

# Mechanical Engineering 4Q03/6Q03 – Mechanical Vibrations

Fall – 2019

Lectures: Mon., Thurs. 12:30-1:20, Tue. 1:30-2:20 JHE 264  
Instructor: Dr. Stephen Veldhuis Office: JHE 326D Hours: Mon. 1:30-3:00  
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Objectives: To provide students with an introduction to the fundamental concepts of vibration engineering. Students will learn an appreciation for harmonic motion as well as the modeling of mechanical systems. This course will draw on the math skills established in previous courses with a special emphasis on understanding the physical phenomena involved as well as interpret and apply the results to real problems.

Learning Outcomes: Upon successful completion of the course the student will be expected to have demonstrated the ability to:

1. Be able to describe dynamic systems using accurate terminology
2. Model a dynamic system as a collection of masses, springs and dampers.
3. Develop and solve the equation of motion for a dynamic system.
4. Comment on dynamic behaviour in terms of natural frequency and amplitude of vibration for both free and forced vibration cases.
5. Assess the implications of changing mass, stiffness and damping on system behaviour and performance.
6. Analyze general forcing conditions, apply them to a system and solve for the system response.
7. Model and solve for natural frequencies and mode shapes of multi degree of freedom systems.
8. Solve continuous systems for natural frequencies, mode shapes and nodes.
9. Be able to make design recommendations that will improve system performance.

Graduate Attributes: This course provides students with an opportunity to develop the following:

Graduate Attributes	Learning Outcomes where it is measured
Knowledge base for Engineering (Indicator 1,3,4)	1,3,4,6,7,8
Problem Analysis (Indicator 1,2,3)	2,3,5
Investigation (Indicator 1,2)	3,4,6
Design (Indicator 1,2)	5,9

Grades:

Assignments Not graded, detailed solutions posted on Avenue

Class Quizzes 10% Graded – details to be discussed in class (no MSAF) 80% attempted with 2/4 = 10%

Mid Term 1 15% End of Sept., Location TBD

Midterm Rec. Oct. 14 – 20

Mid Term 2 15% End of Oct., Location TBD

Mid Term 3 15% End of Nov., Location TBD

**All MSAF'ed Mid Term Grade Weighting will be Shifted to Final**

Final Exam 45% Scheduled by the Registrar during the exam session.

\*\* Crib Sheet - 2 sides of an 8½ x 11 sheet only / no worked problems / submit sheet with test/exam

ME6Q03 Please see instructor to discuss course project.

<b>Lecture Topic</b>	<b>Text Chapter</b>	<b>Comments</b>
Course Introduction	1	Concepts, Definitions and Examples
<ul style="list-style-type: none"> <li>• Concepts, definitions and basic elements</li> <li>• harmonic motion</li> </ul>		
One DOF Models	2	Modeling of Translational and Rotational Systems
<ul style="list-style-type: none"> <li>• Newton's approach</li> <li>• energy methods</li> <li>• equivalent systems</li> </ul>		
Free Response with a Single DOF	2	First Order Response and Introduction to Viscous Damping
<ul style="list-style-type: none"> <li>• free undamped vibration</li> <li>• free damped vibration</li> </ul>		
Harmonically Excited Vibration	3 & 9	Introduction to Various Sources of Excitation
<ul style="list-style-type: none"> <li>• forced vibration</li> <li>• base excitation</li> <li>• rotating imbalance</li> <li>• base isolation and vibration absorbers</li> </ul>		
General Forcing Conditions	4	Consider General Periodic Inputs
Two-degree of Freedom Systems	5	Introduce Concept of Modes of Vibration
Multi-degree of Freedom Systems	6	Introduce Matrix Representations
Continuous Systems	7	Transverse Vibration of a string or Cable and Longitudinal Vibration of a Bar or Rod
Course Review		Review Extra Study Problems

**Recommended Textbook: Mechanical Vibrations 6<sup>th</sup> ed. S. Rao, Prentice Hall**

(Limited number of copies available at the Bookstore and Amazon)

**TA's:**

**TBD**

**POLICY STATEMENT:**

**A. ACADEMIC ETHICS AND DISHONESTY:**

ATTENTION IS DRAWN TO THE STATEMENT OF ACADEMIC ETHICS AND THE SENATE RESOLUTIONS ON ACADEMIC DISHONESTY. DISHONESTY IS FOUND IN THE SENATE POLICY STATEMENTS DISTRIBUTED AT REGISTRATION AND AVAILABLE IN THE SENATE OFFICE. ANY STUDENT WHO INFRINGES ONE OF THESE RESOLUTIONS WILL BE TREATED ACCORDING TO THE ESTABLISHED POLICY.

"Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3, located at <http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf>

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

**B. DISCRIMINATION:**

THE FACULTY OF ENGINEERING IS CONCERNED WITH ENSURING AN ENVIRONMENT THAT IS FREE OF ALL ADVERSE DISCRIMINATION. IF THERE IS A PROBLEM THAT CANNOT BE RESOLVED BY DISCUSSION AMONG THE PERSONS CONCERNED, INDIVIDUALS ARE REMINDED THAT THEY SHOULD CONTACT THEIR DEPARTMENT CHAIR, THE SEXUAL HARASSMENT OFFICE OR THE HUMAN RIGHTS CONSULTANT, AS SOON AS POSSIBLE. MORE INFORMATION CAN BE FOUND AT: [http://www.mcmaster.ca/policy/General/HR/Anti-Discrimination\\_policy.pdf](http://www.mcmaster.ca/policy/General/HR/Anti-Discrimination_policy.pdf)