Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2023-2024

Course Handout Part II

10th August 2023

In addition to Part-I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Course No. **: DE G631**
Course Title **: Materials Technology and Testing**
Instructor-In-Charge **: Prabakaran Saravanan**
Instructor (Lab) **: Danavath Balu**

1. Course Description:

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibers, and other modern engineering materials and their application with particular reference to railways. Destructive and nondestructive testing techniques and their applications in Railways.

2. Scope and Objective of the Course:

This course is for higher degree students and is intended to focus their attention to the nature of different classes of engineering materials. The study includes characteristics of metals, polymers, ceramics, composites, biomaterials, and their applications. Methods of testing the materials (destructive and non-destructive), understanding corrosion and selection of the materials for a given application and considering environmental social, and economic issues are included. At the end of the course, the student will be able to apply the core concepts in materials technology to effectively choose the material as per the design requirements and do the necessary characterization.

3. Textbooks:

1. William D Callister Jr. **Materials Science and Engineering: An Introduction**, John Wiley & Sons, Singapore, Seventh Edition, (2008).
2. George E. Dieter, 'Mechanical Metallurgy', McGraw Hill, SI Metric Edition

Reference books:

1. William F. Smith, Javad Hashemi, 'Material Science & Engineering", In SI units Fourth edition, McGraw-Hill.
2. Norman E. Dowling, Mechanical Behavior of Materials, Pearson Publications.
3. Marc Andre Meyers, Krishan Kumar Chawla, Mechanical Behavior of Engineering Materials Cambridge University Press (2009).
4. Thomas H. Courtney, Mechanical Behavior of Materials, McGraw Hill Education.
5. Ravi Prakash Nondestructive Testing Techniques New Age, India, 2007.
6. Joseph R. Davis, Corrosion: Understanding the Basics, ASM International.
7. Machine Learning for Beginners: An Introduction to Artificial Intelligence and Machine Learning by John Slavio.

4. Course Plan:

Lecture No.	Learning Objectives	Topics To Be Covered	Book Chapter
1-4	Basic engineering materials	Atomic bonding, classification of materials, structure, and characteristics of metals (ferrous and nonferrous), polymers, ceramics, composites, and advanced materials (electronic materials, smart materials, nanomaterials, etc.)	**T1(**Ch1-4, Ch11-16), **R1** (Ch1-3, 9-12), **R2**(Ch3)
5-8	Structural characterization techniques	Importance of materials characterization, optical microscopy, electron microscopy, grain size measurement, x-ray diffraction fundamental.	**T1(**Ch3-4), **R1**(Ch3-4), **Lecture notes**
9-11	Elastic-Plastic Behavior of Materials - Review	Concept of stress and strain, stress-strain relationship for elastic behavior, elastic and plastic behavior of materials (metals, ceramics, polymers, and composites)	**T1(**Ch6), **T2**(Ch2,3), **R2** (Ch5-6)**, R3 (**Ch2-3)**, R4, R5**
12-15	Testing of Materials- Tensile Testing, Hardness Testing	Tensile testing and test standards for metals, polymers, and composites, engineering stress-strain curve, true stress-strain curve, determination of mechanical properties from a tensile test, poison's ratio, instability in tension, effect of temperature, and strain rate. The hardness of materials, hardness testing of metals, polymers, and composites, hardness test standards, analysis of indentation, brinell hardness, meyer hardness, vickers hardness, rockwell hardness, shore hardness, micro-hardness tests, nanoindentation.	**T2(**Ch8), **R2**(Ch4) **T2** (Ch 9), **R2**(Ch4)
16-20	Fracture behavior of materials	Fundamentals of fracture, types of fractures in metals, theoretical cohesive strength of metals, theory of ductile and brittle fracture, crack initiation and growth, stress concentration and fractures, metallographic aspects of fracture, fracture under combined stress, case studies.	**T2(**Ch7, Ch11), **R2** (Ch 7-8), **R4**(Ch9-10)
21-24	Impact testing, torsion testing, compression testing, and bend test	Fracture toughness of materials, fracture mechanics, notch bar impact testing, bending (flexure) tests, heat-deflection test, torsion test, testing of thin-walled tubes in torsion mechanical properties in torsion, torsion failure, test methods for compression, materials properties in compression, trends in compressive behavior. Test standards for compression, impact, bend and torsion tests.	**T2(**Ch10-11, Ch14), **R2**(Ch4), **R3** (Ch10, Ch14)
25-29	Fatigue, creep and stress rupture behavior of materials	Fatigue of metals, stress cycles, s-n curve, standards for fatigue test and determination of s-n curve, theories of fatigue, paris law, factors affecting fatigue and mitigation methods, origin of residual stress, effect of residual stress, stress relief. Creep curve, creep and stress rupture test and test standards, deformation at elevated temperature, factors affecting creep behavior, interpretation of creep data, larson miller parameter	**T2(**Ch12), **R2** (Ch9-11, Ch14) **T2(**Ch13), **R2** (Ch 15), **R3**(Ch13)

30-32	Nondestructive testing of materials	Overview of the non-destructive testing, detection of surface flaws, detection of internal flaws, visual inspection, liquid penetrant testing, magnetic particle testing, thermography, eddy current testing, radiography, ultrasonic testing, acoustic emission	**R1(**Ch7), **R6**
33-36	Introduction to friction & wear, corrosion behavior of the materials	Basic understanding of friction and wear, laws of friction, archard laws & equations, and an overview of the pin-on-disc wear test. Corrosion electrochemistry, Nernst equation, cathodic protection.	**T1(**Ch17), **R1**(Ch13), **R3**(Ch16), **R7, R8**
37-42	Introduction to Machine learning for material characterization	Introduction to ML, different ML algorithms & models, ML for metallic material characterization i.e., machine learning in tribology, corrosion, fatigue, and tensile properties.	**R9 + Class notes**

5. Evaluation Scheme:

Evaluation component	Duration	Weightage	Date/Time/Venue	Evaluation type
Quiz 1	30 min	10 %	Sep	Open book
Mid-Semester Test	90 min	25 %	11/10 - 4.00 - 5.30PM	Closed book
Quiz 2	30 min	10 %	Nov	Open book
Comprehensive Examination	180 min	35 %	13th Dec (AN)	Closed book
Lab (12 Experiments)		20 %	Aug - Dec	Open book

***Chamber Consultation Hour:** To be announced in the class room.

1. **Notices:** All notices concerning this course shall be displayed only on Google Classroom

2. **Make-up Policy:** Make-up shall be given only to genuine cases with prior confirmation. Request for the make-up tests, duly signed by the students, should reach the undersigned well before the scheduled test.

3. **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.

Instructor-in-Charge
DE G631