MNE6141: DEFORMATION AND FRACTURE OF MATERIALS AND STRUCTURES

Effective Term
Semester A 2026/27

Part I Course Overview

Course Title
Deformation and Fracture of Materials and Structures

Subject Code
MNE - Mechanical Engineering
Course Number
6141

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
MNE8126 Deformation & Fracture of Materials and Structures

Exclusive Courses
Nil

Part II Course Details

Abstract

This course aims to provide postgraduate students with an in-depth understanding of the deformation and fracture behaviours of materials and structures under complex loading. The content covers mechanical principles from the atomic to the macroscopic scale, including fundamental and advanced concepts in elasticity theory, plasticity theory, and fracture mechanics. Students will learn about material yield criteria, hardening models, mechanisms of crack initiation and propagation, as well as time-dependent failure behaviours' such as fatigue and creep. The course will also introduce experimental/computational methods applied to deformation and fracture analysis, cultivating students' ability to use interdisciplinary knowledge to solve critical engineering problems in fields such as advanced manufacturing, aerospace, and microelectronics.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Acquire essential concepts and interdisciplinary knowledge regarding the deformation (elasticity, plasticity) and fracture (fracture mechanics) of materials and structures.		x	x	
2	Apply specialized knowledge of material deformation and fracture to solve engineering problems critical to the future growth of industry and business.		x	x	
3	Work effectively with people possessing diverse educational and experiential backgrounds in mechanical-related disciplines.			x	
4	Apply interdisciplinary teamwork to develop abilities to meet the increasingly competitive and dynamically changing global market.			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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture/ Group Project	Systematic lectures on core theories, models, and engineering application cases of material deformation and fracture. Students, in groups, conduct research, analysis, and design solutions for a practical engineering failure case or a cutting-edge research problem, culminating in a report and oral presentation.	1, 2, 3	2 hours/week
2	Seminar/Tutorial	Thematic seminars and tutorial sessions focusing on complex engineering problems, emphasizing knowledge application and problem-solving.	1, 2	1 hour/week

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Group projects (report & presentation)	1, 2, 3, 4	30	-	Yes
2	Mid-term exam Assignments	1, 2, 3, 4	20	-	No

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

3

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

Assessment Rubrics (AR)

Assessment Task
Examination

Criterion
Ability to comprehensively apply course principles to analyze and solve complex 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
Mid-term Examination & Assignments

Criterion
Level of mastery and understanding of core concepts, principles, and fundamental models of deformation and fracture.

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
Group Project

Criterion
Teamwork efficiency, depth and innovation of problem analysis, feasibility of solutions, clarity and professionalism of report and presentation.

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

Stress and strain analysis; Generalized Hooke's Law; Yield criteria (Tresca, von Mises); Plastic flow rules; Work hardening.

Linear Elastic Fracture Mechanics (Stress Intensity Factor, Energy Release Rate); Elastic-Plastic Fracture Mechanics (J-Integral); Fatigue crack initiation and propagation (S-N curve, Paris' law); Creep deformation and fracture.

Deformation and failure of composite and multiphase materials; Interface mechanics.

Fundamentals of computational solid mechanics; Application of the Finite Element Method in deformation and fracture analysis. Experimental methods for fracture toughness measurements (e.g., compact tension experiments, single edge notched bend bar tests)

Reading List

Compulsory Readings

	Title
1	David Roylance, Mechanics of Materials, John Wiley & Sons. (Provides foundational core concepts)
2	T. L. Anderson, Fracture Mechanics: Fundamentals and Applications, 4th Ed., CRC Press

Additional Readings

	Title
1	Marc André Meyers and Krishan Kumar Chawla, Mechanical Behavior of Materials, Cambridge University Press.
2	S. Suresh, Fatigue of Materials, Cambridge University Press.
3	R. W. Hertzberg, R. P. Vinci, and J. L. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, Wiley.
4	Relevant international journal papers (e.g., International Journal of Fracture, Engineering Fracture Mechanics, Journal of the Mechanics and Physics of Solids).