ME5B04  Engineering Vibration and Noise

Lecturer:  Assist. Prof. John Kennedy (kennedj@tcd.ie)
Semester:  2
Credits:  5 ECTS

Module Description
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 vibration as well as the experimental and numerical tools necessary to model and analyse vibration 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.

Module Organisation:
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. There is also a detailed laboratory session and associated assignment which must be formally written up. Total contact time is 50 hours.

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<tr>
<th>Semester</th>
<th>Start Week</th>
<th>End Week</th>
<th>Associated Practical Hours</th>
<th>Lectures Per week</th>
<th>Total</th>
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<td>1</td>
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<td>12</td>
<td>6</td>
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<td>33</td>
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Total Contact Hours: 50

Learning Outcomes
On completion of this module, the student will be able to:
1. understand the principles of vibration isolation and assess designs for solutions of one of the most common problems faced by noise and vibration engineers in practice;
2. analyse and recognize multi-degree of freedom systems and apply modal methods to their solution;
3. model and analyse continuous systems;
4. understand the problems associated with the analysis of non-linear vibrating systems;
5. assess vibration exposure in the workplace;
6. apply industry standard metrics for noise and vibration monitoring;
7. predict vibration properties of systems using finite elements;
8. perform noise and vibration measurements and compare the results with those obtained by the analytical and numerical methods developed in the course.

Module Content
- **Vibration measurement and isolation:**
  - Forced vibration of single degree-of-freedom systems
  - Vibration measurement
  - Vibration isolation and vibration absorbers
- **Multi degree of freedom systems:**
  - Free and forced vibration of multi-degree of freedom systems
• **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

• **Non-linear Vibration**
  - Analysis of non-linear vibrating systems

• **Noise and Vibration Measurement and Control:**
  - Measurement hardware and calibration
  - Signal processing for noise and random vibration analysis
  - Measurement of modal content
  - Noise metrics
  - Passive/Active control measures

• **Numerical Methods:**
  - Vibrating rod and beam finite elements
  - Commercial FEM software

• **Vibration Assessment**
  - The effects of vibration on people and buildings
  - Estimation of vibration exposure

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**Teaching strategy**

This module lecture programme is supplemented by a detailed laboratory experiment which makes use of the latest vibration measurement tools including 3D laser scanning vibrometry. The laboratory work is augmented by finite element modelling of the measured system using commercial and custom vibration analysis software. Students will prepare a formal report on the experimental and numerical analysis of the vibrating system.

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

**Recommended Text**

- Engineering Vibration, DJ Inman, Prentice Hall

**Other Relevant Texts**

- Mechanical Vibrations, SS Rao, Pearson/Prentice-Hall
- Theory of Vibration with Applications, WT Thomson, Chapman & Hall

**Assessment**

This module is assessed by a formal written examination (75% of final mark) together with continuous assessment (25%) consisting of a laboratory experiment and work assignments.