DEFORMATION AND VIBRATION OF STRUCTURES - 2024/5

Module code: ENG2135

Module Overview

This module is an essential component of the mechanical engineering science program as it directly relates to several core areas of study. By understanding the behavior of structures under static and dynamics loads, students will be better equipped to tackle various engineering challenges, such as designing robust structures, vehicles, and machinery that can endure the deformations and vibrations they may encounter during their operational lifespan. The module builds upon the knowledge gained in earlier engineering courses, including solid mechanics, materials and statics, mathematics, and physics and it serves as a foundation for subsequent specialised modules. By exploring the fundamental concepts and practical applications of deformation and vibration analysis, students will develop a strong foundation for their future engineering studies and professional careers.

Module provider

Mechanical Engineering Sciences

Module Leader

MOHAGHEGHIAN Iman (Mech Eng Sci)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 5

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 63

Lecture Hours: 32

Tutorial Hours: 11

Laboratory Hours: 1

Guided Learning: 11

Captured Content: 32

Module Availability

Semester 1

Prerequisites / Co-requisites

N/A

Module content

Indicative content includes:

1. Deformation of structures

Strain energy methods in linear elastic systems

The concept of strain energy: axial loading and bending.

The method of calculating deflections for beams and trusses.

Plastic bending deformation of beams, shape factor, limit load.

Concept of instability and buckling of slender columns.

2. Vibration of structures

2.1 Vibration of systems with a single degree of freedom.

Undamped free vibration

Equation of motion using Energy method

Time response Systems with rotational DOF

Viscous damped free vibration

Overdamped system

Critically damped system

Underdamped system

2.2 Forced vibration of a Single Degree of Freedom System

Undamped forced vibration-Harmonic force

Viscous damped force vibration-Harmonic force

General forced response

Response to an impulse

Response to a general forcing condition

Vibration isolation

Assessment pattern

Assessment type	Unit of assessment	Weighting
Online Scheduled Summative Class Test	ONLINE MCQ TEST - 1 OF 2 (90 minutes)	5

Assessment type	Unit of assessment	Weighting
Attendance only	Lab1	Pass/Fail
Online Scheduled Summative Class Test	ONLINE MCQ TEST - 2 OF 2 (90 minutes)	5
Attendance only	Lab2	Pass/Fail
Examination	Final Exam (2 hours)	90

Alternative Assessment

For labs, if not attended they need to write a lab report based on set of existing data.

Assessment Strategy

The assessment strategy is designed to provide students with the opportunity to demonstrate their abilities (i) to apply the principles of mechanics to cases of axial load and bending and to calculate forces and displacements in statically determinate beams and/or trusses, (ii) to apply the principles of simple dynamic systems to the solution of vibration/oscillatory problems

Formative assessment and feedback

Formative assessment and feedback is provided via the weekly supported tutorial work and through self-assessment exercises provided via SurreyLearn. The students complete a set of worked solutions to a range of questions in the tutorial classes and are provided with tutor support in comment and feedback in the sessions.

Summative assessment

The summative assessment consists of 2 online tests covering the Mechanics content, 2 lab demonstrations covering the Mechanics content and a final examination covering the Mechanics and Dynamics content.

Class test 1 - Learning outcome 1

Lab 1 - Learning outcome 1

Class test 2 - Learning outcomes 2 & 3

Lab 2 - Learning outcomes 2 & 3

Exam - Learning outcomes 1-6

Module aims

- To introduce the students to the deformability of structures and the principles of the elastic analysis of statically determinate structural forms.
- To gain knowledge of how structures can fail with introduction of plastic analysis of beams and buckling analysis of slender structures.
- To develop an understanding of the dynamic response of un-damped and damped single degree of freedom systems under free and forced vibration.

Learning outcomes

		Attributes Developed
001	Determine and interpret the internal loads and resulting displacements in simple statically determinate structures subjected to axial or moment loads	C
002	Calculate elastic and plastic section properties for typical plane beam sections	C
003	Predict the elastic buckling loads and modes of failure for linearly elastic slender struts	C
004	Determine the natural frequency and dynamic response of systems with a single degree of freedom	C
005	Determine the forced response of systems with a single degree of freedom	C
006	Analyse vibration isolators for vibrating mechanical systems	K

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to:

Introduce solid mechanics principles in the areas of stress analysis and dynamics through theory with worked examples. This is delivered principally through lectures and tutorial classes.

The learning and teaching methods include:

- Mechanics lectures and tutorials
- Dynamics lectures and tutorials

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: ENG2135

Other information

The School of Mechanical Engineering Sciences is committed to developing graduates with strengths in Employability, Digital Capabilities, Global and Cultural Capabilities, Sustainability and Resourcefulness and Resilience. This module is designed to allow students to develop knowledge, skills and capabilities in the following areas;

Employability: Learning fundamentals of deformation and vibration of structures is crucial in the design and analysis of structures, machinery, and mechanical systems. Employers often require professionals who can do back of the envelope calculation and accurately predict the behaviour of materials under different loads, ensure structural integrity, and optimise designs. Proficiency in solid mechanics allows you to make informed decisions during the design, testing, and production processes, making you an asset to employers.

Sustainability: Understanding the fundamentals of deformation and vibration of structures allows engineers to design sustainable structures that optimise material usage, enhance energy efficiency, improve durability and resilience, ensure performance and safety, and contribute to sustainable infrastructure development.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Aerospace Engineering BEng (Hons)	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Aerospace Engineering MEng	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Automotive Engineering BEng (Hons)	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Automotive Engineering MEng	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Biomedical Engineering BEng (Hons)	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Biomedical Engineering MEng	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Mechanical Engineering BEng (Hons)	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module
Mechanical Engineering MEng	1	Compulsory	A weighted aggregate mark of 40% is required to pass the module