BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI–
HYDERABAD CAMPUS
FIRST SEMESTER 2020-2021
COURSE HANDOUT (PART II)

17th August 2020

Course No.	**: ME F213**
Course Title	**: Materials Science and Engineering**
Instructor-in-Charge	**: Sujith R**
Instructors	**: Jella Gangadhar, Amar Sheelwant, Ankit Sharma**

1. Course Description: The course gives an introduction to materials science and its structure at the atomic and microscopic level. The relation between structure and properties of materials is also highlighted. The course mainly discusses about the structure and properties of different types of materials such as metals, ceramics and polymers.

2. Scope and Objectives: The primary focus of this course is on the microstructure-processing-properties correlation. This course will help the student to learn the behavior of various material systems such as metals, polymers and ceramics by correlating it to the structure. Study includes atomic structure and bonding, crystal structures, defects in crystals, phase diagrams and phase equilibria, and mechanical properties.

At the end of this course student will be able to apply core concepts in materials science to solve engineering problems.

Prescribed Text Book

T1. Callister William D & R. Balasubramaniam, Materials Science and Engineering, Wiley Student Edition, 7th Edition, 2007.

Reference Books

R1. William F Smith, Javad Hashmi and Ravi Prakash, Materials Science and Engineering, Fourth Edition, Tata McGraw Hill Education Private Limited, New Delhi.

R2. George E. Dieter, Mechanical Metallurgy, SI Metric Edition McGraw Hill Book Company, London.

R3. R. A. Higgins, Applied Physical Metallurgy, Sixth edition, Viva Low priced students edition, New Delhi.

R4. Thomas. H. Courtney, Mechanical Behavior of Materials, McGraw Hill Publication Company, Materials Science series, II Edition (2000).

R5. Material Science and Engineering, V. Raghavan, Fifth Edition, Prentice-Hall of India Private Limited (2004).

Lecture No.	Learning Objectives	Topics Covered	Book Chapter
1	Introduction	Course introduction and evaluation scheme, Historical perspective, Why study materials science and engineering?	T1
2-3	Identify the different types of atomic bonds in solids and evaluate the effect of bonding on material properties	Bonding forces and energies; Primary and Secondary bonding	T2
4-6	Distinguish between crystalline and amorphous materials, Identify the crystal structures and specify the miller indices, Define isotropy and anisotropy	Unit cells; Crystal structures: Metals, Ceramics & Polymers; Density computations; Crystallographic directions and planes; Crystalline and Amorphous materials; Determination of crystal structures using X-ray diffraction	T3
6-8	Identify the different type of defects in crystals, Differentiate between the two types of solid solutions, Describe the ionic point defects	Point defects in metals Dislocations, Surface and Volume defects, Microscopic techniques (SEM & TEM), Grain size determination (OM)	T5
9-10	Describe the atomic mechanisms of diffusion, Distinguish between the steady state and non-steady state diffusion.	Diffusion mechanisms; Steady state and Non-steady state	T6
11-12	Determine the modulus of elasticity, yield strength and toughness of various material systems, Compute impact toughness and hardness	Stress-strain behavior of metals, polymers & ceramics, Viscoelasticity, Impact strength & Hardness	T7
13-15	Describe how plastic deformation occurs by movement of dislocations, Define slip systems, Describe and explain various strengthening mechanisms, Differentiate between hot working and cold working	Slip systems; deformation by twinning; strengthening mechanisms; recovery, recrystallization & grain growth	T8
16-19	Describe how plastic deformation occurs by movement of dislocations, Define slip systems, Describe and explain various strengthening mechanisms, Differentiate between hot working and cold working	Characteristics of dislocations, Slip systems, Slip in single crystals and polycrystalline materials, Deformation by twinning, Strengthening mechanisms, Recovery, recrystallization and growth	T8
20-22	Differentiate between ductile and brittle fracture, Define	Fundamentals of fracture: ductile and brittle, Principles of fracture	T9

	fracture toughness, Distinguish between fatigue and creep	mechanics, Fatigue: S-N Curve, Crack initiation and propagation, Generalized creep behavior	
23-26	Identify and interpret one component and two component phase diagrams, Use Gibbs phase rule to identify the invariant reactions, Sketch and interpret iron carbon phase diagram	Definition and basic concepts, Phase equilibria, Unary and binary phase diagrams, Gibbs phase rule, Iron –iron carbide phase diagram, Development of microstructure in iron-carbon alloys, Influence of other alloying elements	T10
27-29	Sketch and interpret time temperature transformation diagram and continuous cooling transformation diagram, Design a heat treatment that will produce a specified microstructure, Explain the mechanism of age hardening.	The kinetics of solid state reactions, Isothermal transformation diagram, Continuous cooling transformation diagrams, Martensite structures and tempering, Heat treatments, Glass transition temperature.	T11

Evaluation Scheme:

No.	Evaluation Component	Duration	Weightage (%)	Date & Time	Nature of Component
1	Test 1	30 min	15	September 10 –September 20 (during scheduled class Hour)	Open Book
2	Test 2	30 min	15	October 9-October 20(during scheduled class hour)	Open Book
3	Test 3	30 min	15	November 10-November 20 during scheduled class hour)	Open Book
2	Comprehensive exam	2 h	25	TBA	Open Book
3	Tutorial quizzes*	-	20		Open Book
4	Quizzes		10		Open Book

* Best 8 out of 10 quizzes will be considered for evaluation.

Note:

1. **Chamber Consultation hour:** Friday 4 to 5 pm.
2. **Notices:** All notices concerning this course will be displayed on CMS.
3. **Make-up Policy**: Make-up will be granted only to genuine cases. For cases related to illness, proper documentary evidence is essential. Prior permission is necessary if the student is out of station on the test date.
4. **Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.
5. **No Credit Policy:** Failure to gather minimum 20% marks will results in no credits for this course.

Instructor-in-charge
ME F213