MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

16361 (ME305/16318) DYNAMICS AND CONTROL

Module Registrar: Mr Daniel Johnston daniel.johnston.100@strath.ac.uk	**Taught To (Course): Cohorts for whom the module is compulsory or optional**	
Other Lecturers Involved:	**Credit Weighting: 20 (ECTS 10)**	**Semester: 1 and 2**
Compulsory and optional module	**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 2 (or equivalent)
MM117 Mathematics 1M (or equivalent)
ME108 Engineering Analysis and Numerical Methods (or equivalent)
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 on assessments	External	Online	Project	Private Study	**Total**
42	28		20				110	200

Educational Aim

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) Consider the use of energy methods in dynamical modelling.

The semester 2 (Control) course 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 semester 1, the student is expected to be able to:

LO1 Model single-degree-of-freedom vibrating systems using a variety of methods then categorise, compare, and describe the behaviour of single-degree-of-freedom systems using the theory of classically damped vibrating systems.

LO2 Examine the impact of transmitted vibrations through base excitation and rotating unbalance (considering displacement and force transmissibility).

LO3 Model multi-degree-of-freedom systems using Lagrange's method and apply the principles of modes of vibration to examine vibratory behaviour in two-degree-of-freedom systems

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

LO4 Determine a linearised mathematical model of the dynamics and control of an engineering system in the time and frequency domains and determine system response characteristics based on the system model and input.

LO5 Analyse the performance of 2nd order systems and apply fundamental stability theory correctly to assess closed-loop system stability.

Syllabus

The module will teach the following:

Dynamics (semester 1)

- Mathematical modelling of dynamic systems and system responses
- Free undamped vibration of single-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
- Application of energy methods to deriving system differential equations

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

Semester 1
LO1

C01 Mathematically model the dynamics of simple 1-DOF systems using Newton’s Laws.
C02 Mathematically model the dynamics of simple 1-DOF systems using energy conservation.
C03 Mathematically solve ordinary differential equations describing the motion of 1-DOF systems.
C05 Understand the principles and the main mechanisms of free damped and undamped vibration.
C06 Understand the principles and the main mechanisms of forced damped and undamped vibratory motion.
C07 Describe and categorise the behaviour of vibrating systems using measures such as their natural and damped frequencies, damping ratios, periods of vibration, and logarithmic decrement.

LO2

C08 Be able to distinguish between rotating unbalance and base excitation problems.
C09 Examine systems with rotating unbalance and base excitations to assess displacement and force transmissibility.
C10 Investigate the impact of varying levels of damping on transmitted vibration problems.

LO3
C11 Mathematically model the dynamics of multi-DOF systems using Newton's Laws.
C12 Mathematically model the dynamics of multi-DOF systems using Lagrange's method.
C13 Analyse a 2-DOF system to ascertain its natural frequencies.
C14 Use the matrix representation of a 2-DOF system to obtain its mode shapes.
C15 Analyse a system's mode shapes to describe its motion at each of its natural frequencies.

Semester 2
LO4
C16 Find a set of linearised differential equations to model the dynamics of appropriate systems.
C17 Represent the mathematical model as a block diagram.
C18 Use differential equations and block diagrams to determine system transfer functions.
C19 Solve analytically for the output response in the frequency domain of a system based on a specific input function and a mathematical model.
C20 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.

LO5
C21 Determine the poles and zeros of a system.
C22 Determine the tracking error and the steady-state error of a system.
C23 Design models for dynamic and control responses
C24 Design a specific control system and assess its performance.
C25 Assess the characteristics of a system response and its stability by constructing and evaluating a Routh-Hurwitz array.
C26 Assess the response of a system on the threshold of stability.

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

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 conducted via two methods. LO1-2 will be assessed via an individual coursework in which students develop their own mock multiple-choice questions (and corresponding solutions). This assessment features an opportunity to implement feedback later in the semester. LO1-3 will be assessed via a time-constrained, full-day assessment in the Semester 1 exam diet. This second assessment will have students work in groups to complete an authentic challenge that reflects potential workplace scenarios for engineers practicing in the field of vibration dynamics.

Assessment in semester 2 is conducted via coursework and an exam. Students will complete the coursework in groups and will have the opportunity to complete a peer assessment activity associated with this. The coursework will focus on an authentic control systems design problem. Groups will be given "milestones" to help monitor and manage progress through this task. The assessment of this coursework will evaluate the efficacy of each group's product and will allow assessors to ask groups questions based on their submissions. A final exam will subsequently be used to individually assess theoretical understanding and analytical problem-solving.

In both semesters, feedback is given in different forms:
- Self-directed feedback and self-assessment through worked examples and tutorial question sets with answers/solutions
- Peer feedback in group work during tutorials and coursework
- Informal feedback will be provided through an online forum, by peers and teaching staff
- Comments will be provided to groups based on the coursework they submit.

Tutorials are the primary mechanism for providing regular feedback. This is achieved through discussions/Q&A with lecturers, tutors, and other students, and through self- and peer-assessment during module participation.

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

Examination				Coursework		Practical		Project	
Number	Month(s)	Duration	*Weighting*	Number	*Weighting*	Number	*Weighting*	Number	*Weighting*
1	Dec	7 hrs	35%	1 (sem1)	15%				
1	Apr/May	1.5 hrs	35%	1 (sem2)	15%				
*LO1-5				*LO1-5					
For this module, peer assessment will be applied to each group-based assignment. Students will evaluate their peers' contributions to the assignment using Myplace. The students' grade will be determined by combining the staff grade for that assignment with the students' weighted contribution – determined from each member's evaluation of the student.									

** 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: • A coursework (MCQs; worth 15%) will be released in week 5 and submitted in week 7. Students will then have an opportunity to implement their feedback on this submission. • An open-book, group exam (group; authentic task; worth 35%) will be undertaken over one working day (10:00-17:00) during the exam diet - date TBC pending exam timetable. The challenge will be set at 10:00, and all groups must have returned their submissions by 17:00. Late submissions for this assessment will not be accepted unless by recommendation of the Personal Circumstances Board. For semester 2: • A coursework (group; control design; worth 15%) will be released in week 5, submitted in week 9, and assessed in week 10.
Resit Assessment Procedures: 16361: 2-hour examination in July/August diet 16318 and ME305: 1-hour examination in July/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 July/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: modelling 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: 2025/26

Approved:

Programme Lead / Director Signature:	**Dr Andrew McLaren**
Date of Last Modifications:	**25 August 2025**

(MAE template updated June 2025)

MODULE TIMETABLE

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

Brief Description of Assessment:

Semester 1 (ME305) is assessed by one coursework and one full-day, open-book, group exam during the exam diet.
Semester 2 (16318) is assessed by one coursework and an exam

Assessment Timing

Indicated in the table below are the start/submission dates for each assignment/project and the timing of each exam/assessment.

Please note: Timings could change during unforeseen periods of disruption; 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.	Course work Set	Choose an item.	Course work Submit	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Time-constrained (7hr) coursework

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.	Course work Set	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Course work Submit	Present ation	Choose an item.	Exam