

Course Outline

1. COURSE INFORMATION

Session Offered	Winter 2020	
Course Name	Systems Analysis and Controls	
Course Code	ENGTECH 3CT3	
Date(s) and Time(s) of lectures	Wednesdays, 6:30 pm – 9:30 pm	
Program Name	Manufacturing Engineering Technology Stream and Power and Energy Engineering Technology Stream, Bachelor of Technology Program	
Calendar Description	Mathematical foundation: differential equations, Laplace transforms, transform by partial fraction expansion; transfer functions; modelling of physical systems; stability, Routh criteria; time and frequency domain ; Root-locus technique; design of control systems.	
Instructor(s)	Dr. Chi Tang, P.Eng	E-Mail: cktang@mcmaster.ca Office Hours & Location: 4 pm to 10 pm, ETB-214

2. COURSE SPECIFICS

Course Description			
Instruction Type	Code	Type	Hours per term
	C	Classroom instruction	39
	L	Laboratory, workshop or fieldwork	
	T	Tutorial	
	DE	Distance education	
	Total Hours		39
Resources	ISBN	Textbook Title & Edition	Author & Publisher
	ISBN: 9781118170519	Control Systems Engineering	Norman Nise, John Wiley & Sons, 7 th Edition
	Other Supplies	Source	
Prerequisite(s)	ENGTECH 3MA3 and Registration in Manufacturing Engineering Technology or Power & Energy Engineering Technology		
Corequisite(s)			
Antirequisite(s)			
Course Specific Policies			
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 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.</p> <p>Instructor has the right to submit work to software to identify plagiarism.</p>	
3. SUB TOPIC(S)		
Week 1	<p>Course Introduction</p> <ul style="list-style-type: none"> • Course Outline • Essential Mathematical Tools: <ul style="list-style-type: none"> ○ Polynomial Equations: Roots, Factor Theorem, Remainder Theorem, Partial Fractions ○ Ordinary Differential Equations ○ Fourier Series and Fourier Transform ○ Laplace Transform 	Ch. 1
Week 2	<p>Modelling of Physical Systems</p> <ul style="list-style-type: none"> • Time Domain and Frequency Domain Representation • Transfer Functions of SISO Control Systems • Block Diagrams • Spring-Mass System • Filters • Servomotors 	Ch. 2, Ch.3, Ch.5
Week 3	<p>Analysis of Control Systems in Time Domain</p> <ul style="list-style-type: none"> • Time Response of Second Order System • Step Response <ul style="list-style-type: none"> ○ Damping Factor ○ Undamped Natural Frequency ○ Design Parameters: Rise Time, Settling Time, Maximum Overshoot, Steady State Errors 	Ch. 4, Ch. 7
Week 4	<p>Analysis of Control Systems in s-Domain</p> <ul style="list-style-type: none"> • Stability Analysis • Routh-Hurwitz Stability Criterion 	Ch. 6
Week 5	<p>Root-Locus Analysis</p> <ul style="list-style-type: none"> • Root-locus Plots • Root-locus Analysis of Control Systems • Numerical Examples 	Ch. 8
Week 6	<p>Analysis of Control Systems in Frequency Domain</p> <ul style="list-style-type: none"> • Nyquist Contour • Nyquist Stability Criterion • Relative Stability: Gain Margin and Phase Margin • Polar Plots 	Ch. 10
Week 7	Mid-term Recess: Monday, February 17 to Sunday, February 23, 2020	

Week 8	Midterm Exam (To be finalized)	
Week 9	Analysis of Control Systems in Frequency Domain - II <ul style="list-style-type: none"> • Bode Plots • Phase Margin and Gain Margin 	Ch. 10
Week 10	Control System Compensation Techniques <ul style="list-style-type: none"> • Control System Design Specifications • Lead Compensator • Lag Compensator • Lead-Lag Compensator 	Ch. 11
Week 11	Control System Compensation Techniques <ul style="list-style-type: none"> • PID Controller 	Ch. 11
Week 12	Modern Control Theory <ul style="list-style-type: none"> • MIMO Feedback Control Systems • Controllability and Observability • State Space Representation of MIMO Systems 	Ch. 12
Week 13	Course Review	

Classes end: Tuesday, April 7, 2020
Final examination period: Monday, April 13 to Tuesday, April 28, 2020
All examinations MUST be written during the scheduled examination period.

List of experiments

Lab 1	
Lab 2	
Lab 3	
Lab 4	
Lab 5	
Lab 6	
Lab 7	
Lab 8	
Lab 9	
Lab 10	
Lab 11	
Lab 12	

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.

4. ASSESSMENT OF LEARNING *including dates*	Weight
Assignments	20
Mid-term test	30
Final examination (tests cumulative knowledge)	50
TOTAL	100%

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

5. LEARNING OUTCOMES

1. Be able to grasp basic mathematical tools necessary for the design and analysis of feedback control systems
2. Be able to model physical systems in time domain and frequency domain
3. Understand control system design specifications in time domain as well as in frequency domain
4. Be able to analyse the stability performance of feedback control systems by time domain and frequency domain techniques: Routh Stability Criterion, Nyquist Stability Criterion, Root-locus Plots, Bode Plots
5. Be able to enhance stability performance by designing lead compensators, lag compensators, lead-lag compensators, and PID controllers
6. Be able to model multi-input multi-output (MIMO) modern control systems
7. Be able to analyse SISO feedback control systems using MATLAB and SIMULINK

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/Discrimination_Harassment_Sexual_Harassment-Prevention&Response.pdf

Academic Integrity

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

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.

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: <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 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 an on-line self-reporting tool for Undergraduate Students to report absences for:

- 1) Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:
 - Students may submit a maximum of one academic work missed request per term. It is the responsibility of the student to follow up with instructors immediately (within the 3 day period that is specified in the MSAF) regarding the nature of the accommodation. All work due in that time period however can be covered by one MSAF.

- MSAF cannot be used to meet religious obligation or celebration of an important religious holiday, for that has already been completed or attempted or to apply for relief for any final examination or its equivalent.
- 2) For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has not been used previously in that term:
- Students must visit their Associate Dean's Office (Faculty Office) and provide supporting documentation.

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> and <http://www.mcmaster.ca/policy/Students-AcademicStudies/StudentCode.pdf>