BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE – PILANI, HYDERABAD CAMPUS
FIRST SEMESTER 2021-2022
(COURSE HANDOUT: PART-II)

12th August 2021

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

Course No. : **DE G631**
Course Title : **MATERIALS TECHNOLOGY AND TESTING**
Instructor-in-Charge : **Dr. Piyush Chandra Verma**
Instructor :

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 the engineering materials. 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, considering environmental social and economic issues are included.

   At the end of the course the student will be able 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. Richard W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons.
   6. Ravi Prakash Nondestructive Testing Techniques New Age, India, 2007.
   7. Ian Hutchings, Philip Shipway, Tribology: Friction and Wear of Engineering Materials, Butterworth-Heinemann publisher.
   8. Joseph R. Davis, Corrosion: Understanding the Basics, ASM International.

4. Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Book Chapter
1-6	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)
7-9	Structural characterization techniques	Importance of materials characterization, Optical microscopy and Electron microscopy, grain size measurement, X-ray diffraction fundamental.	**T1(**Ch3-4), **R1**(Ch3-4), **Lecture notes**
10-12	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**
13-15	Testing of materials- Tensile testing	Tensile testing and test standards for metals, polymers and composites, Engineering stress strain curve, true stress strain curve, determination of mechanical propertied from tensile test, Poison's ratio, Instability in tension, Effect of temperature and strain rate.	**T2(**Ch8), **R2**(Ch4)
16-17	Hardness Testing	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, nano indentation	**T2** (Ch 9), **R2**(Ch4)
18-20	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)

25-28	Fatigue 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, Residual stress measurement methods, Stress relief	**T2(**Ch12), **R2** (Ch9-11, Ch14)
29-31	Creep and Stress rupture	High temperature behavior of materials, 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(**Ch13), **R2** (Ch 15), **R3**(Ch13)
32-34	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**
35-38	Introduction to Friction & Wear	Basic understanding of Friction and wear, Laws of friction, Archard law's & equation, different type of wear, overview of Pin-on-disc wear test.	**T1(**Ch17), **R1**(Ch13),
39-42	Corrosion behavior of the materials	Corrosion Electrochemistry, Nernst equation, forms of corrosion, Cathodic Protection.	**R3**(Ch16), **R7, R8**

5. Evaluation Scheme:

Evaluation Component	Duration	Weightage (%)	Date & Time	Nature of Component
Quiz 1	45 min	5	September 10 –September 20 (During scheduled class hour)	OB
Quiz 2	45 min	5	October 09 –October 20 (During scheduled class hour)	OB
Project/Seminar	As desired by the Instructor(s)	10	November 10 – November 20 (During scheduled class hour)	OB
Mid SEM Exam	90 min	35	As announced in the Timetable	OB
Laboratory Component	As desired by the Instructor(s)	10	Evenly spaced throughout the semester (To be completed by November 2021)	OB
Comprehensive Examination	120 min	35	As announced in the Timetable	OB

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

6. **Notices:** All notices concerning this course shall be displayed only on the CMS

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

8. **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