Module Title **Engineering Analysis 3** **Keywords** Vibration of Discrete and Continuous Systems, Normal Mode Analysis, Vibration Instrumentation, Modal Testing, Frequency Response Functions, Finite Element Analysis, Shape Functions, Beam and Plate Elements, Structural Non-linearity	Reference EN5500 SCQF SCQF Level 11 SCQF Points 15 ECTS Points 7.5 Created December 2003 Approved March 2004 Amended August 2011 Version No. 2

This Version is No Longer Current

The latest version of this module is available here

Prerequisites for Module

Engineering Analysis 2 (EN4500)

Corequisite Modules

None.

Precluded Modules

None.

Aims of Module

To enable the student to understand, analyse and interpret the static and dynamic behaviour of engineering systems using advanced analysis and testing techniques.

Indicative Student Workload

Contact Hours	Full Time	Part Time
Lectures	20	20
Supervised Laboratory	6	6
Tutorial	9	9
Directed Study		
Coursework preparation	45	45
Directed self-study	30	30
Private Study		
Private study	40	40

Learning Outcomes for Module

On completion of this module, students are expected to be able to:

1. Discuss FE principles used for dynamic analysis, analyse simple beam element model and compare with exact solution.
2. Use FE package to model dynamic behaviour of plate or beam structure and compare with experimental measurements.
3. Explain experimental modal analysis and evaluate dynamic behaviour of structures from measured data.
4. Relate and discuss shape functions and element formulations for higher order elements such as beams and plates.
5. Use FE package to model selected structural non-linearities.

Indicative Module Content

Multi-degree-of-freedom lumped parameter and continuous systems: Lagrangian dynamics. Matrix representation. Normal mode analysis. Principle coordinates. Orthogonality. Dealing with damping. Dynamic analysis using FEM: Elemental mass and stiffness matrices. Assembly of global matrices. Eigenvalue extraction. Practical limitations.

Mode of Delivery

Lectures and tutorials will be utilised to introduce the principal study topics, after which supervised laboratory and student centred case studies will be used to achieve the learning outcomes.

Assessment Plan

	Learning Outcomes Assessed
Component 1	1,2,3
Component 2	4,5

Component 2 is coursework covering the statics part of the module (50% weighting).

Component 1 is coursework covering the dynamics part of the module (50% weighting).

Indicative Bibliography

1. CORREA, J., JUAN, C. A., LOZANO GUZMAN, A. A., 2020. Mechanical vibrations and condition monitoring, London : Academic Press, ISBN : 9780128203903
2. SZEIDL, G., KISS, L. P., 2020. Mechanical Vibrations, an introduction. SPRINGER NATURE, ISBN : 9783030450748

Experimental modal analysis: Vibration measurement. Signal processing requirements. Excitation techniques. Frequency response function. Modal extraction techniques. Complex modes. Simplifying assumptions. FEM verification. Beam and Plate Elements: Shape Functions. Higher Order Element Formulations. Assembly and Solution of Matrix Equations. Structural Non-linearity using FEM: Inelastic materials. Contact Analysis. Newton-Raphson Method.

3. RAO, SINGIRESU S. 2018. Mechanical vibrations in SI units, 6th Edition, Harlow: Pearson, ISBN : 9781292178615
4. HAN, Q., WEI, J., HAN, Q., ZHANG, H., 2016. Dynamics and Vibration Analyses of Gearbox in Wind Turbine. Singapore : Springer Singapore, ISBN : 9789811027475
5. ZHUMING, B., 2019. Finite Element Analysis Applications: A Systematic and Practical, Academic Press, ISBN 978-0-12-809952-0