MSE3169: MATERIALS TESTING TECHNIQUES

Effective Term
Semester B 2022/23

Part I Course Overview

Course Title
Materials Testing Techniques

Subject Code
MSE - Materials Science and Engineering
Course Number
3169

Academic Unit
Materials Science and Engineering (MSE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
AP2102/MSE2102 Introduction to Materials EngineeringAP2104/MSE2104 Mechanics of Solids

Equivalent Courses
AP3169 Materials Testing Techniques

Exclusive Courses
Nil

Part II Course Details

Abstract
Characterization is an essential aspect of materials research and of quality control in materials production. This course aims to develop an elementary understanding of some basic testing techniques on the analysis and testing of materials, and

to lay down their engineering applications in such a way that the students can identify the appropriate testing techniques required in given engineering problems and apply them to solve the problems.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Recognize the role and importance of testing techniques in materials research and materials production.		x		
2	Identify the principles and functions of some commonly used materials testing methods and equipment.		x	x	
3	Identify the appropriate testing techniques required in given engineering problems and apply them to reveal suitable solutions.		x	x	x
4	Interpret simple experimental results obtained from the testing techniques covered in the course.		x	x	x
5	Apply basic theories to do simple calculations with the data from experiments.			x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Large Class Activities		1, 2, 3, 4, 5	2 hrs/week
2	Small Class Activities		2, 3, 4, 5	0.5 hr/week
3	Lab Work		2, 3, 4, 5	1 hr/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Assignment (Term Paper)	2, 3, 4, 5	10	
2	Mid-term test	1, 2, 3, 4, 5	20	
3	Lab report (s)	2, 3, 4, 5	10	

Continuous Assessment (%)
40

Examination (%)
60

Examination Duration (Hours)
2

Additional Information for ATs
For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)

Assessment Task
1. Examination

Criterion
Ability to describe and explain the scientific principles and to solve physics and engineering problems

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
2. Lab report(s)

Criterion
Ability to explain the methodology and to analyse the data

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
3. Mid-term test

Criterion
Ability to explain scientific principles and to solve related problems

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Assessment Task
4. Term Paper

Criterion
Ability to describe and to use scientific principles.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

- The role of materials testing
- Optical Microscopy
  Lens formula. Image formation in compound microscope. Major parts in a modern optical microscopy and their functions, Resolution of microscope. Aberrations of a lens. Bright-field and Dark-field images.
- Thermal Analysis
  Design of furnace for accurate temperature control and minimal influence on weighing mechanism. Calibration methods. Thermogravimetric analysis (TGA). Dynamic mechanical analysis (DMA). Viscoelastic properties of solids.

Storage modulus and loss modulus. Typical design of DMA mechanism. Differential scanning calorimetry (DSC). Construction of a power-compensated DSC.

- X-ray diffraction
  Generation of x-ray. X-ray spectra. Filtering of x-ray. Interaction of x-ray with crystals. Scattering of x-ray by atoms. Bragg’ s law. Structure factor of crystals. Debye-Scherrer method. Diffractometer method. Indexing x-ray diffraction patterns. Structure identification and determination of lattice parameter.
- Molecular spectroscopy
  Electromagnetic radiation. Internal energy of molecules. Electronic spectroscopy. Vibrational spectroscopy. Oscillator model. UV-Visible absorption spectroscopy. Beer’ s law. Infrared (IR) spectroscopy. Characteristic absorption regions. Double-beam vs. Fourier transform (FT) IR spectrometers. Scattering. Raman spectroscopy.
- Non-Destructive Tests
  Dye-penetration inspection. Magnetic particle inspection. Eddy-current examination method. Radiography. Ultrasonic inspection.

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	P E J Flewitt and R K Wild, “Microstructural Characterisation of Metals and Alloys”, The Institute of Metals (TN690 .F55 1986).
2	D A Skoog, F J Holler, and T A Nieman, “Principles of Instrumental Analysis” Philadelphia (QD79.I5 S58 1998).
3	R F Speyer, “Thermal Analysis of Materials”, Marcel Dekker (TA418.24 .S66 1994).
4	J R Fried, “Polymer Science and Technology” Prentice Hall (QD381 .F73 1995).
5	J D Ingle and S R Crouch, “Spectrochemical Analysis”, Pentice Hall, (QD95 .I48 1988).
6	H Günzler and H U Germlich, “IR Spectroscopy: An Introduction”, Wiley-VCH, (QD96.I5 G86 2002).
7	P E Mix, “Introduction to nondestructive testing: a training guide”, John Wiley & Sons, (TA417.2 .M59 2005).