

MSE-233 Inspection and Testing of Materials

Credit Hours: 3-0

Pre-requisites: Nil

Course Description

In this course, the students will learn to perform and interpret the results of destructive & non-destructive testing of materials as per renowned international standards. The special emphasis will be on hardness, tensile, compression, torsion, bending, impact, creep, and fatigue testing. Additionally, different non-destructive testing techniques will also be discussed in detail. The students will learn how to ensure the quality of the material to meet the specific industrial requirement.

Course Contents

Introduction to inspection and testing of Materials.

Non-destructive testing (Visual Testing, Leak, Radiographic method, Magnetic particle method, Magnetic flux leakage, Eddy Current Testing, Dye penetrant method, ultrasonic method, Phase array testing, Thermal/infrared testing, Vibration Analysis etc. Reliability and maintainability, inspection of different types of materials and products for evaluation.

Hardness Testing (Arbitrary or indentation hardness, Rebound of dynamic hardness, Scratch hardness, Abrasion test, File test. Macrohardness Testing (Brinell, Rockwell), Microhardness Testing (Knoop, Vicker, Ultrasonic). Tensile testing (Engineering Stress Strain Curve and its explanation. Resilience, Toughness, True-stress-strain concepts, ductile & brittle fracture, Power law or Holloman's relationship, Effect of strain rate & temperature, Compression test).

Bend test, Torsion test (torsion properties, Torque Twist Diagram, Torsional stresses for large plastic strains, Hot Torsion Test).

Fatigue test (SN curve), Creep test (creep curve), Impact Test (Izod, Charpy), Temperature Transition Curve (Ductile to Brittle Transition Temperature)

Introduction to standards. Familiarization of standards and societies for testing of materials, ASNT, ASTM, BS, JIS GOST, ISO, and Pakistan Standards etc.

Weekly Plan

| Week | Topics |
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| 1 | Introduction to subject and Introduction to Mechanical Testing, Types of Mechanical Testing. Introduction to Hardness Testing. |
| 2 | Macro Hardness Testing e.g. Brinell, Rockwell, Shore, Poldi Hardness Testing. Micro Hardness Testing e.g. Vickers and Knoop Hardness testing. |
| 3 | Nano Hardness Testing. Hardness at Elevated Temperatures, Relationship b/w hardness and other mechanical Properties |
| 4 | Tensile Testing, Analysis of Stress-Strain Curves like Elastic and Plastic deformation. |
| 5 | Factors Affecting the Form of the Stress/Strain Curve like The material and its microstructure; The test temperature, and The testing rate. Testing at Higher and lower temperatures |
| 6 | Toughness testing |
| 7 | Creep Testing |
| 8 | Torsion |
| 9 | Mid-Semester Exams |
| 10 | Intro to NDT Visual Testing |
| 11 | Penetrant Testing |
| 12 | Magnetic Particle Inspection |
| 13 | Radiography |
| 14 | Eddy Current Testing |
| 15 | Familiarization of standards and societies for testing of materials |
| 16 | Other techniques, Revision |
| 17-18 | End Semester Exams |

Course Outcomes

At the end of the course, students will be able to:

- Describe the working principles of various material inspection techniques for their application to engineering materials.
- Analyze the data generated from various testing techniques to determine mechanical properties of engineering materials.

- Select/ Compare different NDT techniques used for determining flaws and other useful properties of engineering materials to ensure product quality standards.

Suggested Books

- Charles J. Hellier, Handbook of Nondestructive Evaluation, 1st Edition, The McGraw-Hill Companies, Inc. (2001)
- Metallurgy by George E. Dieter. McGraw-Hill Book Company (UK) Ltd., (2002)
- Elton N. Kaufmann, Characterization of Materials, Volume 1 and 2, Wiley, (2003)
- Norman E. Dowling, Mechanical Behavior of Materials, 2nd Edition, Prentice Hall, 1999
- Robert E. Green, B. BoroDjordjevic, Manfred P. Hentschel, Nondestructive Characterization of Materials XI, Springer-Verlag, Berlin, Germany, (2003)
- Robert Cahn, Concise Encyclopedia of Materials Characterization, 2nd Edition, Elsevier Science, (2005)
- Inspection of Metals: Understanding the Basics by F. C. Campbell, ASM International (2015)
- Volume 8: Mechanical Testing and Evaluation, ASM Handbook edited by H. Kuhn and D. Medlin.
- Introduction to Non-Destructive Testing, a training guide by Paul E. Mix. 2nd ed. Wiley, (2005)
- The Science and Engineering of Materials by D. R. Askeland, W. J. Wright. enhanced 7th ed. Cengage Learning (2020).