LOK JAGRUTI UNIVERSITY (LJU)

INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Mechanical Engineering

Bachelor of Engineering (B.E.) – Semester – IV

Course Code:	**017103404**
Course Name:	**Material Science and Metallurgy**
Category of Course:	Professional Core Course (PCC)
Prerequisite Course:	Physics (017101192), Strength of Materials (017103391), Manufacturing Technology (017103401)

Teaching Scheme				
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**Total Hours**
3	**0**	**0**	**3**	**30**

Syllabus

Unit No.	Topic	Prerequisite Topic	Successive Topic	Teaching Hours
01	**Introduction to Material Science and Metallurgy**			**3 (10%)**
	1.1 Introduction to material science and metallurgy	---	---	
	1.2 Classification of material & advance engineering material	---	Define Plastic processes and types of Plastics (017103401 – Unit- 9.1) Jig bushes, Jigs and Fixtures for various machining operations (017103401 – Unit- 8.4)	
	1.3 Engineering requirement of material	---	---	
	1.4 Selection criteria of material	---	---	
	1.5 The processing-microstructure-properties-performance relationship	---	---	
	1.6 Mechanical properties like strength, toughness, hardness, stiffness, brittleness, ductility, elasticity, resilience, malleability, creep, fatigue, machinability & weldability	---	---	
	1.7 Stress – strain diagram of ductile and brittle material	Stress and types of stress, Strain and types of strain (017103391 - unit-1.2)	---	
02	**Crystallography**			**4 (13.33%)**
	2.1 Types of solid like crystalline solids and amorphous solids	---	---	
	2.2 Important crystallography terms like space lattice, unit cell, lattice parameter, lattice angle, atomic packing efficiency and coordination number	---	---	
	2.3 Types of unit cell and types of crystal system	---	---	
	2.4 Atomic Packing Efficiency of S.C, B.C.C, F.C.C & H.C.P	---	---	
	2.5 Miller indices for direction and plane	---	---	
	2.6 Numerical related density and atomic packing efficiency	---	---	
	2.7 Imperfection in solids	---	---	
	2.8 Point defects like vacancy, self-substitutional defect, substitutional impurity and interstitial defects	---	---	
	2.9 Line defects like edge and screw dislocations	---	---	
	2.10 Surface defects like grain boundary, twin boundary, stacking fault and low angle boundary defects	---	---	
03	**Solidification of Metal and Phase Diagram**			**3 (10%)**
	3.1 Solid solution like substitutional and interstitial solid solution	---	---	
	3.2 Hume Rothery rule	---	---	
	3.3 Solidification of metal	---	Chvorinov's rule, chills and sleeves, solidification of metal (017103401 – Unit-3.4)	
	3.4 Homogeneous and heterogeneous nucleation	---	---	
	3.4 Gibbs Phase rule	---	---	
	3.5 Cooling curves for pure metal, binary alloy, eutectic binary alloy and off eutectic binary alloy	---	---	
	3.6 Lever rule	---	---	
	3.7 Unary and binary equilibrium phase diagram plotting and finding different phases present in it.	---	---	
04	**Allotropy of Iron**			**3 (10%)**
	4.1 Allotropy of iron	---	---	
	4.2 Iron -iron carbide equilibrium phase diagram	---	---	
	4.3 Equilibrium cooling of eutectoid, hypo eutectoid and hyper eutectoid steel with its composition of different phases present in it.	---	---	
05	**Ferrous Material**			**2**

	5.1 Wrought iron	Iron -iron carbide equilibrium phase diagram (017103404-Unit-4.2)	---	**(6.67%)**
	5.2 Types of cast iron like grey cast iron, white cast iron, ductile and malleable cast iron	---	---	
	5.3 Plain carbon steel and its type	---	---	
	5.4 Effect of different alloying elements like nickel, chromium, molybdenum, tungsten, vanadium, titanium, aluminium, copper, boron and lead on steel	---	---	
	5.5 Alloy steels like structural steel, free cutting steel, stainless steel, high speed steel, bearing steel, spring steel	---	---	
06	**Non Ferrous Material**			**2 (6.67%)**
	6.1 Copper and its alloy like brass, bronze and cupronickel alloy and its type	---	---	
	6.2 Aluminum and its alloy like duralium, Y-alloy, magnalium and hindalium	---	---	
	6.3 Nickel and its alloy like monel metal, Inconel, nichrome and nimonics	---	---	
07	**Heat Treatment of Steels**			**4 (13.33%)**
	7.1 Purpose of heat treatment	Iron -iron carbide equilibrium phase diagram (017103404-Unit-4.2)	---	
	7.2 Time temperature transformation diagram	---	---	
	7.3 Continuous cooling transformation diagram	---	---	
	7.4 Heat treatment processes like annealing, normalizing, hardening and tempering	---	---	
	7.5 Austempering and martempering	---	---	
	7.6 Surface hardening methods like carburizing, nitriding, cyaniding, flame hardening and induction hardening.	---	---	
08	**Powder Metallurgy**			**2 (6.67%)**
	8.1 Powder production technique	---	---	
	8.2 Steps followed in powder metallurgy	---	---	
	8.3 Sintering process	---	---	
	8.4 Advantages, limitations and applications of powder metallurgy	Sand casting (017103401 – Unit-4.1	---	
09	**Metallography**			**5 (16.67%)**
	9.1 Macro and micro examination	---	---	
	9.2 Types of fracture like brittle and ductile.	---	---	
	9.3 Micro specimen preparation	---	---	
	9.4 Etchant mechanism	---	---	
	9.5 Metallurgical microscope	---	---	
	9.6 Testing and inspection of material like tensile strength testing, impact testing, hardness testing, liquid penetrant testing, magnetic particle testing, ultrasonic testing, radiography testing	Flaw detection system and pulse echo system(017101192-Unit-5.5)	---	
10	**Corrosion of Metal and Alloys**			**2 (6.67%)**
	10.1 Mechanism of corrosion	---	---	
	10.2 Types of corrosion like uniform, galvanic, crevice, pitting, stress, corrosion fatigue, intergranular and erosion corrosion	---	---	
	10.3 Preventive measures of corrosion	---	---	

Proposed Theory + Practical Evaluation Scheme by Academicians
(% Weightage Category Wise and it's Marks Distribution)

L :	3	T:	0	P:	0

Note : In Theory Group, Total 4 Test (T1+T2+T3+T4) will be conducted for each subject.
Each Test will be of 25 Marks.
Each Test Syllabus Weightage: Range should be 20% - 30%

Group (Theory or Practical)	Group (Theory or Practical) Credit	Total Subject Credit	Category	% Weightage	Marks Weightage
Theory	3	3	MCQ	60%	65
Theory			Theory Descriptive	30%	25
Theory			Formulas and Derivation	4%	4
Theory			Numerical	6%	6
Expected Theory %	**100%**		**Calculated Theory %**	**100%**	**100**
Practical	0		Individual Project	0%	0
Practical			Group Project	0%	0
Practical			Internal Practical Evaluation (IPE)	0%	0

Practical			Viva	0%	0
Practical			Seminar	0%	0
Expected Practical %	**0%**		**Calculated Practical %**	**0%**	**0**
Overall %	**100%**			**100%**	**100**

Course Outcome	
	Upon completion of the course students will be able to
1	Analyze the structure of materials and basic concepts of materials.
2	Construction and identification of phase diagrams and reactions to create desired microstructure and application of ferrous material.
3	Suggest the heat treatment process for engineering application and its impact on microstructure and material properties and study regarding nonferrous material.
4	Understand different non-destructive testing methods, powder metallurgy and also find the causes and prevention of metallic corrosion.
Suggested Reference Books	
1	Callister's Materials Science and Engineering by R. Balasubramanian, John Wiley and Sons.
2	A Text book of Materials Science And Metallurgy by O. P. Khanna, Dhanpat Rai Publications.
3	Material Science & Metallurgy for Engineers by V.D.Kodgire and S.V.Kodgire, Everst Publication House
4	The Science and Engineering of Materials by D. R. Askland, P. P. Fulay, W. J. Wright, Cengage Learning
5	Introduction to Physical Metallurgy by Sydney. H. Avner, McGraw-Hill
6	Principles of Materials Science and Engineering by W.F. Smith, McGraw Hill.
7	Metallography and Microstructure by Ed. George F. Vander Voort, ASM International 2004.
8	Materials Science and Metallurgy by K. I. Parashivamurthy, PHI Publication
9	Heat Treatment: Principles and Techniques by T.V.Rajan, C.P.Sharma, Ashok Sharma, PHI Publication
10	Corrosion Engineering by M. G. Fontana, McGraw-Hill

List of Open Source Software/Learning website	
1	www.coursera.com
2	https://nptel.ac.in
3	https://wileyassets.s3.amazonaws.com