Western University  
Department of Mechanical & Materials Engineering  

MME 9521a –Systems and Control  

COURSE OUTLINE 2017-2018  

DESCRIPTION: Modern Control techniques for solving vibration and control problems associated with practical mechanical systems. The emphasis of the course is on the concepts, applications and numerical simulations to aid Power-train dynamics, Hardware-in-the-loop (HIL) simulations and communications via Control Area Network (CAN).

COURSE INFORMATION:  
Instructor: Dr. Thambirajah Ravichandran  
Office: TBA  
Email: travich@uwo.ca  
Office Hours: By email appointment  

Lectures:  
Tue 11:30 – 1:30 SEB-1056  
Wed 3:30 - 4:30 SEB-1056

Tutorials:  
Wed 4:30 - 6:30 SEB-1056

PREREQUISITES: Graduate student standing in MME or permission from the instructor

TOPICS:  

2. Controller and Observer design via Full state feedback; Controllability and Observability; Pole placement design; Ackermann’s formula.  
3. Introduction to optimal control; Linear Quadratic Regulator and Kalman Filter.  
4. Pole placement and optimal control and observer design via MATLAB.  
5. Computer implementation of digital compensators; Tustin’s method, direct and cascade realizations.  
7. Practical case studies and implementations include Semi-active / fully-active automotive suspension systems, Inertial Stabilization and control and other Multi-input multi-output mechanical/electro-mechanical/electro-hydraulic systems, Hardware-in-the-loop (HIL) simulations, Communications via Control Area Network (CAN).

CONTACT HOURS: 3 lecture hours, 2 tutorial hours, half course


REFERENCES:  

UNITS: S.I.

EVALUATION: The final course grade will be determined as listed below:  
Deadline dates for assignments, projects, presentations, and examinations are determined according to the tentative schedule as follows:  

All examinations will be LIMITED OPEN BOOK. ONE PAGE (double sided) hand-written, self-prepared sheet allowed.
Individual Assignments:
Assignment 1: Due week of Sept 25 – 29 3.75%
Assignment 2: Due week of Oct 16 – 20 3.75%
Assignment 3: Due week of Nov 6 – Nov 10 3.75%
Assignment 4: Due week of Nov 27 – Dec 1 3.75%
Mid-term Exam (2 hours): Week of Oct 23 – Oct 27 20%
Group Assignment / Presentation: Due Week of Nov 27 – Dec 1 25%

The group assignment: Practical case studies of Controller Design, simulation and Implementation for Mechanical Systems (two students per group)

Final Examination (3 hours) During U/G examination period 40%

Assignments will provide minimal (but sufficient) experience to master each aspect of the course. Marks will be deducted for late submissions of assignments.

**ENGLISH:**
In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests and examinations for the improper use of English. Additionally, poorly written work with the exception of final examinations may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

**ATTENDANCE:**
Any student who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student will be debarred from taking the regular examination in the course.

**HEALTH/WELLNESS**
As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western’s Campus Recreation Centre. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page [http://www.music.uwo.ca/](http://www.music.uwo.ca/), and our own McIntosh Gallery [http://www.mcintoshgallery.ca/](http://www.mcintoshgallery.ca/). Information regarding health- and wellness-related services available to students may be found at [http://www.health.uwo.ca/](http://www.health.uwo.ca/).

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at [http://www.health.uwo.ca/mental_health/resources.html](http://www.health.uwo.ca/mental_health/resources.html).

To help you learn more about mental health, Western has developed an interactive mental health learning module, found here: [http://www.health.uwo.ca/mental_health/module.html](http://www.health.uwo.ca/mental_health/module.html). This module is 30 minutes in length and provides participants with a basic understanding of mental health issues and of available campus and community resources. Topics include stress, anxiety, depression, suicide and eating disorders. After successful completion of the module, participants receive a certificate confirming their participation.

**CONDUCT:**
Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

**SICKNESS:**
Students should immediately consult with the instructor or Associate Chair (Graduate) if they have problems that could affect their performance in the course. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal.
ACCESSIBILITY: Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

PLAGIARISM/ACADEMIC OFFENCES: Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence. Scholastic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence (see Western's scholastic discipline regulations for graduate students).

NOTICES: Students are responsible for regularly checking their Western email and notices posted on Instructors' doors.

NOTE: The above topics and outline are subject to adjustments and changes as needed.
## Learning Outcomes (MME9521a/b)

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| Depth and breadth of knowledge | 60%    | • Assignments • Mid-term Exam • Final Exam • Group Assignment | • Understands advanced concepts and theories  
• Aware of important current problems in the field of study  
• Understands computational and/or empirical methodologies to solve related problems |
| Research & scholarship    | 5%     | • Assignment(s) • Group Assignment                    | • Able to conduct critical evaluation of current advancements in the field of specialization  
• Able to conduct coherent and thorough analyses of complex problems using established techniques/principles and judgment |
| Application of knowledge  | 15%    | • Assignment(s) • Group Assignment                    | • Able to apply knowledge in a rational way to analyze a particular problem  
• Able to use coherent approach to design a particular engineering system using existing design / Analysis tools |
| Professional capacity / autonomy | 5%     | • Group Assignment                                    | • Aware of academic integrity  
• Implements established procedures and practices in the coursework  
• Defends own ideas and conclusions  
• Integrates reflection into his/her learning process |
| Communication skills      | 10%    | • Assignments • Mid-term / Final Exams • Group Assignment Presentation and Reporting | • Communicates (oral and/or written) ideas, issues, results and conclusions clearly and effectively |
| Awareness of limits of knowledge | 5%     | • Assignment(s) • Group Assignment                    | • Aware of the need of assumptions in complex scientific analyses and their consequences  
• Understands the difference between theoretical and empirical approaches  
• Acknowledges analytical limitation due to complexity of practical problems |