Programme : **Diploma in MT**
Programme Code : **05/19**
Name of Course : **Project and Seminar**
Course Code : **MT481**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	--	--
Practical	**08**	**128**

Evaluation Scheme:

	Progressive Assessment	Semester End Examination			
		Theory	Practical	Oral	Term work
Duration		3Hrs.	--	--	--
Marks	**50**	--	--	**50**	**50**

Course Objectives:

The project work is included in the syllabus to encourage the students to undertake and tackle an independent problem related to metallurgical field. The project may also comprise of literature survey of a problem assigned. Student should be well acquainted with the skill required for independent thinking and applications to a problem where he can develop in himself 'Self Reliance'. He should be able to make use of library.

The project work will be done by a group of 4 to 6 students. The students will select a topic related to any subject in their syllabi and will design and construct the required equipment, carry out tests and trials and they will submit a report of the work done by them in a suitable form. The project may consist of a market survey or a literature survey of recent developments in the field of metallurgy or it may be a study of a metallurgical processes.

Course Content:

Selection of topic for project work and relevant experimentation, literature survey, interpretation of results. Group discussion and presentation of the project work in writing.

Seminar:

Each student will select a topic related to technical field and collect detailed information on it. He will deliver a seminar and submit a report.

Laboratory Work:

As per the topic selected by student.

Instructional Strategy:

Literature survey, experiments, trials, group discussion, interpretation of results and discussion with industrial experts.

Reference Books:

As per the selected topic for the project.

Learning Resources: Relevant books and experiments.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
1	Oral	20	15	15	50

Skills to be acquired by Technician:

Various skills are developed depending on the selected topic. These skills are as follows;

Reading skill, tapping resources including library, using knowledge already acquired, thinking and communication skills, working in group, leadership. Interactions with industries, developing contacts, meeting people, making survey, cost consciousness, using resources available in other institutes or industries, skill of handling equipment and instruments safety, observing operations critically, skill of recording results and interpretation of results with group discussion, finding solution for problems and quality awareness, presentation of report in writing, participation in exhibition and developing personality and self confidence.

Prof.N.S.Kadam **Prepared By**	**Prof.A.S.Kampure** **Secretary, PBOS**	**Prof.N.S.Kadam** **Chairman, PBOS**

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Elements of Physical Metallurgy**
Course Code	:	**MT482**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	04	64
Practical	03	48

Evaluation Scheme:

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

Course Rationale:

This subject deals with the solidification of metals and alloys, and various types of equilibrium diagrams and their applications. It covers metallographic examination of metals and alloys such as macroscopic examination and quantitative metallography. The subject includes study of iron-iron carbon equilibrium diagrams, transformation systems on different cooling rates, TTT diagram hardenability of steels.

Course Objectives:

After studying this course, the student will be able to

- Understand the use of binary equilibrium diagrams.
- Determine composition and quantity of different phases in equilibrium.
- Perform metallographic examination.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
1	**Solidification of Metals**			
	1.1	Transformation of liquid metal to solid metal, nucleation, dendrite formation, grains & grain boundaries.	06	09
	1.2	Cooling curves for pure metals & alloys.		
	1.3	Phase equilibrium, Gibb's phase rule & its application.		
	1.4	Solid solution & its types, intermetallic compounds, Hume Rothery rules.		
2	**Equilibrium Diagram**			
	2.1	Types of cooling curves for binary alloy.	06	09
	2.2	Construction of binary equilibrium diagram, reactions in binary system; Monoeutectic, Eutectic, Eutectoid and peritectoid reactions, partial solubility.		
	2.3	Lever rule, its derivation & application.		
	2.4	Identification of microstructural changes with respect to equilibrium diagram.		
3	**Microscopic Examination**			
	3.1	Sample preparation techniques, methods of polishing; mechanical & electrolytic polishing.	05	06
	3.2	Etching techniques, etching reagents.		
	3.3	Principle of working of metallurgical microscope.		
	3.4	Microphotography; negatives, exposing, developing & printing.		
	3.5	Macroscopic examination; principle, interpretation of results, Sulphur printing, Phosphorous printing.		
4	**Quantitative Metallography**			
	4.1	ASTM grain size numbers, measurement of plating thickness, case depth.	03	04

5	**Iron Carbon Equilibrium Diagram**			
	5.1	Allotropic transformation of pure iron.	**10**	**12**
	5.2	Fe-C equilibrium diagram, various phases, critical temperatures. Reactions in Fe-C diagram; peritectic, eutectic and eutectoid.		
	5.3	Cooling of various steels from liquid to room temperature, relationship between microstructure & properties of steel.		
	5.4	Specification of steels; AISI, SAE, EN, IS etc.		
6	**Cast Iron**			
	6.1	Graphitization in cast iron, morphology of graphite, carbon equivalent, Maurer's diagram.	**10**	**12**
	6.2	Forms of graphite; A, B, C, D & E, flake size of graphite, ASTM size. Relationship between microstructure & mechanical properties, phosphide eutectic.		
	6.3	Properties of cast iron; tensile strength, machinability, damping capacity, ductility, impact, hardness etc.		
	6.4	Types of cast iron; Composition, microstructure, properties and applications of- Gray CI, White CI, Chilled CI, Malleable CI, SG iron, high duty CI-Meehanite, Alloy CI.		
7	**T.T.T Diagram**			
	7.1	Construction & use of T.T.T. diagram, cooling rates & microstructure, CCR, CCT diagram.	**06**	**06**
8	**Hardenability Of Steel**			
	8.1	Actual cooling curve after quenching, stages in cooling curve, severity of quench, quenching mediums, Hardness penetration curve.	**06**	**06**
	8.2	Hardenability of steel, determination of hardenability, Grossman & Jominy end quench test, determination of ideal critical diameter from Jominy end quench test.		
	8.3	Factors affecting hardenability, use of hardenability data in industries.		
	8.4	Hardenability of different steels.		

9	**Effect Of Alloying Elements**			
	9.1	Effect of alloying elements on Iron-Carbon diagram & T.T.T. curve.	**03**	**04**
10	**Metallurgy Of Nonferrous Alloys**			
	10.1	Brasses: Cu- Zn equilibrium diagram, order-disorder transformation, hot working of brasses, orange peel defect, season cracking, dezincfication, Zn equivalent, coring & twining in microstructure. Composition, properties & applications of commonly used brasses.	**09**	**12**
	10.2	Bronzes: Cu- Sn equilibrium diagram. Composition, properties & applications of commonly used bronzes; Gun metal, Phosphor Bronzes.		
	10.3	Aluminum Alloy: Al-Si equilibrium diagram, modification of Al-Si alloy. Composition, properties & applications of Al-Si alloys. LM series, Al-Cu alloy system, Duralumin.		
	10.4	Bearing metals: Classification of bearing metals, requirement of good bearing metals. Sn-Sb, Pb-Sb equilibrium diagram. Composition, microstructure, mechanical properties & applications of lead base & tin base bearing metals, effect of Cu addition.		
		Total	**64**	**80**

List of Practical/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment	Hrs
1	Preparation of specimen.	08
2	Mounting of specimen.	04
3	Etching techniques.	02
4	Metallurgical microscope.	02
5	Macroscopic examination.	04
6	Quantitative metallography.	04
7	Microstructures of plain carbon steels.	08
8	Microstructures of cast irons.	08
9	Measurement of hardenability of steel.	02
10	Microstructures of copper, aluminum alloys and bearing metals.	06
	Total	**48**

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
1	Solidification of Metals	Lecture method
2	Equilibrium Diagram	Lecture method, Demonstration with chart
3	Microscopic Examination	Lecture method, Demonstration with chart
4	Quantitative Metallography	Lecture method, Demonstration with chart
5	Iron Carbon Equilibrium Diagram	Lecture method, Demonstration with chart
6	Cast Iron	Lecture method, Demonstration with chart
7	T.T.T. Diagram	Lecture method
8	Hardenability of Steel	Lecture method
9	Effect of Alloying Elements	Lecture method
10	Metallurgy of Nonferrous Alloys	Lecture method

Text Books:

Sr. No	Author	Title	Publication
1	Clark and Verney	Physical Metallurgy for Engineers	CBS Publishers and Distributors
2	Avner	Introduction to Physical Metallurgy	Tata Mc Graw Hill Publishing Company Ltd, New Delhi.
3	Dr.V.D.Kodgire	Material Science And Metallurgy	Everest Publishing House

Reference Books:

Sr. No	Author	Title	Publication
1	George L. Khel	Metallurgical Laboratory Practice	Eurasia Publishing House (Pvt) Ltd, New Delhi
2	Robert E. Reed - Hill	Physical Metallurgy Principles	Affiliated East-West Press Pvt. Ltd, New Delhi.

Learning Resources: O. H. P., Charts, CDs.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
1	Solidification of Metals	05	02	02	09
2	Equilibrium Diagram	05	02	02	09
3	Microscopic Examination	04	01	01	06
4	Quantitative Metallography	03	--	01	04
5	Iron Carbon Equilibrium Diagram	08	02	02	12
6	Cast Iron	08	02	02	12
7	T.T.T. Diagram	04	01	01	06
8	Hardenability of Steel	04	01	01	06
9	Effect of Alloying Elements	02	01	01	04
10	Metallurgy of Nonferrous Alloys	08	02	02	12
	Total	**51**	**14**	**15**	**80**

Prof.
Prepared By

Prof. A.S.Rampure
Secretary, PBOS

Prof.N.S.Kadam
Chairman, PBOS

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Foundry Engineering**
Course Code	:	**MT483**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	04	64
Practical	03	48

Evaluation Scheme:

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

Course Rationale:

The Metallurgical engineer who is supposed to work as metallurgist or methods Engineer in foundry industries come across specialized foundry processes. He should be able to work as a supervisor for various processes. These processes have been developed depending upon the quantity of castings to be produced, surface quality required, dimensional accuracy achieved, metal cast etc.

Course Objectives:

- The students entering foundry industry will be acquainted with the details of various casting processes, its process variables and controls on the quality of castings.
- To teach the students the basic principles of designing the castings.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
	SECTION I			
1	**Introduction**			
	1.1	Importance of foundry engineering.	02	04
	1.2	Comparison of casting process with other manufacturing processes.		
2	**Pattern Making**			
	2.1	Pattern materials: Material for patterns and core boxes such as metal, wood, epoxy resin, wax, thermocol etc.	12	14
	2.2	Types of patterns: One piece, split, loose piece, matchplate, gated, skeleton etc. Comparison of various patterns. Pattern plates for hand and machine molding, master pattern.		
	2.3	Pattern design and construction: Pattern allowances, pattern joints, parting line selection, core prints, loose pieces, location of pins on pattern, pattern-lifting devices, color codes for pattern.		
	2.4	Design and construction of various types of core boxes, core venting.		
3	**Sand Molding Process**			
	3.1	Molding sand: Principal ingredients, sand grains, moisture, binders- inorganic and organic.	18	22
	3.2	Additives in molding sand: Role of additives, commonly used additives such as; Coal dust, Iron oxide, Dextrin, Molasses etc.		
	3.3	Mold washers/coatings, sand preparation and treatment.		
	3.4	Molding sand testing: Need for sand testing, various sand control tests; Moisture content, clay content, grain fineness, permeability, strengths, refractoriness, mold hardness.		

	3.5	Types of sand molding processes: Principle, ingredients, pattern and equipments, casting size, alloy range, application, advantages and limitations of; green sand, dry sand, loam sand, CO_2 sand, shell molding, investment casting processes.		
SECTION II				
4	**Molding Process using Metal Moulds**			
	4.1	Principle, equipments, casting size, alloy range, application, advantages and limitations of; Die casting –Gravity, low pressure, high pressure.	**12**	**14**
	4.2	Centrifugal casting.		
	4.3	Continuous casting.		
5	**Miscellaneous Molding Processes**			
	5.1	Study of miscellaneous molding processes such as; plaster molding, ceramic molding, slush casting, pit and floor molding, stack molding.	**06**	**08**
6	**Melting Furnaces**			
	6.1	Cupola furnace: Principle, construction, melting procedure, types of cupola furnace.	**10**	**12**
	6.2	Electric furnace- Coreless, Induction furnace, Duplexing.		
	6.3	Oil fired furnace.		
7	**Selection of Molding Process**			
	7.1	Selection of molding process with respect to quantity and weight of metal e.g. lathe bed, manhole cover, piston ring, gear box housing, motor body, turbine housing etc.	**04**	**06**
		Total	**64**	**80**

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment	Hrs
1	Study of various molding tools.	04
2	Study of different types of patterns.	04
3	Study of various sand control tests.	08
4	Study of green sand molding.	08

5	Study of CO_2 sand molding.	04
6	Study of shell molding.	04
7	Study of stack molding.	04
8	Casting aluminum in gravity die casting.	04
9	Study of cupola furnace.	04
10	Visit to various foundries to see induction and direct arc furnace.	--
11	Assignment- To select molding process for particular application e.g. lathe bed, manhole cover, piston ring, gear box housing, motor body, turbine housing etc.	04
	Total	**48**

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
	SECTION I	
1	Introduction	Lecture
2	Pattern Making	Practical, lecture
3	Sand Molding Process	Practical, lecture and industrial visit
	SECTION II	
4	Molding Process using Metal Molds	Practical, lecture and industrial visit
5	Miscellaneous Molding Processes	Lecture, industrial visit
6	Melting Furnaces	Practical, lecture and industrial visit
7	Selection Of Molding Process	Discussion, assignment

Text Books:

Sr. No	Author	Title	Publication
1	T. V. Ramana Rao	Metal Casting Principle and Practice	New Age International (P) Ltd,Publishers.
2	Richard W.Heine, Carl R Loper, Philip C Rosenthal	Principle of Metal Casting	Tata MacGraw Hill Publishing Comp.

Reference Books:

Sr. No	Author	Title	Publication
1	--	Metal Hand Book no-6	American Soc. Of Metals

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

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
	SECTION I				
1	Introduction	04	--	--	04
2	Pattern Making	08	02	04	14
3	Sand Molding Process	12	06	04	22
	SECTION II				
4	Molding Process using Metal Molds	08	02	04	14
5	Miscellaneous Molding Processes	04	04	--	08
6	Melting Furnaces	06	02	04	12
7	Selection Of Molding Process	02	00	04	06
	Total	**44**	**16**	**20**	**80**

Prof.N.S.Kadam
Prepared By

Prof. A.S. Zanpure
Secretary, PBOS

Prof.N.S.Kadam
Chairman, PBOS

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Powder Metallurgy**
Course Code	:	**MT484**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	**04**	**64**
Practical	**03**	**48**

Evaluation Scheme:

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

Course Rationale:

Powder metallurgy is one of the important techniques of manufacturing metallic components used in several fields of engineering, automotive, atomic energy, defense, high temperature technology etc. This subject deals with the manufacture and uses of components produced by powder metallurgy techniques.

Course Objectives:

To make the students aware of manufacture, properties and processing of metal powder, compacting and sintering techniques and various applications of sintered products.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
	SECTION I			
1	**Introduction**			
	1.1	Scope of powder metallurgy in industry.	04	06
	1.2	Comparison of powder method with other shaping or forming methods of production.		
	1.3	Principle of the process, its applications, advantages and limitations.		
2	**Powder Production**			
	2.1	Classification of metal powder production methods.	14	16
	2.2	Various methods of powder production such as Grinding, crushing, Milling, Atomization, Condensation, Carbonyl method, Reduction method, Electrolysis etc.		
	2.3	Specific characteristics of powder manufactured by each method and applications to various metals and alloys.		
3	**Characteristics and Testing of Metal Powders**			
	3.1	Particle size, shape and distribution, its measurement, Hall flow meter.	14	18
	3.2	Density of metal powders.		
	3.3	Compressibility and its measurement.		
	3.4	Surface area and surface energy.		
	SECTION II			
4	**Powder Compaction**			
	4.1	Classification of compacting methods.	16	18
	4.2	Compacting methods such as pressure less shaping methods, cold compacting methods and compacting with heat.		
	4.3	Brief outline of die and punch. Design, ejection methods.		
	4.4	Lubricants and their use in compacting.		
	4.5	Component shape design, various presses used for compacting, their applications, advantages and disadvantages.		

	4.6	Special compacting methods such as powder rolling, isostatic compacting, explosive forming, cyclic compacting, powder extrusion etc.		
5	**Sintering of Powder**			
	5.1	Purpose of sintering.	**10**	**12**
	5.2	Mechanism of sintering process.		
	5.3	Liquid phase sintering.		
	5.4	Controls in sintering.		
	5.5	Sintering furnaces and atmosphere.		
	5.6	Post sintering operations- sizing, coining, impregnation		
6	**Applications of Sintered Products**			
	6.1	Tools materials, Bearing metals, Permeable materials, friction materials, Magnetic materials and refractory metals etc. Specifications of various sintered products.	**06**	**10**
	6.2	Manufacture of P/M parts such as; Cemented carbides, electrical contact materials, sintered metal friction material.		
		Total	**64**	**80**

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment	Hrs
1	Study of various metal powder manufacturing processes for metal powders of Fe, Cu, Al.	08
2	Flow rate of metal powder.	07
3	Apparent and tap density of powder.	07
4	Compaction of different types of powder in die punch. Effect of load.	08
5	Study of sintering operation given to compacted products.	08
6	Determination of bearing properties of sintered bearing alloys.	08
7	Visit Report on powder metallurgical plant.	--
	Total	**48**

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
	SECTION I	
1	Introduction	Lecture method
2	Powder Production	Lecture method
3	Characteristics and Testing of Metal Powders	Lecture method
	SECTION II	
4	Powder Compaction	Lecture and demonstration method
5	Sintering of Powder	Lecture method
6	Application of Sintered Products	Lecture method

Text Books:

Sr. No	Author	Title	Publication
1	K. Sinha	Powder Metallurgy	Dhanpat Rai And Sons, Delhi
2	Sands & Shakespeare	Powder Metallurgy	George Neunes Ltd., London.

Reference Books:

Sr. No	Author	Title	Publication
1	C.G. Goetzel	Treatise On Powder Metallurgy	Interscience Publishers, NewYork

Learning Resources: O.H.P./ Transparencies, industrial visit.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
	SECTION I				
1	Introduction	06	--	--	06
2	Powder Production	06	05	05	16
3	Characteristics and Testing of Metal Powders	05	05	08	18
	SECTION II				
4	Powder Compaction	05	05	08	18
5	Sintering of Powder	04	04	04	12
6	Application of Sintered Products	02	02	06	10
	Total	**28**	**21**	**31**	**80**

Prof. R.G. Injewar
Prepared By

Prof. A.S. Zanpure
Secretary, PBOS

Prof.N.S.Kadam
Chairman, PBOS

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Metal Working Processes**
Course Code	:	**MT485**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	**04**	**64**
Practical	**03**	**48**

Evaluation Scheme:

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

Course Rationale:

This subject deals with shaping of metal to a suitable form. In this subject, methods of metal working such as rolling, forging, extrusion, wire drawing, tube making and spinning etc. are studied with reference to their uses, applications, equipment and principals etc.

Course Objectives:

After studying this subject, students are expected to know the principles, applications, products, equipments, procedure etc. of various metal working processes.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
	SECTION I			
1	**Rolling of Metal**			
	1.1	Classification of rolling mills; longitudinal, cross and helical rolling.	12	16
	1.2	Elementary metal rolling theory, coefficient of draught, zone of deformation, angle of bite, contact arc, roll bite condition, steady conditions of rolling, determination of coefficient of friction, neutral plane and neutral angle, forward slip, spread, effect of various parameters on spread.		
	1.3	Distribution of drought in the passes, open and close roll pass, neutral line, roll parting line, top pressure and bottom pressure, roll redressing coefficient.		
	1.4	Various types of rolls, construction of rolling mill rolls.		
	1.5	Rolling mills: construction, auxiliary equipment, plant layout, typical roll pass sequence for blooms, billets, rods and flats.		
	1.6	Rolling of tubes.		
	1.7	Defects in rolled products.		
2	**Drawing of Wire and Rod**			
	2.1	Definition of drawing. Range of starting materials and finished products.	10	12
	2.2	Need for preparation of wires. Preparation of wire; cleaning, rinsing, coating; lime, borax, phosphate coating, baking. Flash baker.		
	2.3	Dies: Construction, shape, materials used, tungsten carbide, diamond dies. Lubrication.		
	2.4	Sink drawing and tube drawing, types of mandrels used, variables in wire drawing, deformation of metal in a drawing die.		

	2.5	Blocks. Wire drawing machines: drawbenches, bull blocks, motor blocks, multiple draft machines, cumulative and non-cumulative continuous machines, drawing frames.		
	2.6	Heat treatments of wires, patenting,		
	2.7	Defects in wires.		
3	**Spinning of Metal**			
	3.1	Parts produced by spinning, definition of spinning, comparison of spinning with sheet metal working, accuracy of spinning.	**10**	**12**
	3.2	Manual spinning: materials used for forms for manual spinning, collapsible mandrel, various types of spinning tools, lubricants used, various spinning operations, optimum speeds for spinning.		
	3.3	Shear spinning (Power spinning): Advantages of power spinning, power spinning in vertical machine, materials for mandrels used, lubrication, shear spinnability.		
	3.4	Defects in spinning.		
		SECTION II		
4	**Forging of Metal**			
	4.1	Definition of forging, Types of forging- Cold, hot and warm forging. Ring rolling, near net shape forgings. Selection of steel for forging.	**12**	**16**
	4.2	Heating for forging, various fuels used for heating forgings, changes in properties of metals on heating, oxidation and decarburisation of steel, over heating and burning of steel, forging temperature interval, determination of time required for heating stock for forging, heating stock by electric current by contact method and induction heating.		
	4.3	Various hand tools, various hand forging operations like drawing out, fullering or spreading, chiseling, upsetting, bending, punching and piercing, allowances and tolerances on forging. Applications of forging.		

	4.4	Working principal of various hammers and presses; Spring hammer, Pneumatic hammer, Single and double acting air, steam hammer, Belt and board drop hammer, Hydraulic press, Screw friction press, Mechanical press. High-pressure water supply for forging press, Cooling of forgings.		
	4.5	Forging defects.		
5	**Extrusion of Metal**			
	5.1	Direct and indirect extrusion.	**10**	**12**
	5.2	Extrusion machines, dies, mandrels, container, profile of dies.		
	5.3	Hydraulic operation of presses, extrusion of tapered and stepped sections.		
	5.4	Heating of the container, heating of billets before extrusion, flow in metal during extrusion, lubrication, variables in extrusion like type of extrusion, extrusion ratio, working temp, speed of deformation and frictional conditions.		
	5.5	Impact extrusion and hydraulic extrusion.		
	5.6	Applications of extrusion, extrusion defects.		
6	**Sheet Metal Working**			
	6.1	Parts made by sheet metal working.	**10**	**12**
	6.2	Various cutting operations like shearing, blanking, piercing, trimming, shaving, notching or slitting. Various types of shears like Guillotine shears, shears with inclined blades, circular shears.		
	6.3	Bending operation, spring back, bending with stretching, geometry and dimensions of bending punches and dies, rubber pad bending, lubrication in bending.		
	6.4	Drawing operation, draw reduction ratio, determine need for blank holder or clamp plate, determining dimensions and shape of blanks, determining allowance for edge trimming. Erickson cupping test.		

	6.5	Applications of sheet metal working. Defects in sheet metal working.		
		Total	**64**	**80**

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Practical/Experiment/Assignment	Hrs
1	Study of various types of rolling machines.	06
2	Study of draw bench.	06
3	Study of continuous wire drawing machine.	06
4	Study the effect of drawing operation on properties of metals.	06
5	Study of spinning machine.	06
6	Study of various forging hammers.	06
7	Study of various forging presses.	06
8	Study of different types of extrusion processes.	06
	Total	**48**

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
	SECTION I	
1	Rolling of Metal	Lecture, demonstration and industrial visits.
2	Drawing of Wire and Rod	Lecture, demonstration and industrial visits.
3	Spinning of Metal	Lecture, demonstration and industrial visits.
	SECTION II	
4	Forging of Metal	Lecture, demonstration and industrial visits.
5	Extrusion of Metal	Lecture, demonstration and industrial visits.
6	Sheet Metal Working	Lecture, demonstration and industrial visits.

Text Books:

Sr. No	Author	Title	Publication
1	George E. Dieter	Mechanical Metallurgy	McGrawhill International Book Co.
2	V. Masterov, V. Berkovsky	Theory of Plastic deformation & Metalworking	MIR Publication

Reference Books:

Sr. No	Author	Title	Publication
1	Claud, Pearson & Parkins	The Extrusion of metals	Chapman and Hall, London
2	K. Burtsev	Rolling Practice	MIR Publication
3	G. Kamenshchikiv, S. Koltan, V. Naumov, B. Chernobrovkin.	Forging Practice	MIR Publication
4	P. Polukhin, N.Fedosov, A. Korolyov, Y. Matveyer	Rolling Mill Practice	MIR Publication
5	Raymond A. Higgins	Engineering Metallurgy	English University Press
6	S. E. Rusinoff	Forging & Forming Metals	D. B. Taraporewala & Sons
7	ASS Book	Making Shaping & Treating of Steel	American Society for Steel

Learning Resources: Books, Models and CDs.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
	SECTION I				
1	Rolling of Metal	8	4	4	16
2	Drawing of Wire and Rod	6	3	3	12
3	Spinning of Metal	6	3	3	12
	SECTION II				
4	Forging of Metal	8	4	4	16
5	Extrusion of Metal	6	3	3	12
6	Sheet Metal Working	6	3	3	12
	Total	**40**	**20**	**20**	**80**

Prof.A.V.Mehtre
Prepared By

Prof. A.S. Zarpure
Secretary, PBOS

Prof.N.S.Kadam
Chairman, PBOS

Programme	:	**Diploma in MT**
Programme Code	:	**05/19**
Name of Course	:	**Heat Treatment of Metals and Alloys**
Course Code	:	**MT486**

Teaching Scheme:

	Hours /Week	Total Hours
Theory	**04**	**64**
Practical	**03**	**48**

Evaluation Scheme:

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

Course Rationale:

The subject includes study of transformation systems, TTT diagram, hardenability of steel. The mechanical properties of metals and alloys are important from design point of view. After selection of material and alloys the mechanical properties such as tensile strength, ductility, fatigue, hardness can still be further improved by various types of heat-treatment given to ferrous and non -ferrous alloys. Hence, the course has its own value in metallurgical field.

Course Objectives:

After studying this course, the student will be able to

- Understand various transformations in steel.
- Know heat treatments of steels and cast-iron.
- Study heat treatment of non-ferrous alloys.
- Study the relation between microstructure and heat treatment.
- To make aware of safety in heat treatment shops.

Course Content:

Chapter No.	Name of Topic/Sub topic		Hrs	Weightage
	SECTION I			
1	**Transformations in Steels**			
	1.1	Transformation of Pearlite into Austenite on slow heating. Effect of grain size, Determination of Austenitic grain size, Measurement of grain size.	12	10
	1.2	Transformation of Austenite into Pearlite on slow cooling. Nucleation and growth of Cementite and ferrite. Effect of time & grain size.		
	1.3	Martensite Transformation: MS – MF temperature, Characteristics of Martensite transformation, effect of carbon and alloying elements, retained Austenite, CCR, effect of Austenitic grain size, Volumetric changes during martensite transformation.		
	1.4	Bainite Transformation: Characteristics comparison with Martensite & Pearlite transformation.		
2	**Hardening Heat Treatment**			
	2.1	Heat treatment furnaces, Vacuum Heat treatment furnaces.	12	10
	2.2	Factors governing heating rate.		
	2.3	Furnace atmospheres – oxidation, decarburization.		
	2.4	Quenching mediums, properties, selection of quenching medium. Polymer quenching- principle, advantages and disadvantages. Selection of H. T. cycle for given steel.		
	2.5	Finishing operations after H. T.		
	2.6	Finishing operation on HT Treated component, Shot blasting and Shot pinning.		
	2.7	Defects in heat treatment.		
3	**Tempering of Steel**			
	3.1	Objects of tempering, stages in tempering, effect of temperature and time of tempering on structure and properties.	04	10
	3.2	Precipitation of carbides, Temper embrittlement.		
	3.3	Secondary hardness.		

4	**Annealing and Normalizing**			
	4.1	Various purposes of annealing.	**04**	**10**
	4.2	Subcritical and full annealing, recrystalization, homogenizing annealing, Stress relieving annealing.		
	4.3	Normalizing; purposes, changes in properties.		
	SECTION II			
5	**Types of Heat Treatments Based on T.T.T. Diagram**			
	5.1	Martempering.	**02**	**06**
	5.2	Austempering.		
	5.3	Ausforming.		
	5.4	Patenting.		
	5.5	Isothermal annealing.		
	5.6	Sursulf process.		
6	**Case Hardening Of Steel**			
	6.1	Carburising– pack, gas and liquid carburizing. H. T. after carburizing.	**12**	**12**
	6.2	Nitriding.		
	6.3	Cyaniding – carbonitriding.		
	6.4	Diffusion metallizing, Plasma Nitriding.		
	6.5	Vacuum processes- Carburising, nitriding, brazing.		
7	**Surface Hardening Of Steels And C.I.**			
	7.1	Induction hardening.	**10**	**08**
	7.2	Flame hardening.		
	7.3	Electrolytic bath hardening.		
	7.4	Laser hardening.		
8	**Heat Treatment Of Cast Irons**			
	8.1	H. T. of grey C. I., White C. I., Malleable C.I., H. T. of S. G. Irons.	**02**	**06**
9	**Heat Treatment of Non-ferrous Metals And Alloys**			
	9.1	Effect of annealing on cold working metals. H. T. of Al, Copper and Mg alloys. Modification of Al-Si alloys using St/Na.	**04**	**06**
	9.2	Precipitation hardening of Al-Cu system.		
10	**Safety Measurements In H. T. Shop**			
	10.1	Environmental control in H. T. shop.	**02**	**02**
		Total	**64**	**80**

List of Practicals/Experiments/Assignments:

Sr. No.	Name of Pracical/Experiment/Assignment	Hrs
1	Study of heat treatment furnaces.	06
2	Study of hardening of steels. Effect of various parameters on hamdening.	06
3	Study of tempering of steels. Effect of various parameters on tempering.	06
4	Study of annealing of steels.	06
5	Study of normalizing of steels.	06
6	Heat treatment of cast irons.	06
7	Precipitation hardening of aluminum copper alloys.	06
8	Hardening of aluminum bronze	06
	Total	**48**

Instructional Strategy:

Sr. No.	Topic	Instructional Strategy
1	Transformations In Steels	Class room teaching, practical work, Group discussion and industrial visits.
2	Hardening Heat Treatment	Class room teaching
3	Tempering Of Steel	Class room teaching
4	Annealing And Normalizing	Class room teaching, industrial visits
5	Types Of Heat Treatments Based On T.T.T. Diagram	Class room teaching, group discussion and industrial visits.
6	Case Hardening Of Steel	Class room teaching, expert lectures
7	Surface Hardening Of Steels & C. I.	Class room teaching, expert lectures group discussion and industrial visits.
8	Heat Treatment Of Cast Irons	Class room teaching
9	Heat Treatment Of Non-Ferrous Metals And Alloys	Class room teaching, expert lectures
10	Safety Measurements In H. T. Shop	Class room teaching

Text Books:

Sr. No	Author	Title	Publication
1	Clark & Verney	Physical Metallurgy for engineers	CBS publishers and distributors
2	Avner	Introduction to Physical Metallurgy	Tata Mc Graw Hill Publishing Company Ltd, New Delhi.
3	Higgins	Physical metallurgy	English University Press, London

Reference Books:

Sr. No	Author	Title	Publication
1	--	ASM Handbook	American Society of Metals
2	Prabhudeva,	Heat treatment handbook	Tata McGraw Hill Co. Ltd.

Learning Resources: Models, charts, structures, slides and photographs.

Specification Table:

Sr. No.	Topic	Cognitive Levels			Total
		Knowledge	Comprehension	Application	
	SECTION I				
1	Transformations In Steels	6	2	2	10
2	Hardening Heat Treatment	5	3	2	10
3	Tempering Of Steel	6	2	2	10
4	Annealing And Normalizing	6	2	2	10
	SECTION II				
5	Types Of Heat Treatments Based On T.T.T. Diagram	4	1	1	6
6	Case Hardening Of Steel	8	2	2	12
7	Surface Hardening Of Steels & C.I	6	1	1	8
8	Heat Treatment Of Cast Irons	4	1	1	6
9	Heat Treatment Of Non-Ferrous Metals And Alloys	4	1	1	6
10	Safety Measurements In H.T. Shop	1	0	1	2
	Total	**50**	**15**	**15**	**80**

Prof. A. V. Mehbe
Prepared By

Prof. A. S. Zanpure
Secretary, PBOS

Prof. N. S. Kadam
Chairman, PBOS