Name of Programme : **Diploma in Metallurgical Engineering**

Programme Code : **05/19**

Name of Course : **Mini Project**

Course Code : **MT381**

Teaching Scheme:

	Hours / Week	Total Hours
Theory	--	--
Term work / Practical	2	32

Evaluation:

	Progressive Assessment	Semester End Examination			
		Theory	Practical	Oral	Term work
Marks	--	--	--	25	25

Course Aim:

The Mini Project work is included in the curriculum to encourage the students to undertake and tackle an independent problem related to Metallurgical field. The project also comprises of literature survey of a problem assigned.

Course Objectives:

Students will be acquainted with the skill required for independent thinking and applications to a problem where he can develop in himself, self reliance.

After completing the project work, the student will be able to:

- Work independently as a leader as well as member of a team.
- Collect data and prepare a report of these activities.
- Use and integrate knowledge of different subjects to prepare working drawings of scheme.
- Make simple designs according to data collected with the help of handbooks, standard data books, I.S. codes etc.

Course Content: (A) Mini Project

Sr. No	Topic / Subtopic	Practical
1	Mini Project	The students will select a topic related to any course in the curriculum and submit a report of the work done. The Project work will be done by a group of 4 to 6 students. Oral will be based on term-work.

Prepared by

(N.S.Kadam)

(A.S.Zanpure)
Member Secretary
P.B.O.S

(N.S.Kadam)
Chairman P.B.O.S.

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Basic Metallurgy**
Course Code	:	**MT382**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	04	64
Practical	04	64

Evaluation Scheme:

	Progressive Assessment	Semester End Examination			
		Theory	Practical	Oral	Term work
Duration	Three class tests, each of 60 minutes	3Hrs.	--	--	--
Marks	20	80	--	50	25

Course Rationale:

Basic metallurgy mainly deals with basic topics required for understanding metallurgical subjects. The subject is a collection of widely different basic topics such as fuels, refractories, vacuum technology, conceptual understanding of structure of solid materials and their properties.

Course Objectives:

Metallurgical industries require use of high temperature equipment and materials for its productions. Therefore the students are required to be well conversant with materials and fuels involved in furnace technology. Besides metals, many non-metallic materials are now used in the field. A basic understanding of their structure, properties and uses is therefore necessary.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
1	**Introduction**			
	1.1	Importance of metallurgy, branches of metallurgy and scope under Indian condition.	02	--
2	**Nature of Solids**			
	2.1	States of matter, types of structures, atomic structure of metals, allotropy, miller indices for planes and directions.	06	08
	2.2	Imperfections in the crystals of point, line and surface.		
	2.3	Polymorphism.		
3	**Plastic Deformation**			
	3.1	Grain structure, cold working, annealing, recrystallisation, recovery and grain growth.	08	10
	3.2	Structures of silicates, carbon, glasses.		
	3.3	Polymeric structure. Ceramics and their comparison with metals (Strength to weight ratio).		
4	**Solid Fuels**			
	4.1	Classifications of fuels, solid fuels, occurrence of coal with reference to Indian conditions.	14	18
	4.2	Classifications of coal, carbonization of coal, properties of coke, bi-products of coke. Use of pulverized and briquetted coal or coke.		
	4.3	Selection of fuel for particular application. Combustion calculation.		
5	**Liquid and Gaseous Fuels and Furnace Technology**			
	5.1	Important properties and uses of liquid fuels.	14	18
	5.2	Manufacture of gaseous fuels. Gaseous fuels composition. Properties and uses of Natural gas. Blast furnace gas, coke oven gas and liquefied petroleum gases.		
	5.3	Study of types of flames. Burners required for combustion of liquid and gaseous fuels and their working principles. Regenerators & recuperators.		
6	**Refractory Materials**			

	6.1	Classification, properties and application of fireclay, silica, magnesite, chromite, carbon and special refractories like insulation materials, fused silica, alumina, zirconia, insulation materials like cer-wool.	06	08
7	**Furnace Technology**			
	7.1	Basic types of furnaces, Use in industries.	08	10
	7.2	Refractories used in furnaces, different fuels used in furnaces.		
	7.3	Types of furnaces – Shaft, reverbaratory, coke fired furnace.		
	7.4	Applications of Thermocouples and Pyrometers in Metallurgical Industries.		
	7.5	Introduction to Infrared analyzer for temperature measurement.		
8	**Vacuum Technology**			
	7.1	Management of vacuum production, equipments, its working principles. Application of Vacuum Metallurgy.	06	08
		Total	64	80

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment	Hrs
1	Crystal structures and planes – F.C.C., B.C.C., H.C.P., structures to be studied with the help of models, sketching structures and planes. Miller indices with the help of models.	08
2	Proximate analysis of coal and coke: Determination of moisture content volatile matter and ash content of coal antl coke.	08
3	Calorific value of fuel: Determination of calorific value of coal and coke by using bomb calorimeter.	08
4	Study of flash point apparatus: Determination of flash point of liquid fuel such as furnace oil.	08
5	Study of burners.	08
6	Study of burners used for gas and liquid fuels.	08
7	Properties of refractories: Determination of cold crushing strength and porosity of different refractories.	08
8	Visual inspection of refractories identification of various types of	08

	refractories and physical defects such as chips, cracks etc.	
	Total	**64**

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
1	Introduction	Lecture method
2	Nature of Solids	Demonstration method
3	Plastic Deformation	Lecture method
4	Solid Fuels	Industrial Visit, Lecture method
5	Liquid and Gaseous Fuels and Furnace Technology	Demonstration & Lecture Method
6	Refractory Materials	Lecture method
7	Furnace Technology	Demonstration & Lecture Method
8	Vacuum Technology	Lecture method

Text Books:

Sr. No	Author	Title	Publication
1	Francis	Fuel Technology Vol I & II	Pergaman Press, London
2	D Swarup	Elements of Metallurgy	Rastogi Publication, Meerut.

Reference Books:

Sr. No	Author	Title	Publication
1	Gilchrist J.D.	Fuels & Refractories	Perganson
2	Gupta	Elements of Fuels, Refractories	Oxford Press

Learning Resources: O. H. P., Charts and Models.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
1	Nature of Solids	04	02	02	08
2	Plastic Deformation	05	05	-	10
3	Solid Fuels	10	04	04	18
4	Liquid & Gaseous Fuels & Furnace Technology	10	04	04	18
5	Refractory Materials	04	02	02	08
6	Furnace Technology	06	02	02	10
7	Vacuum Technology	04	02	02	08
Total		**43**	**21**	**16**	**80**

Prof.
Prepared By

Prof. A.S.Rampure
Secretary, PBOS

Prof.N.S.Kadam
Chairman, PBOS

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Material Testing and Quality Assurance**
Course Code	:	**MT383**

Teaching Scheme:

	Hours /Week	. Total Hours
Theory	**04**	**64**
Practical	**04**	**64**

Evaluation Scheme:

	Progressive Assessment	Semester End Examination			
		Theory	Practical	Oral	Term work
Duration	Three class tests, each of 60 minutes	3Hrs.	--	--	--
Marks	**20**	**80**	**50**	--	**25**

Course Rationale:

To expose the students to various tests that can be carried out on materials, their purpose and utility. To study the effect of various metallurgical parameters on test results.

Course Objectives:

After studying this course, the student should be able to

- Understand the general terms used in testing.
- Relate theoretical concepts to the results obtained.
- Get familiar with the machines and equipments used for testing.
- Use and apply test results to improve quality of material.
- Diagnose the reasons of poor quality and identify the remedial measures.
- Understand terms used in quality standards and different national and international existing quality standards used.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
1	**Mechanical properties of metals**			
	1.1	A brief introduction to bonding arrangement in materials and especially in metals and alloys i.e. metallic bond.	12	16
	1.2	Deformation of metals under various loading conditions i.e. tensile, compressive and shear.		
	1.3	Elastic and plastic deformation, various terms used i.e. stress, strain, elasticity, plasticity, toughness, resilience. Stress- Strain curves, Yield point and yielding phenomenon, percentage elongation and reduction in area, proof stress. Hook's law, Modulus of elasticity, Young's modulus.		
	1.4	Shear and torsion tests.		
	1.5	Fracture and its mechanism. Fracture of ductile and brittle materials. Study of different tensile testing machines, universal testing machine etc.		
2	**Hardness Tests**			
	2.1	Concept of hardness. Methods of hardness test, such as indentation, scratch and rebound.	10	14
	2.2	Types of indentation hardness tests, such as Brinell, Vicker, Rockwell and Knoop, their indenters and measurements of hardness number.		
	2.3	Rebound hardness test. Shore Scleroscope. Dynamic hardness tester. Poldi Hardness Tester.		
	2.4	Scratch hardness test: Moh's scale of hardness, File test, Brief introduction to hardness machines and their operations.		
	2.5	Principle of Microhardness tester.		
3	**Impact Tests**			
	3.1	Significance of impact test.	08	12
	3.2	Izod and Charpy impact tests. Their specimen details, mounting of specimens in each case. Effect of variables on the impact test values such as variation in striking velocity, size and shape of specimen, temperature, grain size and composition.		

	3.3	Embrittlement phenomena: temper and hydrogen embrittlement.		
	3.4	Impact strength- Temperature relationship and transition temperature range.		
4	**Fatigue Test**			
	4.1	Concept of fatigue. Repeated loadings, their types.	**10**	**12**
	4.2	Fatigue test, fatigue strength, and endurance limit. Orowan's and Wood's theories explaining fatigue failure. Effect of composition, stress concentration, size and surface conditions on fatigue strength.		
	4.4	Measures to be taken to improve fatigue life.		
5	**Creep Test**			
	5.1	Concept of creep. Creep Test. Standard creep curve with explanation of various stages. Effect of temperature on creep test, equi-cohesive temperature.	**08**	**10**
	5.2	Factors affecting creep such as composition, grain size, method of steel making and heat treatment.		
	5.3	Relation between creep rate, stress and temperature.		
6	**Non-Destructive Testing**			
	6.1	Need for non-destructive tests. Concept of non-destructive tests.	**10**	**12**
	6.2	Comparison between destructive and non-destructive tests.		
	6.3	Introduction to various non-destructive tests such as: Visual examination, Leakage testing, Penetrant test, Magnetic methods, Acoustic methods, Ultrasonic test, Radiography, Thermal tests, Electrical methods- Eddy current method.		
7	**Quality Aspects**			
	7.1	Concept of quality. Brief introduction to various quality standards, such as ISI, BIS and ISO. Brief introduction to ISO 9000 series standards.	**06**	**04**
		Total	**64**	**80**

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment	Hrs
1	To carry out tensile test on mild steel and aluminum.	08
2	To draw stress-strain curve. To interpret the curve with respect to applicability of materials.	08
3	To acquaint with various tensile test machines.	08
4	To carry out hardness tests on samples using Vicker, Brinell, Rockwell and Poldi Hardness Testers.	08
5	To carry out impact tests on brass, aluminum and copper specimens.	08
6	To carry out fatigue tests on mild steel and aluminum specimens.	08
7	To study creep test. Interpretation of test results.	08
8	To carry out dye penetrant test and magnetic particle test.	08
	Total	**64**

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
1	Mechanical properties of metals	Lecture and practical
2	Hardness tests	Lecture and practical
3	Impact tests	Lecture and practical
4	Fatigue test	Lecture and practical
5	Creep test	Lecture and practical
6	Non-destructive testing	Lecture and practical
7	Quality aspects	Lecture

Text Books:

Sr. No	Author	Title	Publication
1	George E. Dieter	Mechanical Metallurgy	Mc Graw-Hill Book Company
2	Davis, Troxell and Wiskonell	Testing and Inspection of Engineering materials	Mc Graw-Hill Book Company
3	A.V.K. Suryanarayan	Testing of Metallic Materials	Priatice-Hall of India Pvt Ltd
4	Dr. V.D.Kodgire	Material Science And Metallurgy	Everest Publishing House

Learning Resources: O. H. P., Charts and Models.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
1	Mechanical properties of metals	08	04	04	16
2	Hardness tests	08	03	03	14
3	Impact tests	05	03	04	12
4	Fatigue test	05	03	04	12
5	Creep test	05	02	03	10
6	Non-destructive testing	05	03	04	12
7	Quality aspects	02	01	01	04
	Total	**38**	**19**	**23**	**80**

Prof.
Prepared By
Sarika S. Aglave

Prof. A.S. Zanpure
Secretary, PBOS

Prof.N.S.Kadam
Chairman, PBOS

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Metallurgical Analysis**
Course Code	:	**MT384**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	**04**	**64**
Practical	**04**	**64**

Evaluation Scheme:

	Progressive Assessment	Semester End Examination			
		Theory	Practical	Oral	Term work
Duration	Three class tests, each of 60 minutes	3Hrs.	--	--	--
Marks	**20**	**80**	**50**	--	**25**

Course Rationale:

Material science field is continuously expanding. New alloys and composite materials are coming up rapidly to meet common needs in general and specific needs in particular. Chemical analysis became essential to investigate the composition of these materials to provide data in respect of composition and the properties therefore. The metallurgist is expected to be conversant with various processes of chemical analysis. He should know the principles and laws governing the chemical reactions, which can be applied to decide the extraction path of metals from its specific ores. Metallurgist should have an insight of instruments and their operating principles used for chemical analysis.

Course Objectives:

After studying this course, the student should be able to:

- Know the importance of chemical analysis.
- Know the sampling methods for various materials.
- Know different instruments used for chemical analysis.
- Understand the assay system of analysis.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
1	**Introduction**			
	1.1	A brief insight into Analytical Chemistry. Purpose of analysis. Types of analysis, qualitative and quantitative. Methods of quantitative analysis.	12	12
	1.2	Sample and its importance, methods of sampling of ore; coal and liquid metal and alloys.		
	1.3	Errors in analysis such as systematic; random, absolute, relative and mistakes.		
	1.4	Precision and Accuracy, Deviation, Mean Deviation and Relative Mean Deviation.		
	1.5	Balances and Weights and the calibration of weights.		
	1.6	Equilibrium reaction. Law of mass action: Mass Law Equation: Le Chatelier's Principle.		
	1.7	Electrolytic Dissociation, electrolytes, ions cation. Dissociation of Acid, Base and Salt. Ampholytes. Degree of Dissociation. Effect of concentration, temperature and other ions on, degree of dissociation.		
	1.8	Dissociation of water, Hydrogen ion exponent, P^H; Ionic Product of Water.		
	1.9	Solubility, saturated solution, supersaturated solution. Solubility Product, Salt Effect.		
2	**Gravimetric Analysis**			
	2.1	General process followed i.e. dissolution of sample, precipitation, ignition and weighing of precipitate.	18	25
	2.2	Precipitation: choice of precipitate, amount of precipitate, the condition of precipitation. Requirements of precipitated and weighed form.		
	2.3	Co-Precipitation, washing of precipitate.		
	2.4	Complex salts, masking of ions.		
	2.5	Simple calculations to determine the % of element in a precipitate or compound; Determination of Carbon and Sulphur in Cast Iron. Determination of Silicon in Cast Iron.		
3	**Volumetric Analysis**			

	3.1	Solution, concentration of solution, methods of expression of solution strength, Equivalent weight, Normality of solution, preparation of standard solution.	18	25
	3.2	Acid –Base neutralization reaction.		
	3.3	Titration, types and methods of titration. Equivalence point, End point and Neutral point in Acid-Base titrations.		
	3.4	Indicators, role and action of indicators in titration, P^H range of indicator, Selection of indicator for acid base titration.		
	3.5	Titration curve, plotting of different titration curves depending upon different strength of acid and base e.g. weak acid with strong base etc.		
	3.6	Oxidation-Reduction reactions, Oxidizing and Reducing agents, Oxidation-Reduction potential. Redox titration curve, titrations with potassium permanganate solution, Gram-equivalent of oxidizing and reducing agents, Determination of Fe^{++} by redox method.		
	3.7	Comparisons between gravimetric and volumetric analysis.		
	3.8	Simple calculations with respect to strength of the solution.		
4	**Instrumental Analysis**			
	4.1	Scope for instrumental analysis. Advantages of instrumental analysis.	08	08
	4.2	Introduction to Spectroscopy, Electrolysis, Potentiometric Titration, Polorography and Colourimetry. Beer's Law and Lambert's Law.		
	4.3	Colorimetric methods, Photoelectric colorimeter.		
	4.4	Electrolysis, Potentiometric Titration.		
5	**Fire Assay**			
	5.1	Introduction to and principles of fire assaying, Assay-ton system of weights and sample size in gms taken for assaying.	08	10
	5.2	Steps involved in fire assaying, such as: Sampling, Mixing of reagents, Firing, Casting, Cupelling and Parting.		

	5.3	Scorification of gold and silver ores and crucible assay.		
		Total	**64**	**80**

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment	Hrs
1	Preparation of standard solution.	06
2	Observing the effects of common ion and diverse ion on solubility.	06
3	Determination of chemical formula for crystalline compound.	06
4	Determination of Ni, C & S in cast iron.	06
5	To perform acid-base titration.	06
6	Determination of Fe^{++} by redox method.	06
7	Colorimetric determination of concentration of solution [$CuSO_4$ and/or $KMNO_4$].	06
8	Assay of gold/ silver coins or articles.	06
	Total	**64**

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
1	Introduction	Lecture method
2	Gravimetric Analysis	Lecture method, Question-Answer method
3	Volumetric Analysis	Lecture method, Question-Answer method
4	Instrumental Analysis	Lecture method
5	Fire assay	Lecture method, Question-Answer method

Text Books:

Sr. No	Author	Title	Publication
1	B.C.Agarwal S.P. Jain	Text Book Of Metallurgical Analysis	Khanna Publisher, N. Delhi
2	Dr. S.B. Salunke Dr. B.B. Deogadkar Dr. C.M. Bhavasar	Physical and Analytical Chemistry	Nirali Prakashan, Pune

Reference Books:

Sr. No	Author	Title	Publication
1	V. Alexeyev	Quantitative Analysis	MIR Publisher, Moscow

Learning Resources: O. H. P., Charts and Models.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
1	Introduction	08	02	02	12
2	Gravimetric Analysis	15	05	05	25
3	Volumetric Analysis	15	05	05	25
4	Instrumental Analysis	05	02	01	08
5	Fire assay	05	03	02	10
	Total	**48**	**17**	**15**	**80**

Prof.
Prepared By

Prof.A.S.Zanpure
Secretary, PBOS

Prof.N.S.Kadam
Chairman, PBOS

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Extraction of Ferrous Metals**
Course Code	:	**MT385**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	**04**	**64**
Practical	--	--

Evaluation Scheme:

	Progressive Assessment	Semester End Examination			
		Theory	Practical	Oral	Term work
Duration	Three class tests, each of 60 minutes	3Hrs.	--	--	--
Marks	20	80	--	50	--

Course Rationale:

To expose the students to basic principles and methods involved in extraction of ferrous metals from ores and secondary sources. Metallurgists are required to know, the potential sources of metals, winning of metals from their sources and refining the metals to their highest purity.

Course Objectives:

After studying this course, the student should be able to:

- Understand the general terms used in extraction of metals.
- Correlate the scientific principles and technology used with the different extraction processes.
- Get familiar with major equipments used in extraction of metals.
- Have a brief account of iron and steel industries in India.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
1	**Occurrence of Metals**			
	1.1	Introduction to minerals, their types i.e. native metals, oxides, oxy-salts, sulphides, arsenides etc.	04	04
	1.2	Terminology like ore, gangue, concentrate etc.		
	1.3	General sequence of operations involved in extraction of metals from their ores.		
	1.4	Introduction to Pyrometallurgy, Hydrometallurgy and Electrometallurgy.		
2	**Ore Dressing**			
	2.1	Comminution: Crushing and Grinding with jaw crusher, cone crusher, gyratory crusher and ball mill etc.	09	12
	2.2	Sorting: Operations based on some physical properties such as density, surface properties, or magnetism such as; classification, jigging, tabling, floatation, magnetic separation, electrostatic separation, agglomeration- palletizing, sintering etc.		
3	**Thermodynamics of Chemical Reactions**			
	3.1	Concept of free energy of formation of compounds, change in free energy, enthalpy.	05	06
	3.2	Exothermic and endothermic reactions, spontaneous reactions.		
	3.3	Conditions for reduction and oxidation of metals.		
4	**Manufacturing of Pig Iron**			
	4.1	Preparation of charge for blast furnace i.e. coke, flux and ore.	18	24
	4.2	Blast furnace, its construction and shape, charging arrangement, movement of charge, role of coke and flux.		
	4.3	Chemical reactions occurring in different zones of blast furnace.		
	4.4	Behavior of S, P, Zn and alkali metals, formation of slag and pig iron.		
	4.5	Blast furnace stoves and their use, cleaning of blast furnace gas.		

	4.6	Average quantity of charge per ton of pig iron. Modern practices in blast furnace such as increased top pressure, preheating of air blast, use of oxygen, steam and hydrocarbons in the air blast.		
	4.7	Irregularities in the operation of blast furnace and their remedies.		
5	**Alternative routes of Iron production**			
	5.1	Reduction of ore in solid state.	**05**	**06**
	5.2	Sponge iron, various processes of sponge iron production. Use of sponge iron.		
6	**Iron making in India**			
	6.1	History of iron making in India.	**05**	**04**
	6.2	Ore deposits in India, their quality and other important aspects.		
	6.3	Major plants in India, their location and other relevant information.		
	6.4	Future prospects of iron making in India.		
7	**Production of Steel**			
	7.1	Necessity for conversion of pig iron into steel. Brief historical review of steel making.	**18**	**24**
	7.2	Bessemer Process, Basic Bessemer process.		
	7.3	Oxygen steel making processes such as LD, Kaldo, Rotor etc. & their charge, reactions.		
	7.4	Open hearth processes of steel making. Construction of open hearth furnace, its charge, charging sequence, reactions, ore boils, and lime boil.		
	7.5	Electric processes of steel making. Use of Arc furnace, Resistance furnace and Induction furnace. Their construction and operation. Comparison of different steel making processes.		
	7.6	Secondary metallurgy- AOD, VOD. Laddle refining		
	7.7	Duplex process of steel making. A brief introduction to Integrated Steel Plant.		
	7.8	Principle of Continuous casting process. Its advantages, disadvantages and applications.		
		Total	**64**	**80**

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment
1	Layout of Integrated steel plant.
2	Layout of Integrated ore dressing plant.
3	Write up on Iron pillar of Delhi.
4	A report on Industrial visit.

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
1	Occurrence of Metals	Lecture method
2	Ore Dressing	Lecture method, Demonstration
3	Thermodynamics of Chemical Reactions	Lecture method, Demonstration with chart
4	Manufacturing of Pig Iron	Lecture method, Demonstration with chart
5	Alternative routes of Iron production	Lecture method, Demonstration
6	Iron making in India	Lecture method, Demonstration with chart
7	Production of Steel	Lecture method, Demonstration with chart

Text Books:

Sr. No	Author	Title	Publication
1	Boris Kuznetsov	General Metallurgy	Mir Publishers, Moscow
2	Dr. R.H. Tupkari	Modern Iron Making	Khanna Publishers
3	Dr. R.H. Tupkari	Modern Steel Making	Khanna Publishers

Learning Resources: O.H.P / Transparencies, Charts.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
1	Occurrence of Metals	03	01	00	04
2	Ore Dressing	06	04	02	12
3	Thermodynamics of Chemical Reactions	03	01	02	06
4	Manufacturing of Pig Iron	12	08	04	24
5	Alternative routes of Iron production	04	01	01	06
6	Iron making in India	02	02	00	04
7	Production of Steel	12	08	04	24
	Total	**42**	**25**	**13**	**80**

Prof. Saiuke.
Prepared By
Sarita S. Aglave.

Prof. A. S. Zanpure
Secretary, PBOS

Prof. N. S. Kadam
Chairman, PBOS

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Extraction of Non-Ferrous Metals**
Course Code	:	**MT386**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	04	64
Practical	--	--

Evaluation Scheme:

	Progressive Assessment	Semester End Examination			
		Theory	Practical	Oral	Term work
Duration	Three class tests, each of 60 minutes	3Hrs.	--	--	--
Marks	20	80	--	50	--

Course Rationale:

To expose the students to basic principles and methods involved in extraction and refining of few important non-ferrous metals of engineering and commercial applications.

Course Objectives:

After studying this course, the student should be able to:

- Understand the general terms used in extraction of metals.
- Correlate the scientific principles and technology used in extraction of metals.
- Get familiar with major equipments used in extraction of metals.
- Have a brief account of non-ferrous metal industries in India.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
1	**Classification of Metals**			
	1.1	Common division of metals i.e. ferrous and non-ferrous. A brief introduction to Periodic Table of elements.	06	06
	1.2	Classification of metals based on properties, structure, application, such as refractory metals, rare-earth metals, noble metals, alkali-earth metals etc.		
2	**Metallurgy of Copper**			
	2.1	Important copper minerals and ores; oxides, sulphides and native copper.	12	14
	2.2	Ore dressing processes to obtain concentrate particularly from sulphide ores and flow sheet.		
	2.3	Production of copper from ores and concentrates. Pyrometallurgical methods and Hydrometallurgical methods, their flow sheet.		
	2.4	Refining of copper. OFHC copper and its applications.		
	2.5	Introduction to copper extraction in India.		
3	**Metallurgy of Lead**			
	3.1	Sources of lead. Important lead ores. Ore- Dressing.	08	12
	3.2	Principles used in smelting of lead ores. Ore Hearth Smelting and Blast Furnace smelting of lead.		
	3.3	Refining of lead: Pyrometallurgical and Electrolytic methods. Flow sheets of various processes.		
4	**Metallurgy of Zinc**			
	4.1	Occurrence of zinc its ores. Ore dressing.	10	10
	4.2	Roasting of zinc concentrates. Suspension roasting and Fluidized-bed roasting processes.		
	4.3	Extraction of metallic zinc by distillation in horizontal and vertical retort.		
	4.4	Hydrometallurgical processes for zinc extraction. Flow sheets of various processes.		
	4.5	Refining of Zn by liquation and redistillation.		

5	**Metallurgy of Aluminum**			
	5.1	Sources of aluminum. Preparation of alumina by processes such as acid, alkaline and elecrothermic, with emphasis to Bayer and Le Chetelier-Morin processes.	**14**	**16**
	5.2	Preparation of Cryolite. Manufacturing of carbon electrodes and anode materials.		
	5.3	Production of metallic aluminum by electrolysis, Construction and working of aluminum reduction cell. Composition of bath and its properties. The anode effect, cathode effect and minor effects in the electrolyte. Modern practices in design of electrolytic cell.		
	5.4	Refining of aluminum by chlorination and electrolytic processes.		
	5.5	Recycling of Aluminum.		
6	**Metallurgy of Gold and Silver**			
	6.1	Sources of gold. Methods of gold recovery.	**08**	**12**
	6.2	Gravity concentration, Amalgamation, Cyanidation and gold precipitation from cyanide solutions. Typical flow sheets.		
	6.3	A brief introduction to production of silver.		
	6.4	Refining of gold and silver bullion.		
7	**Metallurgy of Tungsten**			
	7.1	Sources of tungsten. Concentration of ores.	**06**	**10**
	7.2	Treatments to wolframite and scheelite concentrates.		
	7.3	Production of tungsten powder and ductile tungsten.		
		Total	**64**	**80**

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment
1	Preparation of report on historical development of metals.
2	Flow sheet for Flotation process (for mixed sulphite ore).
3	A report on Industrial visit.

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
1	Classification of Metals	Lecture method
2	Metallurgy of Copper	Lecture method
3	Metallurgy of Lead	Lecture method
4	Metallurgy of Zinc	Lecture method
5	Metallurgy of Aluminum	Lecture method
6	Metallurgy of Gold and Silver	Lecture method
7	Metallurgy of Tungsten	Lecture method

Text Books:

Sr. No	Author	Title	Publication
1	Boris Kuznetsov	General Metallurgy	Mir Publishers, Moscow
2	Dr. R.H. Tupkari	Modern Iron Making	Khanna Publishers
3	Dr. R.H. Tupkari	Modern Steel Making	Khanna Publishers
4	J.D. Gilchrist	Extraction Metallurgy	Pergamon Press, London

Learning Resources: O.H.P / Transparencies, Charts.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
1	Classification of Metals	04	01	01	06
2	Metallurgy of Copper	10	02	02	14
3	Metallurgy of Lead	08	02	02	12
4	Metallurgy of Zinc	05	03	02	10
5	Metallurgy of Aluminum	10	04	02	16
6	Metallurgy of Gold and Silver	06	03	03	12
7	Metallurgy of Tungsten	05	03	02	10
	Total	**48**	**18**	**14**	**80**

Prof.S.S.Aglave
Prepared By

Prof.A.S.Zanpure
Secretary, PBOS

Prof.N.S.Kadam
Chairman, PBOS