ES386-15 Dynamics of Vibrating Systems

26/27

Department
School of Engineering
Level
Undergraduate Level 3
Module leader
Oksana Trushkevych
Credit value
15
Module duration
10 weeks
Assessment
30% coursework, 70% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

ES386-15 Dynamics of Vibrating Systems

Module web page

Module aims

Vibrations exert a significant influence on the performance of the majority of engineering systems. All engineers should understand the basic concepts and all mechanical engineers should be familiar with the analytical techniques for the modelling and quantitative prediction of behaviour. Thus, this module provides students with fundamental skills necessary for the analysis of the dynamics of mechanical systems, as well as providing opportunities to apply these skills to the modelling and analysis of vibration.
This third-year module is mandatory for students pursuing a degree in Mechanical Engineering, building upon competences acquired earlier in the course. This module introduces students to the use of Lagrange's equations (applied to 1D and 2D systems only for this module) and to techniques for modelling both lumped and continuous vibrating systems. It includes some coverage of approximate methods both as an aid to physical understanding of the principles and

because of their continuing usefulness. The module assumes basic understanding of mechanics and linear algebra consistent with the level of Year 2 modules.
At the end of the module students should have a sound understanding of the wide application of vibration theory and of the underlying physical principles. In particular, they should be able to use either Newtonian or Lagrangian mechanics to analyse 2D systems, and to determine the response of simple damped and undamped multi-degrees of freedom (DOF) systems to both periodic and aperiodic excitation. They should also be familiar with engineering solutions for measuring and influencing vibrational behaviour.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- Generalised co-ordinates, Lagrange's equation (including preliminary study of other classical methods)
- General application of the Lagrange equation to vibrating systems
- Multi-degree of freedom systems: lumped system models, continuous system models; geared and branched systems; reduction of an n-DOF system to a set of n single-DOF systems; principal co-ordinates
- Matrix methods of analysis: conservative and non-conservative (damped) systems; determination of principal co-ordinates
- Modelling of damping: hysteretic, Coulomb, viscous; measurement of damping factor
- Forced vibration: harmonic excitation of multi-DOF systems; shaft whirling; transmissibility; vibration isolation; non-harmonic and arbitrary excitation (convolution integral)
- Approximate methods e.g. Rayleigh's method, Dunkerley's method

Learning outcomes

By the end of the module, students should be able to:

- 1. Model planar mechanical systems using Newton’s and Lagrange’s equations: Determine appropriate co-ordinate systems, analyse vibrations.
- 2. Abstract more complex engineering mechanisms: analyse using lumped system models or simple distributed mass and stiffness models. Use and justify standard methods and approximations for extended and continuous vibrating systems.
- 3. Evaluate the natural frequencies and modes of vibration of a multi-degree of freedom linear system.
- 4. Determine and analyse the free and forced response of single-degree of freedom systems to periodic and aperiodic excitation, as well as the effects of linear and non-linear damping on the system behaviour.
- 5. Evaluate complex (multi-degree of freedom) undamped or damped systems numerically, using a systematic approach to analyse the natural frequencies and modes, and the response of the system to periodic and aperiodic excitations.
- 6. Demonstrate a sound understanding of the application of vibration analysis to key engineering systems.

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

Subject specific skills

SSS4: Ability to apply relevant practical and laboratory skills.

SSS8: Ability to be pragmatic, taking a systematic approach and the logical and practical steps necessary for, often complex, concepts to become reality.

Transferable skills

TS1: Numeracy: apply mathematical and computational methods to communicate parameters, model and optimize solutions.

TS2: Apply problem solving skills, information retrieval, and the effective use of general IT facilities.

TS3: Communicate (written and oral; to technical and non-technical audiences) and work with others.

TS7: Overcome difficulties by employing skills, knowledge and understanding in a flexible manner.

Study

Study time

Type	Required	Optional
Lectures	21 sessions of 1 hour (14%)	
Seminars	2 sessions of 1 hour (1%)	
Practical classes	1 session of 2 hours (1%)	
Online learning (independent)	5 sessions of 1 hour (3%)	5 sessions of
Private study	120 hours (80%)	
Total	150 hours	

Private study description

Guided independent learning, worksheets, assignment preparation, quizzes, lab preparation, exam preparation etc 120 hours.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

Assessment group D7

	Weighting	Study time	Eligible for self-certification
Assessment component			
Vibration computational and analysis assignment	30%		Yes (extension)
Matlab code submitted on Matlab Grader (30% of assignment credit) and a brief computational report (500 words excluding references or captions, 70% of assignment credit)			
Reassessment component is the same			
Assessment component			
Centrally-timetabled examination (On-campus)	70%		No
Written examination on campus			

- Answerbook Pink (12 page)
- Students may use a calculator
- Engineering Data Book 8th Edition

Reassessment component is the same

Feedback on assessment

- Feedback during laboratory sessions
- Feedback on assignments.
- Model solutions to exam type questions.
- Support through advice and feedback hours.
- Cohort level feedback on examinations

Past exam papers for ES386

Availability

Pre-requisites

To take this module, you must have passed:

- All of
  - ES2C5-15 Dynamics and Fluid Mechanics
  - ES2C7-15 Engineering Mathematics and Data Analytics

Courses

This module is Core for:

- Year 3 of UESA-H315 BEng Mechanical Engineering
- Year 4 of UESA-H314 BEng Mechanical Engineering with Intercalated Year
- Year 3 of UESA-HH35 BEng Systems Engineering
- Year 4 of UESA-HH34 BEng Systems Engineering with Intercalated Year
- UESA-H316 MEng Mechanical Engineering
  - Year 3 of H315 Mechanical Engineering BEng
  - Year 3 of H316 Mechanical Engineering MEng
- UESA-HH31 MEng Systems Engineering
  - Year 3 of HH31 Systems Engineering
  - Year 3 of HH35 Systems Engineering

This module is Core optional for:

- Year 4 of UESA-H317 MEng Mechanical Engineering with Intercalated Year
- Year 4 of UESA-HH32 MEng Systems Engineering with Intercalated Year

This module is Optional for:

- Year 3 of UESA-H113 BEng Engineering
- Year 4 of UESA-H111 BEng Engineering with Intercalated Year
- UESA-H112 BSc Engineering
  - Year 3 of H112 Engineering
  - Year 3 of H112 Engineering

- Year 3 of UESA-H114 MEng Engineering
- Year 4 of UESA-H115 MEng Engineering with Intercalated Year