RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
IV	**Material Science & Engineering**	3	00	00	3	30	70	100	3hrs.

Sr. No.	Course Objective The objective of this course is–
1	To impart Knowledge for analyzing different Microstructure and Crystalline nature of metals.
2	To impart knowledge of Iron-Iron carbide equilibrium diagram and microstructure of commercial steels and Cast Iron.
3	To provide the knowledge of various heat treatment processes.
4	To impart basic knowledge of powder Metallurgy for Powder metallurgical components.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Student will be capable to distinguish microstructure and analyze the effect of Crystalline nature of metals, construct and analyze Iron-Iron carbide equilibrium diagram.
CO2	Student will be able to study the commercial steels.
CO3	Student will be able to analyze and implement suitable heat treatment processes.
CO4	Student will be able to analyze the Cast Iron.
CO5	Student will be able to perceive the basics of powder Metallurgy for powder metallurgical components.

SYLLABUS	
Contents	No of hours
Unit I: **Introduction to materials**, classification of materials. Properties and applications of materials. Crystalline nature of metals, specially microscopic and macroscopic examinations of metals. Alloys and solid solutions, types and their formations, modified Gibbs's phase rule, Lever rule for phase mixtures and their application in system. **Study of equilibrium diagrams** and invariant reactions. Iron-Iron carbide equilibrium diagram, critical temperatures. Microstructure of slowly cooled steels. Estimation of carbon from microstructures; structure property relationship.	10 hrs.
Unit II: Classification and application of plain carbon steels. Examples of alloy steel such as Hadfield Manganese Steel, ball Bearing Steels, etc. Tool Steels – Classification, composition, application and commercial heat treatment practice for HSS, Secondary hardening. Stainless Steels - Classification, composition, application and general heat treatment practice for Stainless Steels. Classification and applications of steels. Effect of alloying elements. ,	10 hrs.
Unit III: Heat treatment and its importance. Annealing, Normalizing, Hardening, Quench Cracks, Hardenability test. TTT diagram and its construction and related Heat Treatment Processes such as Austempering, Martempering, Patenting etc. Retention of Austenite, Effects and elimination of retained austenite, Tempering. Case / Surface hardening treatments such as Carburizing, Nitriding, Cyaniding, Carbonitriding, Flame and Induction hardening.	9 hrs.
Unit IV: Cast Iron – Classification, White cast Iron, Gray Cast Iron, Nodular Cast Iron, Malleable Cast Iron, Chilled and alloy Cast Iron. (Production route, Composition, Microstructure and applications) Effects of various parameters on structure and properties of Cast Iron, Alloy cast Iron such as Ni-resist, Ni-hard. Non-Ferrous Alloys – Study of non-ferrous alloys such as brasses (Cu-Zn diagram), Bronzes (Cu-Sn diagram), Aluminum Alloys (e.g. Al-Si & Al-Cu diagram), Bearing materials.	9 hrs.
UNIT V: Powder Metallurgy: Powder manufacture and Conditioning, Production of Sintered Structural Components, Self lubricating bearing, Cemented Carbides, Ceramics, Sintered Carbide cutting tools.	9 hrs.

Sr. No.	List of Tutorials
01	Study of microstructure and analyze the effect of Crystalline nature of metals.
02	To construct & study of Iron-Iron carbide equilibrium diagram.
03	Study the commercial steels.
04	Analyze and implement suitable heat treatment processes.
05	Study of Cast Iron.
06	Study of powder Metallurgy for powder metallurgical components.

References:

Text Books Recommended:

1. Material Science & Engineering, V. R. Raghavan,1974.

2. Material Science & Engineering, William Callister,1985.

3. Material Science & Engineering, R. K. Rajput,2009.

4. Material Science & Engineering, An Introduction, 6 th Edition, Donald Askeland, 1984..

Reference Books Recommended:

1. Introduction to Physical Metallurgy 29st revised edition, 2009 Sidney H.Avner McGraw-Hill,1964.

2. Engineering Physical Metallurgy and Heat Treatment 21st revised edition, 1988 Yu Lakhtin Mir publishers, Moscow, Russia.

3. Introduction to Engineering Metallurgy 21st revised edition, 2007 Dr. B K Agrawal Tata Mc-GraHill.

4. Metallurgy for Engineers 4th Revised edition 1987 E C Rollason E. Arnold.

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Proposed Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual	University	Total
IV	Material Science & Engineering	00	00	2	2	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Students will be able to create specimen for metallographic examination.
CO2	Students will be able to analyze the microstructure and investigate various properties of ferrous and nonferrous Materials.
CO3	Students will be capable to test different Engineering Materials.
CO4	Students will be able to analyze the hardenability microstructure.
CO5	Students will be capable to test Cast Iron.

List of Practical's

Sr. No.	List of Practical's
01	Study of Metallurgical Microscope.
02	Preparation of Specimen for metallographic examinations.
03	Study and drawing of microstructures of Steels.
04	Study and drawing of microstructures of Cast Iron.
05	Study and drawing of microstructures of Non Ferrous Metals.
06	Study of the effect of annealing and normalizing on properties of steels.
07	Determination of hardenability of steels by Jominy End Quench test.
08	Measurement of hardness of ferrous or non-ferrous materials with the help of Brinell hardness tester & Rockwell hardness tester.
09	Study of effect of alloying elements on properties of steels.
10	Study of Pack carburizing of steel samples.
11	Study of Flame & Induction hardening.

Suggested References:

1. Introduction to Physical Metallurgy 29st revised edition, 2009 Sidney H.Avner McGraw-Hill,1964.
2. Engineering Physical Metallurgy and Heat Treatment 21st revised edition, 1988 Yu Lakhtin Mir publishers, Moscow, Russia.