Module Code	MEP55B14
Module Name	Engineering Vibrations & Noise
ECTS Weighting	5 ECTS
Semester taught	Semester 2
Module Coordinator/s	Dr. John Kennedy (john.kennedy@tcd.ie)
Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline	On successful completion of this module, students should be able to: **L01.** Derive and apply the governing equations of motion for single and multi-degree of freedom systems and continuous structures, and apply wave propagation principles to acoustic fields, demonstrating understanding of the assumptions and range of validity of each. **L02.** Formulate and solve forced and free vibration problems for single and multi-degree of freedom systems using modal analysis methods, selecting appropriate analytical and numerical techniques and justifying their application. **L03.** Model and analyse continuous systems undergoing longitudinal, torsional and transverse vibration, applying mathematical methods to predict natural frequencies, mode shapes and dynamic response. **L04.** Design vibration isolation systems and noise control solutions including sound absorption and insulation measures to meet specified engineering performance requirements, referencing relevant codes of practice and industry standards. **L05.** Plan and execute noise and vibration measurements using industry-standard hardware and signal processing techniques, critically analyse and interpret the results, and evaluate their agreement with predictions from analytical and numerical models. **L06.** Apply an industry-standard numerical or computational tool, either finite element analysis or noise mapping software, to predict the vibration or noise characteristics of a real engineering system, assess the validity of the predictions against measured or reference data, and critically evaluate sources of discrepancy. **L07.** Evaluate the effects of noise and vibration on human health, safety and the built environment; apply relevant regulatory frameworks and industry metrics to assess workplace and community exposure; and critically appraise engineering solutions in terms of their societal and environmental impact. **L08.** Produce a formal technical report documenting the experimental, analytical and numerical investigation of a real engineering noise and vibration problem, communicating methodology, results, critical evaluation and conclusions to a professional engineering standard.

Graduate Attributes: levels of attainment

To act responsibly - Enhanced

To think independently - Enhanced

To develop continuously - Enhanced

To communicate effectively - Enhanced

Module Content

Engineering systems often experience problems associated with unwanted vibration or noise which may lead to failure of physical components or complaints from communities exposed to these systems. This module will provide the student with a fundamental understanding of the problem of noise and vibration control as well as the experimental and numerical tools necessary to model and analyse these problems in engineering systems. The module will introduce the industry standard approaches to noise and vibration control which require analysis during the design phase as well as during the use of these systems.

- **Vibration measurement and isolation:**
  Forced vibration of single degree-of-freedom systems
  Vibration measurement
  Vibration isolation
- **Multi degree of freedom systems:**
  Free and forced vibration of multi-degree of freedom systems
  Vibration absorbers
- **Modal analysis:**
  Stiffness and flexibility matrices
  Mode shapes and natural frequencies
  Modal analysis
- **Continuous Systems:**
  Longitudinal, torsional and transverse vibration
  Applications of continuous vibrating systems
- **Acoustics and Noise Control:**
  Sound propagation, and frequency-weighted noise metrics (e.g. dB(A), dB(C), octave band analysis)
  Sound absorption and insulation - mechanisms, Sabine/Eyring equations, transmission loss and the mass law
  Room acoustics, reverberation time, noise level prediction and passive/active control measures
- **Noise and Vibration Measurement and Control:**
  Measurement hardware and calibration
  FFT analysis, power spectral density, octave band analysis and coherence
  Measurement of modal content
  Noise metrics

Passive/Active control measures

- **Numerical Methods:**
  Vibrating rod and beam finite elements
  Commercial FEM software
- **Noise and Vibration Assessment**
  The effects of noise and vibration on people and buildings
  Estimation of vibration exposure
  Estimation of noise exposure
  Noise and vibration legislation and standards: EU Directive 2002/44/EC, ISO measurement standards, community noise assessment

Teaching and Learning Methods

This module runs for the 12 weeks of semester two (except during study/assignment week) and comprises three lectures per week plus one one-hour tutorial per week.

This module lecture programme is supplemented by a detailed practical experiment which makes use of the latest noise and vibration measurement methods. The experimental work is augmented by modelling using commercial and custom noise and vibration analysis software. Students will prepare a formal report on the experimental and numerical analysis of real engineering problems.

The module makes use of a blended learning environment, including online discussion forums, to aid the weekly design based tutorials. These tutorials focus on common problems facing noise and vibration control engineers.

Assessment Details
Please include the following:

- **Assessment Component**
- **Assessment description**
- **Learning Outcome(s) addressed**
- **% of total**
- **Assessment due date**

Assessment Component	Assessment Description	LO Addressed	% of total	Week due
Written examination	End of semester examination	L01-L07	75%	
Assignment	Experimental & numerical analysis of an engineering system	L05-L08	25%	10

Reassessment Requirements

Written Examination

Contact Hours and Indicative Student Workload

Contact hours: 47
Lectures 33

	Tutorials 11 **Lab 3**
	Independent Study (preparation for course and review of materials): 30
	Independent Study (preparation for assessment, incl. completion of assessment): 44
Recommended Reading List	**Recommended Text** • Engineering Vibration, DJ Inman, Prentice Hall • Engineering Noise Control, David A. Bies, Colin Hansen, Carl Howard, Routledge **Other Relevant Texts** • Mechanical Vibrations, SS Rao, Pearson/Prentice-Hall • Theory of Vibration with Applications, WT Thomson, Chapman & Hall
Module Pre-requisite	NA
Module Co-requisite	NA
Module Website	NA
Are other Schools/Departments involved in the delivery of this module? If yes, please provide details.	No
Module Approval Date	
Approved by	
Academic Start Year	
Academic Year of Date	