राष्ट्रीय प्रौद्योगिकी संस्थान रायपुर
NATIONAL INSITUTE OF TECHNOLOGY RAIPUR
(Institute of National Importance)
G.E.Road, Raipur – 492010 (C.G.)

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

Courses for Semester IV (Year 2)

National Institute of Technology, Raipur (C. G.)													
Course of Study and Scheme of Examination (NEW)				**B. Tech. IV 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	MT20411(MT)	Testing of Materials	3	1	-	20	15	15	50	70	120	4
2	Metallurgy	MT20412(MT)	Physical Metallurgy	3	1	-	20	15	15	50	70	120	4
3	Metallurgy	MT20413(MT)	Ferrous Extractive Metallurgy I (Iron Making)	3	1	-	20	15	15	50	70	120	4
4	Metallurgy	MT20414(MT)	Engineering of Non-metallic Materials (ceramics, glasses, polymers and fluids)	3	1	-	20	15	15	50	70	120	4
5	Metallurgy	MT20415(MT)	Principles of Non Ferrous Extractive Metallurgy	3	1	-	20	15	15	50	70	120	4
6	Metallurgy	MT20416(MT)	Transport phenomena in metallurgical processes	4	1	-	20	15	15	50	70	120	5
7	Metallurgy	MT20421(MT)	Physical Metallurgy Lab	-	-	3	30	-	-	30	20	50	2
8	Metallurgy	MT20422(MT)	Testing of Materials Lab	-	-	3	30	-	-	30	20	50	2
9	Metallurgy	MT20423(MT)	Transport phenomena in metallurgical processes Lab	-	-	3	30	-	-	30	20	50	2
10	Humanities	EN20424(MT)	Personality Development	-	-	2	25	-	-	25	0	25	1
11	Metallurgy	MT20425(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.

राष्ट्रीय प्रौद्योगिकी संस्थान रायपुर
NATIONAL INSITUTE OF TECHNOLOGY RAIPUR
(Institute of National Importance)
G.E.Road, Raipur – 492010 (C.G.)

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

Name of the Subject	Testing of Materials	Subject Code	MT20411(MT)
Semester	IV	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	3	4 (Th) + 2 (P)

Plastic deformation of metals – Lattice defects, deformation by slip and twinning, critical resolved shear stress for slip, yield point phenomenon, strain hardening ,

Failures: Types and their characteristics, nucleation of cracks and their propagation, theoretic cohesive strength of metals, Griffith theory of brittle failure, dislocation theory of fracture, ductile of brittle transition.

Material Testing: Importance and application of testing methods, role of specifications and standard for materials.

Tensile Test – Flow curve, engineering and true stress – true strain curve, yield stress and proof stress universal tensile testing machine and tensometer, principle of stress and strain measurement, bend test measurement of ductility and formability.

Hardness Test – Principles and machines used – Brinnel, Vickers, Rockwell, Scleroscope and micro hardness testing.

Impact Test – Izod and Charpy Notched bar impact test, Metallurgical factors affecting brittle to ductile transition.

Fatigue and Creep Testing – Elementary treatment of fatigue phenomenon, S – N curve and corrosion fatigue, fatigue testing principle

Signification of Creep, testing procedure creep curve and its interpretation, stress-rupture test

Metallurgical and mechanical factors affecting, creep and fatigue failures.

Non-destructive testing – Importance, scope, advantages and limitations – Dye penetrant, radiographic magnetic, ultrasonic and eddy current testing and their application.

Text Books

1. Mechanical Metallurgy – George E. Dieter
2. Testing of Metallic Materials – A V K Suryanarayan

Reference Books

1. Testing and Inspection of Engineering Materials- Davies, Taroxall and Wiscosil
2. Mechanical Testing of Metallic Materials – D A Beument.
3. Engineering Materials Science – C W Richards
4. Non Destructive testing – Bac Gonnagle.

राष्ट्रीय प्रौद्योगिकी संस्थान रायपुर
NATIONAL INSITUTE OF TECHNOLOGY RAIPUR
(Institute of National Importance)
G.E.Road, Raipur – 492010 (C.G.)

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

Name of the Subject	Physical Metallurgy	Subject Code	MT20412(MT)
Semester	IV	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	3	4 (Th) + 2 (P)

Atomic Arrangement in Materials: Concept of crystalline and amorphous solids, Space lattice and Unit cell, Crystal system and Bravais Lattices, Atomic packing Crystal Systems Crystal Structures of metals, Packing efficiency, Crystallographic planes and directions, Miller Indices, Determination of crystal structures.

Crystal defects, Point defects, Vacancies, Substitution and Interstialices, Schottky and Frankel defects, Line defects, Dislocations, Edge & Screw dislocations, Burgers vector. Planer defects stacking fault and volume defects, impurities in solids.

Solid solution, definition and types of solid solution, Substitutional and Hume Rothery Rules, Intermetallic compounds, Normal valency compounds, Electron compounds, Interstitial compounds. Interaction of dislocation and solute atom.

Definitions and basic concept phase diagram, Single component or Unary phase diagram, Binary Phase Diagrams: Isomorphous, Eutectic, Peritectic, Eutectoid, Monotectic & Syntectic reactions, Phase rule and Lever rule. Free energy and phase diagrams of ideal binary solutions. Common tangents to free energy curves.

Iron-Cementite Equilibrium diagrams and physical metallurgy of iron-carbon alloys, Microstructural features, Interpretation of microstructure and details of microstructures, Microstructure chemistry and properties correlation , Monocomponent and binary systems non-equilibrium system , Binary equilibrium diagrams of various systems with complete and partial solid solubilities involving eutectic and peritectic and other reactions.

Introduction of ternary diagrams, order-disorder transformations, Experimental determination of liquids, solids and solvus lines, phase diagram and application in crystalline and non-crystalline solids. Detailed study of Cu-Ni, Zn-Sn, Fe-C, Cu-Sn, Cu-Zn, Pb-Sn, Al-Si, Al-Cu and other important non-ferrous alloys

Nucleation, Homogeneous and Heterogeneous nucleation, Kinetics of nucleation, Growth and overall transformation kinetics,

Study of Metallurgical Microscope, Metallographic specimen preparation, Polishing and Etching techniques, Cold Mounting and Hot Mounting of Metallic samples, High Temperature Microscopy: - Necessity, importance and associated details Macroscopic analyse of metallurgical specimen.

Books

1. Physical metallurgy Principles, R. E Reed-Hill, Thomson
2. Physical metallurgy, Vijendra singh, Standard Publishers, 2004
3. Physical metallurgy, V. Rghvan

राष्ट्रीय प्रौद्योगिकी संस्थान रायपुर
NATIONAL INSITUTE OF TECHNOLOGY RAIPUR
(Institute of National Importance)
G.E.Road, Raipur – 492010 (C.G.)

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

Name of the Subject	Ferrous Extractive Metallurgy I (Iron Making)	Subject Code	MT20413(MT)
Semester	IV	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1		4 (Th)

Brief details of coke making, Beneficiation of iron ores and metallurgical coals, Sizing of iron ores, Agglomeration of iron ore fines, sintering and pelletising. Importance of sizing & beneficiation of raw materials, Evaluation of properties of blast furnace burden materials and application to blast furnace performance, Functions/Role of Coke in blast furnace.

Chemical processes in Blast Furnace, Reactions in Tuyere, hearth and bosh zone. Reduction and coke gasification, Reactions in stack and exit gases. Thermodynamics of Blast furnace process requirement in Blast furnace, critical hearth temperature, temp. profile in the furnace. Free energy and equilibrium consideration in Blast furnace A brief discussion on blast furnace stoichiometry and enthalpy balance. Basic idea of Blast furnace aerodynamics.

Blast furnace plant and operation-Modern blast furnace, plant layout, Details of construction of blast furnace and its main accessories; gas cleaning system, hot blast generation. Blast furnace refractories and blast furnace cooling system. Blowing in, Blowing out and banking of blast furnace, Role of burden charging and distribution in iron extraction. Irregularities in Blast furnace operation and their remedies. Blast furnace products Their quality control and disposal, coke rate and fuel efficiency of B.F. operations.

Modern trends in Blast furnace practice-Production of super flux sinter, pellets, super flux and cold bonded pellets. Auxiliary fuel injection in the blast furnace. High temp. blast, humidified and oxy generated blast, Detailed discussion of high top pressure, Desulphurization of hot metal & decrepitation.

Alternate route for iron making: charcoal blast furnace, low shaft furnace and electro thermal processes of iron making. Direct reduction processes, their classification, choice of DR process. Applicability and present status of Technology in India.

Production of Ferro-alloy, Ferro Alloy industry in India. Beneficiation of indigenous raw materials for ferro alloy industry. Production of various ferro-alloys Fe-Mn, Fe-V, Fe-Cr etc. uses of ferro-alloys in iron and steel industry.

Text Books:

1. The manufacture of Iron – G.R. Bashforth
2. Modern Iron Making – Dr. R.H. Tupkary

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

3. Principles of Blast Furnace iron making – Dr. A K Biswas
4. production of ferro-alloys-Riss and Lipnitzky
5. Steel Making – AK chakrabarti, Prentice-Hall of India Pvt. Ltd, New Delhi, 2007

Reference Books:

1. Making Shaping and Treating of steel – US. Steel
2. Physical chemistry of iron and manufacture steel – Bods Worth C.h.S. Bell
3. The reduction of iron – Boadandy L. V. and S.j. Engell
4. The theory and practice – Blast Furnace ltd. – J.H. Siressearger

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

Name of the Subject	Engineering of Non-metallic Materials (ceramics, glasses, polymers and fluids)	Subject Code	MT20414(MT)
Semester	IV	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1		4 (Th)

Fundamentals of ceramics, Methods of shape forming ceramic powders, Properties and tests, Sintering of ceramics, Alumina ceramics, Magnesia ceramics, Zirconia ceramics, Aluminum titanate ceramics, Non-oxide ceramics, Silicate ceramics, Carbon materials, Applications of ceramics, Properties of ceramics

Polymer materials (Introduction), Polymer structure, Elastomers, Thermoplastics, Thermosets, Thermoforming, Extrusion of polymers, Injection molding of polymers, Blow molding, Compression molding of polymers, Transfer molding of polymers, Vulcanization, Shore (Durometer) hardness test, Adhesives, Paints, Ion exchange resins, Plastics recycling, Properties of polymers.

Classification of composites, Structure of composites, Estimations of composite materials properties, Metal Matrix Composites, Ceramic Matrix Composites, Polymer Matrix Composites, fiberglass, Carbon Fiber Reinforced Polymer Composites, Kevlar, Properties of composites

Lubricants, Classification of lubricants, Additives in lubricating oils, Engine oils, Gear oils, Hydraulic oils, Cutting fluids (coolants), Way lubricants, Compressor oils, Rust protection oils, Quenching and heat transfer oils, Transformer oils (insulating oils), Solvents, Gases, Dispersions, Properties of fluids

Reference / Text Books :

1. Material Science & Engineering – William F Smith, Javed Hashemi, Ravi Prakash (4th Ed. TMC)

राष्ट्रीय प्रौद्योगिकी संस्थान रायपुर
NATIONAL INSITUTE OF TECHNOLOGY RAIPUR
(Institute of National Importance)
G.E.Road, Raipur – 492010 (C.G.)

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

Name of the Subject	Principles of Non Ferrous Extractive Metallurgy	Subject Code	MT20415(MT)
Semester	IV	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1		4 (Th)

General methods of extraction in Pyrometallurgy - Drying, Calcination, Roasting, Smelting, Carbothermic and Metllothermic reduction, Refining techniques like Liquation, Distillation, Vacuum Distillation etc

Principles of hydro and electrometallurgy with suitable examples

Leaching techniques, Leaching solvents, Theory of leaching, Bacterial leaching, Electrochemical nature of leaching, Gold and silver extraction.

Pressure leaching, Sherritt - Gorden process for Copper, Nickel, Cobalt ores; Solvent extraction, Ion exchange.

Electrometallurgy - Electrolysis of aqueous solutions and fuses salts, Cell design, Recovery of metal values by Cementation, Electro-winning, Electro-refining etc. Principles and important applications.

Extraction of metals from oxides - Magnesium and Titanium extraction,

Bayer's process, Hall Heroult process.

Extraction of meals from sulphides: , Extraction of Copper, Lead, Zinc, Nickel.

Reference / Text Books :

1) Ray H.S., Sridhar R., Abraham K.P.;.Extraction of Non-ferrous Metals; West Publin., 1990
2) Rosenquist T; Principles of Extractive Metallurgy; McGraw Hill Koga Kusha, 1985.
3) Serynkova; General Metallurgy
4) Volsky A.; Theory of Metallurgical Processes; Mir Publication, 1971.
5) Philipova N.; Theory of Metallurgical Processes, Mir Publication; 1975.
6) Jackson Eric; Hydrometallurgical Extraction; John Wiely & Sons, 1986.
7) Bray J.L.;. Extraction of Non-ferrous Metals; John Wiely & Sons, 1959
8) Dr. Venkatachalam; Hydrometallurgy; Narosa Publishline House, 1998.

राष्ट्रीय प्रौद्योगिकी संस्थान रायपुर
NATIONAL INSITUTE OF TECHNOLOGY RAIPUR
(Institute of National Importance)
G.E.Road, Raipur – 492010 (C.G.)

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

Name of the Subject	Transport phenomena in metallurgical processes	Subject Code	MT20416(MT)
Semester	IV	Board of Studies	Metallurgy
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
4	1	3	5 (Th) + 2 (P)

Fluid Flow: Classification of fluids, Differential and total energy balances, Laminar and Turbulent flows. Flow through pipes and ducts, and beds of solids. Flow through pipes and ducts, and beds of solids. Flow measurement, Application of dimensional analysis of fluid flow. Concept of boundary layer. Miscellaneous topics such as Bed and Particulate fluidization, Macroscopic mechanical energy balances, Chimney draft, air leakage from openings, molecular of Knudsen flow, etc. as in problems and exercises.

Heat Transfer I: Steady –state and Transient conduction in solids. One dimensional steady state problems of heat flow through composite walls, Cylinder and Spheres. Unsteady conduction in one dimensional system examples of heating and cooling of plates and cylinders, Use of Heisler charts and applications. Convective heat transfer, equation of energy, free and forced convections. Application of dimensional analysis to convection problem. Concept of heat Example, problems and exercises on the above.

Heat Transfer II: Radiation , Nature of thermal radiation, Black and Grey bodies, Stefan and Boltzmann law, Kirchoffs laws, Intensity of radiation, lamberts law, View factor. Heat transfer between two black walls in an enclosure. Radiation shields, Radiation through opening in furnaces, radiation from flames and gases. Combined effect of convection, conduction and radiation. Over all heat transfer coefficient. Example problems and exercises on systems of steady heat flow important in Metallurgy.

Mass transfer and kinetics: Importance in Heterogeneous metallurgical systems of reactions. Steady one dimensional mass diffusion of component through stationary media. Convective mass transfer in fluids ,concept of concentration boundary layer, Mass transfer coefficient. Heterogeneous reactions of metallurgical importance, Their rate controlling steps. Discussion of the following examples from metallurgical systems: Nucleation and growth and bubble formation phenomenon, Interfacial reaction, Carbon gasification by CO2, slag-metal reaction at the interface, Topo-chemical model of gas-sokid reaction.

Process Rate Calculation in Reactor Engineering:
Metallurgical reactors, classification with examples, Staged Operations of metallurgical engineering, Pyro metallurgical reactors. Introduction to reactor kinetics, concept of retention times and other parameters of reactors, Analysis of rates in batch – type semi-batch type/cocurrent and counter current mode reactors. Introductory remarks on mixing and residence time-distribution in metallurgical reactors, determination of the value of E.

Essential Readings:

Phone : (0771) 2254200
Fax : (0771) 2254600
Website : www.nitrr.ac.in

1. R.B. Bird, W.E. Stewart and E.N.Lightfoot, Transport Phenomena, Wiley, 1994.
2. G.H. Geiger and D.R. Poirier, Transport Phenomena in Materials Processing, Addison Wesley, Mass, 1994.

Supplementary Readings:

1. J.R. Welty, R.E. Wilson and C.E. Wicks, Fundamentals of Momentum Heat and Mass Transfer, Wiley, 1976.
2. R.I.L. Guthrie, Engineering in Process Metallurgy, Oxford Science, 1992.