Unit Title	Dynamics and System Modelling
Level	6
Reference No. ***(showing level)***	MED_6_DSM
Credit Value	15 CAT points (1 unit = 15 points)
Student Study Hours	Contact hours: 52 Student-managed learning hours: 98
Pre-requisite learning	Dynamics Advanced Engineering Mathematics and Modelling
Co-requisites	None
Excluded combinations	None
Unit co-ordinator	TBC
Faculty/Department	ESBE / Engineering and Design
Short Description	This unit introduces the student to advanced dynamical systems theory. This involves mathematical modelling of engineering systems using both Newtonian and Lagrangian approaches. The unit includes investigative work into mechanical systems using computer software and laboratory experiments.
Aims	This unit's aims are as follows - to equip the student with the knowledge, understanding and analytical skills which are required to investigate mechanical vibrations, dynamical systems and the performance of related real-world engineering systems. - to enable the student to identify, classify and describe the performance of dynamical systems through the use of analytical methods and modelling techniques. - to enhance the student's depth of understanding of solid mechanics.
Learning Outcomes	**Knowledge and Understanding** The student should attain the ability to: 1. construct mathematical models of various dynamical systems of one and two degrees of freedom and solve the resulting (differential) equations; 2. use both Newtonian and Lagrangian approaches to study a dynamical system; 3. use a computer to model a dynamical and/or structural system and investigate the system's qualitative behaviour (e.g., the phase plane); 4. apply the principles of mechanics to a rigid body having three dimensional motion (e.g., a gyroscope); 5. appreciate the significance of the difference between linear and nonlinear models of physical systems; 6. demonstrate an enhanced understanding of the principles of solid mechanics and the ability to apply them to physical systems (this may involve investigative work in a laboratory). **Transferable Skills** - developed skills in relating mathematics to physical real world systems; - an enhanced knowledge of the application of mathematical and computer-based methodology for the purposes of modelling and analysing engineering problems; - ability to use analytical methods to identify, classify and then describe the performance of an engineering system; - ability to integrate knowledge and understanding of mechanical engineering with related engineering disciplines and to apply this to the study of a system's behaviour.
Teaching and learning pattern	The unit objectives will be accomplished by a series of lectures together with some laboratory work and the use of computer simulation software. The unit is supported by a comprehensive set of tutorial sheets.
Indicative content	*Theory lectures:* - Introduction to dynamical systems. Distinction between linear and nonlinear systems. Vibration analysis procedure; use of free body diagrams and Newton's

	and Euler's laws to develop mathematical models of vibration. Initial value problems and boundary value problems. Solution techniques for ordinary differential equations and introduction to partial differential equations. Interpretation of results. - Free, damped and forced vibrations. Resonance. - Systems with two degrees of freedom. - Introduction to Lagrangian dynamics. - Vibrations of rigid bodies and structures - Introduction to gyroscopic motion. *Practical computer/laboratory work:* This aspect of the unit encompasses the following: - An investigation of a physical system in the laboratory. - The use of computer software (e.g., MATLAB) to model and study a variety of systems including nonlinear systems. - The finite element method. - Introduction to vibration measurement.
Assessment ***Elements & weightings***	3 hour end of unit exam, closed book - 60% - Assignments: case studies. 40% Note that the case studies may involve open ended problems and may extend to vibration and mathematical modelling problems as they arise in other disciplines related to mechanical engineering. In this type of case study the student will be required to integrate his/her knowledge and understanding of mechanical engineering with the other engineering discipline.
Indicative Sources ***(Reading lists)***	Core Texts: (all in SI units) - Meriam J.L., and Kraige. L.G., *Engineering Mechanics: Dynamics* 6th Ed, Wiley 2007. - Hibbeler R.C., *Engineering Mechanics: Dynamics* 6th Ed, Pearson, 2007 - Rao S.S., *Mechanical Vibrations* Pearson 2005. - Magrab et al., *An Engineer's Guide to Matlab* 2nd Ed, Pearson, 2005. Relevant laboratory sheets will also be available to the student.