STATE COUNCIL FOR TECHNICAL EDUCATION AND VOCATIONAL TRAINING, ODISHA

TEACHING AND EVALUATION SCHEME FOR 3rd 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		Elementary mechanical Engg.	4		-	20	80	3	100
Th.2		Mineral Processing	4		-	20	80	3	100
Th.3		Fuels & Refactories	4		-	20	80	3	100
Th.4		Ferrous metallurgy I	4			20	80	3	100
Th.5		Environmental studies	4			20	80	3	100
		Total	20			100	400	-	500
		Practical							
Pr.1		Mineral Processing	-	-	6	25	75		
Pr.2		Fuel testing & Chemical Analysis	-	-	6	25	75		
Pr.3		Workshop	-	-	4	50			
		Student Centred Activities(SCA)		-	3	-	-	-	-
		Total	-	-	*19*	*100*	*150*	-	*250*
		Grand Total	**20**	**-**	**39**	**200**	**550**	**-**	**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 3RD SEMESTER

For

DIPLOMA IN METTALURGY ENGINEERING

(Effective FROM 2019-20 Sessions)

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

THIRD SEMESTER METALLURGICAL ENGINEERING
ELEMENTARY MECHANICAL ENGINEERING (Th-01)
(COMMON TO METALLURGY & CERAMIC)

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

A. RATIONALE:

Metallurgical Engineering is intimately related with certain areas of mechanical engineering. It is therefore, essential for a metallurgical engineer to have basic knowledge of mechanical engineering.

B. OBJECTIVES:

After the completion of this subject students will have knowledge about:

1. Shear Force, bending moment and stresses on different types of load.
2. Links kinematic chain and different types of mechanism.
3. Working of belt, ropes and chain drives, brakes and dynamomentans.
4. Basic principles of thermodynamics and steam tables.
5. Functions and types of boiler and turbines with idea on steam condensers.
6. IC engine, types of I.C.engines and calculation of power and efficiency.
7. Refrigeration and Air Conditioning,
8. Different types of conventional machine tools with idea on CNC milling and Turning.

C. TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Shear Force and Bending Moment	10
2	Machine and Mechanism	08
3	Belt, Rope and Chain drives, Brakes and Bearings	08
4	Basic Principles of Thermodynamics	06
5	Boilers and Turbines	10
6	Internal Combustion Engines	06
7	Refrigeration and Air-Conditioning	06
8	Machine Tools	06
	TOTAL	60

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

1.0 Shear Force and Bending Moment

1.1 Define shear force and bending moment

1.2 Construct shear force and bending moment diagram of cantilevers, simple supported beam with point load and uniformly distributed load.

1.3 Determine stress of loaded beams

2.0 Machine and Mechanism

2.1 Define machine, mechanism, kinematics, link, kinematics pair, kinematics chain

2.2 Illustrate four – bar linkage, crank – connecting rod, quick return mechanism

2.3 Understand function of a cam and cam follower

3.0 Belt, Rope and Chain drives, Brakes and Bearings

3.1 Determine the length of open belt drive

3.2 Determine the ratio of tensions and power transmitted by belt drive

3.3 Discuss advantage of rope and chain drive

3.4 State working principle of simple brake and dynamo meters

3.5 Define and classify bearings (bush and anti-friction)

4.0 Basic Principles of Thermodynamics

4.1 Define heat and work and derive inter – relationship

4.2 Determine work done by compression and expansion of gases

4.3 Explain properties of steam (sensible, latent heat & dryness fraction)

4.4 Discuss use of steam tables.

5.0 Boilers and Turbines

5.1 Explain the functions of the boiler

5.2 Define fire tube, water tube, boiler.

5.3 Define and classify steam turbines (impulse and reaction type and steam condensers)

6.0 Internal Combustion Engines

6.1 Define and classify internal combustion (I.C.) engine

6.2 Explain Otto and Diesel cycles

6.3 Explain and compare 2 stroke and 4 stroke and I.C. engine

6.4 Define Indicate power, brake power and mech, efficient.

7.0 Refrigeration and Air-Conditioning

7.1 Define Refrigeration and Air – conditioning and state various application

7.2 Explain simple vapour compression refrigeration system

7.3 State types of refrigerants and explain their properties

7.4 Describe the basic concept of air – conditioning with reference to a room air conditioner

8.0 Machine Tools

8.1 Define machine tools

8.2 Describe different machine tools and their functions (lathe, drill, shaper, milling machine and grinding machine)
Brief idea on CNC milling and CNC Turning

Portion for Internal Assessments:

Topics: - 1, 2&3

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Strength of material	R.S.Khurmi	S.Chand Publisher
2.	Engineering Thermodynamics	P.L.Ballanney	Khanna Publisher
3.	Refrigeration and Air Conditioning	R.S.Khurmi	S.Chand Publisher
4.	Theory of Machine	R.S.Khurmi	S.Chand Publisher
5.	Basic Mechanical Engineering	Dr.N.R.Banapurma Mr.V.S.Yaliwal	Vikas Publisher

MINERAL PROCESSING (Th-02)

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

A.RATIONALE:

Ores and minerals are the sources of all metals and alloys. Ores and minerals, as available in nature are mixed with various other substances and of odd sizes which are not suitable for various extraction processed. Useable quality and size of ores / minerals are obtained by different process called mineral dressing. Thus this subject is of great important in the study of metallurgy.

B.OBJECTIVES:

After the completion of this subject students will have knowledge about:

1. Ores and minerals of metals and their resources.
2. Size reduction operation of the minerals
3. Various sizing and screening processes.
4. Concentration methods based on the different physical and chemical / surface properties of ores.

C.TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Various Mineral Resources in India	03
2	Crushing	10
3	Grinding	07
4	Laboratory Sizing	06
5	Industrial Screening Classification	06
6	Gravity Concentration	08
7	Heavy Media Separation	06
8	Flotation	08
9	Magnetic and Electrostatic Separators	06
	TOTAL	60

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

1.0 Various mineral resources of India

2.0 Unit Operations : Ore dressing :

2.1 Distinction between Mineral and Ore

2.2 Explain the scope and objective of Ore dressing

2.3 Communition and liberation

2.4 Different physical and chemical property of ore with their application to mineral dressing

3.0 Crushings :

3.1 Describe crushing operations

3.2 Explain the type of crushers:Blake and Dodge jaw Crushers

3.3 Describe capacity and reduction ratio of crusher

3.4 Explain angle of nip of a crusher

3.5 Explain in details gyratory and roll crushers

3.6 Explain the principle of operation of gyratory and roll crushers

4.0 Grinding:

4.1 Classify different types of grinding equipment

4.2 Explain the ball mill operations

4.3 State the difference between open circuit and close circuit grinding

4.4 State the difference between dry grinding and wet grinding

5.0 Laboratory Sizing Technique :

5.1 Explain the methods of size analysis

5.2 Describe different types of standard screens with screening techniques

5.3 Explain in details Rotap sieve shaker

6.0 Industrial Screening :

6.1 Explain the principle of screening

6.2 Classify types of screening

6.3 Explain the effectiveness, capacity, efficiency of Industrial screens

6.4 Explain different types of classifiers and their applications

7.0 Gravity Concentration :

7.1 Describe the general principles of flowing film concentration

7.2 Describe in details the operations and application of wilfley table

7.3 Define jigging

7.4 Describe the factors affecting stratification in jigs

7.5 Explain the types of jigs and their uses

8.0 Heavy Media Separations :

8.1 Explain the fundamental principle of heavy media separations

8.2 Explain the different industrial process using heavy liquid and heavy suspensions, Du - Pont process, chance process

9.0 Flotation :

9.1 Define are froth and skin flotation

9.2 Explain the elementary principle of froth flotation

9.3 Explain the practical utility of frother, collector, modifier, activators, depressant (without physic – chemical Principle)

9.4 Describe the application with practical examples of froth flotation process

9.5 Describe different types of flotation cells

10.0 Magnetic & Electrostatic Separator :

10.1 Explain the principles of magnetic and Electrostatic separator with their application to mineral dressing

Portion for Internal Assessment:

Topics:-1, 2, 3 & 4

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Principle of Mineral Dressing	Gaudin A.M.	Tata Mc Graw-Hill
2.	Non-Ferous Metallurgy	H.S.Roy Sridhar & Abraham	EWP
3.	Hand book of Mineral/Dressing Ores & Minearls	A.F.Taggart	Willey Handbook Series
4.	Minearl Processing Technology	B.A.Wills B.H.Butterworth	Heineman
5.	Fundamentals of Mineral Dressing	C.Mohapatra	JJTP

FUELS AND REFRACTORIES (TH - 03)

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

A. RATIONALE:

For different metallurgical processes starting from extraction of metals from ores down to shaping and treating of metals, heating is an essential operation for which fuel is used. To allow all these thermal processes in a furnace, use of refractory is a must to contain heat and protect the furnace structure. Study of fuels and refractories is thus a very important topic in Metallurgy.

B. OBJECTIVES:

After completion of this subject students will have knowledge about

1. Solid liquid and gases fuels.
2. Various manufacturing processes and uses of solid liquid and gaseous fuels.
3. Testing of various fuels for their suitability.
4. About combustion processes.
5. Various refectories , their type and use.
6. Manufacturing of various refectories.

C.TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Fuels	04
2	Solid Fuels	12
3	Liquid Fuels	10
4	Gaseous Fuels	10
5	Combustion	08
6	Refractories	08
7	Special Refractories	03
8	Selection of Refractories	05
	TOTAL	60

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

1.0 Fuels :

1.1 Define the Fuel

1.2 Classify the types of fuel

1.3 State the importance of Solid, Liquid and Gaseous fuels

1.4 Describe different fuels and resources of india

2.0 Solid Fuels :

2.1 COAL :

2.1.1 Explain the origin of coal
2.1.2 State the composition of coal
2.1.3 Discuss the characteristics and significance of constituents
2.1.4 Distinguish between proximate and ultimate analysis
2.1.5 Define the calorific value of coal
2.1.6 Describe coking properties and swelling index of coal
2.1.7 Discuss the criteria of selection of metallurgical coal.

2.2 COKE :

2.1.1 Discuss the scope and objectives of carbonization of coal
2.1.2 Explain the carbonization of coal
2.1.3 Differentiate between high temperature carbonization and low temperature carbonization
2.1.4 State the merits and demerits of H.T.C and L.T.C
2.1.5 Discuss different taste carried out for coke(Shatter and Micum index)

3.0 Liquid Fuels

3.1.1 Explain origin and constitution of petroleum
3.1.2 Discuss the properties of petroleum products
3.1.3 Discuss the distillation process of crude petroleum
3.1.4 Explain the production and uses of coal tar.

3.1 Testing of liquid Fuels:

3.1.1 Define specific gravity, viscosity, flash point, cloud point & pour point, aniline point, octane number and cetane number.
3.1.2. Discuss the methods of testing of following properties:
Specific gravity, viscosity, flash point, cloud point and pour point

4.0 Gaseous Fuels

Explain the production and utilization of following gaseous fuels:
Methane, water gas, producer gas, carbureted water gas, coke oven gas, blast furnace gas, natural gas, mixed gas.

5.0 Combustion

5.1 Discuss the elementary principle of combustion, Hess's law of constant heat summation, Kirchoff's law.
5.2 Work out simple combustion calculation.

6.0 Refractories :

6.1 Define and Classify Refractories

6.2 Explain the desirable properties of Refractories in details

6.3 Discuss the raw – materials, methods of manufacturing and properties of silica, fire clay, magnesia, dolomite, chrome magnesite, graphite and magnesia carbon bricks.

1. **Special Refractories**
   Discuss about the special refractories like high alumina, mullite, SIC, Zirconia

2. Give criteria for selection and types of refractories selected for blast furnace, L.D., open hearth, arc furnace, ladle, soaking pit, coke oven, reheating furnaces, copper smelting flash and reverberatory furnaces.

Portion for Internal Assessment:

Topics: - 1,2 &3

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Refactories	Cheisty M.L.Mishra	PHI
2.	Fuels & Combustion	Samir Sankar	Orient Longman
3.	Fuels	Himus	L.HILL
4.	Elements of fuels,Furances & Refactories	R.C.Gupta	PHI

FERROUS METALLURGY - I (TH-04)

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

A. RATIONALE:

Pig Iron is by far the most important and maximum used engineering material. Therefore, ferrous metallurgy is one of the most important subjects in steel and cast iron under metallurgical engineering studies.

B. OBJECTIVES:

After completion of this subject student will have idea about

1. Raw materials require for iron making and their quality requirements.
2. Bourden preparation
3. Principle of iron making.
4. Different furnaces and accessories.
5. Irregularities and their remedies during blast furnaces operation,

C. TOPIC WISE DISTRIBUTION OF PERIODS

SL.NO.	TOPIC	PERIODS
1	Raw Materials for iron making	04
2	Quality requirements of raw materials	08
3	Blast Furnace Fuels	08
4	Blast Furnace operations	08
5	Blast Furnace accessories	08
6	Blast Furnace irregularities and blast furnace operational problems	08
7	Chemistry of blast furnace operation & charge calculation	08
8	Modern development of blast furnace operation	08
	TOTAL	60

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

1.0 Raw Materials for Iron Making

1.1 Different Raw Materials and their functions

1.2 Deposits of iron ores flux and coal in india with particulars reference to Odisha

2.0 Quality requirements of raw materials

2.1 Different types of iron ores

2.2 Composition and characteristics of raw materials.

2.3 Evaluation of iron ores.

2.4 Metallurgical coal

2.5 Difference between coal and coke

2.6 Required properties of coke for making iron

2.7 Flux and its types

2.8 Evaluation of Flux (available base & basicity)

3.0 Burden Preparation

4.1 Quality of burden (physical & chemical properties)

4.2 Different types of agglomeration required for burden preparation for blast furnace

4.0 Blast Furnace Fuel :

4.1 Function of coke

4.2 Quality requirement of coke

4.3 Preparation of B.F. fuel in India

4.4 Auxiliary fuels

4.5 Fuel Injection

4.6 Factors affecting fuel consumption in blast furnace

5.0 Blast furnace Operation

5.1 Charging methods and process

5.2 Blowing in

5.3 Drying

5.4 Filling

5.5 Blowing out

5.6 Banking in

5.7 Blowing down

5.8 Tapping

5.9 Fanning

5.10 Back draughting

5.11 Disposal of slags

5.12 Slags granulation & their utilization

6.0 Blast furnace Accessories :

6.1 Blast furnace refractories
6.2 Stack lining
6.3 Hearth lining
6.4 Hearth walls
6.5 Bosh lining
6.6 Blast furnace cooling arrangement
6.7 Shaft coolers
6.8 Hearth & bosh coolers
6.9 Tap holes and top hole drilling machine
6.10 Cast house
6.11 Tuyeres assembly
6.12 Raw materials section
6.13 Charge hosting appliances
6.14 Top charging system
6.15 Blowers, boilers, pumps
6.16 Gas cleaning plant
6.17 Blast furnace stoves

7.0 Blast Furnace irregularities and Remedies :

7.1 Hanging
7.2 Scaffolding
7.3 Slip
7.4 Chilled hearth
7.5 Pillaring
7.6 Break out
7.7 Chocking of gas off take
7.8 Flooding and coke ejection through tap hole
7.9 Leaking tuyers tap holes and coolers
7.10 Channeling

8.0 Chemistry of Blast Furnace operation :

8.1 Blast furnace profile
8.2 Thermal, physical and chemical profile
8.3 Physical chemistry of blast furnace process
8.4 Reactions in tuyere zone
8.5 Reaction in stack
8.6 Reaction in bosh
8.7 Reaction in hearth
8.8 Efficiency of B. F. process
8.9 Direct & indirect reduction
8.10 Silicon & sulphur reaction

8.11 Burden calculation for B/F operation

9.0 Modern Development of Blast furnace operation

9.1 Bell less charging
9.2 High top pressure operation
9.3 Humidification & oxygen enrichment of blast
9.4 External disiliconisation
9.5 desulphurization

Portion for Internal Assessments:-
Topics:- 1,2,3& 4

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Iron & Steel	Basforth Vol- I	Chapman & Hall
2.	Iron making	Tupkaray R.H.	Khanna Publication
3.	Iron & Steel Making	A.K.Biswal	SBA Publication
4.	An Introduction to physical chemistry of iron & steel making	Ward-Hodder	Stoughton in education
5.	Blast Furnace Iron Making	A.K.Biswas	SBA Publisher.

ENVIRONMENTAL STUDIES (TH-05)

(Common to All Branches)

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

A. Rationale:

Due to various aspects of human developments including the demand of different kinds of technological innovations, most people have been forgetting that, the Environment in which they are living is to be maintained under various living standards for the preservation of better health. The degradation of environment due to industrial growth is very much alarming due to environmental pollution beyond permissible limits in respect of air, water industrial waste, noise etc. Therefore, the subject of Environmental Studies to be learnt by every student in order to take care of the environmental aspect in each and every activity in the best possible manner.

B. OBJECTIVES:

After completion of study of environmental studies, the student will be able to:

1. Gather adequate knowledge of different pollutants, their sources and shall be aware of solid waste management systems and hazardous waste and their effects.
2. Develop awareness towards preservation of environment.

C. TOPIC WISE DISTRIBUTION OF PERIODS

SL.NO.	TOPIC	PERIODS
1	The Multidisciplinary nature of environmental studies	04
2	Natural Resources	10
3	Systems	08
4	Biodiversity and it's Conservation	08
5	Environmental Pollution.	12
6	Social issues and the Environment	10
7	Human population and the environment	08
	TOTAL	60

Unit 1: The Multidisciplinary nature of environmental studies

Definition, scope and importance, Need for public awareness.

Unit 2: Natural Resources

Renewable and non renewable resources:

a) Natural resources and associated problems.
   - Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction mining, dams and their effects on forests and tribal people.
   - Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.
   - Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources.
   - Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity, .
   - Energy Resources: Growing energy need, renewable and non-renewable energy sources, use of alternate energy sources, case studies.
   - Land Resources: Land as a resource, land degradation, man induces landslides, soil erosion, and desertification.

b) Role of individual in conservation of natural resources.

c) Equitable use of resources for sustainable life styles.

Unit 3: Systems

- Concept of an eco system.
- Structure and function of an eco system.
- Producers, consumers, decomposers.
- Energy flow in the eco systems.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following eco system:
- Forest ecosystem:
- Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries).

Unit 4: Biodiversity and it's Conservation

- Introduction-Definition: genetics, species and ecosystem diversity.
- Biogeographically classification of India.
- Value of biodiversity: consumptive use, productive use, social ethical, aesthetic and optin values.
- Biodiversity at global, national and local level.
- Threats to biodiversity: Habitats loss, poaching of wild life, man wildlife conflicts.

Unit 5: Environmental Pollution.

Definition Causes, effects and control measures of:

a) Air pollution.
b) Water pollution.
c) Soil pollution
d) Marine pollution
e) Noise pollution.
f) Thermal pollution
g) Nuclear hazards.

Solid waste Management: Causes, effects and control measures of urban and industrial wastes.

Role of an individual in prevention of pollution.

Disaster management: Floods, earth quake, cyclone and landslides.

Unit 6: Social issues and the Environment

- Form unsustainable to sustainable development.
- Urban problems related to energy.
- Water conservation, rain water harvesting, water shed management.
- Resettlement and rehabilitation of people; its problems and concern.
- Environmental ethics: issue and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies.
- Air (prevention and control of pollution) Act.
- Water (prevention and control of pollution) Act.
- Public awareness.

Unit 7: Human population and the environment

- Population growth and variation among nations.
- Population explosion- family welfare program.

- Environment and human health.
- Human rights.
- Value education
- Role of information technology in environment and human health.

Syllabus coverage upto I.A

Units 1, 2, 3

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Textbook of Environmental studies	Erach Bharucha	# UGC
2.	Fundamental concepts in Environmental Studies	D.D. Mishra	S.Chand & Co-Ltd
3.	Text book of Environmental Studies	K.Raghavan Nambiar	SCITECH Publication Pvt. Ltd
4.	Environmental Engineering	V.M.Domkundwar	Dhanpat Rai & Co

MINERAL PROCESSING LABROTORY

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	3rd
Total Period:	90	Examination :	3 hrs
Theory periods:	6P / week	Sessional	25
Maximum marks:	100	End Semester Examination ::	75

(Students are required to perfoform atleast 5 experiments)

11.1 Crushing:

(i) Reduction Ratio

(ii) Determination of capacity

11.2 Grinding:

(i) Grinding Index

(ii) Performance of Ball Mill

11.3 Screening & size analysis

11.4 jigging

11.5 Tabling

11.6 Flotation

11.7 Magnetic separation

11.8 Electrostatic separation

Experiments to be done in the laboratory will be decided by the teacher.

Sl.No	Title of the Book	Name of Authors	Name of Publisher
1	Modern Ore Testing	K.K.Krishnamurthy	Khanna publisher
2	Principle of Minearl Dressing	Gaudin A.M.	Tata MC Graw - Hill

FUEL TESTING & CHEMIICAL ANALYSIS LAB

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	3rd
Total Period:	90	Examination :	3 hrs
Theory periods:	6P / week	Sessional	25
Maximum marks:	100	End Semester Examination ::	75

(Students are required to perform at least five experiments)

1. Proximate analysis of coal
2. Determination of flash point and fire point
3. Determination of Fe in iron ore
4. Determination of Mn in manganese ore
5. Determination of Calcium, Magnesium in Dolomite
6. Determination of Cu, Zn in Brass
7. Determination of Chromium in Chromite ore

WORKSHOP PRACTICE – I I

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	3rd
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Sessional	50
Maximum marks:	50	End Semester Examination ::	80

1.0 MACHINE SHOP

1.1 Shop talk on different types of machine tools, their functions, different tools used and general safety precautions to be observed.

1.2 Study a centre lathe

1.3 Operate a centre lathe on a cylindrical ob and perform following operations like plain turning, taper turning, facing, parting

1.4 Operate a drill machine to perform drilling and counter boring operation on a job

1.5 Observe milling, shaping and grinding operations during demonstration at the shop floor

2.0 FOUNDRY SHOP

2.1 Prepare a simple wooden pattern

2.2 Make a green sand mould using above pattern

3.0 WELDING SHOP

3.1 Observe demonstration of different type of welding methods and TIG & MIG welding

Sl.No	Title of the Book	Name of Authors	Name of Publisher
1	Workshop Technology - II	Hazra & Choudhury	Media Promoters Publisher
2	Advance welding Technology	Dr.Ali Hasan Dr.Islam Nawaz	SCITECH Publisher.

STATE COUNCIL FOR TECHNICAL EDUCATION AND VOCATIONAL TRAINING, ODISHA

TEACHING AND EVALUATION SCHEME FOR 4th 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		Material Testing	4		-	20	80	3	100
Th.2		Physical Metallurgy	5		-	20	80	3	100
Th.3		Principles of Extractive Metallurgy	4		-	20	80	3	100
Th.4		Sponge Iron & Ferro Alloys	4			20	80	3	100
		Total	17			80	320	-	400
		Practical							
Pr.1		Material Testing Lab	-	-	6	25	100	3	125
Pr.2		Metallography Lab-I.	-	-	6	25	100	3	125
Pr.3		Machine Drawing / CAD	-	-	3	50			50
Pr.4		Technical seminar		-	4	50			50
		Student Centred Activities(SCA)			3				
		Total	-	-	*22*	*150*	*200*	-	*350*
		Grand Total	**17**	**-**	**39**	**230**	**520**	**-**	**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 4TH SEMESTER

For

DIPLOMA IN METTALURGY ENGINEERING

(Effective FROM 2019-20 Sessions)

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

Th1. MATERIAL TESTING

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

A. RATIONALE:

Selection and use of various metals and alloys depend on their mechanical properties. Mechanical properties largely depend on various metallurgical processes these materials undergo. It is important for a metallurgical engineer to understand and measure these mechanical properties.

1. OBJECTIVE:

After completion of this course student will have knowledge about

2. Different mechanical properties like strength,fatigue,creep etc.
3. Measuring different mechanical properties of materials.
4. Non-destructive testing and their application.
5. Temperature measurement instruments and their application.
6.

B. Topic wise distribution of periods:		
Sl. No.	**Topics**	**Period**
1	Hardness Test	10
2	Tensile Test	10
3	Impact Test	06
4	Fatigue Test	08
5	Creep Test	06
6	Non-Destructive Testing	14
7	Temperature Measurement and Calibration	06
	Total	**60**

C. COURSE CONTENTS

1. Hardness Test

1.1 Explain and derive expressions for Brinell, Vickers and Rockwell hardness test

1.2 Discuss rebound hardness with reference to shore's Scleroscope.

1.3 Describe scratch hardness and explain mho's scale.

1.4 Discuss the imperical relationship of hardness with strength.

2. Tensile Test :

2.1 Draw and explain stress-strain curve
2.2 Explain modulus of elasticity, proof stress
2.3 Discuss with sketch about yield point phenomenon.
2.4 Explain true stress and true strain curve.
2.5 Define ductility and toughness

3. Impact Test:

3.1 Define impact strength
3.2 Discuss about Charpy and Izod impact tests
3.3 Discuss about transition temperature and ductility, brittle fracture

4. Fatigue Test:

4.1 Explain different stress cycles
4.2 Describe S.N curve and endurance limit
4.3 Explain the procedure of fatigue testing and fatigue testing machine
4.4 Mention different metallurgical factors that affect fatigue behavior

5. Creep Test:

5.1 Define creep and its importance
5.2 Discuss engineering creep curve,constant stress creep curve and Andrad concept
5.3 Explain equicohesive temperature
5.4 State various factors that affect creep
5.5 Describe creep testing machine
5.6 Describe stress rupture test

6. Non – destructive Testing:

6.1 Discuss the scope and elementary idea about different NDT and their significance

6.2 Give brief description of the following NDT

(a) Visual testing
(b) Leakage test
(c) Magnetic particle testing
(d) Dye penetration test
(e) Acoustic methods and ultrasonic testing
(f) Eddy current testing
(g) X – ray diffraction

7. Temperature Measurement and Calibration:

7.1 Analysis the basic principle of pyrometry

7.2 Explain different types of pyrometer and thermocouples.

Syllabus to be covered up to I.A.

Chapter: 1,2,3, 4.1 & 4.2

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Testing of Metallic Material	Surya Narayan	B.S.Publication
2.	Mechanical Metallurgy	Deiter	Mc Graw Hill
3.	Introduction to Physical Mettallurgy	Avner	Mc Graw Hill
4.	X-Ray diffraction	BD Culity	Person Publication
5.	Mechanical Testing of Engineering Materials	C.Mohapatra	JJTP,Bhubaneswar

Th2. PHYSICAL METALLURGY

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	4th
Total Period:	75	Examination :	3 hrs
Theory periods:	5P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination ::	80

RATIONALE :

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

OBJECTIVES :

After completion of the subject students will have knowledge about

1. Physical properties & related mechanical properties of metals & alloys.
2. Structure of metals & alloys.
3. Solidfication process of metals & alloys.
4. Various types of equilibrium diagrams.
5. Iron carbon equilibrium diagram.
6. Optical Metallurgical microscope & electron microscope.

C.TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Crystal Structure of metals	10
2	Solidification of Pure metals and alloys	10
3	Equilibrium Diagrams	20
4	Solid Solution	12
5	Cast Iron	15
6	Metallurgical Microscope	08
	TOTAL	75

1.0 **Crystal Structure of metals** :

1.1 Define crystal and crystallography

1.2 Define space lattice and unit cell

1.3 Compare different types of crystal lattices, bravis lattices and primitive lattices.
1.4 Define with sketch B.C.C., F.C.C & H.C.P.
1.5 Define Miller indices, planes and directions
1.6 Define isotropy and anisotropy in metallic materials
1.7 Define imperfections in metallic materials
1.8 Differentiate between types of imperfections : point defect, line defect, surface defect and volume defect (elementary idea)

2.0 **Solidification of pure metals & alloys** :
2.1 Define alloys and solid solution
2.2 Define solidification and crystallization
2.3 Explain role of free energy thermodynamic potential in conversion of liquid to solid
2.4 Define super cooling, under cooling, degree of super cooling
2.5 Explain mechanism of solidification/ crystallization, nucleation, critical size nucleus, spontaneous nucleation, relation between ration of nucleation and grain growth.
2.6 Discuss shape of crystals and solidification of ingot.

3.0 **Equilibrium Diagram** :
3.1 Define equilibrium diagram
3.2 Discuss the importance of equilibrium diagram
3.3 Draw equilibrium diagram of binary alloys
3.4 State types of equilibrium diagram
3.5 Explain isomorphous equilibrium diagram with examples
3.6 Explain eutectic type and eutectoid equilibrium diagram with example
3.7 Explain peritectic type and peritectoid equilibrium diagram with example
3.8 Define phase rule, lever rule
3.9 Apply phase rule, and lever rule in each equilibrium diagram.
3.10 Draw iron carbon equilibrium diagram and describe different phases and micro constituent in iron carbon diagram
3.11 Discuss role of carbon with iron to differentiate steel and cast iron
3.12 Apply lever rule in iron and carbon diagram
3.13 Differentiate between iron-carbon, iron-cementite, and iron-graphite diagram.

4.0 **Solid solution** :
4.1 Define solution, alloying
4.2 Explain different types of solid solution
4.3 Differentiate between substitutional and interstitial solid solution, chemical compound, mechanical mixture and intermetallic compounds.
4.4 Differentiate between ordered and disordered solid solution.

4.5 Define Hume Rothery rule and describe the different factors governing the formation of solid solutions.

5.0 **Cast iron** :

5.1 Define cast iron, differentiate between steel and cast iron, alloy steel and alloy cast iron.

5.2 Discuss different types of cast iron with their composition

5.3 Define graphitization and role of graphitization in cast iron

5.4 Draw structures of cast iron

6.0 **Metallurgical Microscope** :

6.1 Differentiate between metallurgical microscope & biological microscope

6.2 Describe different types of metallurgical microscope

6.3 State working principle of metallurgical microscope

6.4 Define magnifying power & resolving power, spherical and chromatic aberration.

6.5 Explain with sketch principle of electron microscope

6.6 Prepare a sample for study of microstructures e.g. sampling, cutting, grinding, rough polishing, intermediate polishing, fine polishing and etching.

Portion for Internal Assessment:

Topics:-1, 2 & 3.1 TO 3.9

Learning Resources:

Sl.No	Title of the Book	Name of Authors	Name of Publisher
1.	Engineering Physical Metallurgy	Laktin	CBS Publishers & Distribution
2.	Physical Metallurgy	Reed Hill	EWP
3.	Material Science and Engineering	Raghavan	PHI
4.	Physical Metallurgy	Smallman	Cutterworth- Heinemann
5.	Introduction to Engineering Materials	C.Mohapatra	JJTP,Bhubaneswar
6.	Engineering materials and Metallurgy	R.K.Rajput	S.Chand,New Delhi
7.	Material Science	R.S.Khurmi & R.S.Sendha	S.Chand,New Delhi
8.	Physical Metallurgy	Bijendra Singh	Standard Publishers

Th3. PRINCIPLES OF EXTRACTIVE METALLURGY

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

RATIONALE :

This subject deals with different methods and principles of extraction of metals from their mineral/ores. It is therefore, a very important topic under metallurgical engineering.

OBJECTIVES:

After completion of the course, the students will have knowledge about:-

1. Different types of extraction process – pyrometallurgical extraction, hydrometallurgical extraction, and electrometallurgical extraction.
2. Extraction process applicable to different ores.
3. Refining operation of the extracted metals.
4. Application of metallurgical thermodynamics and kinetics in extraction processer.

C. TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Definition of metallurgical terms	05
2	Principles of pretreatment of ores for metal extraction	10
3	General methods and principle of extraction	25
4	Basic approaches to refining	03
5	Principles of metal extractions	10
6	Principles of metallurgical thermodynamics reaction kinetics	07
	TOTAL	60

D.COURSE CONTENT :

1.0 Definition of metallurgical terms :

1.1 Define ores and minerals

1.2 Define gangue, flux and slag

1.3 Define matte and speiss

1.4 Define metals and alloys

2.0 Principle of pre-treatment of ores for metal extractions :

2.1 Explain drying

2.2 Define and explain calculation

2.3 Explain different agglomeration process like briquetting nodulising, vacuum extrusion, sintering, palletizing.

3.0 General Methods of Extraction :

3.1 Pyrometallurgical processes

3.2 Explain roasting and different roasting methods

3.3 Explain Ellingham diagram (oxides) and predominance area diagram (sulphides)

3.4 Explain smelting and different smelting practices, Flash smelting, hearth smelting, matte smelting

3.5 Explain the method of distillation and sublimation

3.6 Explain the process of converting of matte and pig iron

3.7 Explain hydrometallurgical process

3.8 Explain different stages of hydrometallurgical process

3.9 Write the flow diagram of hydrometallurgical extraction

3.10 Explain leaching and different leaching methods, bacterial leaching and pressure leaching

3.11 Electrometallurgical process

3.12 Define electrolysis, ionic conductivity, EMF series, faraday's law of electrolysis

3.13 Explain electro wining, electro refining

4.0 Basic approaches to refining :

Explain refining, process – zone refining, fire refining

5.0 Principle of metal extractions :

5.1 Explain principles of metallurgical thermodynamics, zeroth law of thermodynamics

5.2 Review 1^{st}, 2^{nd}, and 3^{rd} law of thermodynamics, explain their application to metallurgical process.

5.3 Explain on details the concept of Internal Energy, enthalpy, entropy and entropy change, Free energy of a chemical reaction.

5.4 State Henry's law and Sivert's Law.

6.0 Reaction Kinetics :

6.1 Explain first order reaction and its significance.

6.2 Explain the application of first order reaction of metallurgical processes.

Portion for Internal Assessment:

Topics:-1, 2 & 3.1 TO 3.6

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Extraction of Non-ferrous Metals	H. S. Roy, Shridhar & Abraham	EWP Distribution
2.	Principle of Extractive Metallurgy	A. Ghosh & H. S. Roy	New Age
3.	Metallurgy Thermodynamics	R. H. Trupkary	Khanna
4.	Elements of Metallurgy	Swarup & Saxsena	Rastogi Publication

Th4. SPONGE IRON AND FERRO ALLOYS

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

A.RATIONALE:

Sponge iron and Ferro alloys have lot of importance as raw materials for steel manufacture; sponge iron is gradually replacing pig iron due to scarcity of coke in India and its use in B. F. to produce pig iron.

B.OBJECTIVES:

After completion of the course, the students will have knowledge about:-

1. Importance of sponge iron & Ferro alloys.
2. Various raw materials & their qualify requirements for sponge iron & ferroalloy production.
3. Principal & process of sponge iron production.
4. Various practical processes / furnaces are in use for production of Sponge iron & Ferro alloys..
5. Various uses of the sponge iron & ferroalloys.

C. **TOPIC WISE DISTRIBUTION OF PERIODS**

SL.NO.	TOPIC	PERIODS
1	Review of Sponge Iron Making Processes	04
2	Thermodynamics of Sponge Iron Making	12
3	Major direct reduction processes	08
4	Parameters of Sponge Iron Making	08
5	DRI Plant Operation and Abnormalities	08
6	Quality Control in Sponge Iron Plant	06
7	Environmental Management in DRI Plants	06
8	Production of Ferro-alloys	08
	TOTAL	60

D.COURSE CONTENTS:

Chapter-1: Review of Sponge Iron Making Processes:

1.1 Historical Development.
1.2 Reasons for Rapid growth of DR Process
1.3 Chronological Evolutions of some of the DRI Processes
1.4 Conventional versus DRI Steel Making
1.5 Direct Reduction of Iron Ore.

Chapter-2: Thermodynamics of Sponge Iron Making:

2.1. Principles of Direct Reduction Reactions.
2.2. Reaction between Coal, Oxygen and Carbon dioxide. (Set-I).
2.3. Reaction between Iron ore and CO (Set-II).
2.4. Reaction Mechanism in Coal based DRI
2.5. Reaction Mechanism in Gas based DRI.
2.6. Reduction by Carbon monoxide
2.7. Reduction by Hydrogen
2.8. Boudourd reaction and Reduction by Carbon
2.9. Carbon Deposition
2.10. Kinetics in DRI
2.12. Factors Influencing the Reducibility of Iron Ore.
2.13. Rate Controlling Theories.

Chapter-3: Major direct reduction processes

3.1 Coal based DR process using rotary kilns.
SL/RN,CODIR,ACCAR,TDR,OSIL,Krupp-Rein processes.
3.2 Coal based processes using reactors other than rotary kilns.
Rotary hearth processes based on
Inmetco,fastmet,It mk-3,
Tunnel kiln processes
kinglor-meter,hogans,
3.3 Gas based direct reduction
HYL processes,MIDREX
Fluidwise bed processes-FIOR-HIB
3.4 Uses of DRI in iron making and steel making.

Chapter-4: Parameters of Sponge Iron Making:

4.1 Raw materials of Sponge Iron Making
4.2. Chemical and Physical Tests on iron ore: Chemical composition, Reducibility, Strength, Tumbling, Abrasion and Shatter Index, Porosity, Bulk Density, Thermal Degradation Index (TDI).
4.3. Tests on Non Coking Coal: Proximate and Ultimate Analysis, Reactivity, Calorific Value, Coking Index, Swelling Index, Ash Fusion Temperature, Bulk Density.
4.4. Effect of Iron Ore size on Reduction
4.5 Carbon Enrichment of Sponge Iron
4.6 How Carbon Enrichment of Sponge Iron is performed
4.7. Flow of Solids in the Reactor or Kiln
4.8. Process Parameters of Sponge Iron Production: Raw materials, Iron Ore Feed Rate, Coal Feed Rate, C/FeRatio, Dolomite Feed, Rate, Reduction Coal to Blow Coal Ratio , Ratio of coarse and Fines in Blow Coal, Blow Coal Pressure, Temperature Profile, Kiln Speed,Ore Retention Time and Cooler Discharge end Pressure.

4.9. Nonmagnetic Percentage in the Kiln Discharge

Chapter-5: DRI Plant Operation and Abnormalities:

5.1. Daily Operating Parameters.

5.2 Operational Abnormalities: Process Pressure Fluctuations, Temperature Deviations, Back Spill, Loss of Process Fan(s), High Temperature of Cooler Discharge, Loss of Product Quality

5.3 Major Problems of DRI Kiln Operation: Injection Coal Jam, Feed Pipe Jam, Transfer Chute Jam, Main Drive Problem, Refractory Failure their causes and remedies

5.4. Shutdown Procedure: Normal Shutdown Schedule for a 500 TDP Kiln.

5.5. The Start Up process: Heating of the Reactor Refractory

5.6. Accretion Formation

5.7. Key notes on process plant operation.

Chapter-6: Quality Control in Sponge Iron Plant

6.1. Sampling: Sponge Iron and the Raw materials

6.2. Chemical Analysis of Sponge Iron, Iron Ore, Lime Stone/Dolomite and Coal

6.3. Scheme of Quality Control of input Raw Materials: Reactor Feed Iron Ore, Reactor Feed Coal, Back –Spill Coal, Slinger Coal.

6.4. Determination of Total Iron (FeT), Ferrous Iron and metallic Fe.

Chapter-7: Environmental Management in DRI Plants:

7.1. Air Pollution Mitigation Measures

7.2. Fugitive Dust Generation

7.3. Water Pollution Mitigation Measures

7.4. Solid Waste Generation and Disposal

7.5. Hazardous Wastes and Chemicals

7.6. Occupational Health and Safety

7.7. Environmental Monitoring

7.8. Environmental Standards

Chapter - 8: Production of Ferro-alloys:

8.1. Introduction to Ferro-alloying elements.

8.2. Different Ferro alloys.

8.3. General methods of producing Ferro alloys: carbothermic and aluminothermy reductions,

8.4. Refining of Ferro alloys.

8.5. Production of individual Ferro alloys: Ferro manganese, Ferro chrome, charge chrome,ferrosilicon

Fe-Ti, Fe-W, Fe-Mo and Fe-V.

<u>Portion for Internal Assessment:</u>

Topics: - 1,2,3 & 4

Learning Resources:			
Sl. No.	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Sponge iron Production	Direct Reduction of Iron oxide	PHI
2.	DRI Process and its relevance to India	S. Dasgupta, T. K. Ray & B. Ray	M.N. Dastur companies Pvt Ltd.
3.	DRI Process in Rotary kiln	Alis Chalmers	USA
4.	Production of ferro alloys	A. Riss, Y. Khodorrosky	ForeignLanguage Publishing House
5.	Fundamentals of Sponge Iron making	C.Mohapatra & D. Patnaik	JJTP BBSR.
6.	Alternate methods of iron making	Surya Kumar Dutta & R.Saha	S.Chand New Delhi,

Pr1. MATERIAL TESTING LABORATORY

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	4th
Total Period:	90	Examination :	3 hrs
Theory periods:	6P / week	Sessional	25
Maximum marks:	125	End Semester Examination ::	100

(Student are required to perform at least seven experiments)

1. Study the operation of different hardness testers such as Brinell, Rockwell & Vickers hardness testers.
2. Determination of BHN of metals & alloys
3. Determination of VHN of metals & alloys
4. Determination of RB & RC hardness values for metals & alloys
5. Study & operation of micro hardness tester..
6. Study the operation of impact tester
7. Determination of impact value of a steel specimen by Charpy & Izod machine
8. Study of fatigue testing machine and determination of fatigue limits
9. Study of U.T.M. & determination of tensile & compression strength values.

Sl. No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1	Testing of Engineering Materials	AVK Suryanaryan	TMH
2	Practical Experimental Metallurgy	Rawlings	EWP
3	Mechanical Metallurgy	Dietor	TMH
4	Introduction To Physical Mettalurgy	S.H.Avner	TMH

Pr2. METALLOGRAPHY LAB-I

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	4th
Total Period:	90	Examination :	3 hrs
Theory periods:	6P / week	Sessional	25
Maximum marks:	125	End Semester Examination ::	100

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

1. Study of metallurgical microscope.
2. Preparation of metallic specimen for metallographic study by grinding, polishing and etching
3. Study of specimen mounting press and preparation of mounted specimens.
4. Study of microstructure of different steels (hypo, eutectoid and hypereutectoid steels)
5. Study of microstructure of different cast iron (atleast three)
6. Study of microstructure of nonferrous metals and alloys e. g. copper, aluminum, brass and bearing metals.

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

Pr3. MACHINE DRAWING/CAD

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	4th
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Sessional	50

1. Drawing of Isometric views of Nuts, Bolts, Screws, Rivets and Locking devices is free hand.
2. Drawing of different thread forms: left and right, single and multi-start.
3. Knuckle and cotter joints front view, top view, and side view.
4. Plummer block and flange coupling sectional front view, plan & side view.
5. AutoCAD theory & practice on latest auto-cad software using computers in Auto cad Lab.

Sl. No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1	Machine Drawing	N. D. Bhatt	Charotor Publishing
2	CAD/CAM (Theory and Practice)	Kuldeep Saren, & Chandan Deep Grewal	S.Chand

LABORATORY WISE LIST OF EQUIPMENTS FOR 3RD SEMESTER

MINERAL DRESSING LABROTORY
(For 30 students)

1. Jaw crusher with Grindability Index Attachment ----01no.
2. Ball mill with media ----------01no.
3. Sieve shaker with set of sieves ---------03sets.
4. Jigging m/c ----------01no.
5. Wilfley table ----------01no.
6. Flotation cell ----------01no.
7. Magnetic separator ----------01no.
8. Electrostatic separator ----------01no.
9. Crushing Rolls ----------01no
10. Cone Crusher ---------- 01no
11.Pulverizert ---------- 01no
12. Digital balance(2 kg)----------03 nos.

FUEL TESTING AND CHEMICAL ANALYSIS LAB
(For 30 students)

1. Pensky Martin Digital flash and fire Point Apparatus. --- 2 nos
2. Electrolytic Analyzer. ---------- 02 nos
3. Heating Oven(heating up to 130 deg. C) ----------02 nos
4. All standard set up for chemical analysis.----------15 sets.

LABORATORY WISE LIST OF EQUIPMENTS FOR 4TH SEMESTER
MATERIAL TESTING LABORATORY
(FOR 30 STUDENTS)

1. Brinell hardness tester ---------- 02nos.
2. Rockwell hardness tester ---------- 02nos.
3. Vickers hardness tester ---------- 02nos.
4. Charpy impact tester ---------- 01nos.
5. Izod impact tester ---------- 01nos.
6. Fatigue testing m/c ---------- 01nos.
7. Universal testing m/c ---------- 01nos.
8. Microhardness Tester ---------- 1 no

METALLOGRAPHY LAB-

(FOR 30 STUDENTS)

1. Sample cutter ----------01
2. Power hacksaw ----------01
3. Belt polisher ---------- 03
4. Wheel grinder ----------01
5. Polishing machine (two disc type)---------- 03
6. Metallurgical Microscope----------03
7. Specimen mounting press----------03
8. Automatic polishing etching machine--------03

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

STATE COUNCIL FOR TECHNICAL EDUCATION AND VOCATIONAL TRAINING, ODISHA

TEACHING AND EVALUATION SCHEME FOR 6TH 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		Foundry Technology	5		-	20	80	3	100
Th.2		Mechanical Metallurgy	4		-	20	80	3	100
Th.3		Industrial Metallurgy	5		-	20	80	3	100
Th.4		Elective: 1.CorrosionEngg. 2.Metallurgical Thermodynamics	4			20	80	3	100
		Total	18			80	320	-	400
		Practical							
Pr.1		Foundry Lab..	-	-	6	50	50		100
Pr.2		Non Destructive Testing & Pyrometry Lab.	-	-	3	25	50		75
Pr.3		Project Phase II		-	7	50	100		150
Pr.4		Life skills			2	25	-	-	25
		Student Centred Activities(SCA)			3				
		Total	*18*	-	*21*	*150*	*200*	-	*350*
		Grand Total			**39**	**230**	**520**	**-**	**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/Idea Tinkering and Innovation Lab Practice etc., Seminar and SCA shall be conducted in a section.

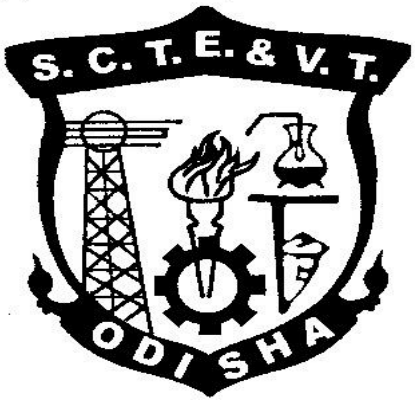
There shall be 1 Internal Assessment done for each of the Theory Subject. Sessional: Marks shall be total of the performance of individual different jobs/ experiments in a subject throughout the semester

CURRICULLUM OF 6TH SEMESTER

For

DIPLOMA IN METTALURGY ENGINEERING

(Effective FROM 2020-21 Sessions)



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

FOUNDRY TECHNOLOGY (Th-01)

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	6th
Total Period:	75	Examination :	3 hrs
Theory periods:	5P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Casting is by far the most important manufacturing process of converting metals and alloys into useable shapes. It is therefore, a very important subject for metallurgical engineering branch.

B.OBJECTIVES:

On completion of the subject the students will have idea about:-

1. Casting process
2. Preparation of various types of pattern, cores & molds.
3. Melting practices in different furances.
4. Defects in casting & remedial measures.
5. Special techniques casting.
6. Polution in foundry industry

C. TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Introduction of Foundry	03
2	Pattern Making	04
3	Moulding Materials	11
4	Binders	04
5	Core and Core Making	04
6	Mould and Mould Making	09
7	Special Moulding Process	04
8	Melting Practices	09
9	Methods of Pouring & Feeding	10
10	Cleaning of Casting	04
11	Special Casing Techniques	07
12	Casting Defect	06
	TOTAL	75

D.COURSE CONTENTS :

1.0 **Introduction to Foundry as a Manufacturing Process**

- 1.1 Define casting as a process of manufacturing.
- 1.2 State principles of casting
- 1.3 State the basic steps involved in making a casting.
- 1.4 Mention advantages &disadvantages of metal casting.

2.0 **Pattern and Pattern Making**

2.1 Define pattern
2.2 Differentiate between pattern and casting.,
2.3 State the reason for selection of pattern materials.
2.4 Describe different pattern materials.
2.5 Explain different types of pattern giving examples.
2.6 Explain different types of pattern allowances.
2.7 State the basis and merits of pattern colours giving examples.
2.8 Mention the utilities of storing and preservation of patterns.

3.0 **Moulding Materials**.
3.1 State different sources of moulding sand.
3.2 State different types of moulding sand
3.3 Give different ingredients of moulding sand.
3.4 State the classification of moulding sand in two different ways namely:
3.4.1 Classification based upon grain size
3.4.2 Classification base upon grain shape.
3.5 State the properties desired for moulding sand.
3.6 Differentiate between facing sand and backing sand.
3.7 Differentiate between sand preparation and sand conditioning.
3.8 State the functions of sand preparation/conditioning
3.9 State the reasons of sand reclamation.
3.10 Explain different sand reclamation techniques.
3.11 Testing of moulding sand.
3.12 Describe the procedure f moisture content test of molding sand.
3.13 Derive an expression for AFS grain fineness number of moulding sand
3.14 Describe the procedure for clay content test of moulding sand.
3.15 Describe the procedure for mould hardness test.
3.16 Derive an expression for permeability number of moulding sand.
3.17 Describe the procedure for compression strength of moulding sand.

4.0 **Binders and Additives**.
4.1 State the functions of binder
4.2 Explain different types of clay binders
4.3 State the function of additives
4.4 State the different types of additives.
4.5 Differentiate between facing materials and coarse materials.
4.6 Describe the utilities of different cushion materials giving examples.
4.7 Explain the functions of special additives giving examples.

5.0 **Core and Core Making**
5.1 Define core
5.2 State different functions of core
5.3 State essential characteristics of core and explain different types of core with sketches.
5.4 Describe the steps involved for core making.
5.5 Explain various methods of core baking
5.6 Explain different core baking machines.

6.0 **Moulds and Mould Making**
6.1 Define mould

6.2 State different characteristics of mould
6.3 Explain with sketches different types of mould.
6.4 Describe different moulding methods such as:
a. Bench Moulding
b. Floor Moulding
c. Pit Moulding
d. Machine Moulding.

7.0 **Special molding process**
7.1 Describe the different methods of ramming:
7.1.1 Hard ramming
7.1.2 Squeezing
7.1.3 Jolting
7.1.4 Sand slinging
7.2 Name special molding processes
7.3 Explain the molding method in permanent mould
7.4 Describe the method of shell molding giving sketch
7.5 Give the essential feature of investment mould.
7.6 Describe the carbon dioxide molding process.

8.0 **Melting Practices**
8.1 State different types of furnaces with sketches that are used in foundry for melting of ferrous and non-ferrous metals.
8.2 Describe Induction furnace of coreless high frequency type.
8.3 Explain the working principle of induction furnace.
8.4 Explain the construction and operation of cupola used for cast iron melting.
8.5 Estimate the different quantities of raw material to get a specific grade of C.I. with the help of simple charge calculation.
8.6 State the advantages and limitation of cupola.
8.7 Mention modern development of cupola. Explain different electric arc furnaces namely
a. Direct Arc type
b. Indirect Arc type
8.8 Highlight recent trends in melting techniques.

9.0 **Methods of Pouring and Feeding**
9.1 Explain gating system.
9.2 State elements of gating system with sketch.
9.3 State function of a riser.
9.4 Describe different types of riser with sketches.
9.5 Explain the importance of size and shape of riser in metal casting.
9.6 Justify the location of riser in the gating system.
9.7 Define directional solidification.
9.8 Describe progressive and directional solidification and use of chills.
9.9 State the factors which increase the efficiency of riser such as:
a. Use of insulating material
b. Use of exothermic materials
c. Use of chills
d. Use of padding
e. Use of chaplets
f. Use of molding materials of different chill capacities.
g. Use of topping up
h. Use of electric arc feeding
i. Riser head design

9.10 State Chvorinov's rule.
9.11 Mention the effects of poring temp. on the quality of casting.

10.0 **Cleaning of Casting**

10.1 Explain shake out.
10.2 Explain fettling.
10.3 Classify fettling operation in two stages namely
a. Removal of cores
b. Cleaning of canting surfaces.
10.4 Compare between sand blasting and shot blasting
10.5 Describe the process of chemical cleaning
10.6 Explain different methods or removal of gates and risers etc. such as:
a. Chipping by hammers
b. Flogging
c. Sheering
d. Sawing
e. Abrasive wheel slitting
f. Machining
g. Flame cutting
h. Plasma cutting
i. Grinding
j. Gouging
k. Trimming and sizing.

11.0 Special Casting Techniques

11.1 Explain the following die casting techniques and processes
a. Gravity die casting
b. Pressure die casting
c. Vacuum die casting
d. Cold chamber process
e. Hot chamber process
11.2 Explain the following centrifugal casting techniques
a. True centrifugal casting having
b. The De Lavaud process
c. Moore casting system
d. Semi centrifugal casting
e. Centrifuging
11.3 Mention the advantages of die casting
11.4 Mention the advantages of centrifugal casting
11.5 Explain investment casting process

12.0 Casting Defects

12.1 Mention different types of casting defects with example and their remedies
a. Defects caused by patterns and molding box.
b. Defects caused by improper molding and core making.
c. Defects caused by improper mixing and distribution.
d. Defects caused by improper molding core making and gating
e. Defects due to improper mold drying and core baking
f. Defects occurring while closing and Pouring in the moulds
g. Defects caused by molten metal
h. Defects occurring during fettling.
i. Defects due to faulty heat treatment
j. Solidification Shrinkage of cast metal.
k. Warpage

Syllabus to be covered up to I.A.

Topics :1,2,3,4,5 & 6

Learning Resources:			
Sl.No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Foundry Technology	Lal & Khanna	Khanna Publishers
2.	Foundry	Goel	Standard Publishers
3.	Foundry Practice	Salman and Simons	PHI
4.	Principle at Metal casting	Heine and Rosenthal	Mc Graw Hill
5.	Foundry Technology	Raghu Vansi	PHI

MECHANICAL METALLURGY (Th-02)

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	6th
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Major bulk of metals and alloys are converted to useable shapes by a group of manufacturing processes utilizing plastic deformation. These processes are important for a metallurgical engineer and are the subject matter of this topic.

B.OBJECTIVES:

Upon the completion of the course the students will have knowledge about:

1. Types of defects in crystal and their relation with plastic deformation.
2. Elastic and plastic behavior of metals with criteria for yielding.
3. Plastic deformation of single crystal and polycrystalline aggregate.
4. Strengthening mechanism
5. Working of metals - hot working and cold working.
6. Processes like rolling, forging, extrusion, drawing, sheet metal forming etc.

C. TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Introduction	08
2	Deformation of metals	08
3	Strengthening mechanism	10
4	Fundamentals of metal working	06
5	Recovery Recrystallization & grain growth	04
6	Rolling	06
7	Forging	05
8	Extrusion	05
9	Wire drawing	04
10	Elementary concept of deep drawing Sheet working metal	04
	TOTAL	75

D.COURSE CONTENTS :

1.0 Introduction

1.1 Dislocation, types, its basic behavior & role in deformation.

1.2 Dislocation in various crystals

1.3 Source of dislocation

1.4 Twinning & deformation.
1.5 Slip & Deformation.

2.0 **Deformation of metals**:
- 2.1 Explain the elastic & plastic behavior of metals.
- 2.2 Explain yielding criteria.
- 2.3 Derive critically resolved shear stress.
- 2.4 Explain deformation of polycrystalline aggregates.

3.0 **Strengthening mechanism**:
- 3.1 Explain strengthening mechanism
- 3.2 Describe the role of grain boundary in strengthening
- 3.3 Define Hall Petch equation
- 3.4 Describe yield point phenomenon.
- 3.5 Explain strain-aging
- 3.6 Explain solid solution strengthening from fine particles
- 3.7 Describe fiber strengthening
- 3.8 Describe martensitic strengthening
- 3.9 Explain strain hardening
- 3.10 Describe Bauschinger's effect.

4.0 **Fundamentals of Metal working**:
- 4.1 Classify different metal working process.
- 4.2 Explain hot working and cold working of metals and alloys
- 4.3 State the advantages and disadvantages of hot and cold working

5.0 **Recovery, recrystallization and grain growth**
- 5.1 Explain the following phenomena,
  - (a) Recovery
  - (b) Recrystallization
  - (c) Grain growth

6.0 **Rolling:**
- 6. 1 Explain principles of rolling
- 6.2 Compare between hot rolling and cold rolling.
- 6.3 Explain the types of roll pass-open pass and box pass.
- 6.4 State different types of rolling detects and their control

7.0 **Forging:**
- 7.1 Explain types of forging process
- 7.2 Describe the properties of forged products
- 7.3 Explain the defects of forged products and their control

8.0 **Extrusion:**
- 8.1 Explain the elementary principle of extrusion
- 8.2 Classify the defects in extruded product
- 8.3 Explain the manufacturing of seamless pipes

9.0 **Wire drawing:**
- 9.1 Explain the elementary principle of wire drawing
- 9.2 Classify the defects of wire drawing

10.0 **Forming methods**

10.1 Describe the elementary concept of deep drawing

10.2 Explain different sheet metal forming - bending shearing aid blanking

Syllabus to be covered up to I.A.

Topics :1,2,3 & 4

Learning Resources:

Sl.No	Title of the Book	Name of Authors	Name of Publisher
1.	Mechanical metallurgy	Dieter	Mc Graw Hill
2.	Introduction to physical metallurgy	Avner	Mc Graw Hill
3.	Physical metallurgy principles	Reed Hill	EWP
4.	Mechanical Treatment of metals	R.N. Parkins	Geoge Allen &Unuin
5.	Mechanical Testing of Materials	C.Mohapatra	JJTP,Bhubaneswar

INDUSTRIAL METALLURGY (Th-03)

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	6th
Total Period:	75	Examination :	3 hrs
Theory periods:	5P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Metals and alloys are converted into useable products of different shapes and Sizes by number of manufacturing processes. Powder metallurgy and metal Joining are two of the major manufacturing processes of shaping metals and alloys.

B.OBJECTIVES:

On completion of the subject the students will have idea about:-

1. Various welding process & their techniques.
2. Metal joining process like brazing & soldering.
3. Powder metallurgy & its application
4. Various method of powder production.
5. Production of metal powder articles.

C. TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Classification of Welding Processes	04
2	Gas Welding	05
3	Arc Welding	05
4	Thermit Welding	04
5	Resistance Welding	04
6	Welding of Steel C.I & Cu. Alloys	05
7	Metallurgy of Welding	04
8	Brazing & soldering	04
9	Scope of Powder Metallurgy	04
10	Methods of Powder Production	10
11	Compaction of Metal Powders	06
12	Sintering of Metal Powders	10
13	Flow Sheets of Production of P/M Components	10
	TOTAL	75

METAL JOINING

1.0 **Classification of Welding Processes**.

1.1 Classify different welding process such as pressure welding processes and non-pressure welding process.

2.0 **Gas Welding**

2.1 Explain different flames, equipments, steps, advantages, disadvantages and application of gas welding.

3.0 **Arc Welding**

3.1 Describe various arc welding process such as

a. Metallic Arc

b. Submerged Arc

c. TIG Welding

d. MIG Welding.

4.0 **Thermit Welding**

4.1 Discuss the principle, procedure, advantages and disadvantages of Thermit welding.

5.0 **Resistance Welding**

5.1 Explain the principle and various types of resistance welding.

6.0 **Welding of Steel, C.I. and Cu Alloys**.

6.1 Mention the precaution required for welding of steel.

6.2 Explain the joint design and techniques required for C.I. welding.

6.3 Describe the welding of copper and its alloys

7.0 **Metallurgy of Welding**.

7.1 Explain the temperature distribution in we1dng of steel.

7.2 Discuss the structural changes in weld metal and parent metal after welding.

7.3 Define weldability.

7.4 Mention different welding defects.

7.5 Discuss various methods for testing welding joints.

8.0 **Brazing and Soldering.**

8.1 Define brazing and explain its principle and procedure.

8.2 Discuss various brazing methods of common ferrous and nonferrous metals.

8.3 Define soldering and explain various types of solders.

8.4 Describe the basic steps of soldering of common metals.

POWDER METALLURGY

9.0 **Scope of Powder Metallurgy**.

9.1 Define powder metallurgy.

9.2 Depict the historical development of powder metallurgy.

9.3 Mention advantages disadvantages and applications of P/M

9.4 Briefly describe primary and secondary characteristics of powders.

10.0 **Methods of Powder Production**

10.1 Name different methods of powder production.

10.2 Describe the mechanical, physical, chemical and electro chemical methods.

11.0 **Compaction of Metal Powders**

11.1 Give the significance and different methods of conditioning.

11.2 Explain different die-compaction techniques,

11.3 Describe isostatic pressing with advantages, limitation applications.

11.4 Give brief outline on continuous compaction.

12.0 **Sintering of Metal Powder**.

12.1 Define sintering and Explain its various stages.

12.2 Explain briefly mechanism of sintering process.

12.3 Explain the process variables and furnaces used for sintering

12.4 Give a note on liquid phase sintering.

13.0 **Flow Sheets of Production**

13.1 Give Flow Sheets for the Production of the Following.

a. Porous bearing
b. Sintered friction materials
c. Sintered carbides
d. Magnetic Materials
e. Cermets
f. Dispersion strengthened materials

Syllabus to be covered up to I.A.

Topics :1,2,3 & 4

Learning Resources:

Sl. No	Title of the Book	Name of Authors	Name of Publisher
1.	Introduction to Powder Metallurgy	A.K.Sinha	L Hanpat Rai Publication
2.	Powder Metallurgy	R.L.Sande&C.R.Sha	Geore Newton Ltd. London
3.	Applied Metallurgy 1or Engineers	Curton.	Mc Graw Hill
4.	Manufacturing Process	Badman	
5.	The Metallurgy of Welding, razing and Soldering	J.Lankaster	George Allen &wnwin Ltd.
6.	Welding Technology	O. P. Khanna	Dhanpat
7.	Welding Technology	Richard Little	Mc Graw Hill
8.	Powder Metallurgy	R.L.Sande&C.R.Sha	Geore Newton Ltd. London
9.	Applied Metallurgy 1or Engineers	Curton	Mc Graw Hill

COROSSION ENGINEERING (Th-04-A)
(ELLECTIVE)

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	6th
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Major cause of failure and/or deterioration with time of any metallic structure is corrosion. It is, therefore, of utmost importance to understand the causes of metallic corrosion and how to prevent such corrosions, which is the contents of this topic.

B.OBJECTIVES:

On completion of the subject the students will have idea about:-

1. Different types of corrosion & It‘s Principle.
2. Can identify & analysis different types of corrosion.
3. Can apply corrosion prevention method at practical fields.

C. TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Introduction to Corrosion	10
2	Corrosion principles	08
3	Types of electrochemical cells	06
4	Electrodes potential	06
5	Different forms of corrosions	15
6	Corrosions preventions	15
	TOTAL	60

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

1.0 **Introduction toCorrosion:**
- 1.1 Define corrosion
- 1.2 Explain cost of corrosion, direct and indirect losses
- 1.3 State the importance of corrosion studies
- 1.4 Classify different types of corrosion
- 1.5 Differentiate between electrochemical corrosion and chemical corrosion.
- 1.6 State the corrosion rate

2.0 **Corrosion principles**:
- 2.1 Explain the electrochemical principle of corrosion
- 2.2 State the Faraday’s law and its causes and its deviation

3.0 **Types of electrochemical cells**
- 3.1 Discuss in details galvanic cell, concentration cell and electrolytic cell

4.0 **Electrode potential**:

4.1 State its significance without experimental measurement.

4.2 Discuss in details electromotive force and galvanic series and their application with reference to corrosion and protection.

5.0 **Different forms of corrosion**:

5.1 Explain in details about factors affecting mechanism and prevention of following-corrosion:

i. Atmospheric corrosion
ii. Intergranular corrosion
iii. Pitting corrosion
iv. Corrosion fatigue
v. Galvanic corrosion
vi. Stress corrosion/cracking
vii. Cavitation corrosion
viii. Fretting corrosion
ix. High temperature oxidation corrosion
x. Stray current corrosion

6.0 **Corrosion Prevention**

6.1 Study the physical, mechanical and chemical characteristic of protective coating.

6.2 Explain corrosion prevention by inhibition and passivation by control of environment (without kinetics).

6.3 Discuss the cathodic and anodic protection

Syllabus to be covered up to I.A.

Topics :1,2,3 & 4

Learning Resources:

Sl. No	Title of the Book	Name of Authors	Name of Publisher
1.	Introduction to electrometallurgy and corrosion	Saran & Narayan	Standard
2.	Corrosion Engineering	M.G. Fontana and Green	Mc Graw Hill
3.	Hand book of corrosion	Uhlig	Wiley

METALLURGICAL THERMODYNAMICS (TH-04-B)

(ELECTIVE)

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	6th
Total Period:	60	Examination :	3 hrs
Theory periods:	4P / week	Internal Assessment:	20
Maximum marks:	100	End Semester Examination	80

A.RATIONALE:

Metallurgical Thermodynamics is one of the core subjects of metallurgy and deals with fundamental aspects of any metallurgical reaction and / or processes. The possibility of a metallurgical reaction and its kinetics can only be known by studying the laws of thermodynamics. Hence study of thermodynamics is essential for proper understanding of metallurgical reactions.

B.OBJECTIVES:

1. Basic idea about thermodynamics & various laws of thermodynamics.
2. Feasibility of chemical reactions,
3. Reaction Kinetics
4. Various types of solution
5. How to calculate concentration of reactants and products.

C. TOPIC WISE DISTRIBUTION OF PERIODS		
SL.NO.	**TOPIC**	**PERIODS**
1	Introduction to Thermodyanmics	12
2	First Law of Thrmodynamics	12
3	Second Law of Thermodynamics	06
4	Free Energy	06
5	Third Law OF Thermodynamics,Statistical Thermodynamics	04
6	Fugacity	08
7	Thermodynamics of Solutions	08
8	Topochemical Reaction	04
	TOTAL	60

D.COURSE CONTENTS

1.0 **Introduction to Thermodynamics**

- 1.1 Thermodynamics
- 1.2 Process
- 1.3 Property
- 1.4 Equation of States
- 1.5 Simple Equilibrium
- 1.6 Thermodynamic Equilibrium
- 1.7 Internal Energy

1.8 Gibbs Phase Rule

2.0 **First Law of Thermodynamics**

2.1 First Law of Thermodynamics
2.2 Heat Capacity
2.3 Enthalpy
2.4 Hess's Law
2.5 Kirchhoff's Law
2.6 Thermo Chemistry & its Applications
2.7 Adiabatic & Isothermal Process

3.0 **Second Law of Thermodynamics**

3.1 Second Law of Thermodynamics
3.2 Entropy
3.3 Entropy of a Perfect Gas
3.4 Temperature Dependence of Entropy
3.5 Reversible & Irreversible Process

4.0 **Free Energy**

4.1 Combined Expressions of First & Second Law of Thermodynamics
4.2 Criteria of Thermodynamic Equilibria
4.3 Gibbs Helmholtz Equations
4.4 Maxwell's Relation

5.0 **Third Law OF Thermodynamics, Statistical Thermodynamics**

5.1 Third Law OF Thermodynamics
5.2 Debye & Einstein Concept of Heat Capacity

6.0 **Fugacity**

6.1 Escaping Tendency
6.2 Arrhenius Equation
6.3 Activity
6.4 Equilibrium Constant.
6.5 Use of S Function
6.6 Ellingham-Richardson Diagram

7.0 **Thermodynamics of Solutions**

7.1 Ideal & Non-Ideal Solutions
7.2 Partial & Integral Molar Quantities
7.3 Gibbs-Duhem Equation
7.4 Activity vs Mole Fraction (Henry's Law)
7.5 Regular Solutions
7.6 Sievert's Law

8.0 **Topochemical Reaction**

8.1 Topochemical Reaction
8.2 Johnson-Mehl's Equation
8.3 Differnce between Molecularity & Order of the Reaction

Syllabus to be covered up to I.A.

Topics :1,2,3 & 4

Learning Resources:			
Sl. No	**Title of the Book**	**Name of Authors**	**Name of Publisher**
1.	Engg. Thermodynamics	P.K.Nag	Mc Graw Hill
2.	Text book of Materials & Metallurgical Thermodynamics	Ghosh A.	PHI
3.	Physical chemistry of metals	Darken and Gurry	CBS
4.	Metallurgical Thermodynamics	Dubey and Upadhaya	PHI
5	Introduction to Metallurgical Thermodynamics	David Gaskel	Taylor & Francis

Pr1. FOUNDRY ENGINEERING LAB

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	6th
Total Period:	90	Examination :	3 hrs
Theory periods:	6P / week	End Exam	50
TOTAL	100	Sessional	50

(Students are required to perform at least five experiments from Section A& Section B in full)

SECTION-A

1 Determination of moisture content of molding sand by speed moisture teller.
2 Determination of clay Content in molding sand.
3 Determination of A.F.S.grain fineness no. of molding sand
4 Determination of green permeability of molding sand and core sand.
5 Determination of green compression test of molding sand and core sand.
6 Determination of dry strength of mould.
7 Determination of shear strength
8 Determination of mould hardness.

SECTION-B

Students should prepare at least one ferrous or non ferrous casting from pattern making to finishing.

Pr2 NONDESTRUCTIVE TESTING & PYROMETRY LAB

Name of the Course: Diploma in Metallurgical Engineering			
Course code:		Semester	6th
Total Period:	60	Examination :	3 hrs
Theory periods:	3P / week	End Exam	50
TOTAL	100	Sessional	25

1. Study of ultrasonic flaw detector & inspection of defects by using UFD.
2. Study of magnetic crack detector and inspection of defects by using it.
3. Find defect using liquid penetrant
4. Inspection of defects of cast and welded specimen by using suitable NDT equipments.
5. Measurement of temperature by using pyrometer and thermocouples.

Pr3. PROJECT Phase - II

Name of the Course: Diploma in Mettalurgical Engineering			
Course code:		Semester	6th
Total Period:	150	Examination	3 hrs
Lab. periods:	10 P / week	Sessional	75
Maximum marks:	175	End Sem Examination	100

RATIONALE

Students' Project Work aims at developing innovative skills in the students whereby they apply the knowledge and skills gained through the course covered in many subjects and Labs, by undertaking a project. The prime emphasis of the project work is to understand and apply the basic knowledge of the principles of Mettalurgy engineering and practices in real life situations, so as to participate and manage a large Mettalurgy engineering projects, in future. Entire Project spreads over 5th and 6th Semester. Part of the Project covered in 5th Semester was 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.
- Develop software packages or applications and implement these for the actual needs of the community/industry.
- Identify and contrast gap between the technological knowledge acquired through curriculum and the actual industrial need and to 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.
- To achieve real life experience in Project design.
- To develop the skill of writing Project Report

Project Phase-I and Phase-II

The Project work duration covers 2 semesters(5th and 6th sem). The Grouping of students,

selection of Project, assignment of Project Guide to the Group was done in the beginning of 5th semester under Project Phase-I. The students were allowed to study literature, any existing system and then define the Problem/objective of the Project. Preliminary work and Design of the system also have to be complete in Phase-I. Development may also begin in this phase. Project Milestones are to be set so that progress can be tracked .

In Phase-II Development, Testing, Documentation and Implementation have to be complete. 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-II in 6th semester there shall be one presentation by each group on whole Project work undertaken by them.

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.

The Project Report need to be prepared as per standard format and following is the indicative format. The Teacher Guide may make minor alteration keeping the sense in tact.

Organization of Project Report

1. Cover page:
   It should contain the following (in order)
   (i) Title of the Project
   (ii) "Submitted in partial fulfillment of the requirements for the Diploma in <Branch Name>"
   (iii) By Name of the Student(s)
   (iv) Logo of the Institution
   (v) Branch Name/Depart Name and Institution Name with Address
   (vi) Academic Year
2. 1st Inner page
   Certificate:
   It should contain he following
   "This is to certify that the work in this Project Report entitled <Project Title> by <Name of student(s)> has been carried out under my supervision in partial fulfillment of the requirements for the Diploma in <Branch Name>" during session <session > in <Branch /Department Name> of <Institute name> and this work is the original work of the above student(s).

   Seal and signature of the Supervisor/Guide with date
3. 2nd Inner Page
   Acknowledgement by the Student(s)
4. Contents.
5. Chapter wise arrangement of Reports
6. Last Chapter: Conclusion
   It should contain
   (i) Conclusion
   (ii) Limitations
   (iii) Scope for further Improvement
7. References

Pr-4 LIFE SKILL

(Common to All Branches)

Practical	**2 Periods per week**	**Sessional**	**25 Marks**
Total Periods	**30 Periods**	**Total Marks**	**25 Marks**

Objective: After completion of this course the student will be able to**:**

- Develop team spirit i.e. concept of working in team
- Apply problem solving skills for a given situation
- Use effective presentation techniques
- Apply task management techniques for given projects
- Enhance leadership traits
- Resolve conflict by appropriate method
- Survive self in today's competitive world
- Face interview without fear

DETAIL CONTENTS:

1. SOCIAL SKILL

Society, Social Structure, Develop Sympathy and Empathy
Swot Analysis – Concept, How to make use of SWOT
Inter personal Relation**:** Sources of conflict, Resolution of conflict ,
Ways to enhance interpersonal relation

2. PROBLEM SOLVING

Steps of Problem solving**:**

- Identify and clarify the problem,
- Information gathering related to problem,
- Evaluate the evidence,
- Consider alternative solutions and their implications,
- Choose and implement the best alternative,
- Review
- Problem solving techniques:

1) Trial and error, 2) Brain storming, 3) Lateral (Out of Box) thinking

3. PRESENTATION SKILL

Body language , Dress like the audience
Posture, Gestures, Eye contact and facial expression. STAGE FRIGHT,
Voice and language – Volume, Pitch, Inflection, Speed, Pause
Pronunciation, Articulation, Language, Practice of speech.
Use of AV aids such as Laptop with LCD projector, white board etc.

4. GROUP DISCUSSION AND INTERVIEW TECHNIQUES

Group Discussion:

Introduction to group discussion, Ways to carry out group discussion,
Parameters— Contact, body language, analytical and logical thinking,
decision making

Interview Technique :

Dress, Posture, Gestures, facial expression, Approach
Tips for handling common questions.

5. WORKING IN TEAM

Understand and work within the dynamics of a groups.
Tips to work effectively in teams,
Establish good rapport, interest with others and work effectively with them
to meet common objectives,
Tips to provide and accept feedback in a constructive and considerate way ,
Leadership in teams, Handling frustrations in group.

6. TASK MANAGEMENT

Introduction, Task identification, Task planning ,
organizing and execution, Closing the task

PRACTICAL

List of Assignment: *(Any Five to be performed including Mock Interview)*

a. SWOT analysis:-

Analyse yourself with respect to your strength and weaknesses, opportunities and threats. Following points will be useful for doing SWOT.

a) Your past experiences,
b) Achievements,
c) Failures,
d) Feedback from others etc.

b. Solve the True life problem assigned by the Teacher.

3. Working in a Team

Form a group of 5-10 students and do a work for social cause e.g. tree plantation, blood donation, environment protection, camps on awareness like importance of cleanliness in slum area, social activities like giving cloths to poor etc.(One activity per group where Team work shall be exhibited)

4. Mock Interview

5. Discuss a topic in a group and prepare minutes of discussion.

6. Deliver a seminar for 5 minutes using presentation aids on the topic given by your teacher.

7. Task Management

Decide any task to be completed in a stipulated time with the help of teacher. Write a report considering various steps in task management (with Break up into sub tasks and their interdependencies and Time)

Note: -1. Please note that these are the suggested assignments on given contents/topic. These assignments are the guide lines to the subject teachers. However the subject teachers are free to design any assignment relevant to the topic.

Note: -2. The following Topics may be considered for Seminar/GD in addition to other Topics at the discretion of the Teacher.

(Comparison with developed countries, Occupational Safety, Health Hazard, Accident & Safety, First-Aid, Traffic Rules, Global Warming, Pollution, Environment, Labour Welfare Legislation, Labour Welfare Acts, Child Labour Issues, Gender Sensitisation ,Harassment of Women at Workplace)

METHODOLOGY:

The Teacher is to explain the concepts prescribed in the contents of the syllabus and then assign different Exercises under Practical to the students to perform.

Books Recommended:-

Sl.No	Name of Authors	Title of the Book	Name of the Publisher
01	E.H. Mc Grath , S.J	Basic Managerial Skills for All	PHI
02	Lowe and Phil	Creativity and problem solving	Kogan Page (I) P Ltd
03	Adair, J	Decision making & Problem Solving	Orient Longman
04	Bishop , Sue	Develop Your Assertiveness	Kogan Page India
05	Allen Pease	Body Language	Sudha Publications Pvt. Ltd.

LABORATORY WISE LIST OF EQUIPMENTS FOR 6TH SEMESTER

EQUIPMENTS OF FOUNDRY ENGINEERING LAB

(FOR 30 STUDENTS)

1. Standard sieves and sieves shaker-----1 set
2. Rapid Moisture Teller ----------1 no
3. Clay Content tester ---------- 01 no
4. Permeability Tester ---------- 01no
5. Core hardness Tester ---------- 01no.
6. Sand UTM ---------- 01 no.
7. Sand Muller ---------- 01 no
8. Molding Sand Sample Rammer. --------- 02no
9. Mould Boxes ---------- 10 nos
10. Different patterns
11. Molding kit Box ---------- 1no for each 10 students.
12. Melting F/C for cast iron and aluminum (induction type) --- 01 no
13. Graphite Crucible,5 kg capacity ----------05 nos
14. Stainless steel Crucible,10 kg capacity ----------02 nos

EQUIPMENTS OF NONDESTRUCTIVE TESTING & PYROMETRY LAB

(FOR 30 STUDENTS)

1. Magnetic particle tester kit ---------- 01nos.
2. Ultrasonic flow detector ---------- 01nos.
3. Optical pyrometer ---------- 02nos.
4. Thermocouple (with accessories potent meter) -------- 02nos.
5. Micro hardness Tester ---------- 01 no