CEG 4158 - Computer Control in Robotics
Course Outline
Fall 2018

Professor: Pierre Payeur, SITE 5066
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WEB Page: www.eecs.uottawa.ca/~ppayeur/CEG4158 & Virtual Campus

Lectures: Monday, 11:30 AM to 1:00 PM, SMD 425
Thursday, 1:00 PM to 2:30 PM, SMD 425
-special lecture: Sep. 10th, 2018, 4:00 to 5:30PM, DMS 1130

Tutorials: Monday, 4:00 PM to 5:30 PM, DMS 1130
(every week from September 17th, 2018)

Lab Sessions: Monday, 1:00PM to 4:00PM, CBY B519 OR
Wednesday, 7:00 PM to 10:00 PM, CBY B519 OR
Monday, 7:00PM to 10:00PM, CBY B519 (limited space)
(every week from September 24th OR 26th, 2018)

Professor Consultation: Thursday, 2:45 PM to 4:00 PM, SITE 5066

Course Notes: • CEG-4158 COMPUTER CONTROL IN ROBOTICS
by P. Payeur (will be available online, via Virtual Campus)

Optional Reference Manuals: • “Introduction to Robotics, Analysis, Systems, Applications”,
• “Introduction to Robotics”, 3rd edition,

Mandatory Tool: It is required to have a scientific calculator which is able to handle
operations on 4x4 matrices (TI-83, TI-84 series are popular models,
but other brands and models are also appropriate). It is your sole
responsibility to have one available for midterm and final exams.

Calendar Description: “Evolution of robotics, mobile and manipulator robots, coordinate
systems, kinematic models of manipulators, position, velocity and
force control, sensors and actuators, robotic vision, workspace
modeling, task and path planning, industrial robots, manufacturing
and autonomous systems, robot programming.” (Extract from
calendar)

Objectives: CEG4158 is a specialization course targeting students interested in
automation, robotics and autonomous systems in general. It provides
the knowledge required to understand how robots work and to apply
conceptual approaches to achieve practical implementations
involving elements of robotics, either in industry or research &
development. It also aims at developing design and integration
abilities as well as team work and project management skills, while
providing hands-on experience on real robotic and sensor systems by
transposing theory into practice.
**Course Contents:**

**Introduction**
History, definitions, robotic systems design, applications.

**Coordinate systems**
Cartesian coordinates, degrees of freedom, reference frames, orientation, bidimensional and tridimensional transformation matrices, relative and general transformations, homogeneous transformations, inverse transformations, graphs.

**Robots systems and structures**
Robot architectures, technical concepts of robotics, actuation.

**Robot kinematics: position**
Joints, members, reference frames, $A$ matrices, direct and inverse kinematics, trigonometric solutions, precision, efficiency/complexity of kinematic solutions.

**Robot kinematics: velocity**
Derivatives, velocity of rigid bodies, differential movement, Jacobian, singularities.

**Sensors and perception**
Internal and external sensors, sensors hierarchy, interfaces, data fusion, classification, localization, robotic vision, applications.

**Control**
Classical approaches for robot control, feedback loops, position and force control, compliance, fuzzy logic control.

**Task and path planning**
Action-level planning, workspace modeling, path planning, collision avoidance.

**Evaluation:**

**Project:** 20% A design and implementation project in robotics will be completed and will involve a demonstration at the end of the semester. Intermediate milestones will also be set and evaluated during some LAB sessions. A final report will have to be submitted for each team of 3 students. Deadlines must be respected. Late submissions/demonstrations will be graded 0.

Dates: Milestone 1 demo: **Mon., Oct. 29th, OR Wed., Oct. 31st, 2018**
Milestone 2 demo: **Mon., Nov. 19th, OR Wed., Nov. 21st, 2018**
Final demo: **Mon., Dec. 3rd, OR Wed., Dec. 5th, 2018**
Final report: **Wed., Dec. 12th, 2018 before 4:00PM**

**Quizzes:** 10% Two short closed-book quizzes will be written over the semester during the tutorial periods. These evaluations are mandatory. No take-up will be possible for missed quizzes. An absence will result in a mark 0 for the quiz.

Dates: Quiz 1: **Monday, October 15th, 2018, 4:00 to 4:15PM**
Quiz 2: **Monday, November 26th, 2018, 4:00 to 4:15PM**
Midterm Exam: 30% A mandatory closed-book midterm exam will be written. No take-up will be possible for the midterm. Students are responsible for bringing their own calculator to efficiently handle operations on matrices.

Date: October 18th, 2018, 1:00PM to 2:30PM (pending room availability, date and time may change).

Final Exam: 40% A closed-book final exam will be written during the exam period at the end of the semester. Students are responsible for bringing their own calculator to efficiently handle operations on matrices.

Date: to be determined by the faculty.

Final Mark: The final mark (FM) will be computed using the following rule (no exception):

IF \[0.3 \times \text{Midterm}(\%) + 0.4 \times \text{Final}(\%)\] \geq 35
THEN:
FM=0.2 \times \text{Project}(\%) + 0.05 \times \text{Quiz1}(\%) + 0.05 \times \text{Quiz2}(\%) + 0.3 \times \text{Midterm}(\%) + 0.4 \times \text{Final}(\%)
ELSE:
FM=1.4286 \times [0.3 \times \text{Midterm}(\%) + 0.4 \times \text{Final}(\%)]

(which results in D, E or F, that is a failure mark)!!!

Note: Plagiarism and academic fraud will not be tolerated on any component of the course. Any such situation will be brought to the attention of the faculty and procedures will follow. The University of Ottawa’s regulation on academic integrity which addresses plagiarism and academic fraud can be found here: (http://web5.uottawa.ca/mcs-smc/academicintegrity/regulation.php)

Note: In accordance with Faculty’s regulation, class attendance is mandatory for all lectures, tutorials and laboratory sessions. Also, all components of the course (project, lab reports, milestone and final demos, quizzes, and exams) must be fulfilled as scheduled, otherwise students will receive an EIN as a final mark (equivalent to a failure). This is also valid for students who are taking the course for a second time.

Note: Cellphones must be turned off before entering the class. The use of a smartphone, tablet, or any other electronic device for the purpose of taking pictures, videos, or recording any part of lectures or tutorial sessions is prohibited in class. Violation of the rule will lead to immediate expulsion from the room.

Update: August 30th, 2018