. Reynolds, Crasshoofs, Nusselt and Station numbers. RADIATION: Emissivity, absorptivity, reflectivity and transmissivity. Simple Heat transfer between black and gray surfaces. Re-radiating surfaces. Heat losses from furnaces. Combined effects of conduction, convection and radiation. Steady and unsteady heat flow in some metallurgical processes, e.g melting, solidification, heating/cooling of ingots and billets, etc. FLUID FLOW: Viscosity and Newton's law of viscosity. Newtonian and non-Newtonian fluids. Conservation of mass and continuity equation. Energy of fluids. Euler's and Bernoulli's equations. Loss of energy due to friction. Flow through pipes. Laminar and Turbulent Flow, Reynold's number. Compressed air and air blasts. Energy used for compression. Compressor and blower efficiency characteristics. 10 16 16 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3  $\sqrt{}$

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36 8. Suggested Books: S. No. Name of the Book Author(s) Publisher Year of Publications 1. 2. 3. 4. 5.  
Engineering Heat Transfer A Text on Heat transfer Heat transfer Heat transfer Fluid Mechanics Gupta &  
Prakash S.P. Sukhatme Holman Domkundwar Khurmi Nem Chan & Bros. Universities Press (India) Pvt.  
Ltd McGraw- Hill Dhanpat Rai Publishing Company (P) Ltd. S. Chan & company 1976 2005 1976 2005  
1987

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37 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials  
Engineering 1. Subject Code: MEC-413P Course Title: Laboratory Practice in Heat Transfer and . Fluid  
Flow 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative  
Weightage: MSLE: ESLE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To familiarize with the  
conduct of basic experiments to evaluate the relevant properties. 7. List of Experiments: S. No.  
Experiments 1. 2. 3. 4. 5. 6. To find the thermal conductivity of a liquid by the guarded hot plate method.  
To determine the thermal conductivity of good conductor of heat (metal rod). Heat transfer through a  
composite wall. Heat transfer in forced convection. To determine Stefan - Boltzmann's constant of  
radiation heat transfer. Emissivity measurement apparatus. 0 0 0 2 2 5 2 5 0 1 v

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40 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials  
Engineering 1. Subject Code: ECE-405 Course Title: Electronics and Metallurgical Industrial  
Instrumentation 2. Contact Hours: L: 2; T: 0; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4.  
Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To  
gain knowledge about the basics of electronics, and to familiarize with the working principles of  
metallurgical industrial electronic instruments. 7. Details of the Course: S. No. Particulars Contact Hours  
1. 2. 3. 4. Construction, symbol and characteristics of semiconductors diodes, transistors and silicon-  
controlled rectifiers. Rectifiers and invertors. Motor control. Induction and dielectric heating. Electric arc  
furnaces and their accessories. Ultrasonic waves and their applications. Pulse, digital and switching  
circuits and systems. Transducers. Measurements of current, voltage, power and energy. Cathode-ray  
oscilloscope and its applications. Temperature control, gas flow and fluid flow controls, PID, load cells,  
and strain gauge etc. 13 15 10 04 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 2 v

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41 8. Suggested Books: S. No. Name of the Book Author(s) Publisher Year of Publications 1. 2. Pulse Digital and Switching Wave Form Integrated Electronics Millman & Taub. Millman & Halkais. Tata McGraw - Hill McGraw- Hill 2007 1972

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42 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: ECE-406P Course Title: Laboratory Practice in Electronics and Metallurgical Industrial Instrumentation 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To become familiar with the working of relevant electronic devices. 7. List of Experiments: S. No. Experiments 1. 2. 3. 4. 5. 6. 7. 8. Diode & Zener diode characteristics. Common emitter configuration D.C characteristics and amplifier. Emitter follower and common basic amplifier. To assemble a two stage cascaded amplifier and study its performance. Differential amplifier. Feedback amplifiers, current series and current shunt. RC phase shift oscillator. Basic logic gates. 0 0 0 2 2 5 2 5 0 1 v

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44 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: HSS-402 Course Title: Industrial Economics & Management 2. Contact Hours: L: 2; T: 2; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 4th Semester: Autumn Spring 6. Objective: To gain knowledge about the concepts involved in industrial economics and management. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. INDUSTRY: Introduction to industry, Industrialisation, Benefits of industrialisation. Economics and social effects of industrialisation. MANAGEMENT: Meaning of management, functions and principles of management, industrial change and development. MANAGEMENT OBJECTIVES: Defining management objectives, Testing of objectives, Primary, secondary and social objectives of management. PERSONNEL MANAGEMENT: Importance of personnel management. Main functions of personnel department. Selection, training and placement of manpower resources. ECONOMIC SCIENCE: Division of economics and development of economic life CONSUMPTION: Nature of human wants and their satisfaction - utility, law of diminishing marginal utility, Law of demand and supply, elasticity of demand. PRICE DETERMINATION: Concept of markets, - competent and monopoly markets - price and output determination under perfect competition and monopoly. PRODUCTION: Meaning of production, production function, laws of production. 08 07 09 06 07 05 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 4 v

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45 8. Suggested Books: S. No. Name of the Books/Publisher Author(s) Publisher Year of Publications 1. 2. 3. 4. Elementary Economic theory Indian Economics Introduction to Economics Principles of

Management K.K. Dewett and J.D. Verma M.K.K. Dewett & J.D.Verma M.L. Seth George Terry Premium Pub. Co. S. Chan L.N.Agarwal R.D.Irwin 1964 1971 1964 1977

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46 S. NO. COURSE NO. TITLE / SUBJECT ENGAGEMENT C R E D I T L T P TH. P TOTAL 1. MME-501 MME-501 P Thermodynamics and Kinetics of Metallurgical Processes Laboratory Practice in Thermodynamics and Kinetics of Metallurgical Processes 3 1 - 2 4 - - 1 4 1 2. MME-502 MME-502 P Minerals Processing Laboratory Practice in Minerals Processing 2 - 1 - - 2 3 - - 1 3 1 3. MME-503 MME-503 P Metallography Laboratory Practice in Metallography 2 - 1 - - 2 3 - 1 3 1 4. MME-504 MME-504 P Fuels, Furnaces and Refractories Laboratory Practice in Fuels, Furnaces and Refractories 3 - 1 - - 2 4 - - 1 4 1 5. MME-505 Electronic, Magnetic and Dielectric Materials 2 2 - 4 - 4 6. MME-506 Principles of Metal Extraction & Refining Processes 2 1 - 3 - 3 TOTAL 14 7 8 21 4 25 B. Tech. 5th Semester SEMESTER WISE COURSE STRUCTURE L – Lecture T – Tutorial P – Practical TH – Theory METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

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48 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-501 Course Title: Thermodynamics & Kinetics of Metallurgical Processes 2. Contact Hours: L: 3 ; T: 1 ; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 5th Semester: Autumn Spring 6. Objective: To provide an understanding of the thermodynamic principles and kinetics pertaining to the metallurgical processes/systems. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. Brief review of generalized systems, solutions and laws/ postulates. Statistical thermodynamics, thermodynamics of interfaces. Phase rule, liquid-vapour, solid-vapour, solid liquid and solid-solid equilibria, heterogeneous equilibria. Equilibrium and temperature- pressure diagrams, their applications to various metallurgical systems. Chemical kinetics and its related laws, theories of reaction rates, reaction mechanism, kinetics of important metallurgical processes. Concept of activated state and activated energy. Diffusion in solids, Fick's laws and Kirkendal effect. Diffusion in direct/indirect reduction and agglomeration processes. Kinetics of heterogeneous metallurgical operations: viz Gas-solid, slag metal, and other such systems. Kinetics of solid state transformations. Mass transfer in solid, liquid and gaseous systems. Total 02 10 08 22 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 4 V

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49 9. Suggested Books: S. No. Name of the Book Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. Physical Chemistry of Metals Thermodynamics of Materials Thermodynamics Chemical Kinetics. Thermodynamics for Chemists Theory of Rare process Thermodynamics of Solids Metallurgical Thermochemistry Introduction to Chemical Metallurgy Chemical Metallurgy . Darken and Gurry David V

Ragone Partington Laidler Glasstone Glasstone, Laidler and Eyring R.A. Swalin Kubaschewski R.A. Parker. J J Moore CBS John Wiley & Sons, Inc. London Constable Paperback EWP Elsevier Science B.V. John Wiley Sons Inc. Pergamum Pergamum press, NY Heinemann Ltd. 2002 1995 1987 2008 1988 1975 1966 1993 1978 1990

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50 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-501P Course Title: Laboratory Practice in Thermodynamics & Kinetics of Metallurgical Processes 2. Contact Hours: L:0 ; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE : 5. Credits: 5th Semester: Autumn Spring 6. Objective : To familiarize with the conduct of different experimental studies. 7. List of Experiments S. No. Experiments 1. 2. 3. 4. 5. 6. 7. Determination of Specific Heat by Bomb calorimeter (Adiabatic). Determination of Specific Calorimetry (Isothermal). Measurement of Partial Molar Volume. Study of Thermo - Analytical Techniques of Dissociation of Carbonates. To study the calcination of CaCO<sub>3</sub> and calculate the percentage decomposition by varying time and temperature. To study the effect of time and temperature on the kinetics of roasting of CuS. To study the cementation process for extraction of copper from CuSO<sub>4</sub> bath with iron. 2 5 0 0 0 2 2 5 0 1 v

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52 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-502 Course Title: Mineral Processing 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage M-I: M-II: ASM: ME: PRE: 5. Credits: 5th Semester: Autumn Spring 6. Objective: To familiarize with the processing of ores and to extract valuable minerals. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. Location of principal ore bodies and extracting plants. Indian Mineral resources and metallurgical industries. Estimated tonnage of metals produced /imported /exported by India. Purpose of Mineral Dressing, scope and limitation of available methods. Classification of ores. Comminution units like jaw crusher gyratory, cone crusher, Roll and impact crusher, attritor and other grinding units, their performance, applications and limiting reduction ratio. Sizing and classification. Methods of sizing, both Laboratory and Industrial. Various types of screens. Classification as a means of sizing. Laws of classification. Types of classification. Filtration and Thickening. Gravity concentration process. Jigging, bedding, types of jigs, shaking- tables, riffled, tables and tilting tables and vanners. Their performance and applications heavy media separation. Flotation: Its physico-chemical principles. Flotation reagents. Flotation machines flotation as used for concentration of copper, lead zinc and their complex ores. Miscellaneous methods of concentration, Electro- static and Magnetic methods of separation. Dewatering, filtering, amalgamation and thermal processes. Benefaction of coals and iron ores, washing methods, Case studies. 05 10 27 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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53 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. . 5. Powder Metallurgy and Particulate Materials Processes Mineral Processing Technology Principles of Mineral Processing Elements of ore dressing Unit operations German R.M Wills B.A. Gaudin P.M., A.F.Taggart Meab and Smith Metal powder industries federation Pergamon Press. Tata McGraw Hill. John Wiley McGraw Hill 2005 1992 1987 1951 1997

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54 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-502P Course Title: Laboratory Practice in Mineral Processing 2. Contact Hours: L:0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 5th Semester: Autumn Spring 6. Objective: To provide understanding of the basic construction, and principles of working different mineral processing equipments. 7. List of Experiments S.No. Experiments 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. To study the parts of a Jaw Crusher and to operate it using different ore materials and various gape settings, and determine the reduction ratios. To study the size reduction of an ore by a roll crusher using different roll settings. Use a laboratory ball mill to reduce a given crushed ore to a - 200  $\mu\text{m}$  size fraction using different milling times and changing the weight of the grinding medium. Make energy calculations. Compare the energy efficiency of attritor with ball mill. To perform Sieve Analysis on a given dry milled Ore for 1/2, 1 and 2 hrs and to calculate i) percentage loss in screening, ii) the average size of particles and iii) plot various sizing curves. To study the effect of any one of the following grinding variables on the performance of the ball mill or rod mill; i) Ball load or rod load ii) time of grinding. Conduct the Classification of a mill product using a) Spiral Classifier b) A Cyclone. Concentrate a given Sulphide Ore (Chalcopyrite, Sphalarite, Galena) by Froth Flotation and list the reagents used. Concentrate a given Ore using: a) Shaking Tables b) Magnetic Separator, and c) Jigs. Study of a) Hammer mill, and b) Impact mill. Study the working of a) Screens, and b) Grilles Study of a Thickener. Dewatering a given slurry by thickening. Determination of Fines carried by thickener overflow. Filtering a given slurry under normal gravity and using Vacuum Filtration. 0 3 0 0 2 5 2 5 0 1 v

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55 Heavy media separation of Coal

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56 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-503 Course Title: Metallography 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 5th Semester: Autumn Spring 6. Objective: To understand the basic principles of the techniques used for the study of metal samples. 7.Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. Macro and Micro examination of materials, principle of a Metallurgical microscope, microscopic objectives, chromatic and spherical abrasion, different types of objectives. Properties of objectives.

Magnifying power, Numerical aperture, resolving power, curvature of field and vertical resolution. Oil immersion objectives. Eyepieces- Negative, amplifying eyepieces, measuring and reticle type. Low reflection coating. Types of Microscopes. Illuminating source, light collimators, cooling cells, light filters, diaphragms. Vertical illuminators, bright field and dark field illumination, prism and plan glass reflector, calcite prism, oblique illumination, conical stop illumination, critical Köhler illumination method of focussing, principles and techniques of photomicrography. Microscopy and Photomicrography with ultraviolet light. Microscopy with polarized light, principle of polarized light microscopy, equipment and technique. Principles of phase contrast microscopy and its application. Interferometry principles and equipment details, Use and techniques of structure of metals. Maintenance and care of optical parts. Metallography: Examination of samples by low and high power microscopy. Preparation of metallic samples for microscopic and Microscopic examination. Etching of samples for metallographic examinations (Micro and Macro) Quantitative Microscopy:- Estimation of grain size, size distribution of inclusions from measurements on a two dimensional section, Image analysis through computers. 06 20 16 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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57 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. 8. The principles of Metallographic practice Practical Metallography Structural Metallurgy Modern Microscopy Modern Metallographic Techniques and their Applications Metallography: Principle and practice ASM Handbook, Volume 10, Materials Characterisation Elements of X-ray Diffraction Kehl Greeves and Wrighton Barrelet V.E. Cosslett Phillips V A Vander Voort Whan R E (Ed) Cullity B D McGraw Hill D.Van Nostrand Co. PHI/McGraw Hill McGraw Hill Wiley Eastern McGraw Hill ASM international Prentice Hall, Inc 1949 1957 1979 1966 1971 1984 1986 2001

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58 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-503P Course Title: Laboratory Practice in Metallography 2. Contact Hours: L:0 ; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 5th Semester: Autumn Spring 6. Objective: To familiarize with the preparation of metallographic specimens and to study macro and microstructures of different metal specimens. 7. List of Experiments S. No. Experiments 1. 2. 3. 4. 5. 6. Detailed study of a Metallurgical Microscope. Preparation of a standard specimen for microscopic examination. Electro-polishing of a given specimen. Microstructure studies of the following: \* Hypo- eutectoid, eutectoid and Hyper-eutectoid Steels. \* Various types of cast irons. \* Cu, Al, and their alloys. \* HSS, Tool Steel, Stainless Steel, etc. To determine the average grain size by linear interception method. Study of Twining in Pb-Sn alloys under a Metallurgical microscope. 0 0 0 2 2 5 2 5 0 1 v

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60 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-504 Course Title: Fuels ,Furnaces and Refractories 2. Contact Hours: L: 3; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 5th Semester: Autumn Spring 6. Objective: To familiarize with the various types of fuels, furnaces and refractories used in metallurgical engineering processes, and their importance. 7.Details of the Course: S.No. Particulars Contact Hours 1. 2. 3. REFRACTORIES: Their classifications, compositions, structures , properties and applications. Manufacture of Acid, Basic and Neutral Refractories. Special Refractories like Graphite, Zirconia, Thoria etc. Testing and Quality control of Refractories. FUELS: Their classifications and resources in India. Composition and Constitution of Coals. Metallurgical Coke and its properties and production. Gaseous and liquid fuels: Coal Gasification, Petroleum and its Refining, Coke Oven and Petroleum by-products. Combustion of fuels, Regenerators, Recuperators and their efficiencies. Newer sources of energy, testing of solids , liquids and gaseous fuels. FURNACES: Their classification. Elements of furnace construction. Batch type and continuous furnaces, fuel economy, heating and heat saving methods. Furnace design. Furnace temperatures and Furnace atmospheres and their control. 14 18 10 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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61 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. Coal Fuels . Refractories Re Refractories- production, properties and applications Iron and Steel Production Vol. III Industrial furnaces Metallurgical engineering principles Handbook of Refractories Elements of Fuels Furnaces and Refractories Refractories Production and Properties Francis Brame and King Norton F.H Chesti A.R. G.R. Bashforth Trinks W. Schuman D.N Nandi O.P.Gupta Chester Penguin ASTM, Philadelphia Tata McGraw Hill PHI B.I Publication & Chapman & Hall John Wiley and Sons Weinheim, Germany Tata McGraw Hill Khanna Publications IOM 1967 1967 1984 1986 2000 2004 2004 1987 1993 1973

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62 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-504P Course Title: Laboratory Practice in Fuels, Furnaces and Refractories 2. Contact Hours: L:0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 5th Semester: Autumn Spring 7. Objective: To analyse various fuels and to study different types of furnaces and refractories. 8.List of Experiments S. No. Experiments 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. Determination of the Calorific Value of coal and fuel oil. Flame Temperature Measurement of a fuel oil. To determine the flash point of a given oil. To study the effect of temperature on viscosity of oil. To determine the Shatter Index of a Metallurgical coal. To determine the Bulk density measurement of a refractory material. To carry out the Cone test of a Refractory brick. To study the construction of a simple muffle furnace. To determine the temperature profile of a furnace. To carry out the calibration of thermocouples (Pt-Rd, Chromel- Alumel). 0 0 0 2 2 5 2 5 0 1 v

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64 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-505 Course Title: Electronic, Magnetic and Dielectric Materials 2. Contact Hours: L: 2 ; T: 2; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 5th Semester: Autumn Spring 6. Objective: To familiarize with various electronic, magnetic and dielectric materials and to study their varied applications. 7. Details of the Course: S.No. Particulars Contact Hours 1. 2. 3. 4. Free electron theory and its limitations, Metallic conduction and factors affecting conductivity, semi conductor materials and techniques of processing semi conductors. Oxidation, diffusion, ion and electron beam, ion implantation, plasma technology etc. MOS, MNOS and SOS etc. technologies, Gas I.C. technologies etc. Doping , Hall effects, p-n junctions etc. Ionic and super-ionic conduction, single crystal growth. Magnetic materials; dia, para, ferro, ferri, antiferro, ceramic magnetic materials. Magnetism, theory of magnetism, Hard and soft Magnetic materials, their classification and applications, technology of their production, precipitation hardening magnetic alloys, permanent magnetic materials. Di-electric materials, Piezo, and ferro electric materials, doping and electric breakdowns, ferrites, transformer and switching materials, Optical materials, lasers etc. General discussion on the performance of materials in the development and growth of : - Electrical , electronics and telecommunication equipment/ system, - Energy sector, and - Bio-Medical 15 10 07 10 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 4 v

65 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. Introduction to Solid State Physics Physical Metallurgy Principles Materials Science & Engineering Theoretical Structural Metallurgy Structure and properties of materials, Vol. IV Semiconductors Kittel Reed Hill Raghvan, V Cottrell Wulf Series Smith, R.A Wiley Affiliated East West Press Pvt Ltd. PHI Arnold John Wiley Cambridge University Press 2004 2006 2008 1962 1966 1986

66 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-506 Course Title: Principles of Metal Extraction and Refining Processes 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 5th Semester: Autumn Spring 6. Objective : To familiarize with the fundamental principles of extraction and refining of metals from ores / concentrates. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. Principles of Metallurgical Processes as applied to ores and concentrates for the extraction of metals: Importance of physico- chemical processes in metal extraction and refining. Roasting processes: drying and calcination, oxidizing, sulphatizing, chlorination, fluorination and reducing roasting, Sintering and other agglomeration processes, Smelting processes: reducing, oxidizing electro-thermic, metallothermic and reaction smelting processes, Refining processes: liquefaction, fractional re-crystallization, distillation, oxidation, chlorination, Sulphidizing and carbon refining processes, Hydro-metallurgical processes: leaching, refining of leach solutions, recovery of metals; electrolytic and bacteria processes, Electro-

metallurgical processes: Principles, advances, processes and applications of electro- refining, electrolytic cleaning, electropolishing, electro-forming, electroleaching, electromachining, etc. Regeneration of electrolytes. Slags and their functions in extractive Metallurgy. Principles of working of the equipment used for roasting and agglomeration. Hearth roasters, flash roasters, fluidized bed roasters, sintering machines, etc. 05 05 06 06 05 08 07 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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67 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. 6. 7. 8. Theory of Metallurgical processes Non-Ferrous Extractive Metallurgy Hydrometallurgy Introduction to Chemical Metallurgy Principles of Extractive Metallurgy Extractive Metallurgy Extractive Metallurgy Unit Processes in Extractive Metallurgy A.Volsky and E.Surgiovskaya H.S.Ray Venkatachalam R.H. Parker Terkel Rosenqvist J.D.Ghilchrist J. Newton Pehlke R D Mir Publishers East-West press Narosa Publishing Pergamum press, NY McGraw Hill McGraw Hill Willey Willey Eastern American Elsevier Publishing Co. 1991 2008 1998 1978 1983 1989 1959 1993

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68 S. NO. COURSE NO. TITLE / SUBJECT ENGAGEMENT C R E D I T L T P TH. P TOTAL 1. MME-601 Non Ferrous Extractive Metallurgy 4 1 - 5 - 5 2. MME-602 Extractive Metallurgy of Iron and Production of Ferro- Alloys 3 1 - 4 - 4 3. MME-603 MME-603P Physical Metallurgy Laboratory Practice in Physical Metallurgy 3 - 1 - - 2 4 - - 1 4 1 4. MME-604 MME-604P Mechanical Behaviour of Materials Laboratory Practice in Mechanical Behaviour of Materials 2 - 1 - - 2 3 - - 1 3 1 5 MME-605 MME-605P Joining of Materials Laboratory Practice in Joining of Materials 2 - 1 - - 2 3 - - 1 3 1 6. MME-606 Material Characterization Techniques 2 1 - 3 - 3 7. MME-607 Tour, Training and Professional Interview TOTAL - 16 - 6 - 6 - 22 2 5 2 27 L – Lecture T – Tutorial P – Practical TH – Theory B. Tech. 6th Semester SEMESTER WISE COURSE STRUCTURE METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

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70 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-601 Course Title: Non-Ferrous Extractive Metallurgy 2. Contact Hours: L: 4; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To develop basic understanding of physico-chemical principles and processes involved in the extraction of various metals. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. Over view of the Physico-Chemical principles and processes of metal extraction. Production /extraction of heavy metals (Cu, Pb, Zn, Sn, Ni, Cr, Sb, Co). Light metals (Al, Mg, Ti) and precious metals (Au, Ag, Pt). Rare metals (W, Mo, Zr, U, Be) and semi

conductor metals (Ge, Si). Detailed flow sheets for the extraction/production of the above metals 06 25  
11 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 5 v

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71 8. Suggested Books: S. No. Name of the Books/Publisher Author(s) Publisher Year of Publications 1. 2.  
3. 4. Extraction of Non-Ferrous Metals Non-Ferrous Metallurgy Extractive Metallurgy Non Ferrous  
Production Metallurgy Ray & Abraham W.H.Dennis Newton J. J.L. Bray Affiliated E-W Press Sir Issac  
Pitman & Sons Ltd Wiley Eastern John Wiley & Sons 2008 1980 1959 1985

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72 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials  
Engineering 1. Subject Code: MME-602 Course Title: Extractive Metallurgy of Iron and Production of  
Ferro- Alloys 2. Contact Hours: L: 3; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative  
Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To provide  
knowledge about iron making from iron ore through blast furnace route and to understand the  
alternative methods of iron production. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3.  
Iron - Raw materials and their preparation. Blast furnace stoves and blast preheating. Blast furnace  
design, construction and instrumentation. . Thermal and material balance sheets. Burden calculations. B.  
F. slags and their behaviour slag-metal reactions. . Modifications, high top pressure, humidification.  
Oxygen-enriched blasts, solid, liquid and gaseous injection through hot blast, alternative methods of  
iron production. Sintering and palletizing. Introduction to ferro alloys , Production of ferro-alloys (Fe-  
Mn, Fe-Si, Fe-Mo, ). Alternative methods of iron production such as: DRI, COREX, ROTARY KILN, SHAFT  
AND STRATEGIC- UDY PROCESSES. 14 18 10 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 4 v

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73 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6.  
7. Production of Iron and Steel Vol.I Iron Making Iron Making Sponge Iron Production by Direct  
Reduction of Iron Oxide High Metal Production by Smelting Reduction of Iron Oxide Physical chemistry  
of Iron & Steel making Physical chemistry of Iron & Steel making G.R. Bashforth A.K. Biswas Tupkary R. H  
Amit Chatterjee Amit Chatterjee Ward R.G. Bodsworth C. Chapman & Hall SBA Publications Khanna  
Publishers, New Delhi PHI PHI ELBS ELBS/Edward Arnold Pub. 1965 2005 2008 2010 2010 1999 1988

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74 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials  
Engineering 1. Subject Code: MME-603 Course Title: Physical Metallurgy 2. Contact Hours: L: 3; T: 1; P: 0  
3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5.  
Credits: 6th Semester: Autumn Spring 6. Objective: To provide the knowledge of structure property  
correlation regarding different metals and alloys. 7. Details of the Course: S.No. Particulars Contact  
Hours 1. 2. Brief review of Structure of metals and imperfections and their influence on the properties of  
materials. Classification and their influence on the properties of materials. Solid solutions - their

characteristics and governing factors Classification - primary, secondary solid solutions and inter-metallic compounds. Solidification and nucleation, thermal curves, phase rule and equilibrium diagrams and Iron carbon equilibrium diagram and the critical phenomena. Binary and ternary systems. Eutectic, eutectoid, peritectic, peritectoid, monotectic, and precipitation reactions. Binary system: Cu-Ni, Cu-Zn, Cu-Be, Cu-Al, Al-Zn, Al-Si, Al-Mg, Pb-Sn etc. Isothermal transformation of Fe-C systems. Ternary alloys -white metal, Ni-Silver fusible alloys. Diffusion in solid state and its mechanism. Laws of diffusion. Kirkendal effect, Factors governing diffusion. Specifications of ferrous and non-ferrous alloys. 16 26 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 4 v

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75 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. 8. 9. Principles of Physical Metallurgy Engineering Physical Metallurgy Introduction to Physical Metallurgy Physical Chemistry Of Metals A Textbook on Physical Metallurgy Cast Iron Technology Physical Metallurgy- Principles And Practice Material Science And Engineering Physical Metallurgy Reed Hill Lakhtin Avner Darken & Gurry A K Mitra Tiwan V.Raghavan W D Callister Hansen Peter Affiliated E-W Press Pvt.Ltd. MIR Publishers Tata McGraw Hill CBS CBS CBS Prentice Hall Of India John Wiley And Sons Cambridge University Press 2008 1998 2008 2002 2005 2009 2007 2000 1987

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76 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-603P Course Title: Laboratory Practice in Physical Metallurgy 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ELSE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To study the microstructures and to familiarize with the measurement of micro-hardness of different materials. 7. List of Experiments: S. No. Experiments 1. 2. 3. 4. 5. Study BCC, FCC, HCP crystal models (Computer aided studies) Study of Burgers vector in edge and screw dislocations. Measurement of Micro-hardness on the surface of a steel specimen. Stereographic projections - construction of Wulff's net. Microstructure study of various standard samples of steel, non-ferrous alloys (binary and ternary systems), and cast irons. 0 0 0 2 2 5 2 5 0 3 v

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79 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-604 Course Title: Mechanical Behaviour of Materials 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II:

ASM: ME: PRE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To develop basic understanding of the response of engineering materials to mechanical loading. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. 08. Introduction to elasticity, stress-strain curves, toughness and stiffness. Yield phenomena, Slip-formation of slip line, slip bands, cross slip, twinning. Strain hardening, theories, stress curves for single and poly crystals, effect of grain size, temperature, speed, Bauschinger's effect, texture and preferred orientation. Effect of solutes and precipitates on yield stress and hardening. Influence of defects on the mechanical properties. Recovery, recrystallization and grain growth. Fracture -theory, classification and strength. Ductile to brittle fracture. Testing of materials, principles and its significance, measurement of load, length and deformation. Tests -static, tension and compression, static shear and bending, hardness and impact. Fatigue and creep 03 03 06 02 03 05 10 10 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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80 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. Mechanical Metallurgy Physical Metallurgy Introduction to Dislocations Mechanical Behaviour Of Materials Mechanical Behaviour Of Materials Dieter G E Reedhill D.Hull & D.J.Bacon T.H.Courtney M.A.Meyers & K K Chawla McGraw Hill Affiliated E-W Press Pvt.Ltd. Butterworth Heinemann McGraw Hills Prentice Hall 1988 2008 2001 1990 1999

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81 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-604P Course Title: Laboratory Practice in Mechanical Behaviour of Materials 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To gain knowledge about the working of different material testing equipments, and principles of testing etc. 7. List of Experiments: S. No. Experiments 1. 2. 3. 4. 5. 6. Tensile test - preparation of a steel specimen and its testing. Measurement of Brinells Hardness of some alloys/steel specimens. Testing of a given sample for: a. Rockwell Hardness b. Vickers Hardness. Determination of the impact strength of a given sample (L.C.Steel, M.C. Steel, H.C.Steel and C.Iron) by Izod and Charpy method. Cupping Test of a given sheet metal. Study of the various types of fractures occurring in different materials. 0 0 0 2 2 5 2 5 0 1 v

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83 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-605 Course Title: Joining of Materials 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To familiarize with the materials joining processes, principles and the equipments involved therein. 7. Details of the Course: S. No. Particulars Contact Hours

1. 2. 3. 4. 5. 6. Principles and classification of joining methods. Some important commercial applications of brazing and soldering. Conventional and special/recent welding practices including submerged, Laser, Plasma, MIG, TIG, Electron beam welding, solid-state welding processes, etc. Welding equipments, Structure of welds and fusion zones. Transformations in parent metal, design of weldments, slag-metal equilibria, gas pick up by welds and its influence. Weld cracking and its prevention. Preheating of base metals. Preheating temperature etc. Heat treatment of welds. Testing and quality control of welds- Macro and micro examinations etc. Metallurgical aspects of welding. Weld defects and testing. Joining of metals and non metallic materials (Adhesive joining). Weldability of carbon, stainless steel and other alloy steels, cast irons, Cu, Al, Ti and their alloys, etc. ISI and other specifications. 05 05 03 15 10 04 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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84 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. Modern Welding Technology 8. Manufacturing Engineering And Technology Welding Engineering And Technology Welding Technology Welding – Principles And Application Principles Of Welding Howard B Cary, Helzar S. Kalpakjian R.S. Steven R.S. Parmar Gower A. Kennedy Larry Jeffus Robert W Messler Pearson Prentice Hall Prentice Hall Khanna Publishers Macmillan Publishing Company Delmar Thomson Learning John Wiley Sons 2005 2001 2002 1974 1999 1999

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85 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT : Metallurgical & Materials Engineering 1. Subject Code: MME-605P Course Title: Laboratory Practice in Joining of Materials 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To gain knowledge about the various joining methods and the working of equipments involved. 7. List of Experiments: S. No. Experiments 1. 2. 3. 4. 5. 6. 7. 8. 9. Preparation and joining of two surfaces by soldering and brazing. Welding of cast irons, Aluminium, Copper and their alloys. Arc Welding of steel parts/welding to fill a hole in a steel trough. Gas welding of a given sample. Macro and Micro- examination of a welded joint. 6. Determination of the strength properties of a welded joint and weld defects. 7. Heat-treatment of a weld. 8. Welding by other modern techniques for which facilities may be available. Welding of dissimilar metals i.e. Steel, cast iron , Stainless Steel, Mild steel, etc. 0 0 0 2 2 5 2 5 0 1 v

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87 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-606 Course Title: Material Characterization Techniques 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To familiarize with the various

methods of materials characterization and the principles involved therein. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. X-Ray production. Characteristics of X-Rays. X-Ray diffraction. Diffraction theory and Techniques -Laue, Powder and rotating crystal techniques. Intensity calculations and structure determination. Electron Microscopy and its applications to Metallurgical studies. Techniques of specimen preparation for electron microscopy. Principles of Electron diffraction. Electron Emission phenomenon. Field ion Microscopy, Introduction to techniques such as – Auger Electron spectroscopy, scanning tunneling microscopy, Atomic force microscopy. Electron Probe micro analysis etc. Detailed study of Radiographic techniques. 12 08 08 08 06 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 V

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88 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication s 1. 2. 3. Elements of X-Ray diffraction Optical Microscopy Of Metals Electron Microscopy and Analysis B.D. Cullity R.C.Gifkins P.J Goodhew J.Humphreys R Beanland Addison- Wesley Publishing Company Sir Issac Pitman And Sons Taylor and Francis 1980 1970 2001

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89 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-607 Course Title: Tour, Training and Professional Interview 2. Contact Hours: L: 0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 6th Semester: Autumn Spring 6. Objective: To gain practical knowledge about the actual working of the industries, processes involve and the functioning of the industrial equipments etc. 7. Details of the Course: S.No Particulars 1. 2. 3. 4. Each student will be required to undertake practical training during the winter vacations for about 10-16 weeks in metallurgical industries. Each student will submit a training report in the department and give details of the jobs he was assigned during the practical training at the industry where he has taken such practical training. Separate report for the training taken at different industries will be required to be submitted by each candidate. The students will also be required to go for a long industrial/educational tour to visit various industries and educational Organisations of Metallurgical concern. Each student will submit a tour report on completion of the tours. The tour and training report as submitted by each student will be assessed by the staff members and evaluated for sessional awards. A viva-voce examination will be conducted for assessment of Tour and Training undertaken by the student and for his/her professional achievements. 0 0 0 2 0 0 0 0 0 0 5 0 0 0 0 2 V

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91 S. NO. COURSE NO. TITLE / SUBJECT ENGAGEMENT C R E D I T L T P TH. P TOTAL 1. MME-701 Non-Destructive Testing 2 1 - 3 - 3 2. MME-702 Steel Technology 2 1 - 3 - 3 3. MME-703 MME-703 P Phase Transformation & Heat Treatment of Materials Laboratory Practice in Phase Transformation & Heat



Treatment of Materials 2 - 1 - - 2 3 - - 1 3 1 4. MME-704 MME-704 P Mechanical Working of Materials Laboratory Practice in Mechanical Working of Materials 2 - 1 - - 2 3 - - 1 3 1 5 MME-705 Powder Metallurgy 3 1 - 4 - 4 6. MTH-703E MME-706E MME-707E MME-708E ELECTIVE – I One of the following: Operation Research Ceramics, Glass & Polymer Technology Metallurgy of Nuclear Materials Transport Phenomena in Metallurgical Processes 2 - - - - 1 - - - - - - - 3 - - - - - - - 3 - - - - 7. MME-709 Literature Survey of Project Work - 3 - 3 - 2 8. MME-710 Guided Reading, Group Discussion, and Seminar - 1 - - - 1

TOTAL 13 10 4 22 2 24 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR B. Tech. 7th Semester L – Lecture T – Tutorial P – Practical TH – Theory SEMESTER WISE COURSE STRUCTURE METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

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93 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-701 Course Title: Non-Destructive Testing 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective : To familiarize with the basic methods of Non-Destructive Testing technique, principles, test procedures and equipments involved therein. 7.Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. Importance of testing in the quality control of materials/product. Significance of N.D. Testing. Principle , procedure and equipment for conventional methods of NDT such as- Liquid penetrant, Magnetic particle, Eddy current, radiography, Ultrasonic and acoustic emission, optical and acoustic hollowgraphy and thermography, In-situ metallographic examination. Comparison and selection of NDT methods. Advantages, limitations, applications of each N.D. Testing methods. 05 22 08 43 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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94 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. Non-Destructive Evaluation and Quality Control Non-Destructive Testing Non-Destructive Testing Non Destructive Testing ASM Metals Handbook Mc Gonnagle, W T Louis Cartz, Barry Hull and Vernon John American Society of Metals, Metals Park, Ohio McGraw Hill Book Co ASM International, Metals Park Ohio ELBS / Macmillan 2001 1988 1995 1989

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95 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-702 Course Title: Steel Technology 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: To understand the basic principles of steel making. 7.Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. Brief history and earlier methods of steel making. Mixers and their merits. Desiliconization and desulphurization of B.F iron. Steel making by

Bessemer and side blown converters O.H and Duplex/Triplex methods, Electric-Arc and Induction processes. Basic oxygen processes -L.D KALDO, ROTOR, LDAC, and top and bottom blown practices. Physico-Chemical principles of each of the above practices. Inclusions in steel. Deoxidation and vacuum treatment of steels. Electroslag refining. Ingot mould and base plate preparation for casting. Steel casting practice. Ingot defects and their control. Continuous casting practice of steel and its merits. Principles and production of alloy steels - HSLA, Tool and die, stainless, spring, magnetic and silicon steels etc. Recent trends in plain and alloy steel technology. Instrumentation in steel works. Indian Steel plants and practices. 06 10 05 15 06 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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96 8. Suggested Books: S.No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. Iron Making and Steel Making – Theory and practice Introduction to Modern Steel Making The Making, Shaping and Treating of Steel Manufacture of Iron and Steel, Vol 2 Introduction to Steel making Physical Chemistry of Iron and Steel Making Physical Chemistry of Iron and Steel Making Ahindra Ghosh and Amit Chatterjee, Tupkary, R.H. Richard J Fruchal Bashforth, GR R.H.Tupkari R.G.Ward C.Bodswarth PHI Khanna Publications, New Delhi AISE Steel Foundation Chapman & Hall, London Khanna Publishers Edward Arnold Publications Edward Arnold Publications 2008 1994 1998 1965 2004 1999 1988

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97 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-703 Course Title: Phase Transformation and Heat Treatment 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: To develop understanding of phase transformations in metals and alloys and to give insight into the microstructural changes occurring due to different heat treatments. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. Importance of heat treatment, different types of heat treatment processes and their application. Surface hardening treatments. Alloying elements - their effects on Fe-C system. Heat treatment -various processes and their applications. Hardenability - its significance and factors affecting hardenability. Case Hardening - various processes and their applications. Associated phase transformations. Heat treatment of plain carbon and alloy steels, Non-ferrous alloys (Al, Cu, Ni and Co base alloys, bearing alloys, etc). Plain and alloy cast irons and their heat treatment. Phase transformations, classification, mechanics, thermodynamics, and kinetics of solid state transformations. 04 02 06 08 08 10 04 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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98 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. 6. 7. 8. Principles of Physical Metallurgy Heat Treatment Principles and Techniques Handbook of Heat Treatment of Steels Heat Treatment of Metals Metals Handbook Vol.4 Steel and its Heat Treatment Theory of Heat Treatment of Metals Phase transformations in metals and alloys Lakhtin Rajan and Sharma Prabhudev, K H. Vijendra Singh American Society for Metals Karl-Erik Thelning Novikov I Porter & Easterling MIR Publications Prentice Hall of India (P) Ltd, Tata - McGraw Hill Publishing Co. Standard

Publishers Distributors, ASM Metals Parks, Ohio, USA Butterworths London MIR Publishers, Moscow Chapman and Hall, London 1988 2004 2000 1998 2001 1984 1978 1997

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99 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-703 P Course Title: Laboratory Practice in Heat Treatment of Materials 2. Contact Hours: L:0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: To gain practical knowledge about the effects of various heat treatment on the structure and properties of materials. 7. List of Experiments S.No. Experiments 1. 2. 3. 4. 5. 6. Jominy-end-Quench test for determination of harden ability. Effect of the heating time and temperature, and cooling rate on the structure & properties of alloys. Study of the isothermal transformations in Fe-C systems. Annealing and normalizing of alloys. Case carburizing, nitriding, cyaniding, & flame hardening. Heat treatment of tool steels. 0 0 0 2 2 5 2 5 0 1 v

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101 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-704 Course Title: Mechanical Working of Materials 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: To familiarize with the fundamentals involved in understanding the response of engineering materials to mechanical loading and to understand basics of different metal working processes, equipments involved etc. 7. Details of the Course: S. No Particulars Contact Hours 1. 2. 3. 4. 5. 6. Metal working: Classification of metal working(forming processes, mechanics of metal working, flow stress determination, temperature in metal working, effect of strain rates, metallurgical structure. Friction and lubrication. Workability , residual stresses. Rolling: classification of rolling processes, rolling mills, hot rolling and cold rolling, rolling of bars and shapes, defects in rolled products. Extrusion: classification of extrusion processes, extrusion equipment, hot extrusion and cold extrusion, defect in extruded products. Forging: classification of forging processes, forging equipments, open die and closed die forging, forging die materials, forging defects. Drawing of rods, wires and tubes: Rod wire and tube drawing processes, drawing equipments, defects in rods wires and tubes. high velocity forming, press forming of metals - principles, processes and equipments. Analysis of forces operative during various metal working processes. Sheet Metal forming: Forming methods; shearing, blanking, bending, stretch forming, deep drawing, super plastic forming, defects in formed parts. 10 04 04 03 06 04 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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102 7. 8. Non-conventional Forming Methods: Explosive Forming, Magnetic Forming, Electric discharge forming, Laser Forming. Polymer Working Processes: Extrusion, Moulding, Thermoforming Principle, processes and Equipment employed. 05 06 Total 42 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. Mechanical Metallurgy Metals Handbook, Vol.14, Forming and Forging Handbook of Metal Forming Metal Forming Fundamentals and Applications Mechanical Treatment of Steel, Vol.4 Dieter Kurt Lange Tylan Altan, Soo Oh, Harold Gegel Bashforth G R McGraw Hill Metals Park, Ohio, USA Society of Manufacturing Engineers, Michigan ASM, Metals Park, Ohio, USA Chapman & Hall 1988 2001 1988 1983 1968

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103 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-704 P Course Title: Laboratory Practice in Mechanical Working of Materials 2. Contact Hours: L:0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ELSE : 5. Credits: 7th Semester: Autumn Spring 6. Objective: To familiarize the students with the construction and working of different metal working equipments and to perform different tests. 7. List of Experiments S. No. Experiments 1. 2. 3. 4. 5. 6. To perform fatigue testing and drawing of S-N Curves To perform the Stress - Rupture Test. Study of the construction and working of a creep testing machine. To perform wire drawing operation. To perform rolling of materials. To perform the forging operation. 0 0 0 2 2 5 2 5 0 1 v

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105 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-705 Course Title: Powder Metallurgy 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective : To impart knowledge on principles of metal powder processing and methods to make metal powder based engineering products. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. 8. The importance of Powder Metallurgy. Various methods of producing metal powders. Characteristics of metal powders and their correlation with the various methods of production. Hazards in metals powder production. Testing and classification of powders. Treatment of metal powders prior to compacting - Mixing and conditioning of metal powders. Compacting of cold and hot pressing and their limitations. Design of dies. Rolling, slip casting, forging and extrusion of metal powders. Explosive compaction. Factors influencing the properties of compacts. Sintering - its significance in powder metallurgy, sintering environments, importance of controlled atmosphere for sintering. Sintering equipments and their classification. Factors influencing sintering of metal powders. Techniques of activated sintering. Post sintering operations and the properties of sintered products/ compacts. Various powder products including dense, porous, hard, refractory, magnetic, dispersion strengthened and composite materials. Products for electrical contacts, friction parts etc. 01 08 05 05 04 10 06 03 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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106 8. Suggested Books: S.No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. 5. 6. 7. 8. . Powder Metallurgy: Science Technology and Applications Powder Metallurgy Powder Metallurgy of Iron & Steel Metals Handbook, Vol.7, Powder Metallurgy Powder Metallurgy Opportunities for Engineering Industries Powder Metallurgy Applications, Advantages and Limitations Mechanical Alloying Powder Metallurgy Angelo P C and Subramanian Sinha A K German, R M Ramakrishnan Erhard Klar Soni P R Sands and Shakespeare PHI Dhanpat Rai & Sons John Wiley & Sons, NY Metals Park, Ohio, USA Oxford and IBH Publishing Co Pvt Ld American Society for Metals Cambridge International George Newes Ltd, London 2008 1982 1998 1990 1987 1983 2002 1966

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107 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MTH-703E Course Title: Operation Research (Elective -1) 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: To familiarize with the fundamentals of operations research and its associated fields. 7.Details of the Course: S.No. Particulars Contact Hours 1. 2. 3. 4. 5. Nature and Development of Operations Research. Problem formulation, Linear Programming Problem, Graphical Method, Simplex Method, Two phase, Simplex Method. Big M method, Transportation and Assignment Models. Replacement. Models - Simple Problems. Game Theory; Two person Zero Sum Game. Sequencing Models, Processing n-jobs through two Machines, Processing n-jobs through three machines. Queuing Theory: Single- Channel Poisson Arrivals with Exponential Service (M/M/I) Model. 05 12 10 09 06 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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108 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. Linear programming Operations Research An Introduction Theory of Games and Linear Programming Operation research S.I. Gass Hamidi A.Taha S.Vajda Kanti Swarup & P.K.Gupta McGraw Hill Pearson Education Prentice Hall John Wiley & Sons Sultan Chan and Sons 1994 2005 1960 2007

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109 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-706E Course Title: Ceramic, Glass and Polymer Technology 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: This course aims at providing the fundamental knowledge about ceramics, glasses and polymers, and to understand their processing, properties and applications. 7. Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. Ceramics: Introduction to ceramics, structural characteristics of ceramic materials, crystal binding, structural imperfections, phase equilibria and microstructure of ceramic system. High temperature reactions and their kinetics. Classification and applications of ceramic materials. Ceramic powders - their preparation, characterisation, mixing and compaction, various methods of forming ceramic products.

Calcination, firing and finishing of ceramic products, glazing and enamelling. Whitewares, abrasive etc. Testing and quality control of ceramic products. Synthesis of advanced ceramic materials like PSZ, Si-N, Si-C, Alumina, etc. Glass: Classification of glass, glass manufacturing and finishing operations. Factors influencing glass formation. Structure of glass. Mechanical, electrical, thermal, optical and other important properties of glasses. Applications of glasses. Polymers: Classification of Polymers, Properties of polymers, Methods of Polymerisation, common polymer resins such as phenolic resins, Amines resins, epoxy resins, and polyesters. 20 12 10 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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110 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. Polymer Science Fundamentals of Ceramics Foundations of Materials Science and Engineering Introduction to Fine Ceramics Composite Materials: Engineering & Science Ceramic Matrix Composites Modern Composite Materials Physical Ceramics for Engineers Introduction to Ceramics Modern Ceramic Engineering- properties, processing and use in design. Introduction to the principles of ceramic processing. Gowariker , Viswnathan, Jayadev Sreedhar Michael Barsoum William F.Smith Nobuka `Ichinose Mathews and Rawlings Chawla K K Broutman and Krock VanVlack K H, Kingery, W D David W. Richerson Reed J.S New Age International Ltd. McGraw Hill Publishing Co. McGraw-Hill Inc, New York John Wiley Chapman & Hall, London, Chapman and Hall, UK Addison Wesley Co. Addison Wesley Co. John Wiley, USA Marcel Dekker, Inc. A Wiley Interscience Publication 2005 1997 1993 1987 1994 1993 1967 1964 1960 1992 1988

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111 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-707E Course Title: Metallurgy of Nuclear Materials (Elective -I) 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: To provide the knowledge about various nuclear processes and to study the different radio-active materials. 7.Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. 4. 5. Structure of nucleus. Radioactivity, Fusion and fission. Nuclear reactors and the construction, Nuclear power production- Indian Scenario. Nuclear materials, Fuels elements, moderators, coolants, reflectors, control rods and other structural materials. Cannon materials and their properties. Production of nuclear grade metals- U,Th,Zr, Nb and Ta etc processing of spent fuel. Radiation growth theories, Radiation damage, radiation hazards etc. Radio isotopes and their uses, Disposal of radioactive wastes, Occurrence and processing of nuclear materials in India . 04 06 08 12 10 Total 40 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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112 8.Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. Materials in Nuclear Applications- vol.1, Nuclear Fuel Elements: design fabrication and performance Fundamental Aspects of Nuclear Reactor Fuel Elements Nuclear Reactor Fuel Elements, Metallurgy and Fabrication Gupta C K Frost Olander D R Kaufman A R, CRC publications PERGAMON publications NTIS publication John Wiley 1989 1982 1976 1962

113 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-708E Course Title: Transport Phenomena in Metallurgical Processes 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective : To familiarize with the fundamentals of heat, mass and momentum transfer in various metallurgical processes. 7.Details of the Course: S. No. Particulars Contact Hours 1. 2. 3. Mass transfer processes and Metallurgical Kinetics-Rate controlling step. Diffusion – Laws of diffusion – steady state one dimensional – Pseudo-steady state diffusion– unsteady state diffusion Diffusion in gases, liquid and solid. Convection and Mass Transfer in Fluids under Laminar and Turbulent flow. Mass transfer between a fluid and a solid. Boundary Layer – Mass Transfer Coefficient. Fluid flow viscosity, Differential mass and momentum balances. Variables K-influencing Dimensionless groups in Mass Transfer – Analytical, Solution of Mass Transfer co-relations. Mass Transformer between two fluids – film and Boundary Layer Theories, Surface renewed theory of Mass transformer. Theory of reaction rates. Mass transfer processes, convective mass transfer, concept of mass transfer coefficient. Gas-solid and gas liquid interfacial reaction – Adsorption – Slow surface reactions in high temp. metallurgy. Thermodynamics activity of absorbed atomic species. Reaction kinetics , Basic definition and concepts , reaction rate theories, Slag Metal Reaction –Electrochemical Kinetics at High Temp. Nucleation and growth – Homogeneous and Heterogeneous Nucleation – Nucleation of CO Bubbles in molten iron and in de-oxidation of steel. Diffusivity and mechanism of diffusion. 08 10 14 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

114 4. Some special topics Diffusion of gases through porous solid. Role of Merangoni Effect in Fluid Mass Transfer. Heat Transfer and Reaction Rates. Heat conduction equations and their applications. Convective heat transfer and radiative heat transfer. 08 Total 42 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. 6. 7. 8. 9. Basic Fluid Mechanics Fundamentals of Engineering Heat and Mass Transfer Fundamentals of heat and Mass Transfer Transport Phenomena Introduction to Fluid Mechanics Mechanics of Fluids Transport Phenomena Transport Phenomena in Metallurgy Rate Processes in Metallurgy Kothandaraman C.P. and Rudramoorthy, R. Sachdeva, R C Kothandaraman C P Byron Bird R, W E Shawart Robert, W Fox Irving H Shames Bird R.B, Stewart E.S and Light foot Geiger GH and Poirier DR Mohanty AK New Age International Publishers New Age International Publishers New Age International Publishers John-Wiley & Sons Inc. John Wiley & Sons McGraw Hill Publishing Co., New York John Wiley & Sons Addison Wesley Pub. Co PHI 1998 1996 1997 1994 1994 1992 2002 1973 2000

115 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-709 Course Title: Literature Survey of Project Work 2. Contact Hours: L: 0 ; T: 2; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: SYNP: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: To carry out the basic work with regard

to the literature survey, preparation of design and fabrication of the experimental set up etc, list of required consumable and non-consumable items etc. 7.Details of the Course: S. No. Particulars 1. 2. Each student will undertake a project work, involving complete literature survey, design and fabrication of some working process models, and /or a laboratory experimentation, and presentation of results, under the supervision of a faculty members to be fixed in a meeting of the faculty members of the department keeping in view the students choice of project topic, their aptitude, facilities available and the availability of staff. The project will be assigned before the conclusion of the 6th semester examination and students will start working on literature survey etc when 7th semester classes commence. A write-up and a complete list of consumables and non-consumable items to be needed by each student to complete the project work will be submitted to the teacher concerned in a fairly typed form for assessment and for arranging the materials from the market, if necessary, so that the practical work is started just at the commencement of the 8th semester classes. Each student will submit a complete literature survey of the project work assigned to the concerned supervisor for assessment. 0 0 0 2 5 2 5 0 2 v

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117 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-710 Course Title: Guided Reading, Group Discussion and Seminar 2. Contact Hours: L: 0; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: GD: WUP: PRE: 5. Credits: 7th Semester: Autumn Spring 6. Objective: To prepare the students for the group discussions, preparation of talks/seminars etc. 7. Details of the Course: S.No. Particulars 1. 2. A co-curricular activity based on guided reading and seminar talks. This will involve a detailed study of a topic of interest production in the candidates own style. Each student will be required to give seminar talks on the subject of interest. The handouts of the talks will be submitted by the student before the talk is delivered. These seminar talks will prepare the students for proper survey of literature, compilation of information so gathered and presentation of the same to the audience. The handouts submitted by the students will be in accordance with the standard of technical papers. The award of sessional will be based upon the preparation and presentation of seminar talks and performance in the group. 0 0 0 0 1 5 2 0 1 5 0 1 v

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119 S. NO. COURSE NO. TITLE / SUBJECT ENGAGEMENT C R E D I T L T P TH. P TOTAL 1. MME-801 MME-801 P Foundry Technology Laboratory Practice in Foundry Technology 2 - 1 - - 2 3 - - 1 3 1 2. MME-802 MME-802 P Corrosion Engineering Laboratory Practice in Corrosion Engineering 2 - 1 - - 2 3 - - 1 3 1 3.



MME-803 Failure Analysis 2 1 - 3 - 3 4. MME-804 Entrepreneurship Development & its Scope in Metallurgy 2 1 - 3 - 3 5. MME-805E MME-806E MME-807E Elective – II One of the following: Polymer Technology Composites Metallurgy & application of Super alloys 2 --- 1 ----- 3 ----- 3 --- 6. MME 808 Project Work & Project Viva 1 1 6 2 8 10 TOTAL 11 6 10 17 10 27 L – Lecture T – Tutorial P – Practical TH – Theory SEMESTER WISE COURSE STRUCTURE B. Tech. 8th Semester METALLURGICAL AND MATERIALS ENGINEERING DEPARTMENT NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

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121 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-801 Course Title: Foundry Technology 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To familiarize with the fundamentals of foundry technology principles, casting processes, equipments etc. 7. Details of the Course: S.No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. Introduction: Application and advantages of types of foundries. Moulding sands-classification and testing, core sands. binding, parting and facing materials, additives. Patterns: Classification and design, pattern allowance. Core making equipment and processes. Gating & risering. Cupola & other Melting furnaces. Manufacture of cast iron, malleable iron, S.G. Iron - Gray cast iron. Classification and distribution of flake size and shape in gray cast iron. Melting, alloying, casting of non-ferrous alloys. Steel foundry practice, moulding and casting. Classification of casting methods and equipments used. Solidification processes-Directional solidification etc. Casting defects. Cleaning, Inspection, quality control and salvaging of castings. Quality control and testing of castings. 03 05 05 03 03 06 05 06 03 03 Total 42 0 2 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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122 8. Suggested Books: S.No Name of the Books Author(s) Publisher Year of Publication s 1. 2. 3. 4. 5. 6. 7. Principles of Metal Casting Principles of Foundry Technology Metal Casting : Principles and Practice Foundry Engineering ASM Metals hand Book, Vol 15, Casting Foundry Technology Fundamentals of metal casting technology Heine R W., Loper, C.R.Rosenthal Jain P.L Ramana Rao T V. Srinivasan N K. Beeley P R. Mukherjee P.C., Tata-McGraw Hill Publishing Co Ltd Tata McGraw Hill New Age International Publishing Khanna Tech Publications ASM International Butterworths, London Oxford and IBH Publishing House 1995 1995 1996 1994 2001 1982 1996

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123 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-801 P Course Title: Laboratory Practice in Foundry Technology 2. Contact Hours: L:0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To familiarize with the

conduct of various tests on the foundry sands, moulds and castings. 7.List of Experiments S.No. Experiments 1. 2. 3. 4. AFS Sieve analysis of foundry sands. Sand testing: determination of: a. Moisture content b. Clay content c. Permeability d. Flowability e. Hot strength f. Refractoriness Mould testing: Determination of: a. Green strength b. Dry strength c. Collapsibility d. Hardness e. Tensile & compression strength Moulding & casting: a. Preparation of moulds b. Melting, degassing, fluxing & grain refinement c. Making of castings d. Inspection & Testing 0 0 0 2 2 5 2 5 0 1 v

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125 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-802 Course Title: Corrosion Engineering 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To familiarize with the basic knowledge of corrosion behaviour of materials and their protection methods. 7.Details of the Course: S.No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. 8. Introduction and review of electrochemical principles, classification of corrosion processes. Factors influencing corrosion rates. Thermodynamics of high temperature oxidation. Corrosion in water pipe lines, stress corrosion cracking of constructional materials (like steel in concrete). Corrosion prevention, inhibitors, passivation, paints and other non-metallic coatings. Metal deposition- Galvanizing, tinning, electroplating, anodizing etc. Corrosion testing and IS specification. Corrosion resistant alloys. Decorative coatings by electroplating. Electro- plating of Cu, Ni, Cr, Ag, Zn, Au and alloys like Cu-Zn, Cu-Sn etc. Testing of electro-deposits. 05 04 05 08 05 04 08 03 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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126 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. 6. 7. 8. Corrosion Engineering Corrosion–For science and engineering Metallic corrosion and prevention Corrosion and corrosion control – An introduction to corrosion science and engineering ASM hand book – Vol 13: Corrosion Principles and prevention of corrosion Corrosion and corrosion protection handbook An introduction to Electro- metallurgy Greene,N.D., M.G.Fontana, Kenneth R Trethewey and John Chamberlain Rajnarayan Herbert H. Uhlig and R. Winston Revie Denny A. Jones Philip A. Schweitzer Sharan & Narain Tata McGraw Hill Longman Inc Oxford Publications, John Wiley & Sons ASM International Prentice Hall Inc. ASM Standard Publisher 2005 1996 1988 1985 2001 1996 1983 1999

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127 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-802 P Course Title: Laboratory Practice in Corrosion Engineering 2. Contact Hours: L:0; T: 0; P: 2 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: MSLE: ESLE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To gain knowledge about

the methods used to evaluate the corrosion characteristics of different materials under different conditions. 7. List of Experiments S.No: Experiments 1. 2. 3. 4. 5. 6. 7. Aqueous corrosion of metals. To study the effect of cathodic protection on given couple of metallic samples. To study the influence of various inhibitors on corrosion protection. High temperature oxidation of alloys. Electroplating Cu, Ni, Cr, etc. Anodizing of aluminium. To study the effect of various atmospheric conditions on degradation of coatings. 0 0 0 2 2 5 2 5 0 1 v

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129 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-803 Course Title: Failure Analysis 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To understand the basic fundamentals responsible for the failure of materials and to identify the fracture surfaces. 7. Details of the Course: S.No. Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. Engineering aspects of failure and failure analysis. Fundamental sources of failures. General practice in failure analysis. Toughness and fracture – mechanics. High and low temp. failures. Mechanisms of and the influence of structural environmental parameters on failure. Identification of types of failure. Service failures of cold formed parts, forgings, castings, weldments. Case studies - failures in power plants, etc. 02 02 06 06 10 10 06 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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130 8. Suggested Books: S. No. Name of the Books/ Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. 6. 7. Deformation and fracture mechanics of Engineering materials Fundamentals of Fracture mechanics Fracture Mechanics Applications of Fracture Mechanics for the selection of Materials Metallurgy of Failure Analysis Analysis of Metallurgical Failures Testing of Metallic Materials Hertz berg R W Knott. J.F Evalds H L and RJH Warnhil Campbel, Underwood J H, and Gerberich W Das A.K. Colangelo V.A. Suryanarayana AVK John wily sons inc, New York Bullerworth London Edward Arnold Ltd, Baltimore, American Society for Metals, Metals Park Ohio Tata McGraw Hill John Wiley PHI 1983 1973 1984 1982 1992 1985 1979

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131 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-804 Course Title: Entrepreneurship Development and its Scope in Metallurgy 2. Contact Hours: L: 2; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To gain basic knowledge about the procedures and formalities involved in the setting up of industries, marketing management and other related issues. 7. Details of the Course: S. No. Particulars Contact

Hours 1. 2. 3. 4. 5. 6. 7. Entrepreneurship Development: Characteristics of entrepreneurs.

Entrepreneurship - Risks and rewards, Role of society, self assessment, motivation and human behaviour etc in entrepreneurship development qualities. Business exercises. Forms of business organizations and formation of companies. Procedure and other formalities for setting up of new Industries, incentives, subsidies and concessions available for industries. Various Institutions and Organizations for promotion of industrial development sources of financial assistance. Identification of opportunities for setting industries, Techno- economic feasibility studies, Financial viability, and ratios assessment for fixed and working capitals, project scheduling. Marketing management, consumer behaviour, demand and supply, projections, predictions and forecasts. Industrial laws. Factory wages, and workmen compensation acts. Preparation of a project Report. 04 08 10 06 06 04 04 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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132 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4.  
Entrepreneurship Entrepreneurship – Successfully Launching New Ventures Entrepreneurship in Action  
Entrepreneurship– Strategies and Resources Robert D Hisrich, Michael P Peters and Dean Shepherd  
Bruee R Barringer and Duane Ireland Pearson Mary Coulter Marc J Dollinger Tata McGraw Hill Prentice  
Hall Prentice Hall of India Pearson Education 2007 2006 2006 2003

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133 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-805E Course Title: Polymer Technology (Elective-II) 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To familiarize with the fundamentals of polymers. 7. Details of the Course: S.No. Particulars Contact Hours 1. 2. 3. 4. 5. Polymer and their characterisation. Polymer chemistry, polymerisation its kinetics and mechanism. Physical and Mechanical properties of polymerisation. Polymer isotics Reactions and their design. Rheology of polymers. Physical properties, Testing and applications of polymeric materials. Polymer processing equipment and unit operations. Introduction to resins, rubber and plastics, their properties and applications. Introduction to inorganic and some special type of polymers. 05 05 12 10 10 Total 42 0 0 0 3 2 0 2 0 1 0 5 0 0 0 0 3 v

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134 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4. 5.  
Polymer Science Foundations of Materials Science and Engineering Plastics: Materials and processing  
Polymer Processing Plastic Materials Gowariker , Viswnathan, Jayadev Sreedhar William F.Smith Brent  
Strong A Morton-Jones D.H Brydson J A New Age International Ltd. McGraw-Hill Inc, New York Prentice-  
Hall, New Jersey Chapman and Hall, New York Butterworths, London 2005 1997 2000 1989 2004

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135 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-806E Course Title: Composites (Elective-II) 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To impart basic knowledge about the preparation, characterization, and applications of composite materials. 7. Details of the Course: S.No Particulars Contact Hours 1. 2. 3. 4. 5. 6. 7. 8. An introduction to composites. Theoretical and actual strength of solids. Cleavage and shear strength, strength of bulk metals and fibres, etc. Strengthening Mechanisms in composites. Fibre composites, various types of fibres elastic fibres. Elastically and plastically deformable matrix. Effect of fibre orientation on composite strength. Fracture of fibres/ matrix/ composites. Dynamic properties of composite materials - fatigue, creep, high temperature properties, etc. Production of some commercially important composite materials (Resin matrix, ceramic matrix and metal matrix, reinforced plastics, glass fibre and carbon fibre). Directional solidification of eutectic, etc. Joining of composites. Applications of composite materials; civil construction of structure/panels, aerospace industries, automobiles and other surface transport industries, sports components etc. 02 06 06 05 06 06 04 07 Total 42 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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136 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publication 1. 2. 3. 4. 5. 6. Composite Materials Composite Materials: Engineering & Science Ceramic Matrix Composites Modern Composite Material Composite Materials: Science and Applications "Composites" Metals Hand Book Vol.21, 9th Edition Chawla K K, Mathews F L and Rawlings R D Chawla K K Broutman L J, and Krock Deborah Chung D Springer Verlag, New York Chapman & Hall , London Chapman and Hall, UK Addison Wesley Publishing Company Springer International, USA ASM 1998 1994 1993 1967 2004 1989

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137 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-807 E Course Title: Metallurgy and Application of Super Alloys (Elective-II) 2. Contact Hours: L: 2 ; T: 1; P: 0 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: M-I: M-II: ASM: ME: PRE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To familiarize with various super-alloys and their applications. 7. Details of the Course: S. No Particulars Contact Hours 1. 2. 3. 4. Historical review, Classification of Super alloys based on Fe, Co and Ni, specifications, preparation and physical characteristics of super alloys, Role/effect of alloying elements. Applications of super alloys. Influence of aggressive environments such as those involving chlorine and sulphur. Structural ceramics, their properties and advantages over conventional high temperature materials and super alloys. Structural ceramics based on Oxides (Alumina, Zirconia and Thoria etc) and Non-Oxides (Carbides, Nitrides, Silicides etc). Their synthesis, properties and applications. 12 08 10 10 Total 40 0 3 0 0 2 0 2 0 1 0 5 0 0 0 0 3 v

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138 8. Suggested Books: S. No. Name of the Books Author(s) Publisher Year of Publications 1. 2. 3. 4. Powder Metallurgy of Super alloys Modern developments in Powder Metallurgy Vol. 1 & 5 Super Alloys

“A Technical Guide” Super alloys “ Fundamentals and applications” G.H. Geissinger E. N. Aqua , C. I. Whitman Mathew J.Donachie, Stephen J.Donachie Roger C.Reed Metal Powder Industries Federation ASM International Cambridge University Press 1985 2002 2006

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139 NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR NAME OF DEPARTMENT: Metallurgical & Materials Engineering 1. Subject Code: MME-808 Course Title: Project Work and Viva 2. Contact Hours: L: 1 ; T: 1; P: 8 3. Examination Duration (Hrs): Theory: Practical: 4. Relative Weightage: INTASM: PR: PRE: VV: EE: 5. Credits: 8th Semester: Autumn Spring 6. Objective: To familiarize the students with the preparation of project proposals, collection of literature, conduct of experimental work, analysis of data and presentation of results etc. 7. Details of the Course: S. No. Particulars 1. 2. Each student will undertake a project work, involving complete literature survey, design and fabrication of some working process models, and /or a laboratory experimentation, and presentation of results, under the supervision of a faculty members to be fixed in a meeting of the faculty members of the department keeping in view the students choice of project topic, their aptitude, facilities available and the availability of staff. The project will be assigned before the conclusion of the 6th semester examination and students will start working on literature survey etc when 7th semester classes commence. A write up and a complete list of consumables and non-consumable items to be needed by each student to complete the project work will be submitted to the teacher concerned in a fairly typed form for assessment and for arranging the materials from the market, if necessary, so that the practical work is started just at the commencement of the 8th semester classes. Final project report will be submitted by each student after making a presentation of his results/findings etc before his/her supervisor and other faculty members. Final assessment of his/her project work will be done on the basis of a viva-voce examination by an external examiner. 0 3 0 0 2 5 2 0 1 5 1 5 2 5 1 0 v

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