STATE COUNCIL FOR TECHNICAL EDUCATION AND VOCATIONAL TRAINING, ODISHA

TEACHING AND EVALUATION SCHEME FOR 5TH Semester (Metallurgy)(wef 2019-20)

Subject Number	Subject Code	Subject	Periods/week			Evaluation Scheme			
			L	T	P	Internal Assessment/ Sessional:	End Sem Exams	Exams (Hours)	Total
		Theory							
Th.1		Entrepreneurship and Management & Smart Technology	4		-	20	80	3	100
Th.2		Heat Transfer, Fluid Flow & Furnaces	4		-	20	80	3	100
Th.3		Heat Treatment Technology	4		-	20	80	3	100
Th.4		Ferrous Metallurgy II	4			20	80	3	100
Th.5		Non Ferrous Metallurgy	4			20	80	3	100
		Total	20			100	400	-	500
		Practical							
Pr.1		Heat Treatment lab.	-	-	6	50	50	3	100
Pr.2		Metallography Lab-II	-	-	6	50	50	3	100
Pr.3		Project		-	4	50	-	-	50
		Student Centred Activities(SCA)			3				
		Total	-	-	*19*	*150*	*100*	-	*250*
		Grand Total		**-**	**39**	**250**	**500**	**-**	**750**

Abbreviations: L-Lecturer, T-Tutorial, P-Practical. Each class is of minimum 55 minutes duration

Minimum Pass Mark in each Theory subject is 35% and in each Practical subject is 50% and in Aggregate is 40%

SCA shall comprise of Extension Lectures/ Personality Development/ Environmental issues /Quiz /Hobbies/ Field visits/ cultural activities/Library studies/Classes on MOOCS/SWAYAM etc., Seminar and SCA shall be conducted in a section.

There shall be 1 Internal Assessment done for each of the Theory Subject. Sessional: Marks shall be total of the performance of individual different jobs/ experiments in a subject throughout the semester

CURRICULLUM OF 5TH SEMESTER

For

DIPLOMA IN Metallurgy ENGINEERING

(Effective FROM 2020-21Sessions)

STATE COUNCIL FOR TECHNICAL EDUCATION & VOCATIONAL TRAINING, ODISHA, BHUBANESWAR

Th1. ENTREPRENEURSHIP and MANAGEMENT & SMART TECHNOLOGY

(Common to All Branches)

Theory	**4 Periods per week**	**Internal Assessment**	**20 Marks**
Total Periods	**60 Periods**	**End Sem Exam**	**80 Marks**
Examination	**3hours**	**Total Marks**	**100Marks**

Topic Wise Distribution of Periods

Sl No.	Topic	Periods
1	Entrepreneurship	10
2	Market Survey and Opportunity Identification(Business Planning)	8
3	Project report Preparation	4
4	Management Principles	5
5	Functional Areas of Management	10
6	Leadership and Motivation	6
7	Work Culture, TQM & Safety	5
8	Legislation	6
9	Smart Technology	6
	TOTAL	60

RATIONALE

In the present day scenario, it has become imperative to impart entrepreneurship and management concepts to students, so that a significant percentage of them can be directed towards setting up and managing their own small enterprises. It may be further added that an entrepreneurial mind set with managerial skill helps the student in the job market. The students can also be introduced with Startup and Smart Technology concept, which shall radically change the working environment in the coming days in the face of Industry 4.0

In this subject, the Students shall be introduced/ exposed to different concepts and Terminologies in brief only, so that he/she can have broad idea about different concepts/items taught in this subject. Solving numerical problem on any topic/item is beyond the scope of this subject.

OBJECTIVES

After undergoing this course, the students will be able to :

- Know about Entrepreneurship, Types of Industries and Startups
- Know about various schemes of assistance by entrepreneurial support agencies
- Conduct market survey
- Prepare project report
- know the management Principles and functional areas of management
- Inculcate leadership qualities to motivate self and others.
- Maintain and be a part of healthy work culture in an organisation.
- Use modern concepts like TQM
- Know the General Safety Rules
- Know about IOT and its Application in SMART Environment.

DETAILED CONTENTS

1. **Entrepreneurship**
   - Concept /Meaning of Entrepreneurship
   - Need of Entrepreneurship
   - Characteristics, Qualities and Types of entrepreneur, Functions
   - Barriers in entrepreneurship
   - Entrepreneurs vrs. Manager
   - Forms of Business Ownership: Sole proprietorship, partnership forms and others
   - Types of Industries, Concept of Start-ups
   - Entrepreneurial support agencies at National, State, District Level(Sources): DIC, NSIC,OSIC, SIDBI, NABARD, Commercial Banks, KVIC etc.
   - Technology Business Incubators (TBI) and Science and Technology Entrepreneur Parks

2. **Market Survey and Opportunity Identification (Business Planning)**

   - Business Planning
   - SSI, Ancillary Units, Tiny Units, Service sector Units
   - Time schedule Plan, Agencies to be contacted for Project Implementation
   - Assessment of Demand and supply and Potential areas of Growth
   - Identifying Business Opportunity
   - Final Product selection

3. **Project report Preparation**

   - Preliminary project report
   - Detailed project report, Techno economic Feasibility
   - Project Viability

4. **Management Principles**
   - Definitions of management
   - Principles of management
   - Functions of management (planning, organising, staffing, directing and controlling etc.)
   - Level of Management in an Organisation

5. **Functional Areas of Management**
   a) Production management
      - Functions, Activities
      - Productivity
      - Quality control
      - Production Planning and control

   b) Inventory Management
      - Need for Inventory management
      - Models/Techniques of Inventory management

   c) Financial Management
      - Functions of Financial management
      - Management of Working capital
      - Costing (only concept)
      - Break even Analysis
      - Brief idea about Accounting Terminologies: Book Keeping, Journal entry, Petty Cash book, P&L Accounts, Balance Sheets(only Concepts)

d) Marketing Management
- Concept of Marketing and Marketing Management
- Marketing Techniques (only concepts)
- Concept of 4P s (Price, Place, Product, Promotion)

e) Human Resource Management
- Functions of Personnel Management
- Manpower Planning, Recruitment, Sources of manpower, Selection process, Method of Testing, Methods of Training & Development, Payment of Wages

6. **Leadership and Motivation**

a) Leadership
- Definition and Need/Importance
- Qualities and functions of a leader
- Manager Vs Leader
- Style of Leadership (Autocratic, Democratic, Participative)

b) Motivation
- Definition and characteristics
- Importance of motivation
- Factors affecting motivation
- Theories of motivation (Maslow)
- Methods of Improving Motivation
- Importance of Communication in Business
- Types and Barriers of Communication

7. **Work Culture, TQM & Safety**

- Human relationship and Performance in Organization
- Relations with Peers, Superiors and Subordinates
- TQM concepts: Quality Policy, Quality Management, Quality system
- Accidents and Safety, Cause, preventive measures, General Safety Rules , Personal Protection Equipment(PPE)

8. **Legislation**

a) Intellectual Property Rights(IPR), Patents, Trademarks, Copyrights
b) Features of Factories Act 1948 with Amendment (only salient points)
c) Features of Payment of Wages Act 1936 (only salient points)

9. **Smart Technology**
- Concept of IOT, How IOT works
- Components of IOT, Characteristics of IOT, Categories of IOT
- Applications of IOT- Smart Cities, Smart Transportation, Smart Home, Smart Healthcare, Smart Industry, Smart Agriculture, Smart Energy Management etc.

Syllabus to be covered before IA: Chapter 1,2,3,4

RECOMMENDED BOOKS

1. Entrepreneurship Development and Management by R.K Singhal, Katson Books., New Delhi

2. Entrepreneurship Development and Management by U Saroj and V Mahendiratta, Abhishek Publications, Chandigarh
3. Entrepreneurship Development and Management by Vasant Desai, Himalaya Pub.House
4. Industrial Engineering and Management by O.P Khanna ,Dhanpat Rai and Sons
5. Industrial Engineering and Management by Banga and Sharma, Khanna Publications
6. Internet of Things by Jeeva Jose, Khanna Publications, New Delhi
7. Online Resource on Startups and other concepts
8. https://www.fundable.com/learn/resources/guides/startup

Th-2. HEAT TRANSFER, FLUID FLOW & FURNACES

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	5th
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Furnace is one of the most important groups of metallurgical equipment used for making, shaping and treatment of meta1s and alloys. These equipments are used for heating/melting of these metals. Cooling of various parts of a furnace is essential for protection of the furnace. Study of different furnaces along with principles of heat transfer and fluid flow is an important subject.

B.OBJECTIVES:

On completion of the subject the students will have an idea about

1. Types of Fluid & types of fluid flow..
2. The different parameters of flow and their measurement like pressure, flow rate by orifice, venture meter and Pitot tube.
3. The loss of head during fluid flow through a system in a pipe and its determination.
4. Mode of heat transfer and calculation of heat flux in different mode of heat transfer.
5. Different metllurgica1 furnaces & their use.
6. Various types of waste heat recovery system & their application.

C.TOPIC WISE DISTRIBUTION OF PERIODS:		
SL.NO.	**TOPIC**	**PERIODS**
1	Fluid Flow	16
2	Heat Flow	16
3	Classification of Furnace. & Examples of some Metallurgical Furnaces	10
4	Principles of heat Generation in electric Furnaces	05
5	Heat Losses, Heat Balance & Furnace Efficiency	06
6	Waste heat Recovery System in Furnaces	07
	TOTAL	60

D.COURSE CONTENTS (in terms of specific objectives):

1.0 FLUID FLOW

1.1 i) Discuss types of fluids (ideal and real).
ii) Discuss the type of flow (stream line & turbulent).

1.2 i) State and explain Bernoulli's equation.
ii) Discuss the flow through orifices, Pitot tube and venturies

1.3 Define and calculate loss of head (friction loss) in straight pipes, in bends and channel with sudden enlargement and sudden contraction.

2.0 **HEAT FLOW**

2.1 Discuss the elementary idea on different modes of heat transfer.

2.2 i) Define and derive the Fourier's law.
ii) Explain & calculate the steady state heat conduction through flat walls.

2.3 i) Define Convection.
ii) Define and differentiate between natural and forced convection
iii) State the natural and forced heat transfer co-efficient (equation only, no derivation).

2.4 i) Define radiations
ii) State the Stefan Boltzmann's Law
iii) Define emissivity of black bodies and grey bodies.

3.0 **FURNACES**

3.1 Classify the furnaces based on use, heat source and material movements.

3.2 Discuss the following metallurgical furnaces (a) soaking pits, (b) reheating furnace (c) heat treatment furnace (d) melting (e) smelting (f) refining furnaces

4.0 State the principles of heat generation in electric furnaces such as arc, resistance and induction (core less)

5.0 Discuss on heat losses, heat balance and furnace efficiency.

6.0 Explain the types of' waste heat recovery system such as regenerators and recuperates.

<u>Syllabus to be covered up to I.A</u>.

Chapter: 1 & 2

Learning Resources:

Sl.No	Title of the Book	Name of Authors	Name of Publisher
1.	Elements of Fluid Mechanics	V.C.Sheshadri& U. Patankar	Harcourt , Brace & World
2.	Heat Transfer	Isa Chenkov&Sukomel	Mir Publishers MOSCOW
3.	Principles of Extractive Metallurgy	A.Ghosh&H.S.Ray	New Age
4.	Metallurgical Furnaces	Krivandrim& Markov	Mir Publishers MOSCOW

Th-3. HEAT TREATMENT TECHNOLOGY

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	5th
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Physical properties of metals and alloys are dependent on their crystal structures. Heat treatment of metal and alloys explains different aspects of crystal structures of metals and alloys. It is, therefore, a very important subject for a metallurgical engineering.

B.OBJECTIVES:

Upon the completion of the course, students should have the knowledge about

1. Solid state phase transformation and diffusion.
2. Principles of heat treatment of steel.
3. Various heat treatment process for steels.
4. Hardenability of steel
5. Different surface hardening methods.
6. Effect of Alloying elements on steels, different alloy steels and their heat treatment
7. Non ferrous alloys & their heat treatment.

C. TOPIC WISE DISTRIBUTION OF PERIOD:

SL.NO.	TOPIC	PERIODS
1	Solid State Phase Transformation	15
2	Heat Treatment Process for Steel	14
3	Harden ability	08
4	Surface Hardening Methods	12
5	Heat Treatment of Non-Ferrous Alloys	03
6	Alloy Steels and Heat Treatment of Alloy Steels	08
	TOTAL	60

D.COURSE CONTENT :

1.0 Solid State Phase Transformation.

1.1 Give an introduction to diffusion, state fick's law.

1.2 Discuss the formation of austenite.

1.3 Explain the mechanism of formation' of austenite

1.4 Discuss austenitic grain size.

1.5 Explain the methods of determination of austenitic grain size.

1.6 State the importance of grain size

1.7 Explain the method of measurement of grain size.
1.8 Discuss the methods of control austenitic grain size.
1.9 Discuss decomposition of austenite and pearlitic transformation.
1.10 Explain the process of construction of T-T-T diagram and CCT diagram.
1.11 Discuss the TTT Diagram for hypo eutectoid, eutectoid and hyper eutectoid steel.
1.12 Explain bainitic transformation.
1.13 Explain martensitic transformation.

2.0 **Heat Treatment Process for Steels**.
2.1 Discuss annealing.
2.2 Explain stress relieving annealing.
2.3 Explain different types of annealing.
2.4 Explain the process of normalizing.
2.5 Discuss the process of hardening.
2.6 Describe the factors affecting hardening process.
2.7 Explain different methods of hardening.
2.8 Discuss quenching media and different types of quenchants.
2.9 Explain the tempering process for steel.
2.10 Discuss thermo-mechanical treatment of steel.
2.11 Discuss martempering, austempering and subzero treatment.

3.0 **Hardenability**
3.1 Define hardenability
3.2 Discuss the method of determination of hardenability (Gross Man's critical diameter method &Jominey end quench method).
3.3 Discuss the method of estimation of hardenability from chemical composition and fracture test
3.4 Discuss the factors affecting hardenability: effect of austenitic grain size, carbon content, and alloying elements.

4.0 **Surface Hardening Methods**
4.1 Discuss high frequency induction hardening -flame hardening, electron beam hardening, laser hardening.
4.2 Discuss the methods of case depth measurement of steel.
4.3 Explain different carburizing-processes of steel: pack carburizing, liquid carburizing, gas carburizing and vacuum carburizing.
4.4 Discuss the post carburizing heat treatment.
4.5 Explain process of nitriding of steel
4.6 Explain the process of cyaniding, carbo-nitriding of steel
4.7 Explain the plasma nitriding.
4.8 Explain salt bath nitro carburizing.
4.9 Explain boronising, chromizing & Toyato diffusion process.

5.0 **Discuss the Heat Treatment of Non Ferrous Alloys**.

5.1 Discuss Age Hardening of Al-CU alloys.

6.0 **Alloy Steels**

6.1 Discuss different alloy steels- low alloy and high alloy steels.

6.2 Discuss the effect of alloying elements.

6.3 Discuss die steel, high speed steel, high strength, low alloy steels, stainless steels.

6.4 Discus the heat treatment of tool steel and stainless steel.

Syllabus to be covered up to I.A.

Chapter: 1 & 2

Learning Resources:

Sl.No	Title of the Book	Name of Authors	Name of Publisher
1.	Engineering physical Metallurgy	Lakhtin	Mir Publishers Muscow
2.	Physical Metallurgy Principles	Reed-Hill	EWP
3.	Introduction to Physical Metallurgy	S.H.Avner	Mc Graw Hill
4.	Material Science Engineering	Raghavan	PHI
5.	Physical Metallurgy for Engineers	Clark & Varney	S.Chand
6.	Heat Treatment	Rajan&Sharma	PHI
7.	Physical Metallurgy	Raghavan	PHI
8.	Practical Physical Metallurgy	Surajbhan	Khanna
9.	Practical Physical Metallurgy	Rawlings	Butter worth
10.	Practical Heat Treatment	Lakhtin	Mir Muscow
11.	Heat Treatment of Metals	Brijendra Singh	Standand Publishers.

Th-4 FERROUS METALLURGY - II

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	5th
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Iron and its alloys are by far the most important and maximum used engineering materials. Therefore, ferrous metallurgy is one of the most important subjects under metallurgical engineering studies.

B.OBJECTIVES:

On completion of the Study the students will have knowledge about

1. Different steel making processes.
2. Different reactions and principles involved in steel making.
3. Operation merits & demerits of different Steel making process like open hearth.
4. Development of recent steel making processes. Deoxidation, practice, pit side practice, secondary steel making, continuous casting of steel.
5. Know the different pollutions caused by iron and steel industries and measures of controlling the pollution.

C. TOPIC WISE DISTRIBUTION OF PERIOD		
SL.NO.	**TOPIC**	**PERIODS**
1	Commercial steel making process & Principle of steel Making	10
2	Raw materials for steel making	03
3	LD process	12
4	Electric and induction furnace process	05
5	Recent steel making process	06
6	De-oxidation practice	04
7	Pit side practice	04
8	Continuous casting of steel	08
9	Secondary steel making process	08
	TOTAL	60

D.COURSE CONTENTS :

1.0 **Steel Making Processes**

- 1.1 Brief history of principles of steel making & processes of steel making.
- 1.2 Bistre steel making
- 1.3 Shear steel making
- 1.4 Crucible steel making
- 1.5 Bessemer steel making.
- 1.6 Open hearth steel making
- 1.7 Explain these processes with suitable sketches.

2.0 **Principles of steel making**.

- 2.1 Mention different reactions involved in steel making.
- 2.2 Differentiate between acid process & basic process of steel making.
- 2.3 Explain the principles and conditions required in removal of 'P', 'S', Si', 'Mn' and 'C' in steel making.

3.0 **Raw Materials for Steel Making**

- 3.1 List the different raw materials required for steel making
- 3.2 State the important raw materials available in India

4.0 **Steel Making by LD Converter**

- 4.1 Give different raw materials of LD process
- 4.2 Explain the construction and operation of LD converter
- 4.3 Describe the refining reaction in LD converter with reference to decarburization and dephosphorisation.
- 4.4 Mention the quality of steel and composition of slag in LD process
- 4.5 Give the advantages and limitations of LD process.
- 4.6 Describe different developments of LD process
  - a. Bottom, top and combined blowing
  - b. Multi nozzle converter.
- 4.7 Explain OLP process

5.0 **Electric and Induction Furnace Process**

- 5.1 Explain the principle, types of slags prepared by electric arc furnace
- 5.2 Explain the steps of electric arc furnace heating to produce steel
- 5.3 Mention advantages of electric arc furnace process.
- 5.4 Explain the steel making induction furnace.
- 5.5 Mention advantages and limitations of induction furnace process

6.0 **Brief Study of Other Recent Processes of Steel Making.**

- 6.1 Briefly describe the principle of operation, merits arid demerits of the recent steel making processes such as
  - a. Ajax Process
  - b. OBM Process
  - c. Spray Steel Making Process

7.0 **De-Oxidation Practice**

7.1 Explain different De-Oxidisers and their use.

7.2 Differentiate between killed steel semi killed steel and rimming steel

8.0 **Pit Side Practice**

8.1 Describe different teeming methods such as:

a. Direct pouring

b. Tundish teeming and

c. Bottom teeming

8.2 Describe different ingot defects, their causes and remedies

9.0 **Continuous Casting of Steel**

9.1 Explain the principle and operation of continuous casting

9.2 Describe different types of casters.

9.3 Describe about the moulds and mould maintenance in continuous casting.

9.4 Discuss advantages of continuous casting

9.5 Continuous casting of Billets,Blooms and Slabs.

10.0 **Secondary Steel Making Processes**

10.1 Explain the principle operation and advantages of secondary steel making processes such as

a. VAD Process

b. VOD Process

c. AOD Process

10.2 Describe the stream degassing process.

Syllabus to be covered up to I.A.

Chapter: 1, 2,3 & 4

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	. Steel Making	R.H.Tupkary	Khanna
2.	. Steel Making	A.K.biswas	Cootha
3.	Manufacture of iron & Steel VoL II	Bashforth	Chapman and Hall
4.	Elementary Metallurgy (Steel)	Frier	Mc Graw Hill
5.	Metal Process engineering	P.Polukrint	University Press of the Pacific
6.	Chemistry of Steel	Bodsworth	CBS
7.	Steel Making	V. A. Kudrin	VRSS Publishing Group

Th-5 NON FERROUS METALLURGY

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	5th
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Entire range of metals and alloys are grouped under two headings “ferrous” and on-ferrous”. Non-ferrous group consist of a very large number of diverse and useful group of materials and alloys, with their distinct metallurgies This forms an important subject in the study of metallurgical engineering

B.OBJECTIVES:

Upon the completion of the course the students should have the knowledge about.

1. Nonferrous Ore Resources and Nonferrous Industries in India.
2. Methods of Extraction of Metals from SulphideOres : Cu, Zn. Pb, Ni.
3. Process of Extraction of Metals from Oxide Ores : Al, Sn,
4. Process of Extraction of Metals from Halides: U, Ti
5. Process of Extraction of Precious Metals: Au
6. Secondary Metal Extraction: Cu, Al, Zn, Pb
7. Environmental Pollution, their causes Method of Prevention and control

C. TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Non-ferrous ore Reserves and Non-ferrous Metal Industries in India.	03
2	Extraction of Metals from Oxide Ores	15
3	Extraction of Metals from Sulphide Ores	18
4	Extraction of Metals from Halides	10
5	Extraction of Precious Metals	06
6	Production of Secondary Metals	08
	TOTAL	60

D.COURSE CONTENTS (in terms of specific objectives):

1.0 Discuss the non-ferrous ore reserves in India &non ferrous industries in India.

2.0 Extraction of Metals from Oxide ores.

2.1 Extraction of aluminum

2.1.1 Describe the Bayer’s process of alumina production.

2.1.2 Explain the fused salt electrolysis of alumina by Hall Heroult process.
2.1.3 Discuss anode effect
2.1.4 Explain the method of refining of aluminum
2.1.5 State the uses of aluminum.

2.2 Extraction of Tin
2.2.1 Explain the process of tin ore concentration.
2.2.2 Explain the process of concentrate smelting for tin extraction.
2.2.3 Describe the process of refining of tin.
2.2.4 State the uses of tin.

3.0 **Extraction of Metals from Sulphide Ores**.

3.1 Pyrometallurgical Extraction of Copper.
3.1.1 Describe the process of roasting of copper ore.
3.1.2 Describe the process of matte smelting of copper ore.
3.1.3 Explain the process of converting of copper matte.
3.1.4 Explain the refining of copper.
3.1.5 State the uses of copper.

3.2 Pyrometallurgical Extraction of Lead.
3.2.1 Explain roasting and sintering of lead ore.
3.2.2 Explain the process of extraction of lead by blast furnace smelter.
3.2.3 Describe in detail the process of refining of base bullion.
3.2.4 State the uses of lead.

3.3 Pyrometallurgical and HydrometalliIrgia1 Method of Extraction of j Zinc.
3.3.1 Describe the roasting of zinc ore concentrate.
3.3.2 Explain how zinc is extracted by vertical retot process.
3.3.3 Explain the refining of zinc.
3.3.4 Explain the process of leaching and preparation zinc base solution
3.3.5 Describe the electrolysis of zinc solution
3.3.6 State the uses of zinc

3.4 Pyrometallurgical Method of Nickel Extraction.
3.4.1 Explain the roasting of nickel ore.
3.4.2 Explain the method of smelting of nickel concentrate.
3.4.3 Explain the method of refining of nickel
3.4.4 State the uses of nickel.

4.0 **Extraction of Metals from Halides**.

4.1 Extraction of Titanium
4.1.1 Describe extraction of titanium
4.1.2 Explain the type of treatment given to titanium ore.
4.1.3 Explain the process of chlorination and mag. reduction for titanium extraction.

4.1.4 Explain the process of refining of titanium (distillation)

4.1.5 State the uses of titanium

5.0 **Extraction of Precious Metals**

5.1 Explain extraction of gold.

5.2 Explain the process of cyanidation for gold extraction

5.3 State the uses of gold.

6.0 **Production of Secondary Metals**.

Explain the process of production of copper, lead, zinc &. aluminum metals from scraps.

Syllabus to be covered up to I.A.

Chapter: 1, 2,3 & 4

Learning Resources:

Sl.No	Title of the Book	Name of Authors	Name of Publisher
1.	Non Ferrous Production Metallurgy	Bray J.L	J.Wiley
2.	Non-Ferrous Metallurgy of Metal	Dannis W.H.	Isaac Pitman & Sons
3.	Extraction or Non- Ferrous Metal	Roy, Sridhar & Abraham	EWP
4.	Rare Metal Extraction	W. D. Jamrack	Pergamon Press

PR-1 Heat Treatment Laboratory

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	5th
Total Period:	60	Examination :	3 hrs
Theory periods:	6P / week	End Exam	50
TOTAL	100	Sessional	50

(Students are required to perform at least 8 experiments and study the resultant structure)

1. Common practices of heat treatment for plain carbon steel
    a. Annealing
    b. Normalizing
    c. Hardening
    d. Tempering
    e. Study of microstructures before & after above H/T
2. Hardenability measurement of steel by Jominey End Quench method.
3. Heat treatment of high speed steel and stainless steel.
4. Spheroidizing treatment of high carbon steel
5. Case hardening treatment and study of case hardened structures.
6. Photomicrography of at least two structures of' Heat treated samples.
7. Arc welding of steel plates and study of microstructure of weldment before heat treatment and after heat treatment.
8. Micro hardness measurement of various heat treated steel samples.
9. Image Analysis of various heat treated steel samples.

Sl. No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1	Principles of Metallographic practice	Khel	Mc Graw Hill
2	Heat Treatment	Rajan&Sharma	PHI
	Physical Metallurgy	Raghavan	PHI
	Physical Metallurgy	Avner	PHI

PR-2 METALLOGRAPHY LAB-II

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	5th
Total Period:	60	Examination :	3 hrs
Theory periods:	6P / week	End Exam	50
TOTAL	100	Sessional	50

(Students are required to perform atleast six experiments out of the followings)

1. Sample preparation practice for metallographic study.
2. Electrolytic polishing & etching..
3. Grain size measurement.
4. Image analysis of various ferrous and non ferrous alloys.
5. Use of different software in metallographic
6. Micro hardness testing of various ferrous and non ferrous alloys.
7. Photomicrography and image storing of various ferrous and non ferrous alloy using digital camera, scanner and computer using high magnification inverted microscope.

Sl. No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1	Principles of Metallographic practice	Khel	Mc Graw Hill
2.	Physical Metallurgy	Avner	PHI

PR-3 PROJECT WORK (Phase-I)

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	5th
Total Period:	60	Sessional	50
Theory periods:	4P / week		
TOTAL	50		

RATIONALE

Students' Project Work aims at developing innovative skills in the students whereby they apply the knowledge and skills gained through the course by undertaking a project. The individual students have different aptitudes and strengths. Project work, therefore, should match the individual strengths of students. The prime emphasis of the project work is to understand and apply the basic knowledge of the principles of ceramic technology practices in real life situations, so as to participate and manage a large ceramic engineering projects in future.

Entire Project shall spread over 5th and 6th Semester. Part of the Project covered in 5th Semester shall be named as *Project Phase-I* and balance portion to be covered in 6th Semester shall be named as *Project Phase-II*.

OBJECTIVES

After undergoing the Project Work, the student will be able to:

- Implement the theoretical and practical knowledge and skills gained through various subjects/courses into an application suitable for a real practical working environment, preferably in an industrial environment.
- Explain the working of industrial environment and its work ethics.
- Identify and contrast gap between the technological knowledge acquired through curriculum and the actual industrial need and t compensate it by acquiring additional knowledge as required.
- Carry out cooperative learning through synchronous guided discussions within the class in key areas, asynchronous document sharing and discussions, as well as prepare collaborative edition of the final project report.

GENERAL GUIDELINES

The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, Students should be asked to identify the type of project work, they would like to execute. The activity of problem identification should begin well in advance (right from beginning of 5th semester).Students should be allotted a problem of interest to him/her as a project work. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments for their students. The project assignment can be individual assignment or a group assignment. There should not be more than 5 students if the project work is given to a group. The project work identified in collaboration with industry should be preferred.

BROAD SUGGESTIVE AREAS OF PROJECT WORK

1. Study of effect of heat treatment on various metals and alloys for various applications.
2. Casting of metals and alloys and study the properties and application of cast products.
3. To Develop models of various metallurgical industries / Furnaces / Equipments.
4. Drawing and verifications of binary phase diagrams/TTT diagrams.
5. Development of various composite materials and study of their properties.
6. Effects of various metallic coatings on corrosion / corrosion study of metals and alloys.
7. Study and develop mineral processing flow sheets for low grade iron and chromite ore.
8. Improving existing systems/equipments.
9. Any other related areas found worth.

A suggestive criterion for assessing student performance by the external (preferably person from industry) and internal (teacher) examiner is given in table below:

Sl. No.	**Performance Criteria**
1.	Selection of project assignment
2.	Planning and execution of considerations
3.	Quality of performance
4.	Providing solution of the problems or production of final product
5.	Sense of responsibility
6.	Self expression/ communication/ Presentation skills
7.	Interpersonal skills/human relations
8.	Report writing skills
9	Viva voce

The teachers are free to evolve other criteria of assessment, depending upon the type of project work.
It is proposed that the institute may organize an annual exhibition of the project work done by the students and invite leading Industrial organisations to such an exhibition.

Project Phase-I and Phase-II
The Project work duration shall cover 2 semesters(5^{th} and 6^{th} sem). The Grouping of students, selection of Project, assignment of Project Guide to the Group shall be done in the beginning of 5^{th} sem under Project Phase-I. The students may be allowed to study literature, any existing

system related to project work and then define the Problem/objective of the Project. All Preliminary work for the project work including Design if any is to be complete in Phase-I. In Phase-II Execution of work ,Testing, documentation of the project have to be completed. Project Report have to be prepared and complete in Phase-II. All Project reports should be organized uniformly in proper order, irrespective of group. Teacher Guides can make suitable alteration in the components of Task and schedule.

At the end of Project Phase-I in 5^{th} semester there shall be one presentation by each group to mark to progress and also to judge whether the Project is moving in right direction as per the objective of the Project.

LIST OF EQUIPMENTS

HEAT TREATMENT LABORATORY
(FOR 30 STUDENTS)

1. Muffle F/C 1000℃ ----------01no
2. Vacuum F/C 800℃ ----------01no
3. Gradient Muffle F/C 1200℃ ----------01no
4. Salt Bath F/C 1000℃ ----------01no
5. Oil quenching Bath ----------01no
6. Sample Cutter ----------02nos
7. Metallurgical Microscope (student)up 1000Xwith digital recording facility --03nos
8. Belt Polisher ----------02 nos
9. Disc Polisher dual disc----------03nos
10. Inverted Microscope with Image analysis facility. Up to 1000X,
11. Micro hardness tester 1000gm for measuring case thickness and grain size. Supported by software as per ASTM standards.
12. Specimen Mounting Press (hot) ----------01no
13. Radiation Pyrometer.----------01
14. Pt - Pt-Ro thermocouple with calibration curve. ---02 nos.
15. Tools for sample handling during heat treatment.
16. Electrolytic etching machine ---------- 01
17. Hot air drier----------01
18. Melting Furnances ----------01
19. Powder compaction machine----------01

METALLOGRAPHY LAB-II
(FOR 30 STUDENTS)

1. Metallurgical Microscope 400Xwith digital recording facility – 03no
2. Belt Polisher ----------02 nos
3. Disc Polisher dual disc----------03nos
4. Inverted Microscope with Image analysis facility. Up to 1000X, 04 no
5. Micro hardness tester 1000gm for measuring case thickness and grain size. Supported by software as per ASTM standards.
6. Radiation Pyrometer.----------01
7. Pt - Pt-Ro thermocouple with calibration curve. ---02 no.
8. Tools for sample handling during heat treatment.
9. Electrolytic etching machine ---------- 01
10. Hot air drier----------01
11. Electrolytic polishing & etching cell----------01