MSE2104: MECHANICAL BEHAVIOUR OF MATERIALS

Effective Term
Semester A 2023/24

Part I Course Overview

Course Title
Mechanical Behaviour of Materials

Subject Code
MSE - Materials Science and Engineering
Course Number
2104

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
*AP1201 / PHY1201 General Physics I

Precursors
MA1200 Calculus and Basic Linear Algebra I
MA1300 Enhanced Calculus and Linear Algebra I
MA1201 Calculus and Basic Linear Algebra II
MA1301 Enhanced Calculus and Linear Algebra II

Equivalent Courses
AP2104 Mechanics of Solids

Exclusive Courses
Nil

Additional Information

* This pre-requisite requirement is waived for Advanced Standing I students (admitted in 2014/15 and thereafter) and Advanced Standing II students (admitted in 2013/14 and thereafter).

Part II Course Details

Abstract

This course will provide students with sufficient knowledge in mechanics of solids so that they can proceed to the intermediate and more advanced course in the BEng Materials Engineering programme. Stress-strain analysis of materials in the linear elastic regime of simple engineering structures under axial, torsional, shear and bending loads will be introduced.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the contributions of some historical figures in the development of Solid Mechanics		x		
2	Describe the stress and strain components at a point.			x	
3	Solve problems involving simple engineering structures subjected to axial, torsional, bending and/or transverse loads.			x	
4	Perform transformation of stress and strain under plane stress conditions and construct Mohr’ s Circle.			x	
5	Apply solid mechanics knowledge to solve structural design problems			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 self-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	Lecture and Tutorial	Explain the key concepts in Mechanics of solids in an interactive manner	1, 2, 3, 4, 5	4
2	Laboratory	To demonstrate some of the key topics learned in Lecture/Tutorial by experimentation	3, 5	3

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks
1	Tests	1, 2, 3, 4, 5	20	There will be two 1-hour tests, each carries 10%
2	Lab reports	3, 5	15	Students need to complete a number of experiments that demonstrate the principles discussed in lectures/tutorials
3	Assignments	1, 2, 3, 4, 5	5	Take home assignments

Continuous Assessment (%)
40

Examination (%)
60

Examination Duration (Hours)
2

Additional Information for ATs
For a student to pass the course, at least 40% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)

Assessment Task
1. Tests

Criterion
Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
2. Lab reports

Criterion
Ability to explain the methodology and results from experiments

Excellent (A+, A, A-)

High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
3. Assignments

Criterion
Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not even reaching the marginal level

Assessment Task
4. Examination

Criterion
Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)

Not even reaching the marginal level

Part III Other Information

Keyword Syllabus

- Historical development; and engineering examples (1 hour)
- Concept of stress (4 hours)
  Forces and stresses. Axial loading. Normal stress. Shearing stress. Bearing stress in connections. Thermal stress. Analysis of simple structures. Stress on an oblique plane under axial loading. Stress under general loading conditions. Components of stress. Ultimate and allowable stress. Factor of safety.
- Axial loading (4 hours)
  Normal strain under axial loading. Stress-strain diagram. True stress and true strain. Hooke’s law. Modulus of elasticity. Deformation of members under axial loading. Statically indeterminate problems. Problems involving temperature changes. Poisson’s ratio. Multiaxial loading. Generalized Hooke’s law. Dilation. Bulk modulus. Shearing strain. Relationship between modulus of elasticity, Poisson’s ratio and modulus of rigidity. Stress and strain distribution under axial loading. Saint-Venant’s Principle. Stress concentrations.
- Torsion (4 hours)
  Stresses and deformations in circular shafts in the elastic range. Angle of twist. Statically indeterminate shafts.
- Shear and bending-moment diagrams (4 hours)
  Sign conventions for shearing force and bending moment. Determination of shear and bending-moment diagrams for beams under concentrated and/or distributed loads. Relations among load, shear and bending moment.
- Pure bending (2 hours)
  Stresses and deformations in prismatic members in pure bending in the elastic range. Deformations in a transverse cross section.
- Transverse loading (2 hours)
  Transverse loading of prismatic members. Basic assumption regarding the distribution of normal stresses. Determination of the shear in a horizontal plane. Determination of the shearing stresses in beams.
- Stress and failure analysis (4 hours)
  Transformation of plane stress. Principle stresses. Maximum shearing stress. Mohr’s circle for plane stress, yield criteria. (von Mises, Tresca).
- Introduction to structural design (1 hour)

Reading List

Compulsory Readings

	Title
1	Engineering Mechanics 2 Mechanics of Materials, Dietmar Gross, Werner Hauger, Jörg Schröder, Wolfgang A. Wall, Javier Bonet, Springer 2011 (online access from SpringerLink).

Additional Readings

	Title
1	David H. Allen, “Introduction to the Mechanics of deformable solids : bars and beam”, Springer 2013 (online access from SpringerLink).