EML 4840 - ROBOT DESIGN

Spring 2013

Robotics & Automation Laboratory
EC 3435, Phone: (305) 348-6841

Florida International University
Department of Mechanical Engineering
10555 West Flagler Street
Miami, FL 33174

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Course Information

Lectures: Thursdays 11:00am – 1:40PM in EC 1115

Office Hours: Thursdays 1:45 – 3:45 pm in EC 3435.
                     For other times or locations, appointment via e-mail is encouraged.

Course Description:
Robotic arm and mobile platform design including a review of major design components such as actuators, sensors, and controllers. Computer-based design, analysis and hands-on project assignment.
Course Number 16747; 3 credits.

Prerequisite: EML 4806 or permission of the instructor.

Text Book:
No formal textbook will be required for student purchase.

Recommended/Reference Texts:
Students are not required to purchase these texts, but access to at least one of these may be helpful.
*   *Introduction to Robotics: Mechanics and Control* (any edition), John J. Craig.
*   Theory of Applied Robotics: Kinematics, Dynamics, and Control (2nd Edition), Reza N. Jazar
    (available free on-campus via: http://link.springer.com/book/10.1007/978-1-4419-1750-8)
*   *Robotics for Engineers,* Yoram Koren
    (available in both the Miami-Dade and Broward county library systems)

Other texts and papers that may be helpful for students wishing to have further information on topics presented will be noted during lectures. Some reading materials will be provided during the course.

Course Schedule:

If time permits, additional topics may be included or more in-depth information on topics will be provided. Suggestions include MEMS, PLCs, machine learning, or other relevant topics of interest to the class.

The following outline is subject to change. Updates will be posted when possible.

Tentative Schedule

Date	Topics/Activities
Thursday, January 10, 2013	Course Overview, Introductions; Review of robot architectures and configurations (industrial, mobile, humanoid, etc.); Overview of robot components and tools
Thursday, January 17	Review of kinematics from previous course; Flow charts and programming considerations
Thursday, January 24	Velocity analysis; Microcontroller programming
Thursday, January 31	Jacobians matrix methods; Power considerations (batteries, wiring, etc.)
Thursday, February 7	Inverse velocity analysis and singularities; Sensors
Wednesday, February 13	Project 1 due
Thursday, February 14	Acceleration analysis; Motors and linear actuators
Thursday, February 21	Static analysis; Review of Kinematics; Motor control
Wednesday, February 27	Project 2 due, along with Project 3 descriptions
Thursday, February 28	Dynamic analysis – part 1; Alternative drive systems;
Thursday, March 7	Dynamic analysis – part 2; Project 3 initial presentations
March 14	No Class – Enjoy a Safe Spring Break!!
Thursday, March 21	Control and review of dynamics; Human-robot interaction
Thursday, March 28	Comprehensive Review; Robot ethics and industrial design
Thursday, April 4	**Comprehensive Exam;** Project 3 progress reports
Thursday, April 11	Introduction to parallel manipulators; Class-selected topic (TBD)
Wednesday, April 17	Project 3 progress report (mostly complete draft) due
Thursday, April 18	Class-selected topics (TBD) or review
Wednesday, April 24	Project 3 final report due
Thursday, April 25 (*Time TBD*)	Final Project 3 Presentations

Students are responsible for monitoring the official calendar for deadlines regarding registration and payment dates. Visit the registrar's website for more information:
http://registrar.fiu.edu/fileadmin/templates/Registration/images/Forms/Records/2012-2013_Academic_Calendar.pdf

Course Objectives:
1. Introduction to the design of multi-degree-of-freedom robots and mobile platforms.
2. Review of the latest technology available to design robotic systems.
3. Use of professional engineering tools to design robots.
4. Programming of microcontrollers to control a robotic system.
5. Hands-on experience in designing a robotic system.
6. Use and integration of cross-discipline engineering topics.

Learning Outcomes:
Students will be able to design a robot starting with the conceptual design, develop the concept into a model, analyze the model on a computer using engineering software packages, complete the structural design, and be able to build a prototype, present results in terms of a professional mutli-media presentation, develop an engineering report and demonstrate the robot's performance.

ABET MME Program Outcomes (and Academic Learning Compact – ALC) Supported by the Course:
MME departmental program outcomes (and the corresponding Academic Learning Compact – ALC – items) that are supported by the course are as follows:

(a) Ability to apply knowledge of mathematics including statistics, multivariable calculus and differential equations; science including physics, and engineering (ALC 1).
(b) Ability to design a system, component, or process to meet desired needs (ALC 3).
(c) Ability to function on multidisciplinary teams (ALC 5).
(d) Ability to identify, formulate and solve engineering problems (ALC Critical Thinking 1).
(e) Ability to communicate effectively (ALC Oral & Written Communication 1).
(f) Knowledge of contemporary issues (ALC 9).
(g) Ability to use the techniques, skills and modern engineering tools necessary for engineering practice (ALC 4).

Note Regarding ABET MME Outcomes and ALC Items:
ABET program objectives, outcomes and Academic Learning Compact (ALC) items are defined for the MME program that must be achieved by graduating students. Each course supports several of the objectives, outcomes and ALC components incrementally, but must not necessarily achieve them fully.

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Materials and Computing

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Project Materials:
Students should be prepared to purchase materials of their choosing for a final hands-on project. These materials will vary depending upon the project and design selected. A limited selection of materials and equipment will be made freely available via the Robotics & Automation Laboratory. All equipment will be provided for the initial hands-on project (but may be optionally purchased).

Computing Resources:
Students should ensure that within each group they have access to any necessary computing equipment for design, report writing and producing video presentations. The EIC maintains several labs that provide free access during specified hours. These computers have all of the necessary software for the course tasks. Students wishing to work from their own computers will need to use the EIC's remote access (details located at: http://www.eic.fiu.edu/apps/), purchase necessary software, or use free equivalents. Students may also need to download specialty software for the projects. This is recommended on a personally-owned computer or on a laptop borrowed through the EIC.

Electronic Correspondence:

Each student is required to provide a reliable e-mail address for correspondence. Announcements and reminders will be sent via e-mail throughout the semester. Students are expected to check their e-mail regularly and make sure their inboxes are not full as the bounced mail messages will not be sent again.

Students are highly encouraged to open and monitor a DropBox account in order to receive auxiliary course materials and submit work electronically. Students may use their existing DropBox account if they wish. All students will receive an invitation to join the course shared folder. While use of DropBox is not mandatory, this folder will allow advance access to hand-outs and lecture notes as well as a means to view assignment grades.

Grades and Course Policies

Grading Scale:

Percentage	Grade
100 – 95.0	A
94.9 – 90.0	A-
89.9 – 86.0	B+
85.9 – 83.0	B
82.9 – 80.0	B-
79.9 – 76.0	C+
75.9 – 73.0	C
72.9 – 70.0	C-
69.9 – 60.0	D
Less than 60	F

Adjustments to the grading scale may be made at the discretion of the instructor. If so, any adjustment will benefit students.

Grading Criteria:

Activity	Percent
Quizzes	15%
Activities/Participation	10%
Midterm Exam	20%
Project 1	10%
Project 2	20%
Project 3	25%

Quizzes:

Unannounced quizzes based on material covered will be given throughout the semester. These will typically cover material from the previous lecture. Notes and non-communicating calculators will be allowed. No make-ups will be offered for quizzes, as it is extremely impractical to do so. However, the lowest quiz grade will be dropped.

Class Activities:
Full attendance during lectures is expected. There will be frequent graded in-class activities and hands-on demonstrations that do not allow for make-ups. In addition, there may be additional participation activities that can be completed out-of-class.

Exam:
One exam will be given during the course. The exam will be cumulative and include all covered topics to that point. Bound notes (use of a binder, sturdy clip or staple is fine), physical books, bound print-outs of e-books or other electronic resources, and non-communicating calculators will be allowed. Laptops, tablets, cellphones, e-readers or any other similar electronic devices will <u>not</u> be permitted out during the exam. A make-up exam will only be given in extreme circumstances with valid documentation. The make-up exam may be slightly more difficult than that given at the regular time.

Project Outlines:
Full project details and assignments (including the grading criteria) will be provided separately. Projects are to be submitted only in electronic form. The use of DropBox or e-mail (as an attachment or web-link to the files) is preferred, but physical media will also be accepted. No print-outs or hard copies of reports are required. Feedback will be provided electronically.

Project 1: Individual report on robotics topic. Topics will be unique to each student.

Project 2: Team-based robot programming exercise with a short report and video.

Project 3: Team-based robot design, construction, programming, testing, and in-class demonstration. Projects will be determined by mutual agreement of the team and instructor. Project 3 will include several progress reports. The final report will be written professionally in the form of a technical paper for possible submission to a technical conference.

Note on team projects:
Each presentation, progress report and final report is required to clearly demonstrate the contribution of each team member. This requires division of responsibilities clearly ahead of time. Team members should be flexible to take on additional responsibilities and help another member when necessary. Teams will be limited to no more than three members.

Late Work:
Project due dates will be strictly enforced. Late project submissions will not receive full credit. Submissions after the deadline will lose ten-percent of the total grade per day.

Special Accommodations:
Students requiring special accommodations for disabilities, testing needs, University-sanctioned activities (such as sports and conference participation), or religious observances need to contact the instructor as soon as possible. Documentation may be required. Agreements will be made with each student regarding the best means for providing the accommodations needed. Accommodation options may be limited if less than one week of notice is provided.

There sometimes arises emergency situations that students must attend to. Alternative assignments or grading consideration for missed quizzes and class activities will be given <u>only</u> for extreme circumstances with valid documentation. These arrangements can not fully substitute for an in-class experience, however.

Policy on Incomplete Grades:

A grade of "incomplete" will not be assigned to replace an unwanted grade. In order to be eligible to receive "incomplete," only a single component of the entire coursework needs to be missing, and the reason for the missing component must be verified in writing – such as a letter from a medical doctor. The University requires that a student fill out an "Incomplete Grade Form" before the incomplete grade is assigned. The form must be signed by both the student and the professor, and copies provided to the Chair as well as the Dean's office. Otherwise, an incomplete grade will not be assigned.

Ethics:

All work prepared and submitted in this course in the form of projects, presentations, and problem solutions in quizzes and exams are expected to be original and produced by the submitting student. Any portion that may have been borrowed from a previous work must be clearly identified and referenced to indicate the original author along with the title of the work, and where and when it appeared. The origin of each figure, photograph, table as well as text used from other sources must be clearly identified.

It is extremely important to realize that not doing so may result in an accusation of plagiarism. Projects must contain the statement below and include the student's signature. For team projects, all team member names must be listed and each team member must sign the statement.

> The work submitted in this project is solely prepared by NAME LASTNAME, and it is original. Excerpts from others' work have been clearly identified and listed in the list of references. All accompanying materials including engineering drawings, computer programs, formulations and related files submitted are also original and prepared by NAME LASTNAME.
>
> *Student Signature*
> NAME LASTNAME

Not including or signing the statement above does <u>not</u> excuse students from submitting plagiarized work or diminish the penalties from such action.

Distribution of Course Materials:

Recording devices of any kind are <u>not</u> permitted without prior knowledge and approval of the instructor. This include cameras, but especially apply to sound-recordings or video. Students will be notified if any portion of a lecture is being recorded in accordance with Florida law.

Course materials and any recordings, including lecture slides and quizzes, may <u>not</u> be distributed without *written* permission of the instructor.

Student-generated content remains property of the students within all applicable policies of Florida International University. However, student works will be retained and may be used for "in-house" and accreditation-review purposes. All videos, photos and final project reports that are submitted for this course may be made publicly available.

This syllabus based heavily upon Dr. Sabri Tosunoglu's Spring 2012 syllabus.

Revision History:
2012 December 18: Initial posting on instructor's personal website.
2013 January 9: Edited to remove references to EML 6805 (canceled), clarify some wording and adjust grading. FINAL PRE-COURSE VERSION