MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

16361 (ME305/16318) DYNAMICS AND CONTROL

Module Registrar: Dr Christie Maddock christie.maddock@strath.ac.uk	**Taught To (Course): Cohorts for whom class is compulsory or optional**	
Other Lecturers Involved: Daniel Johnston	**Credit Weighting: 20 (ECTS 10)**	**Semester: 1 and 2**
Compulsory and optional class	**Academic Level: 3**	**Suitable for Exchange: Y**

Alternative codes and credit values for those taking only one semester:
Semester 1: ME305 Dynamics 3 [10 Credits / ECTS 5]
Semester 2: 16318 Measurement, Instrumentation and Control [10 Credits / ECTS 5]

Required prerequisites

Note: It is the responsibility of students to ensure that they satisfy the prerequisite knowledge for this module. If unsure, please contact the Module Registrar or discuss with your Programme/Year Adviser of Studies.

16232 Engineering Mechanics
MM117 Mathematics 1M (or equivalent)
ME108 Engineering Analysis and Numerical Methods
ME209 Mathematical Modelling and Analysis (or equivalent)

Mathematical methods:
Calculus, linear algebra, vectors & matrices.

Numerical methods:
Solution of linear and nonlinear equations; differentiation and integration; ordinary and partial differential equations

Mechanics:
Classical mechanics including principles of work, energy, momentum, inertia
General plane motion of rigid bodies, kinematics and kinetics of particles
Coordinate transforms and frames of reference
Simple harmonic motion

Programming skills (suggested):
Knowledge of basic programming principles:
- manipulation of scalar, vectors and matrices variables;
- use of operators, expressions and statements (including conditional statements);
- structured programming logic and flow diagrams; loops; functions and scripts; data flow (inputs, outputs)

The supported programming development environment is Matlab/Simulink, however it is possible to use other programming environments and languages (e.g., Python).

Module Format and Delivery (HOURS i.e. 1 credit = 10hrs of study):

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
32	31		20				40	77	200

Educational Aim

This module aims to:

The Semester 1 dynamics course will:
1) Introduce the basics of modelling the vibrations of mechanical systems.
2) Consider the fundamental theory of free and forced vibrations of damped and un-damped systems.
3) Introduce the general principles of modes of vibration.

4) Study transformations from physical to modal space.
5) Consider fundamentals of some energy methods.

The Semester 2 control course focuses on modelling the dynamics and analysing the performance of controlled systems, and will:

1) Introduce control theory and its application to engineering systems.
2) Study methods to develop mathematical models for the dynamics and control of engineering systems.
3) Introduce control system analysis techniques in order to predict the system performance to given inputs.
4) Show the link between analytical methods and models, and computer models, and explain how to run simulations and analyse the performance of modelled systems.

Learning Outcomes

On completion of the 1st semester, the student is expected to:

LO1 Be able to model and analyse one degree of freedom mass-spring-damper systems.

LO2 Be capable of applying the theory of classically damped vibrating systems to problems of one and two degrees of freedom.

LO3 Be able to apply and understand the energy methods and principles to predict and analyse the vibration of simple mechanical systems.

LO4 Be able to understand and apply the principles of modes of vibration as well as transformation from physical to modal space.

On completion of the 2nd semester, the student is expected to be able to:

LO1 Determine a mathematical model of the dynamics and control of an engineering system in the time and frequency domains.

LO2 Determine the system response based on the system model and input.

LO3 Analyse the performance of a system.

LO4 Appreciate fundamental issues of stability and apply theory correctly to assess closed-loop system stability.

Syllabus

The module will teach the following:

Dynamics (Semester 1):

- Mathematical modelling of dynamic system, and system response
- Free undamped vibration of one degree of freedom systems
- Free vibrations with viscous friction
- Forced and transmitted vibrations
- Applications for single degree of freedom vibration theory
- Concepts of analysis for two-degree of freedom vibration and modes of vibration
- Transformations from physical to modal space
- Application of some energy methods

Control (Semester 2):

- Mathematical modelling (Laplace Transforms, transfer functions, block diagrams, s-plane analysis, general solution for feedback systems)
- Feedback control system characterisation and performance (errors in closed-loop systems, sensitivity of controllers)
- Performance of feedback control systems (test input signals, second order systems
- Stability analysis

Assessment of Learning Outcomes

For each of the Module Learning Outcomes the following criteria will be used to make judgements on student learning:

Semester 1

For each of the Learning Outcomes the following learning criteria will apply such that students should be able to:

LO1

C1 Model mathematically the dynamics of simple single degree of freedom systems

LO2

C2 Derive models for simple 1 DOF vibrating systems.
C3 Derive models for 2 DOF vibrating systems.
C4 Analyse the dynamic motion of simple vibrating systems.

C5 Understand the principles and the main mechanisms of free damped and un-damped vibration
C6 Understand the principles and the main mechanisms of forced vibratory motion and be able to analyse it in terms of dynamic characteristics of appropriate vibrating systems.

LO3
C7 Be able to apply some energy methods to the analysis of practical applications of vibrating structures.

LO4
C8 Be able to apply the principles of modes of vibration for analysis of dynamic systems.
C9 Be able to perform transformation from physical to modal space in some practical applications.

Semester 2
For each of the Learning Outcomes the following learning criteria will apply such that students should be able to:

LO5
C1 Find a set of linearised differential equations to model the dynamics of appropriate systems.
C2 Represent the mathematical model as a block diagram.
C3 Use differential equations and block diagrams to determine system transfer functions.

LO6
C4 Solve analytically for the output response in the frequency domain of a system based on a specific input function and a mathematical model.
C5 Determine the output response of a system in both the time and frequency domains using numerical techniques given a computer model and a specific input.

LO7
C6 Determine the poles and zeros of a system.
C7 Determine the tracking error and the steady-state error of a system.
C8 Design models for dynamic and control responses
C9 Design a specific control system and assess its performance.

LO8
C10 Assess the characteristics of a system response and its stability by constructing and evaluating a Routh-Hurwitz array.
C11 Assess the response of a system on the threshold of stability.

The standards set for each criterion per Module Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessment.

Principles of Assessment and Feedback
(within Assessment and Feedback Policy at: https://www.strath.ac.uk/professionalservices/staff/policies/academic)

Assessment in Semester 1 is through a final exam to assess theory and analytical problem solving.

Assessment in Semester 2 is performed as a project based on group work on an applied design problem during and outwith the tutorials, and assessed through an oral presentation. This will assess the application and implementation of concepts and methods learned. A final exam is used to assess theory and analytical problem solving.

Feedback is given in different forms:
- Self-directed feedback and self-assessment through worked examples and tutorial question sets with answers/solutions
- Peer assessment in group work during tutorials
- Informal feedback will be provided through an online forum, through peers and lecturers

Tutorials are the primary mechanism for providing regular feedback through discussions and Q&A with lecturers, tutors, and other students, and through self- and peer-assessment of the exercises.

Assessment Method(s) Including Percentage Breakdown and Duration of Exams *(individual weightings)*

Examination				Coursework		Online Assessment		Project	
Number	Month(s)	Duration	***Weighting*****	Number	***Weighting***	Number	***Weighting***	Number	***Weighting***
1	Dec	1.5 hrs	40%			1	10%		
1	Apr/May	1.5 hrs	35%					1	15%
*LO1-8								*LO5-8	

** LOs: Indicate which Learning Outcomes (L01, L02, etc) are to be assessed by exam/coursework/practical/project as required.*

NOTE: For ME305 or 16318 registered students, marks from relevant assessments (weighted at 50%) will be scaled to 100%

Coursework / Submission deadlines (*academic weeks*): For Semester 1, an online test will be undertaken in Week 5. For Semester 2, a group project will be submitted in Week 9 and assessed by a presentation in Week 10.
Resit Assessment Procedures: 16361: 3hr examination in August diet 16318 and ME305: 1.5hr examination in August diet

PLEASE NOTE:
Students must gain a summative mark of 40% to pass the module. Students who fail the module at the first attempt will be re-assessed during the August diet. This re-assessment will consist entirely of an exam. No marks from any previous attempts will be transferred to a new resit attempt.

Recommended Reading

*****Purchase recommended** ****Highly recommended reading** ***For reference**

Semester 1
(1) **Beer F., Johnston R., Cornwell, P, Self, B, Vector Mechanics for Engineering: Dynamics, McGraw Hill
(2) **Inman, D., Engineering vibration, Pearson Prentice Hall.
(3) Schmitz, T., Smith, K., Mechanical vibrations: modeling and measurement, Springer

Semester 2
(1) ***Bishop R., Dorf R., Modern Control System, Pearson
(2) To, Cho W. S., Introduction to Dynamics and Control in Mechanical Engineering Systems, American Society of Mechanical Engineers

Additional Student Feedback
(Please specify details of when additional feedback will be provided)

Date	Time	Room No
		Check Myplace, and timetable webpages for details

Session: 2023/24

Approved:

Course Director Signature:	**S Connolly (on behalf of E Henderson)**
Date of Last Modifications:	**15/09/2023**

(Updated September 2023)

MODULE TIMETABLE

Module Code:	**16361 (ME305, 16318)**	**Module Title:**	**Dynamics and Control**

Brief Description of Assessment:

Semester 1 (ME305) is assessed by an online test and an exam
Semester 2 (16318) is assessed by a project and an exam

Assessment Timing

Indicated on the table below are the start/submission dates for each assignment/project and the timing of each exam/assessment.
Dropdowns may be left blank. Add extra notes below the dropdowns where relevant.

Please note: Timings can and will change, this should only be used as a guide.

Semester One	W&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item.	Choose an item. Choose an item.	Online Test	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item.	Choose an item. Choose an item.	Exam

Semester Two	C&D Wk	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	Exam Period
	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Project Set	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Project Submission	Presentation	Choose an item. Choose an item.	Exam