ENGINEERING
McMaster-Mohawk
Bachelor of Technology
Partnership

McMaster University

Course Outline

1. COURSE INFORMATION

Session Offered	Fall 2021	
Course Name	Control Theory	
Course Code	AUTOTECH 3CT3	
Date(s) and Time(s) of lectures	September 7 – December 8, 2021 Tuesday 10:30 am -11:30 pm & Wednesday 12:30 pm – 2:30 pm	
Program Name	Automotive and Vehicle Engineering Technology	
Calendar Description	Analysis and design of closed loop control systems course to include: control system characteristics and performance, stability analysis, system types and performance improvement, digital control systems, compensation, filtering and motion control system analysis and tuning.	
Instructor(s)	Dr. Timber Yuen, P.Eng. (Lectures) Dr. Ahmed Fakhr & Dr. Hamed Afshari (Labs).	Office: MARC 270 E-Mail: timber@mcmaster.ca

2. COURSE SPECIFICS

Course Description

Please see Sub-Topics in section 3 below.

Instruction Type

Code	Type	Hours per term
C	Classroom instruction (on-line)	36
L	Laboratory, workshop or fieldwork (on-line)	18
T	Tutorial	0
	Total Hours	54

Resources

ISBN	Textbook Title & Edition	Author & Publisher
978-1119592921	Control Systems Engineering, 8th Edition	Nise, John Wiley 2019

Other Supplies	Source
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)	ENG TECH 1EL3, 2MT3 and registered in the Automotive and Vehicle Engineering Technology Program
Corequisite(s)	N/A
Antirequisite(s)	N/A
Course Specific Policies	• All assignments and lab reports must be handed in before or on the due date. Late submissions will be subjected to a 20% penalty.
Departmental Policies	Students must maintain a GPA of 3.5/12 to continue in the program. 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 for tests and examinations. Where group work is indicated in the course outline, such collaborative work is mandatory.

	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. 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.	
3. SUB TOPIC(S)		
Week 1	Introduction to Control Theory • Open Loop & Closed Loop Systems – Advantages & Limitations • Relationship between Mass, Stiffness and Natural Frequency • Effects of Damping	
Week 2	Modeling of Mechanical Systems & Laplace Transform Method • Mathematical Models • Transfer Functions • Mass, Stiffness & Damping Components in Automotive Applications • Impulse, Step & Ramp Inputs	
Week 3	Time Domain Computer Simulation using the State Space Method • Tuning of Control System Performance • Effects of Mass, Stiffness and Damping on Systems Response • Servo Control Systems	
Week 4	Poles, Zeros & System Response for 1st Order & 2nd Order Systems • Effect of Pole Locations on System Response • Modeling with 1st Order and 2nd Order Systems • Evaluation of Transient Response • Dead Time, Rise Time, % Overshoot and Settling Time	
Week 5	Review and Term Test 1	
	Study Break	
Week 6	Block Diagrams & PID Controls • Temperature Control System – Sensor Feedback • Block Diagram Algebra • Proportional, Integral and Derivative Control implementation • Effects of each of PID terms • PID control simulation and tuning demonstration	
Week 7	System Stability – Part 1 • Importance of System Stability • Characteristics of Unstable Systems • Stability Analysis & Criteria • The Pole Location Method	
Week 8	System Stability – Part 2 • The Ruth Table Method	
Week 9	System Type and Steady State Errors • Effects & Causes of Steady State Error • Final Value Theorem • How to Reduce Steady State Error?	
Week 10	Review and Term Test 2	

Week 11	Frequency Response & Bode Plots • Harmonic Inputs • Magnitude & Phase Response	
Week 12	Bode Plots & Applications on System Design	
Week 13	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 (3 hours Every Other Week)

Lab 1	MCK Terms Measurement and Modeling
Lab 2	DC Servo Motor Control
Lab 3	Hot Plate Temperature Control (On-Off vs PID)
Lab 4	PID Excel Simulation
Lab 5	MATLAB Simulink Simulation
Lab 6	DC Servo Motor Control Frequency Response

4. ASSESSMENT OF LEARNING *including dates*	**Weight**
Assignments (2 % x 3)	6%
Term Test 1	24%
Term Test 2	24%
Lab Reports	15%
Final Exam	31%
TOTAL	**100%**

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

5. LEARNING OUTCOMES

1. Relate real world components to mathematical model parameters
2. Compare the performance of various control systems
3. Construct control system models by measuring system mass, stiffness and damping
4. Evaluate the effects of changing control system parameters
5. Create control system performance specifications for dynamic systems
6. Design control systems to achieve the required system performance

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

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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.

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 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.