ME 4Q03
Mechanical Vibrations
Fall 2023
Course Outline

COURSE DESCRIPTION

This course provides students with an introduction to the fundamental concepts of mechanical vibrations and covers transient and steady state vibration of single- and multi-degree of freedom systems. Free and forced vibrations of single and multiple degree-of-freedom mechanical systems, transient response, damping and vibration isolation.

During this course students will gain 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 being able to interpret and apply the results to solve real problems.

PRE-REQUISITES

Prerequisite(s): ENGINEER 2Q04 or MECHENG 2Q04 or 2QA4 and registration in any Mechanical Engineering or Mechatronics program

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Golam Mostofa
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Office Hours:
Generally, Thursday 5 – 10 pm
Or by appointment (send an email for appointment)

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

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COURSE WEBSITE

https://avenue.mcmaster.ca/

MATERIALS

Required Texts:
Main: Mechanical Vibrations 6th ed. S. Rao, Prentice Hall - A limited number of copies are available at the bookstore.
Optional: Theory of Vibrationwith Applications, William T. Thomson et al., 5th Edition
Calculator:
Only the McMaster Standard Calculator (available at the bookstore) will be permitted in tests and examinations.

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- 3 classroom-based lectures per week, **ME6Q03 students – course project**
- In class performance quiz and 3 midterm tests, Final exam scheduled by the registrar's office

COURSE SCHEDULE

L #	Date	Content Topic	Text Sections	Text (6th Ed.)	Text Problems
1		Introduction to mechanical vibrations	1.1-1.3	1-15	1.2
2	S-7	Definitions and Terms	1.4-1.5	15-19	1.4, 1.6
3		Modeling and Basic Elements - Springs - Part I	1.6, 1.7	20-31	1.7
4		Basic Elements - Springs - Part II	1.7	32-41	1.11, 1.15, 1.40, 1.47
5	S-14	Basic Elements - Mass and Damping **Last Day for enrolement and course changes (drop/add)**	1.8-1.9	41-55	1.46, 1.50, 1.73
6		Lumped Mass and Harmonic Motion	1.10,	55-64	1.91, 1.92, 1.93, 1.99
7		Beating and Free Vibration	1.10, 2.1-2.2	64, 125-147	1.122, 2.4, 2.6
8	S-21	Natural Frequency and Examples	2.3	148-153	2.10, 2.27, 2.93, 2.94
9		Energy Method	2.2.2	131-132	2.47, 2.48
R1	S-21	**Class Performance Review, Problem Solving**			1.1, 1.8, 1.9, 1.16, 1.26, 1.30, 1.31, 1.52, 1.53 1.54, 1.74, 1.100, 2.7, 2.9, 2.12, 2.25, 2.90, 2.92
X					
M1					
X					
10		Solutions to 1DOF and COP	2.2, 2.3	133-139, 152-153	2.96, 2.97
11	S-28	Damped System Response	2.6	160-179	2.138, 2.140, 2.158
12		Forced Vibration	3.1-3.3	269-281	3. 9, 3.11, 3.25
X		Fall Break			
X	O-5	Fall Break			
X		Fall Break			
13		Forced Vibration with Damping	3.4	281-289	3.30, 3.47
14	O-19	Base Excitation	3.6	292-298	3.61, 3.62
15		Base Excitation - Part II - Truck Example	3.6	292-298	3.58, 3.64
R2	O-26	**Midterm Review and Problem Solving**			2.98, 2.142, 2.147, 3.24, 3.29, 3.34, 3.38, 3.4 3.55, 3.57, 3.72, 3.76, 3.80
X					
M2					
16				298-304	3.77, 3.78
17		Rotating Unbalance Example with Force Transmitted	3.6.1	294-295	3.82, 3.84
18	N-2	Vibration Isolation Example	9.10,	823-844	9.27, 9.32, 9.40
19		Shaft Whirl and Sensors	9.5, 10.1-10.3.3	807-813, 896-913	9.21, 10.1
20		Stability - Machining	2.11, 3.11	203-207, 312-324	2.186
21	N-9	General Forcing Functions - Transfer Function and Laplac	3.12-3.13, 4.7	324-331, 418-439	3.105, 3.109, 4.60
22		2 DOF Systems	5.1-5.2	481-487	5.1, 5.3
23		2 DOF Modes and Natural Frequencies	5.3	488-496	5.8, 5.9
24		2 DOF Examples	5.3-5.4	481-502	5.16, 5.38
25	N-16	Static and Dynamic Coupling and Forced Vibration **Last Day for withdrawing from courses without failure by default.**	5.5, 5.6	502-511	5.41, 5.42
26		Multi DOF Systems & Energy Method for Multi DOF	6.1-6.3, 6.7	568-577, 592-596	6.1, 6.32, 6.44
27	N-23	Dynamic Vibration Absorber	9.11	855-867	9.68, 9.80
28		Continuous Systems	8.1, 8.2	717-728	8.3, 8.7, 8.14, 8.15
R3	N-30	**Midterm Review and Problem Solving**			5.2, 5.4, 5.11, 5.21, 5.36, 5.37, 5.40, 5.43, 5.46, 5.52, 6.3, 6.5, 6.34, 6.36, 6.46, 6.48, 9.30, 9.33, 9.67, 9.70, 8.6, 8.8
M3					
R4	02-Dec	Final Exam Review			1.3, 1.10, 1.27, 1.48, 1.51, 1.56, 1.101, 2.5, 2.13, 2.15, 2.28, 2.44, 2.91, 2.95, 2.141, 3.10 3.19, 3.35, 3.46, 3.58, 3.63, 3.83, 3.85, 5.5, 5.7, 5.22, 5.44, 6.2, 6.4, 6.33, 6.35, 6.45, 6.47 8.6, 8.8, 8.13, 9.31, 9.34, 9.63, 9.66, 9.73, 9.7
R5	6	Final Exam Review			
R6	7	Final Exam Review			

ASSESSMENT

Component	Due Date	Weight
Class Performance	September 21st, 2023	10%
Midterm 1	TBA After Discussing with Students	15%
Midterm 2	TBA After Discussing with Students	15%
Midterm 3	TBA After Discussing with Students	15%
Final Exam	Scheduled by the registrar's office	45%
Total		100%

ACCREDITATION LEARNING OUTCOMES

The Learning Outcomes defined in this section are measured for Accreditation purposes only and will not be directly taken into consideration in determining a student's grade in the course.

Outcomes	Indicators
Be able to describe dynamic systems using accurate terminology	Knowledge Base for Eng. (1.3, 1.4)
Model a dynamic system as a collection of masses, springs and dampers	Problem Analysis (2.1, 2.2)
Develop and solve the equation of motion for a dynamic system	Knowledge Base for Eng. (1.1)
Comment on dynamic behaviour in terms of natural frequency and amplitude of vibration for both free and forced vibration cases	Investigation (3.1, 3.2)
Assess the implications of changing mass, stiffness and damping on system behaviour and performance	Problem Analysis (2.1, 2.2)
Analyze general forcing conditions, apply them to a system and solve for the system response	Investigation (3.1, 3.2)
Model and solve for natural frequencies and mode shapes of multi degree of freedom systems	Knowledge Base for Eng. (1.1, 1.3, 1.4)
Solve continuous systems for natural frequencies, mode shapes and nodes	Knowledge Base for Eng. (1.1, 1.3, 1.4)
Be able to make design recommendations that will improve system performance	Design (4.1, 4.2, 4.3)

For more information on Accreditation, please visit: https://www.engineerscanada.ca

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Mechanical Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the Equity and Inclusion Office.

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the Student Wellness Centre.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour 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. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy*, located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/

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.

ON-LINE

Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in university activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, MS Teams for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

1. It is the students' responsibility to regularly check the course webpage (ex. Avenue to Learn) for updates and announcements.

2. Completing 80% of the Quizzes with a score of 50% constitutes 10/10 for the quiz grade.
3. Missed midterms will automatically have the grade weight shifted to the final exam.
4. Special situations can be discussed with the course instructor.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical, and artistic work, **including lectures** by university instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.