West Bengal State Council of Technical & Vocational Education and Skill Development
(Technical Education Division)

Syllabus
of

Diploma in Metallurgical Engineering
[MET]

Part-II (4th Semester)

Revised 2022

SEMESTER - IV

Sl. No	Category of Course	Code No.	Course Title	Hours per week			Total contact hrs/ week	Credits	Marks
				L	T	P			
1.	Program Core Course – X	MTPC202	Physical Metallurgy – II	2	1	0	3	3	100
2.	Program Core Course - XI	MTPC204	Metal Working Process	2	1	0	2	2	100
3.	Program Core Course – XII	MTPC206	Ferro Alloy & DRI	1	1	0	2	2	100
4.	Program Core Course - XIII	MTPC208	Testing of Metals	2	1	0	2	3	100
5.	Program Core Course - XIV	MTPC210	Blast Furnace Iron Making Process	2	1	0	3	3	100
6.	Program Core Course – XV	MTPC212	Physical Metallurgy - II Lab	0	0	2	2	3	100
7.	Program Core Course – XVI	MTPC214	Destructive Testing of Metals Lab	0	0	2	2	1	100
8.	Program Elective course - I	MTPE202	Alloy Steel & Cast Iron	2	1	0	3	3	100
9.	Minor Project	MTPR202	Minor Project	0	0	4	4	2	100
	Total			**11**	**6**	**8**	**25**	**21**	**900**

COURSE : PHYSICAL METALLURGY – II

Course Code	MTPC202
Course Title	Physical Metallurgy – II
Number of Credits	3
Course offered in	Part - II , 4th. Semester
Course Category	Program Core Course
Hours / Week	3 (Lecture – 2 : Tutorial : 1) ; Total 15 weeks / Sem
Full Marks	100

Marks Distribution: Full Marks =100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Question Type	Marks
1	Mid Semester Tests (Two best out of three)	10x2=20	Objective type questions carrying 1 mark for 20 questions(Qs) out of 25 Qs throughout the syllabus	1x20=20
2	Quizzes, viva-voce, Assignments	10	Question carrying 2 marks for 5 Qs out of 8 Qs (at least 1Q from each unit)	2x5=10
3	Class Attendance	10	Qs carrying 6 marks for 5 Qs (Subjective type) out of 8 Qs (at least 1Q from each unit)	6x5=30
	Total	**40**		**60**

Course Objectives :

Students will have knowledge , skill and attitude on following topic in higher order learning as per Blooms Taxonomy .

1. Understand the meaning of solidification of metals.
2. Understand about the formation of different phases in Iron Carbon equilibrium diagram.
3. Understand about the heat treatment of metals.
4. Gather concept about TTT & CCT diagram, their utility & importance .
5. Understand about Hardenability & its determination process .
6. Understand the mechanism of surface hardening .

Course Outcomes (COs)

ourse	Statement
MTPC202.1	Identify various types of solid solutions with respect to relative atomic size
MTPC202.2	Classify solidification mechanisms of metals and alloys.
MTPC202.3	Gather understanding about T-T-T and C-C-T diagrams.
MTPC202.4	Explain various types of heat treatment and strengthening mechanisms of steel.
MTPC202.5	Assess the extent of formation of martensite following quenching in different quench media.
MTPC202.6	Explain the mechanism of surface hardening .

UNIT WISE DIVISION OF THE SYLLABUS

UNIT	TOPIC	CONTACT PERIODS
1	Alloy System & Phase transformation in Iron - Carbon equilibrium diagram.	7
2	Solidification of Metals & Alloys.	5
3	T-T-T & CCT Diagram .	8
4	Heat treatment of Steel.	12
5	Hardenability	6
6	Different types of Surface Hardening procedure (Chemical and Physical treatment)	7
	Total =	45

Reference Books : -

1. Engineering Physical Metallurgy --- Y. Lakhtin .
2. Introduction to Physical Metallurgy --- S.H.Avner .
3. Physical Metallurgy Principles --- Reed Hill .
4. Metallurgy for Engineers --- E.C. Rollason .
5. Physical Metallurgy for engineers --- Clark & Varney .
6. Journal "Metal News" – Published by The Indian Institute of Metals .
7. The physical metallurgy of steels --- Leslie .
8. Elements of physical metallurgy – A.G.Guy .

DETAIL COURSE CONTENT

1.0 Alloy System & Phase transformation in Iron - Carbon equilibrium diagram. 7 PERIODS

1.1 Alloy System , Classification of alloys, Interstitial, substitutional, Intermetallic compounds.
1.2 Hume - Rothery rules of alloying;
1.3 Types of Solid Solution with example .
1.4 Different phases & their transformation mechanism in Iron - Carbon equilibrium diagram – Brief outline .

2.0 Solidification of Metals & Alloys. 5 PERIODS

2.1 Liquid Phase & Phase rule.
2.2 Nucleation.
2.3 Crystal growth from liquid phase.
2.4 Dendritic growth.
2.5 Freezing of Ingots.
2.6 Cast structure.
2.7 Segregating.
2.8 Homogenization.
2.9 Inverse segregaftion.
2.10 Porosity problems.

3.0 T-T-T & CCT Diagram . 8 PERIODS

3.1 T-T-T curve & its description.
3.2 Effect of temperature on pearlite formation.
3.3 C-C-T diagram.
3.4 Difference between T-T-T & C-C-T diagram .
3.5 Critical cooling rate to produce martensite.
3.6 Formation of bainite.

4.0 Heat treatment of Steel. 12 PERIODS

4.1 Definition & objectives of heat treatment.
4.2 Annealing
4.3 Normalising
4.4 Hardening.
4.5 Tempering.
4.6 Sub-Zero treatment.
4.7 Defects due to heat treatment.

5.0 Hardenability 6 PERIODS

5.1 Definition & concept .
5.2 Determination of hardenability by Grossman method , merits & demerits.
5.3 Determination of hardenability by Jominy method , merits & demerits.
5.4 Effect of grain size, carbon content, & alloying elements on hardenability.
5.5 Severity of quench, Ideal quench.

6.0 Different types of Surface Hardening procedure (Chemical and Physical treatment) 7 PERIODS

6.1 Introduction to Chemical treatment of surface hardening .
6.2 Carburizing
6.3 Nitriding
6.4 Carbo - Nitriiding
6.5 Cyaniding
6.6 Introduction to Physical treatment of surface hardening.
6.7 Induction hardening
6.8 Flame hardening
6.9 Resistance heating

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COURSE: METAL WORKING PROCESSES

Course Code	MTPC204
Course Title	Metal working Processes.
Number of Credits	2
Course offered in	Part - II , 4th. Semester
Course Category	Program Core Course
Hours / Week	2 (Lecture – 1 : Tutorial : 1) ; Total 15 weeks / Sem
Full Marks	100

Marks Distribution: Full Marks =100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Question Type	Marks
1	Mid Semester Tests (Two best out of three)	10x2=20	Objective type questions carrying 1 mark for 20 questions(Qs) out of 25 Qs throughout the syllabus	1x20=20
2	Quizzes, viva-voce, Assignments	10	Question carrying 2 marks for 5 Qs out of 8 Qs (at least 1Q from each unit)	2x5=10
3	Class Attendance	10	Qs carrying 6 marks for 5 Qs (Subjective type) out of 8 Qs (at least 1Q from each unit)	6x5=30
	Total	**40**		**60**

Course Objectives:

Students will have knowledge, skill and attitude on following topic in higher order learning as per Blooms Taxonomy.

1. Introduction to different metal working processes, Concepts of stresses and Yield criterions.
2. Details of different Rolling process.
3. Understanding of different Forging processes.
4. Understanding of different Extrusion processes.
5. Understanding of Wire drawing & Deep drawing processes.
6. Defects related different metal working process

Course Outcomes (COs):

Course	Statement
MTPC204.1	Analyze basic concepts of stress, different types of stresses, Yield criterions and basics of different metal working processes.
MTPC204.2	Analyze different types of Rolling Processes, their defects.
MTPC204.3	Analyze different types of Forging Processes and their defects.
MTPC204.4	Analyze different types of Extrusion Processes and their defects.
MTPC204.5	Analyze wire drawing and deep drawing processes and their defects.

UNIT WISE DIVISION OF THE SYLLABUS

UNIT	TOPIC	CONTACT PERIODS
1	Introduction to different metal working processes, concepts of stresses and yield criterions	4
2	Rolling of metals & Alloys.	6
3	Forging process.	5
4	Extrusion Process.	5
5	Wire drawing .	5
6	Deep drawing .	5
	Total =	30

Reference Book : -

1. Mechanical Metallurgy --- G. E. Dieter.

2. Principles of Industrial Metalworking Processes: G W Rowe

DETAIL COURSE CONTENT

1.0 Introduction to different metal working processes.
1.1 Importance of hot – metal working.
1.2 Temperature in Metal working.
1.3 Classifications of metal – working.
1.4 Thermo -mechanical treatment.
1.5 Concept of Stresses and different yield criterions.

2.0 Rolling of metals & Alloys.
2.1 Classification of Rolling-Mills.
2.2 Hot- rolling.
2.3 Cold-rolling.
2.4 Variables in rolling.
2.5 Forces in rolling.
2.6 Defects in rolling.

3.0 Forging Process .
3.1 Forgability – Forging .
3.2 Open-die Forging.
3.3 Closed die Forging.
3.4 Press & Hammer forging.
3.5 Hot- stamping.
3.6 Defects in forging.

4.0 Extrusion Process
4.1 Types of Extrusion.
4.2 Application & Limitation of extrusion.
4.3 Variables in extrusion.
4.4 Seamless tube production.
4.5 Defects in extrusion.

5.0 Wire - drawing.
5.1 Wire-drawing techniques.
5.2 Wire-drawing die.
5.3 Half-die angle, Patenting.
5.4 Defects in wire drawing.

6.0 Deep – drawing.
6.1 Re-drawing.
6.2 Deep-drawn products.
6.3 Drawability
6.4 Defects in deep Drawing.

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COURSE : FERRO ALLOY & DIRECTLY REDUCED IRON

Course Code	MTPC206
Course Title	FERRO ALLOY & DIRECTLY REDUCED IRON
Number of Credits	2
Course offered in	Part - II , 4th. Semester
Course Category	Program Core Course
Hours / Week	2 (Lecture – 1 : Tutorial : 1) ; Total 15 weeks / Sem
Full Marks	100

Marks Distribution: Full Marks =100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Question Type	Marks
1	Mid Semester Tests (Two best out of three)	10x2=20	Objective type questions carrying 1 mark for 20 questions(Qs) out of 25 Qs throughout the syllabus	1x20=20
2	Quizzes, viva-voce, Assignments	10	Question carrying 2 marks for 5 Qs out of 8 Qs (at least 1Q from each unit)	2x5=10
3	Class Attendance	10	Qs carrying 6 marks for 5 Qs (Subjective type) out of 8 Qs (at least 1Q from each unit)	6x5=30
	Total	**40**		**60**

Course Objectives : (This is a sample . pl do for this subject)

Students will have knowledge , skill and attitude on following topic in higher order learning as per Blooms Taxonomy .

1. Gather concept about application of ferro -alloys & its importance .
2. Understand about principles & different processes of ferro -alloy production .
3. Gather knowledge about sponge iron & production procedure .

Course Outcomes (COs) :

Subject : FERRO ALLOY & DIRECTLY REDUCED IRON

Course	Statement
MTPC206.1	Explain about Ferro-alloy and its present industrial status.
MTPC206.2	Analyze the principles and processes of Ferro – alloy technology.
MTPC206.3	Analyze the Alumino-thermic process of ferro - alloy production.
MTPC206.4	Analyze about Principle and process od Directly reduced Iron (Sponge Iron) .

UNIT WISE DIVISION OF THE SYLLABUS

UNIT	TOPIC	CONTACT PERIODS
1	Survey on ferro alloys .	6
2	Principles & processes of ferro alloys.	8
3	Alumino-thermic process .	8
4	Directly Reduced Iron (Sponge Iron) .	8
	Total =	30

Reference Books : -

1. Ferroalloys technology in India --- C.K.Gupta & A.K.Suri .
2. Production of Ferroalloys --- A.Riss & T. Khodorovsky .
3. Modern Iron Making --- R.H.Tupkary .
4. Metal News --- The Indian Institute of Metals .

DETAIL COURSE CONTENT

1.0 Survey on ferro alloys .

1.1 Definition , classification , applications .

1.2 Deoxidation & alloying .

1.3 Mode of addition .

1.4 Raw materials .

2.0 Principles & processes of ferro alloys.

2.1 Principles .

2.2 Mineral beneficiation & exploration .

2.3 Alluminothermic reduction process .

2.4 Thermit process & operation .

3.0 Aluminothermic process .

3.1 Physical chemistry & raw materials .

3.2 Smelting technology , commercial alloy composition .

3.3 Physical chemistry for production of high and low-carbon Ferrosilicon, Ferrochrome, ferromanganese .

4.0 Directly Reduced Iron (Sponge Iron) .

4.1 Defination & degree of metallisation .

4.2 Physical chemistry of sponge iron making .

4.3 Description of different Sponge iron making processes .

4.4 HyL process , Midrex process , Fludised Bed process , Rotary Kiln process ,SL / RN process .

4.5 Use of sponge iron .

4.6 Indian scenario of sponge iron making .

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COURSE : TESTING OF METALS

Course Code	MTPC208
Course Title	TESTING OF METALS
Number of Credits	2
Course offered in	Part - II , 4th. Semester
Course Category	Program Core Course
Hours / Week	2 (Lecture – 1 : Tutorial : 1) ; Total 15 weeks / Sem
Full Marks	100

Marks Distribution: Full Marks =100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Question Type	Marks
1	Mid Semester Tests (Two best out of three)	10x2=20	Objective type questions carrying 1 mark for 20 questions(Qs) out of 25 Qs throughout the syllabus	1x20=20
2	Quizzes, viva-voce, Assignments	10	Question carrying 2 marks for 5 Qs out of 8 Qs (at least 1Q from each unit)	2x5=10
3	Class Attendance*	10	Qs carrying 6 marks for 5 Qs (Subjective type) out of 8 Qs (at least 1Q from each unit)	6x5=30
	Total	**40**		**60**

Course Objectives :

Students will have knowledge , skill and attitude on following topic in higher order learning as per Blooms Taxonomy .

1. Understand about tensile properties and testing procedure;
2. Understand about impact value and its testing procedure;
3. Know about different hardness value and their testing procedure;
4. Know about definition of fatigue and its properties;
5. Know and explain about various non-destructive testing processes;
6. Know about creep and its measuring parameters.

Course Outcomes (COs) :

Course	Statement
MTPC208.1	Explain the basic concept & terminologies of Tensile property and its testing procedure.
MTPC208.2	Explain the basic concept & terminologies of Impact value and its testing procedure.
MTPC208.3	Explain the basic concept & terminologies of Hardness value and its testing procedure.
MTPC208.4	Explain the basic concept & terminologies of Fatigue value and its property .
MTPC208.5	Explain the basic concept & terminologies of Creep value and its property .
MTPC208.6	Explain the basic concept & terminologies of Non-destructive Testing .

UNIT WISE DIVISION OF THE SYLLABUS

UNIT	TOPIC	CONTACT PERIODS
1	INTRODUCTION	1
2	TENSILE PROPERTY & TESTING PROCEDURE	4
3	IMPACT **:** VALUE & TESTING PROCEDURE	4
4	HARDNESS **:** VALUE & TESTING PROCEDURE	9
5	FATIGUE & FATIGUE PROPERTY	3
6	CREEP **:** PHENOMENON & MEASURING PARAMETERS	3
7	NON-DESTRUCTIVE TESTING	6
	TOTAL =	30

Reference Books : -

1. Mechanical Metallurgy -- G.E. Dieter
2. Testing of Metallic Materials -- A.V.K. Suranarayan
3. Mechanical Testing of Metallic Materials -- E.N. Simon

DETAIL COURSE CONTENT

1.0 INTRODUCTION : 1 PERIOD

1.1 Importance of mechanical testing of metallic materials

1.2 Various testing such as Tension, Compression, Impact, Fatigue, hardness testing etc.

2.0 TENSILE PROPERTY & TESTING PROCEDURE : 4 PERIOD

2.1 Stress - strain diagram, proof - stress, yield - stress, ductility, & True stress, True strain

2.2 Brief description of Tensile testing machine, actual testing, measurements

3.0 IMPACT : VALUE & TESTING PROCEDURE : 4 PERIOD

3.1 Definition

3.2 Izod test

3.3 Charpy test

3.4 Effect of variables on Impact test, Transition temp, Blue – Brittleness, Temper- embrittlement

4.0 HARDNESS : VALUE & TESTING PROCEDURE : 9 PERIOD

4.1 Definition

4.2 Brinell hardness test, its description

4.3 Rockwell hardness test, its description

4.4 Vickers hardness test, its description

4.5 Comparison of Brinell & Vickers hardness values

4.6 Rockwell Superficial hardness test, brief idea

4.7 Rebound hardness test, brief idea

4.8 Hot hardness test, brief idea

5.0 FATIGUE & FATIGUE PROPERTY : 3 PERIOD

5.1 Definition, unit
5.2 Specimen size & shape
5.3 Test procedure, Endurance Limit, application
5.4 failure fracture
5.5 Fatigue Effect of different variables on Fatigue- properties

6.0 CREEP : PHENOMENON & MEASURING PARAMETERS : 3 PERIOD

6.1 Importance of Creep, application area
6.2 Stages of Creep, minimum creep rate
6.3 Homologous Temperature
6.4 Stress- rupture test, application area
6.5 Comparison of creep Vs Stress – rupture
6.6 Statistical Creep data

7.0 NON-DESTRUCTIVE TESTING : 6 PERIOD

7.1 Definition
7.2 Visual examination
7.3 Leakage testing
7.4 Penetrant method
7.5 Magnetic method
7.6 Acoustic method (ultrasonic testing)
7.7 Radiography

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COURSE : IRON MAKING TECHNOLOGY

Course Code	MTPC210
Course Title	Blast Furnace Iron Making Process
Number of Credits	3
Course offered in	Part - II , 4th. Semester
Course Category	Program Core Course
Hours / Week	3 (Lecture – 2 : Tutorial : 1) ; Total 15 weeks / Sem
Full Marks	100

Marks Distribution: Full Marks =100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Question Type	Marks
1	Mid Semester Tests (Two best out of three)	10x2=20	Objective type questions carrying 1 mark for 20 questions(Qs) out of 25 Qs throughout the syllabus	1x20=20
2	Quizzes, viva-voce, Assignments	10	Question carrying 2 marks for 5 Qs out of 8 Qs (at least 1Q from each unit)	2x5=10
3	Class Attendance	10	Qs carrying 6 marks for 5 Qs (Subjective type) out of 8 Qs (at least 1Q from each unit)	6x5=30
	Total	**40**		**60**

Course Objectives :

1. This Course is intended to give concept of conventional as well as alternate routes of iron making technologies.
2. It also provides the knowledge regarding various modern developments and environment consideration in iron making industries, related to the composition of pig iron, constituents, characteristics and uses of slag, and furnace gas, etc.

Course Outcomes (COs) :

Course	Statement
MTPC210.1	Learn & analyze fundamentals of physico-chemical principles of blast furnace iron making.
MTPC210.2	To learn the operational aspects of blast furnace technology.
MTPC210.3	Learn industrial applications of various modern developments in iron making.
MTPC210.4	Solve operational problems of different difficulty levels in iron making.
MTPC210.5	Analyse Ellingham diagram and solve associated numerical problems.

UNIT WISE DIVISION OF THE SYLLABUS

UNIT	TOPIC	CONTACT PERIODS
1	Introduction, Raw Materials for Iron Making .	7
2	Agglomeration of iron ore .	8
3	Iron Blast furnace & its operation .	10
4	Modern developments in BF iron making	10
5	Alternative route of Iron production .	10
	Total =	46

REFERENCE BOOKS:

1. Modern Iron Making --- Dr. R.H.Tupkary .
2. Manufacture of Iron & steel , Iron Production – Vol – I ,II & III --- G.R.Bashforth.
3. Making Shaping & Treating of Steel --- United States Steel .
4. Physical Chemistry of Iron & Steel making --- R.G.Ward .
5. Iron & Steel industry in India --- M.R.Chaudhuri .
6. Ghosh, A. and Chatterjee, A., Principles and Practices in Iron and Steel making, Prentice Hall of India, New Delhi, 2008

DETAIL COURSE CONTENT

1.0 Introduction, Raw Materials for Iron Making . 7 PERIODS

1.1 Introduction to iron and steel making; role of iron making in integrated steel plant .

1.2 Brief geometrical idea and their location.

1.3 Indian iron ores ,quality of iron ores of different zones .

1.4 Beneficiation of iron ores .

1.5 Raw materials for iron making and their preparation.

1.6 Metallurgical coke – important properties required.

2.0 Agglomeration of iron ore . 8 PERIODS

2.1 Justification of agglomeration, comparison of quality between ore and agglomerate

2.2 Various techniques – Sintering, Pelletization, briquetting etc

2.3 Brief description of Sintering process; role of variables

2.4 Brief description of pelletization process; important properties of agglomerates .

2.5 Testing of raw materials

3.0 Iron Blast furnace & its operation . 10 PERIODS

3.1 Description of blast furnace and its accessories , refractory lining and cooling . stoves; gas cleaning system. hot blast.

3.2 Burden distribution and their effects. bell-less top charging methods.

3.3 Physical chemistry of the reactions at various zones, slag formation, sulphur and silicon reactions.

3.4 Calculation of blast furnace charges.

3.5 Factors affecting blast furnace productivity; alumina problem in India.

3.6 Some common operating troubles in blast furnace and their causes and remedies.

3.7 External treatments of hot metal – desulphurization, desiliconization.

3.8 Utilization of BF products – gas and slag

4.0 Modern developments in BF iron making 10 PERIODS

4.1 Importance of reducing coke rate & use of agglomerates (Sinter/ Pellet)

4.2 Injection of solid and liquid through tuyers – injection of coal, oil , plastic granules etc

4.3 Oxygen-enriched blast & its limitations, increase of blast temperature

4.4 High top pressure operation of blast furnace

4.5 Environment cleanliness (de-dusting system in cast house, dry gas cleaning process

4.6 Furnace design- HTP, BLT, Carbon lining, under hearth cooling, stave cooling

4.5 Factors affecting blast furnace productivity

5.0 Alternative route of Iron production . 10 PERIODS

5.1 Limitations of blast furnace route, other options for iron production

5.2 Mini blast furnace –characteristics; difference with conventional iron blast furnace

5.3 Electro – Thermal Smelting Process -- basic principle , operation & effectiveness .

5.4 Direct Reduced Iron (Sponge Iron) Technology - outline of important gas-based and coal- based processes, physical chemistry of the reactions; uses of sponge Iron ; Indian scenario .

5.5 Smelting Reduction (SR) technology – ITMK3 , FINEX / COREX - basic principle , operation & effectiveness .

5.6 Environmental considerations in Iron making Technology

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COURSE TITLE : PHYSICAL METALLURGY – II LAB

Course Code	MTPC212
Course Title	PHYSICAL METALLURGY – II LAB
Number of Credits	2
Course offered in	Part - II , 3rd. Semester
Course Category	Program Core Course
Hours / Week	2 (Practical – 2) ; Total 15 weeks / Sem
Full Marks	100

EXAMINATION SCHEME

Marks Distribution: Full Marks =100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Type	Marks
1.	Continuous Internal Assessment is to be carried out by the teachers throughout the Third Semester. Distribution of marks for Internal Assessment : Performance of Job – 20, Notebook – 20.	40	External Assessment of 50 marks shall be held at the end of the Third Semester on the entire syllabus. Distribution of marks for External Assessment : On spot job – 10 Viva - voce – 30	40
2.	Class Attendance	20		
	Total	**60**		**40**

Course Objectives :

Students will have knowledge , skill and attitude on following topic in higher order learning as per Blooms Taxonomy .

1. Laboratory experiment & study of microstructure of different metals & Alloys .
2. Laboratory experiment on Heat Treatment process .
3. Laboratory experiment on Determination of Hardenability by Jominy method .
4. Laboratory experiment on Calibration of Thermocouple.

Course Outcomes (COs) :

Course	Statement
MTPC212.1	Demonstrate about hands on procedure to study the microstructure of different metals & Alloys .
MTPC212.2	Demonstrate about hands on procedure of Heat Treatment .
MTPC212.3	Demonstrate about the hands on procedure of Determination of Hardenability by Jominy method
MTPC212.4	Demonstrate about the hands on procedure of Calibration of Thermocouple.

REFERENCE BOOKS :

1. Principles of Metallographic Laboratory Practice . --- G.L.Khel .

PRACTICAL : LIST OF LABORATORY EXPERIMENTS :

SL. NO.	NAME OF EXPERIMENT	CONTACT PERIODS
1.0	**Microstructural study.**	**10**
1.1	Study of different plain carbon steel under annealed, normalized, hardened & Tempered conditions.	
1.2	Study of cast- Iron.	
1.3	Study of copper & its alloys	
1.4	Study of Aluminium & its alloys.	
2.0	**Heat Treatment.**	**10**
2.1	Annealing of hypo eutectoid , hyper eutectoid steel , studying microstructures & hardness value.	
2.2	Normalising of above samples , studying microstructures & hardness value.	
2.3	Analysis of above results & explanation	
2.4	Grain size measurement in above samples .	
3.0	**Determination of Hardenability by Jominy method .**	**6**
3.1	Sample preparation for hardenability test (Jominy method) .	
3.2	Austenitising of hadenability sample.	
3.3	Quenching of hadenability sample.	
3.4	Plotting graph .	
3.5	Explanation of readings.	
4.0	**Calibration of Thermocouple**	**4**
4.1	Calibration of thermocouples by primary method .	
	Total =	**30**

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COURSE TITLE : DESTRUCTIVE TESTING OF METALS LAB

Course Code	MTPC214
Course Title	DESTRUCTIVE TESTING OF METALS LAB
Number of Credits	2
Course offered in	Part - II , 3rd. Semester
Course Category	Program Core Course
Hours / Week	2 (Practical – 2) ; Total 15 weeks / Sem
Full Marks	100

EXAMINATION SCHEME

Marks Distribution: Full Marks =100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Type	Marks
1.	Continuous Internal Assessment is to be carried out by the teachers throughout the Third Semester. Distribution of marks for Internal Assessment : Performance of Job – 20, Notebook – 20.	40	External Assessment of 50 marks shall be held at the end of the Third Semester on the entire syllabus. Distribution of marks for External Assessment : On spot job – 10 Viva - voce – 30	40
2.	Class Attendance	20		
	Total	**60**		**40**

Course Objectives :

Students will have knowledge , skill and attitude on following topic in higher order learning as per Blooms Taxonomy .

1. Laboratory experiment & determination of Rockwell Hardness .
2. Laboratory experiment & study of Brinell Hardness Testing .
3. Laboratory experiment & study of Izod Impact Testing
4. Laboratory experiment & study of Charpy Impact Testing .
5. Laboratory experiment & study of Universal Tensile Testing Machine.

Course Outcomes (COs) :

Course	Statement
MTPC214.1	Demonstrate about hands on procedure & determination of Rockwell Hardness of different metals & Alloys .
MTPC214.2	Demonstrate about hands on procedure & determination of Brinell Hardness of different metals & Alloys .
MTPC214.3	Demonstrate about hands on procedure & determination of Izod Impact value of different metals & Alloys .
MTPC214.4	Demonstrate about hands on procedure & determination of Charpy Impact value of different metals & Alloys .
MTPC214.5	Demonstrate about hands on procedure & determination of Tensile Strength and other mechanical properties by UTM of different metals & Alloys .

REFERENCE BOOKS :

1. Mechanical Metallurgy -- G.E. Dieter
2. Testing of Metallic Materials -- A.V.K. Suranarayan
3. Mechanical Testing of Metallic Materials -- E.N. Simon

PRACTICAL : LIST OF LABORATORY EXPERIMENTS :

SL. NO.	NAME OF EXPERIMENT	CONTACT PERIODS
1.0	Rockwell Hardness Testing	4
2.0	Brinell Hardness Testing	4
3.0	Izod Impact Testing	4
4.0	Charpy Impact Testing	4
5.0	To study the Universal Tensile Testing Machine and Perform The Tensile Testing .	14
	Total =	30

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COURSE: ALLOY STEEL & CAST IRON

Course Code	MTPE202
Course Title	Alloy Steel & Cast Iron
Number of Credits	3
Course offered in	Part - II , 4th. Semester
Course Category	Program Elective Course
Hours / Week	3 (Lecture – 2 : Tutorial : 1) ; Total 15 weeks / Sem
Full Marks	100

Marks Distribution: Full Marks =100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Question Type	Marks
1	Mid Semester Tests (Two best out of three)	10x2=20	Objective type questions carrying 1 mark for 20 questions(Qs) out of 25 Qs throughout the syllabus	1x20=20
2	Quizzes, viva-voce, Assignments	10	Question carrying 2 marks for 5 Qs out of 8 Qs (at least 1Q from each unit)	2x5=10
3	Class Attendance*	10	Qs carrying 6 marks for 5 Qs (Subjective type) out of 8 Qs (at least 1Q from each unit)	6x5=30
	Total	**40**		**60**

Course Objectives:

1. Primary objective is to get familiar with various alloy steels.
2. Understand compositions, heat treatment & applications of various alloy steels like HSLA steel, stainless steel, Maraging steel, Hadfield manganese steel, High speed steel.
3. Gather knowledge about the role of alloying elements in alloy steel.
4. Understand concept of Thermo mechanical treatment, hardening & tempering temperature.
5. Gather knowledge about Alloy cast irons.

Course Outcomes (COs):

Course	Statement
MTPE202.1	Ability to understand role of different alloying elements in alloy steel.
MTPE202.2	Understand composition, heat treatment & application of various low alloy steel & high alloy steel.
MTPE202.3	Understand the concept of sensitization problem its avoidance.
MTPE202.4	Explain the concept of various thermo mechanical treatment & its application.
MTPE202.5	Understand various alloy cast iron, composition, heat treatment & its application.

UNIT WISE DIVISION OF THE SYLLABUS

UNIT	TOPIC	CONTACT PERIODS
1	Structural back ground	3
2	Role of alloying elements	6
3	Low alloy steels	6
4	Stainless Steel	8
5	Special Alloy Steels	8
6	Thermo-mechanical treatment of steels.	6
7	Alloy Cast irons.	8
	Total =	45

Reference Books : -

1. Engineering Physical Metallurgy --- Y. Lakhtin .
2. Introduction to Physical Metallurgy --- S.H.Avner .
3. Elements of Physical Metallurgy --- A.G.Guy .
4. Metals Hand Book --- American Society of Metals .
5. Physical Metallurgy for Engineers --- Clark & Varney .
6. Metallurgy for Engineers --- E.C. Rollason .
7. Physical Metallurgy , Principles & Practice --- V. Raghavan .

DETAIL COURSE CONTENT

1.0 Structural background : 3 PERIODS

1.1 Plain carbon steel, its definition.

1.2 Limitation of plain carbon steel.

1.3 Definition of alloy steel, benefits of alloy steel.

1.4 Cast irons – types, a brief review

2.0 Role of alloying elements : 6 PERIODS

2.1 Classification of alloying elements.

2.2 Role of Mn, Ni, W, Mo, V, Boron, Si on Iron carbon diagram.

2.3 Role of alloying elements on structure and properties.

2.4 Hot-shortness, cold shortness.

2.5 Effect of composition on hardenability of steels

2.6 Role of alloying elements on eutectic carbon, eutectic temperature, critical cooling rate.

3.0 Low alloy steels : 6 PERIODS

3.1 Merits & demerits of adding Ni in alloy steel.

3.2 Merits & demerits of Cr in alloy steel.

3.3 Air-hardening steel.

3.4 Ball-bearing steels – properties, heat treatment; quality control.

3.5 Silicon steels composition, properties, heat treatment & applications

3.6 HSLA and Microalloyed steels –composition, properties & applications

4.0 Stainless steel. : 8 PERIODS

4.1 Introduction, classification of stainless steels.

4.2 Ferrite stainless steel, composition, characteristic, application.

4.3 Martensitic stainless steel, composition, characteristic, application.

4.4 Austenitic stainless steel, composition, characteristic, application.

4.5 Duplex stainless steels – wrought and cast, properties and heat treatment

4.6 Substitution of Ni in Stainless steel.

4.7 Sensitization, stabilization.

5.0 Special Alloy Steels : 8 PERIODS

5.1 Spring steels.

5.2 Non deforming – non shrinking tool steel – grades, composition, heat treatment and application.

5.3 High Mn-alloy steel (Hadfield steel) - production, composition , heat treatment , properties, application

5.4 Maraging steel- composition, properties and heat treatment , application

5.5 Perm alloy, composition, heat treatment and application.

5.6 Invar alloy, composition, heat treatment and application

5.7 High speed steel, Composition, Heat treatment.

5.8 Explanation of hardening temperature.

5.9 Explanation of tempering temperature.

5.10 Sub-zero treatment.

6.0 Thermo-mechanical treatment of steels : 6 PERIODS

6.1 Controlled rolling.

6.2 Hot working, Cold working.

6.3 Aus-forming , Iso-forming,

6.4 Strengthening mechanism of HSLA & Micro alloyed steel.

7.0 Alloy Cast Irons : 8 PERIODS

7.1 Introduction, effect of alloying elements on structure & graphite formation

7.2 Effect of alloying on grey and white cast irons – improvement of properties; heat treatment and applications

7.3 Corrosion –resistant cast irons – 'Ni-resist' and similar grades

7.4 Wear-resistant cast irons , alloyed graphitic and ductile irons; 'Ni-hard' grades

7.5 Alloyed ductile iron, aus-tempering process.

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COURSE : MINOR PROJECT

Course Code	MTPR202
Course Title	MINOR PROJECT
Number of Credits	2
Course offered in	Part - II , 4th. Semester
Course Category	MINOR PROJECT
Hours / Week	4 (Lecture – 0 : Tutorial : 4) ; Total 15 weeks / Sem
Full Marks	100

EXAMINATION SCHEME

Marks Distribution: Full Marks = 100

	Internal assessment		End Semester Exam	
Sl No	Type	Marks	Type	Marks
1.	Continuous Internal Assessment is to be carried out by the teachers throughout the Forth Semester. Distribution of marks for Internal Assessment : Performance of Job – 20, Notebook – 20.	40	External Assessment of 80 marks shall be held at the end of the Third Semester on the entire syllabus. Distribution of marks for External Assessment : On spot job – 10 Viva - voce – 30	40
2.	Class Attendance	20		
	Total	**60**		**40**

Course Objectives :

Students will have knowledge , skill and attitude on following topic in higher order learning as per Blooms Taxonomy .

1. Idea about Project Work .
2. Laboratory experiment & Life long learning .
3. Development of brain storming , new ideas and new initiatives .
4. Development of group activities .
5. Development of communication ability .
6. Development of report writing ability .

Course Outcomes (COs) :

Course	Statement
MTPR202.1	Describe and explain about the topic of the project .
MTPR202.2	Demonstrate about details of project .
MTPR202.3	Demonstrate about the laboratory and infrastructural facilities used .
MTPR202.4	Demonstrate the project in digitized format .
MTPR202.5	Understand the theme of the project.

Course Contents: Minor project may be carried out in one or more form of following:

1. Working /non-working models, prototype development .

2. Laboratory experiment development, process modification /development, simulation, software development.

3. Statistical data analysis, survey, creating awareness in society.

4. The student is required to submit a report based on the work.

5. The evaluation of the project shall be on continuous basis.

6. Students should select a problem which addresses some basic home, office or other real life applications.

7. 5-10 pages report to be submitted by students.

8. Group of maximum three students can be permitted to work on a single mini project.

9. Department may arrange demonstration with poster presentation of all mini projects developed by the students at the end of semester.

10. Work as an individual or in a team in development of technical projects.

11. Communicate and report effectively project related activities and findings.

LIST OF MINOR PROJECTS :

1. Process Flow sheet for preparation of Aluminium Smelting Plant.
2. Process Flow sheet for preparation of Aluminium Refining Plant.
3. Modelling of a Hot Rolling Mill along with accessories.
4. Modelling of a Cold Rolling Mill along with accessories.
5. Model preparation of Crystal Structure like BCC, FCC, HCP,.
6. Model preparation of Metallurgical Microscope with demonstration.
7. Visual demonstration/ Videography of Sample preparation or Metallography.
8. Modelling and demonstration of Vickers Hardness Testing Machine for getting VHN
9. Modelling and demonstration of Rockwell Hardness Testing Machine.
10. Preparation of Iron Carbon Diagram with different phases, Invariant Reactions , Critical Temp with Demonstration.
11. Preparation of Ellingham Diagram with Demonstration .
12. To prepare a knowledge book of all testing equipment : containing photograph of machine , Video of operations, model no, SL. no of machine,specifications, dimensions, work instructions for operation of the machine, DO's and DON'Ts.
13. Change in microstructure due to cooling rate change of steel heat treatment.
14. Effect of hardness on different heat treatment process like Annealing and Normalising.
15. To prepare the jominey hardenability curve of few popular steel.
16. To write Operating procedures for ultrasonic testing to detect internal soundness of forged or rolled steel.
17. Report writing after checking a material for chemical composition, mechanical testing, metallurgical testing, ultrasonic testing, magnetic particle testing and any other testing.
18. Preparation and study of the microstructure of pure metals like iron, copper and aluminium.
19. Heat Treatment of different type of steel (whichever steel is available in laboratories).
20. Recovery, recrystallization and grain growth.
21. Micro-hardness testing of various ferrous alloys.
22. Beneficiation of Metal Ores (e.g., Iron Ore).
23. Phase diagram analysis.
24. Pulverized coal injection in blast furnace.
25. Materials Characterization.
26 Study of different types of welding process.
27. Grain size measurement.
28. Process flow sheet of hot rolling, cold rolling, forging.
29. Process flow sheet of extraction of non ferrous alloys.
30. Deformation of aluminium sheet by rolling machine.
31. Solidification of aluminium in induction furnace.
32. Identify defect on various metallic component by using NDT techniques (ultrasonic test, liquid penetration, etc).
33. Collection of different ferrous and non ferrous metal samples and complies the metallographic data with photographs.
34. Design, drawing and fabrication of small proto type metallurgical engineering equipment such as i) Blast furnace ii) Cupola Furnace iii) Open hearth furnace iv) Electric arc furnace v) Induction furnace vi) Muffle furnace vii) Crucible furnace viii) Model making of BCC,FCC & HCP crystal structure.

35. Hardenability of Steel and the effect of alloying elements on hardenability of steels.
36. Structure - property correlation of carbon – steel .
37. Study on High strength Low alloy steel.
38. Study on different Heat treatment practices .
39. Detail report on the production of Mn Steel Crossing (used in railway crossings) from melting to machining after casting

40. Proximate analysis of different grades of coal from different source and identifying best suitable grade for metallurgical application.
41. Identifying different refractory materials.
42. Microscopic examination and microstructural comparison of : steels, copper alloys and aluminium alloys, cast irons.
43. Observation and drawing of different morphologies of grains: equiaxed dendrites, columnar dendrites, cellular structure, equiaxed grains, polygonal grains, elongated grains.
44. Grain size measurement by ASTM comparison method, Heyn's Intercept method, Jefferies planimetric method.
45. Study of etching mechanism of single phase and two phase alloys and preparation of etching reagents for plain carbon steel, cast iron, copper base alloys and aluminium alloys.
46. Preparation of specimens for microscopic examination by hot mounting and cold mounting methods.
47. Rolling Pass Design-A Comparative Study.
48. Studying Reducibility of Iron Ores.
49. Studying Limitations of the Ellingham Diagram.
50. Effect of strain on Cold Worked microstructure-A Microstructural Study.
51. Development of Austempered Ductile Iron.
52. Development of High Chromium based Cast Iron.
53. Cupola furnace: an Over view.
54. Project report on application of Sintering in ferrous industries.
55. Project report on Powder Metallurgy.
56. Project report on Thermo Mechanical Treatment.
57. Project report on Sponge Iron Production.
58. A report on production of sponge iron using solid reductants for direct reductions of iron ore.
59. Techniques of revealing Austenitic grain size and evaluation of ASTM grain size number by comparison method.
60. Effect of rate of straining on tensile test results of any grade of steel.
61 Preparation of Presentation on 'Familiarisation with Industrial standardisation procedure as per ISO 9001 explaining its objective, principle and relevance'.
62. Preparation of standard operating procedure and detailed work instruction for testing hardness by Brinell Hardness Tester in line with any international standard. Use audio-visual means for demonstration.6763.

Preparation of standard operating procedure and detailed work instruction for testing hardness by Rockwell Hardness Tester in line with any international standard. Use audio-visual means for demonstration.

64. Preparation of standard operating procedure and detailed work instruction for testing hardness by Vickers Hardness Tester in line with any international standard. Use audio-visual means for demonstration.
65. Preparation of standard operating procedure and detailed work instruction for tensile testing in line with any international standard. Use audio-visual means for demonstration.
66. Preparation of a plan for improvement of present laboratory layout of the department.
67. Selection of appropriate probes for ultrasonic testing of components of different shape and size.
68. Importance of skin pass process for cold rolled steel sheet production.
69. Calculate the critical temperatures of any two grades of alloy steel using empirical formulae or any other authentic data source and propose reheating temperature for forging/rolling, annealing temperature, normalising temperature, hardening and tempering temperature.
70. Preparation of album of rolling and forging defects with cause and remedies.
71. Temperature calibration of a F/C with Thermocouple.
72. Hardenability Determination by Jominy End Quench Test.
73. Reduction of Fe ore with charcoal in Laboratory.
74. Grain size estimation.
75. Effect of Carbon on Annealing, normalizing, Oil Quenching, Water Quenching.
76. Effect of Cooling Rate on Annealing, normalizing, Oil Quenching, Water Quenching.