



Courses for Semester VI (Year 3)

National Institute of Technology, Raipur (C. G.)													
Course of Study and Scheme of Examination (NEW)				B. Tech. VI semester							METALLURGICAL ENGG.		
S. No.	Board of Studies	Sub. Code	Name of Subject	Period/Week			Examination Scheme					Total Marks	Credits L+(T+P)/2
				L	T	P	TA	FE	SE	T.C.A.	ESE		
1	METALLURGY	MT20611(MT)	Engineering Economics and Industrial Management	3	1	-	20	15	15	50	70	120	4
2		MT20612(MT)	Metal Forming Processes	4	1	-	20	15	15	50	70	120	5
3		MT20613(MT)	Secondary & Special Steel Making	3	1	-	20	15	15	50	70	120	4
4		MT20614(MT)	Materials Modeling and Simulation	3	1	-	20	15	15	50	70	120	4
5		MT20615(MT)	Material Characterization Technique	3	1	-	20	15	15	50	70	120	4
6		MT2063X(MT)	<i>Optional II</i>	3	1	-	20	15	15	50	70	120	4
7		MT20621(MT)	Metal Forming Processes Lab	-	-	3	30	-	-	30	20	50	2
8		MT20622(MT)	Material Characterization lab	-	-	3	30	-	-	30	20	50	2
9		MT20623(MT)	Materials Modeling and Simulation Lab	-	-	3	30	-	-	30	20	50	2
10	Humanities	EN20624(MT)	I & E Skill	-	-	2	25	-	-	25	0	25	1
11	Metallurgy	MT20625(MT)	Discipline	-	-		25	-	-	25	0	25	1
TOTAL				19	6	11	260	90	90	440	480	920	33

TA= Teacher Assessment, FE= First Exam. , SE= second Exam., T.C.A.= Total of continuous assessment, ESE=End Sem. Exam.

Choices for optional courses in Semester in VI (Year 3)

Optional	Subject Code	Course
<i>Optional II</i>	1020631(MT)	Biomaterials
	1020632(MT)	Non Destructive Evolution of Materials



Name of the Subject	Engineering Economics and Industrial Management	Subject Code	MT20611(MT)
Semester	VI	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	-	4 (Th)

ENGINEERING ECONOMICS AND INDUSTRIAL MANAGEMENT

An idea of fundamental concepts of economics, its relationship with engineering and technology. Factors of Production: Characteristics and importance of Demand and Supply analysis, elasticity of demand, Price determination, Laws of returns, monopoly. G.N.P. and National income: Importance, distribution, Direct and indirect taxes, taxes and industrial development, elementary idea of theory of employment.

Meaning and function of money and bank, value of money and its fluctuations, Quantity theory of money, Gresham's law, Devaluation of money, foreign trade. Industrialization: Factory system of production, its advantages, limitations and problems, small scale industries, problems of small scale industries in India, Comparative merits and demerits of small and large scale industries.

Partnership, joint stock company cooperative societies, limited and unlimited liabilities. Financing by Banks and specialized institutions, stock exchange and money market, credit instruments, shares, debentures and bonds.

Depreciation, Depreciation accounting Methods of calculating depreciation. Book keeping and accounting :Importance of accounting for engineers, engineer as a controller of finances, elements of double entry system of book-keeping, preparation of journal and ledger accounts, Interest and profit analysis, Trial balance, Manufacturing and profit and loss accounts, Balance sheet. Elements of cost, components of cost, cost accounting, procedure of costing, costing methods, cost control.

Concept, Development, application and scope of Industrial Management; Productivity, Definition, measurement, productivity index, types of production system, Industrial Ownership. Management Function : Principles of Management- Management Tools – time and motion study, work simplification- process charts and flow diagrams, Production Planning, Specification of Production requirements. Inventory control : Inventory, cost, Deterministic models, Introduction to supply chain management. Quality control : Meaning, process control, SQC control charts, single, double and sequential sampling, Introduction to TQM.

Name of Text Books :

1. Engineering Economics – By Tarachand.
2. Industrial Organisation and Engineering Economics, By T.R. Banga and S.C. Sharma.

Name of Reference Books :

1. Industrial engineering and Management system, Dalela, Dr. Mansoor Ali.
2. Engineering Economics, Accounts and Management By S. Prasad.
3. Industrial Engineering & Management By O.P. Khanna.



Name of the Subject	Metal Forming Processes	Subject Code	MT20612(MT)
Semester	VI	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
4	1	-	5 (Th)

METAL FORMING PROCESS

Fundamentals of Metal Working: Classification of forming processes; Temperature in Metal- working, Hot working, Cold working and Warm working of metals, Heating of metals and alloys for hot working, Friction in Metal working, Lubrication, concept of yield criteria. ; Rolling of Metals: Classification of Rolled products, Types of rolling mills, Terminology used in rolling; Forces and Geometrical relationships in rolling, Rolling variables, Theories of rolling, Rolling Torque and HP calculations. Roll-pass Design: Fundamentals of Roll-pass-design; Mill type, Layout and rolling practice adopted for some common products such as Slabs, Blooms, Billets, Plates, Sheets etc. Rolling defects and their control, ; Forging of Metals: Forging principles, types of forging and equipments needed; calculation of forging load under sticking and Slipping friction conditions. Forging defects and their control. Manufacture of rail wheels and tyres. ; Extrusion: Types, Principles and Equipments. Variables in extrusion, deformations in extrusion, calculation of extrusion pressure under plane strain conditions; extrusion defects; production of tubes and seamless pipes. ; Wire Drawing: Drawing of Rods, Wires and Tubes, calculation of drawing load; drawing defects. ; Sheet Metal Forming: Forming methods such as bending, stretch forming, shearing and blanking, deep drawing, and redrawing. Defects in formed products. Special forming methods such as explosive forming (elementary ideas excluding mathematical treatment).

Essential Reading:

1. G.E. Dieter, Mechanical Metallurgy-Mc Graw Hill-1988
2. Roll pass Design; The United Steel Companies Ltd., U.K.-1960

Supplementary Reading:

1. C. Russak, G.W. Rowe; Principles of Industrial Metal Working processes, 1977.
2. A Ghosh, A.K. Mallick; Manufacturing sciences. East-west press private ltd; latest reprint-1991.



Name of the Subject	Secondary & Special Steel Making	Subject Code	MT20613(MT)
Semester	VI	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	-	4 (Th)

SECONDARY & SPECIAL STEEL MAKING

The concept of cleanliness of steels, non-metallic inclusions, dissolved gases. Tramp & residual elements in steels and their effect on steel properties;

Objectives and techniques adopted in Secondary Steelmaking, Development of secondary steelmaking and their importance under Indian conditions; Sources of inclusions; sulphur phosphorus and gases in steel;

Role of slag and powders in inclusion control; thermodynamic and kinetic consideration of Desulphurization; Dephosphorisation, decarburization and degassing of steel melts; Modifications of inclusion morphologies,

Secondary steelmaking technologies; Inert gas purging; Vacuum degassing – RH/DH, OD, VAD etc., Ladle furnace; Powder injection system – powder dispenser, lance, etc.; Physicochemical and fluid dynamic aspects of powder injection and stirring processes; Role of slag and powders in inclusion control; Desulphurization; Cored wire feeding;

Production of ultra low C, S, P and inclusion free steels; Powder injection system; Addition of CaSi for shape inclusion. Production of stainless steels through VOD, AOD & CLU processes. Production of ultraclean steel through post solidification treatments (VAR, ESR processes);

Refractories used in secondary steelmaking furnaces, their properties and selection criteria. A critical appraisal of hybrid blowing process, UHP electric arc and induction furnaces with respect to raw materials, energy consumption, productivity and product quality; Special grade steels. ;

Recent advance in secondary steel making

Essential Reading:

1. Ghosh Ahindra; Principles of Secondary Processing & Casting of Liquid Steels; Oxford & IBH.
2. Ghosh Ahindra; Secondary Steel Making, Principles & Applications; CRC Press.
3. R. J. Fruehan (ed.): The Making, Shaping and Treating of Steel (Steelmaking Volume), The AISE Steel Foundation, 2004.



Name of the Subject	Materials Modeling and Simulation	Subject Code	MT20614(MT)
Semester	VI	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	-	4 (Th)

MATERAISL MODELLINGA ND SIMULATION

Objectives of materials modelling and optimisation, concepts of simulation and modelling, importance of spatial and temporal length scales in materials modelling, algebraic, differential and integral equations in materials modelling, development and construction of a physical model for a material, chaos computing, fractal theory, wavelet transformation, cellular automaton, percolation models, empirical modelling and statistical methods, one dimensional optimisation, gradient based optimisation, linear programming, constrained optimisation.



Name of the Subject	Material Characterization Technique	Subject Code	MT20615(MT)
Semester	VI	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	-	4 (Th)

MATERIAL CHARACTERIZATION TECHNIQUES

Introduction to materials characterization its importance, structure sensitive/insensitive properties, structure-property correlation, crystallography basics, resolution, depth of field/focus, aberrations (spherical, chromatic and astigmatism), remedial measures for aberrations, levels of characterization (macro, meso and micro).

Optical microscopy (OM) – reflected/transmitted light microscope, theoretical and practical resolution of optical microscope, numerical aperture, principle of image formation, microscope construction and working, effective/empty magnification, different light sources, flat field correction, types of illumination - bright field, dark field, polarized light and phase contrast, applications of each type of illumination.

Sample preparation for optical microscopy, features of an image, introduction to scanning electron microscope (SEM), advantages/disadvantages as compared to OM, mechanics of SEM, types of electron gun and comparison between them (resolution, brightness, efficiency, cost and stability), ray diagram of SEM, working and construction, magnification. Electron-specimen interaction, imaging modes (secondary and backscattered), effect of spot size, apertures, accelerating voltage on SEM image, Everhart-Thornley detector, Robinson detector, solid state segmented detector, atomic number and topological contrast, critical probe current. Chemical analysis using SEM, EDS/WDS working principle, construction, spot analysis, line scan and area scan, resolution of EDS/WDS detector, advantages/disadvantages, calibration of EDS/WDS, qualitative and quantitative analysis.

X-ray diffraction – Generation of X-rays, characteristic X-ray spectrum, Bragg's Law, Diffraction methods - Laue method, rotating crystal method, powder method, Principle, equipment and applications, structural factor, applications of X-ray diffraction in materials characterization – determination of crystal structure, lattice parameter, introduction of GIXRD.

Thermal analysis techniques – Importance, principles and applications of differential thermal analysis (TGA, DTA, DSC), differential scanning calorimetry and thermogravimetric analysis, accuracy, sensitivity, calibration and differences.

Brief idea of TEM: principle of operation, application; Advanced microscopic techniques: AFM, STM, EELS, :only Principle and applications of underlying techniques like Infrared spectroscopy (IR), Raman spectroscopy, Mossbauer spectroscopy, Nuclear magnetic resonance spectroscopy (NMR), Emission spectroscopy (Chromatography techniques). Advanced Characterization Techniques: STEM, AFM, Nanoindentation Testing, EELS- Principle and applications. ; Characterization for materials selection and design case studies.

Essential Readings:



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1. R.E. Whan, Material Characterization, Metals Handbook, Vol 10, ASM, 1986.
 2. E.N Kaufmann, Characterization of Materials, Willey Publishers, 2003.

Supplementary Readings:

1. P. J. Grundy and G. A. Jones, E. Arnold, The structure and properties of solids, 1975.
2. B. D. Cullity, Elements of X-ray diffraction, Addison-Wesley publishing company, 2002.
3. B. M. Rao, Chemical characterization of materials, Himalaya publishing house, 2000.
4. J. I. Goldsetin, C E. Lyman, Scanning electron microscopy and X-ray microanalysis,
5. D. E. Newbury, E. Lifshin, P. Echlin, L. Sawyer, D. C. Joy, J. R. Michael, Springer, 2003.



Name of the Subject	Biomaterials	Subject Code	MT 20631(MT)
Semester	VI	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	-	4 (Th)

BIO MATERIALS

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY :Definition and classification of bio-materials, Biomaterials and their physiological interactions; Material response/degradation: mechanical breakdown, corrosion, dissolution, leaching, chemical degradation, wear; Host responses, foreign body reactions, inflammation, wound healing, carcinogenicity, immunogenicity, cytotoxicity, infection, local/systemic effects

IMPLANT MATERIALS: Metallic implant materials, stainless steels,co-based alloys, Ti-based alloys, ceramic implant materials, aluminium oxides, hydroxyapatite glass ceramics carbons, medical applications.

POLYMERIC IMPLANT MATERIALS :Polymerisation, polyolefin, polyamides, Acrylic, polymers, rubbers, high strength thermoplastics, medical applications.

TISSUE REPLACEMENT IMPLANTS :Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

ARTIFICIAL ORGANS: Artificial Heart, Prosthetic Cardiac Valves, Limb prosthesis, Externally Powered limb Prosthesis, Dental Implants.

Standardization problems on biomaterials and related products. Assessment of reliability and safety of biomedical materials and man-machine systems. Product liability of biomaterials and related products. Bioengineering and materials technology as applied to decontamination against environmental problems

Text Books and References:

1. Bioengineering Materials by R.S.Sharma
2. Engineering Materials by R.L.Timings



Name of the Subject	Non Destructive Evolution of Materials	Subject Code	MT 20632(MT)
Semester	VI	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	-	4 (Th)

NON-DESTRUCTIVE EVALUATION OF MATERIALS

BASIC CONCEPTS AND SURFACE INSPECTION: Concepts of Non-Destructive testing-relative merits and limitations. Types of defects, Visual inspection, Liquid penetrant inspection - principles, practice, applications, advantages and limitations. Principles, applications and instrumentation of thermal inspection, Infrared Thermography. Industrial Computed Tomography (ICT)

RADIOGRAPHY: X-rays and Gamma rays. Properties of X-rays relevant to NDE. Absorption of rays, scattering, types and use of filters, screens, geometric factors, inverse square, law, film type and processing, characteristics of films - density, speed, contrast, Characteristic curves, Penetrameters, Exposure charts, radiographic equivalence, Gamma ray sources, characteristics of Gamma rays, Fluoroscopy, Xero - radiography, Radiography of pipes, welds and castings. Safety with X-rays and Gamma rays

ULTRASONICS :Types of ultrasonic waves, principles of wave propagation, characteristics of ultrasonic waves, attenuation, Production of ultrasonic waves, Ultrasonic probes, couplants. Inspection methods-Pulse echo, Transmission and Resonance techniques. Types of scanning. Immersion testing, thickness measurement. Test block. IIW Standard and reference blocks, calibration in UT. Ultrasonic testing of welds and castings

MAGNETIC PARTICLE AND EDDY CURRENT INSPECTION :Principles, applications, Magnetization methods, magnetic particles. Dry technique and wet technique, demagnetization. Eddy current testing - principles, impedance diagrams, test coils and probes, inspection methods and applications.

OTHER TECHNIQUES: Holography and Acoustic emission technique. Pressure and leak testing. Condition monitoring of machines, Wear monitoring, Spark testing. Brief over view of Non-Destructive testing standards - ASTM, ISO, ASNT, API, ASME boiler and pressure vessel code

TEXT BOOKS:

1. Barry Hull and Vernon John, "Non-Destructive Testing", ELBS/Macmillan,UK, 1988.
2. Baldev Raj, Jayakumar T. Thavasimuthu M, "Practical Non-Destructive testing", Narosa Publishing House, NewDelhi, 1997.
3. McGonnagle.W.T, "Non-Destructive testing", McGraw-Hill Book Co, USA, 1988.

REFERENCES

1. ASM Metals Hand Book, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park ,Ohio, USA, 1989.
2. Louis Cartz, "Non-Destructive testing", ASM International, Metals Park Ohio, USA, 1995.