

## Course Outline

1. COURSE INFORMATION			
Session Offered	Fall 2021		
Course Name	Mechanical Vibrations		
Course Code	AUTOTECH 3VD3		
Date(s) and Time(s) of lectures	September 7 – December 8, 2021 Wednesday 10:30 am - 11:30 am & Thursday 1:30 pm – 3:30 pm		
Program Name	Automotive and Vehicle Engineering Technology		
Calendar Description	Single degree of freedom systems; free vibration; harmonically excited vibration; vibration under general forcing conditions; two degree of freedom systems; multi-degree of freedom systems; natural frequencies and mode shapes; vibration control; vehicle oscillations.		
Instructor(s)	Dr. Timber Yuen, P.Eng. (Lectures) & George Apostol (Labs)	Email: timber@mcmaster.ca Office: MARC 270	
2. COURSE SPECIFICS			
Course Description	Mass, Spring and Damping Elements; Effects of Spring Pre-load; Static Stiffness and Dynamic Stiffness; Free Vibrations; Forced Vibrations; State Space Solutions for Forced Vibrations; Suspension Tuning; Frequency Domain Analysis; Beating; Fast Fourier Transform; Base Excitation; Rotating Unbalanced; Displacement & Force Transmissibility; Use of Accelerometers; Accelerometer Data Analysis; Vibration Control Techniques; 2 DOF Systems; Vibration Absorber Design and Implementation.		
Instruction Type	<b>Code</b>	<b>Type</b>	<b>Hours per term</b>
	C	Classroom instruction (on-line)	36
	L	Laboratory, workshop or fieldwork (on-line)	8
	T	Tutorial	
		<b>Total Hours</b>	44
Resources	<b>ISBN</b>	<b>Textbook Title &amp; Edition</b>	<b>Author &amp; Publisher</b>
	9780471345558	Mechanical Vibration, 2007	Palm, John Wiley & Sons
	<b>Other Supplies</b>	<b>Source</b>	
	PC/Laptop with webcam	Students must have own computer and adequate internet bandwidth for remote access of software and for on-line meetings and presentations	
Prerequisite(s)	AUTOTECH 3AE3, AUTOTECH 3CT3 and registration in the Automotive and Vehicle Engineering Technology Program		
Corequisite(s)	N/A		
Antirequisite(s)	N/A		
Course Specific Policies	<ul style="list-style-type: none"> <li>All assignments and lab reports must be handed in before or on the due date. Late submissions will be subjected to a 20% penalty.</li> </ul>		
Departmental Policies	<p>Students must maintain a GPA of 3.5/12 to continue in the program.</p> <p>In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of “out-of-class” work for every scheduled hour in class. “Out-of-class” work includes reading, research, assignments and preparation</p>		

	<p>for tests and examinations.</p> <p>Where group work is indicated in the course outline, such collaborative work is mandatory.</p> <p>The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception.</p> <p>Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class. Instructor has the right to submit work to software to identify plagiarism.</p>	
<b>3. SUB TOPIC(S)</b>		
Week 1	<p>Introduction</p> <ul style="list-style-type: none"> <li>• Equation of Motion</li> <li>• Mass, Stiffness &amp; Damping Elements</li> <li>• Springs in Parallel &amp; in Series</li> <li>• Energy Method for Motion Study</li> </ul>	
Week 2	<p>Free Vibration</p> <ul style="list-style-type: none"> <li>• Damped Natural Frequency</li> <li>• Damping factor (zeta) vs Damping Coefficient, Effects of zeta and natural frequency on system response &amp; decay</li> <li>• Effects of Mass, Stiffness &amp; Damping on <math>\zeta</math> &amp; <math>\omega_n</math></li> </ul>	
Week 3	<p>Forced Vibration &amp; Frequency Response</p> <ul style="list-style-type: none"> <li>• Solving DE with Sinusoidal Inputs</li> <li>• Complete solution vs State Space Solution</li> <li>• Doing Bode Plots in Excel</li> <li>• Suspension Tuning - Vehicle Weight Distribution</li> </ul>	
Week 4	Review & Term Test 1	
Week 5	<p>Forced Vibration &amp; Frequency Response (Part 2)</p> <ul style="list-style-type: none"> <li>• Multi-Mode Vibration</li> <li>• Fun with Frequency Analysis</li> <li>• Beating</li> <li>• Fast Fourier Transform (FFT)</li> </ul>	
	Study Break	
Week 6	<p>Rotating Unbalance</p> <ul style="list-style-type: none"> <li>• Displacement Transmissibility</li> <li>• Force Transmissibility</li> <li>• Effects of Frequency Ratio</li> <li>• Vibration Control Methods</li> </ul>	
Week 7	<p>Base Excitation</p> <ul style="list-style-type: none"> <li>• Displacement Transmissibility</li> <li>• Force Transmissibility</li> <li>• Effects of Frequency Ratio</li> <li>• Vibration Control Methods</li> </ul>	
Week 8	2 DOF Systems & Vibration Absorbers (Part 1)	

Week 9	Review and Term Test 2	
Week 10	2 DOF Systems & Vibration Absorbers (Part 2)	
Week 11	2 DOF Systems & Vibration Absorbers (Part 3)	
Week 12	Final Review	

Midterm Recess: Monday, October 11 to Sunday, October 17, 2021

Classes end: Wednesday, December 8, 2021

Final examination period: Thursday, December 9 to Wednesday, December 22, 2021

All examinations MUST be written during the scheduled examination period.

Note that this structure represents a plan and is subject to adjustment term by term.

The instructor and the University reserve the right to modify elements of the course during the term. The University may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.

**List of experiments (2 hours Every Other Week – 4 Labs total in 2021 due to COVID-19)**

Lab 1	Effects of Damper on Free Oscillation
Lab 2	FFT Analysis
Lab 3	Rotating Unbalance – Vibration Reduction
Lab 4	Design and Implementation of a Vibration Absorber

<b>4. ASSESSMENT OF LEARNING *including dates*</b>	<b>Weight</b>
Assignments (3 % x 3)	9%
Term Test 1	24%
Term Test 2	24%
Lab Reports	10%
Final Exam	33%
<b>TOTAL</b>	<b>100%</b>

Percentage grades will be converted to letter grades and grade points per the University calendar.

**5. LEARNING OUTCOMES**

1. Relate real world components to vehicle dynamic system mathematical model parameters
2. Evaluate the performance of mass, spring and damping elements in free vibrations
3. Evaluate the performance of mass, spring and damping elements in force vibrations
4. Predict the performance of dynamic system under the effects of harmonic inputs
5. Design vibration control systems to achieve the required vibration reduction criteria
6. Design vibration absorbers for dynamic systems to control vibrations

**6. COURSE OUTLINE – APPROVED ADVISORY STATEMENTS**

**ANTI-DISCRIMINATION**

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

[http://www.mcmaster.ca/policy/General/HR/Discrimination\\_Harassment\\_Sexual\\_Harassment-Prevention&Response.pdf](http://www.mcmaster.ca/policy/General/HR/Discrimination_Harassment_Sexual_Harassment-Prevention&Response.pdf)

**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:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

### **AUTHENTICITY / PLAGIARISM DETECTION**

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to [www.mcmaster.ca/academicintegrity](http://www.mcmaster.ca/academicintegrity).

### **COURSES WITH AN ON-LINE ELEMENT**

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). 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.

### **ONLINE PROCTORING**

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

### **COMMUNICATIONS**

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.

- Check the McMaster/Avenue email and course websites on a regular basis during the term.

### **CONDUCT EXPECTATIONS**

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of 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, WebEx or Zoom 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](mailto:sas@mcmaster.ca) to make arrangements with a Program Coordinator. For further information, consult McMaster University’s Academic Accommodation of Students with Disabilities policy.

### **REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK**

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

### **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. <http://www.mcmaster.ca/policy/Students-AcademicStudies/Studentcode.pdf>

### **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.