McMaster University | Mohawk COLLEGE

Course Outline

1. COURSE INFORMATION

Course Code	AUTOTECH 3CT3
Course Name	Control Theory
Session	Fall 2015
Date(s) and Time(s) of lectures	September 8 – December 8, 2015 Tuesday 10:30 am -11:30 am & Thursday 9:30 am – 11:30 am
Program Name	Automotive and Vehicle 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	Name: Dr. Timber Yuen E-Mail: timber@mcmaster.ca Office: MARC 270

2. COURSE SPECIFICS

Course Description	Open Loop & Closed Loop Control; Modeling of Mechanical Systems; Transfer Functions; Laplace Transform Method; Time Domain Computer Simulation using the State Space Method; On-Off Control & PID Digital Control; Controller Design & Tuning; Control of Thermal Systems & Servo Systems; Poles & Zeros; 1st Order and 2nd Order Response; Block Diagrams; System Stability; Effects of Feedback; System Types & Steady State Error; Final Value Theorem; Frequency Response & Bode Plots

	Code	Type		Total Hours
Instruction Type	C	Classroom Instruction		37
	L	Laboratory, workshop or fieldwork		25
	T	Tutorial		9
	DE	Distance Education		
			TOTAL HOURS	73

Resources	**ISBN**	**Textbook Title & Edition**	**Author & Publisher**
	978-1-118-17051-9	Control Systems Engineering, 7th Edition	Nise, John Wiley 2015
	Other Supplies	N/A	
	Book Available	At the McMaster Campus Store	

Prerequisite(s)	AUTOTECH 2AE3, ENG TECH 1CP3, 1EL3, 1PR3, 2MT3 and registered in the Automotive 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	Review and Mid Term Test 1	
Week 5	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 with Dead Time, Rise Time, % Overshoot and Settling Time	
Week 6	Block Diagrams • Block Diagram Representation of Control Systems • Positive Feedback & Negative Feedback • Block Diagram Reduction Methods • Introduction to PID Control	
Week 7	Review and Mid Term Test 2	
Week 8	Control Hardware & Algorithms • Sensors for temperature control • Omron Temperature Controller • On/Off Control and PID Control Algorithm	
Week 9	System Stability • Importance of System Stability • Characteristics of Unstable Systems • Stability Analysis & Criteria • The Pole Location Method • The Ruth Table Method	
Week 10	System Type and Steady State Errors	

	• Effects & Causes of Steady State Error • Final Value Theorem • How to Reduce Steady State Error?	
Week 11	Review and Mid Term Test 3	
Week 12	Frequency Response & Bode Plots • Harmonic Inputs • Magnitude & Phase Response • Bode Plots & Applications on System Design	
Week 13	Final Review	

FINAL EXAMINATIONS will be scheduled, conducted and invigilated by the Office of the Registrar. All students entering the examination room must produce a McMaster photo identification card. No other identification will be accepted. In addition, for classes that allow you to use a calculator, you must use the McMaster standard calculator. For details, please consult your Instructor.

Note: 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.

4. ASSESSMENT OF LEARNING

	Weight
Assignments (x4)	0%
Mid Term Test 1	17%
Mid Term Test 2	17%
Mid Term Test 3	17%
Lab Reports	16%
Tutorials	3%
Final Exam	30%
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. POLICIES

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/Anti-Discrimination%20policy.pdf

Academic Integrity

You are required to exhibit honestly and use ethical behaviour in all aspects if the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act of 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.

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, located at:

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The following illustrates only three forms of academic dishonesty:
1. Plagiarism. E.g. the submission of work that is not 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.

Requests for Relief for Missed Academic Term Work (Assignments, Mid-Terms, etc.)

The McMaster Student Absence Form is a self-reporting tool for **Undergraduate Students** to report absences that last up to 3 days and provides the ability to request accommodation for any missed academic work. Please note, this tool <u>cannot </u>be used during any final examination period.

You may submit a maximum of 1 Academic Work Missed requests per term. It is YOUR responsibility to follow up with your Instructor immediately regarding the nature of the accommodation.

If you are absent more than 3 days or exceed 1 request per term you MUST visit your Associate Dean's Office (Faculty Office). You may be required to provide supporting documentation.

This form should be filled out immediately when you are about to return to class after your absence. http://www.mcmaster.ca/msaf/

E-Learning Policy

Consistent with the Bachelor of Technology's policy to utilize e-learning as a complement to traditional classroom instruction, students are expected to obtain appropriate passwords and accounts to access Avenue To Learn for this course. Materials will be posted by class for student download. It is expected that students will avail themselves of these materials prior to class. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail account, and program affiliation may become apparent to all other students in the course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about this disclosure please discuss this with the course instructor. Avenue can be accessed via http://avenue.mcmaster.ca.

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.

Turnitin (Optional)

This course will be using a web-based service (Turnitin.com) to reveal plagiarism. Students submit their assignment/work electronically to Turnitin.com where it is checked against the internet, published works and Turnitin's database for similar or identical work. If Turnitin finds similar or identical work that has not been properly cited, a report is sent to the instructor showing the student's work and the original source. The instructor reviews what Turnitin has found and then determines if he/she thinks there is a problem with the work. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to http://www.mcmaster.ca/academicintegrity/turnitin/students/

Protection of Privacy Act (FIPPA)

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should

take care to protect student names, student numbers, grades and all other personal information at all times. For example, the submission and return of assignments and posting of grades must be done in a manner that ensures confidentiality.

http://www.mcmaster.ca/univsec/fippa/fippa.cfm

Academic Accommodation of Students with Disabilities Policy

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca. For further information consult McMaster's policy for Academic Accommodation of Students with Disabilities

http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicAccommodation-StudentsWithDisabilities.pdf

Students must forward a copy of the SAS accommodation to the instructor of each course and to the Program Administrator of the B.Tech. Program immediately upon receipt. If a student with a disability chooses NOT to take advantage of a SAS accommodation and chooses to sit for a regular exam, a petition for relief may not be filed after the examination is complete. http://sas.mcmaster.ca

Student Code of Conduct

The Student Code of Conduct (SCC) exists to promote the safety and security of all the students in the McMaster community and to encourage respect for others, their property and the laws of the land. McMaster University is a community which values mutual respect for the rights, responsibilities, dignity and well-being of others. The purpose of the Student Code of Conduct is to outline accepted standards of behavior that are harmonious with the goals and the well-being of the University community, and to define the procedures to be followed when students fail to meet the accepted standards of behavior. All students have the responsibility to familiarize themselves with the University regulations and the conduct expected of them while studying at McMaster University.

http://judicialaffairs.mcmaster.ca/pdf/SCC.pdf