EML 6805 - ADVANCED DESIGN OF ROBOTS

Spring 2014

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

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

Instructor: Melissa Morris
e-mail: mmorr009@fiu.edu
Website: http://www.melissatronic.com

Course Information

Lectures: Tuesdays & Thursdays 11:00am – 12:15pm in EC 1115 (unless otherwise noted)

Office Hours: Tuesdays 12:45 – 2:00pm in EC 3435 (unless otherwise noted)
For other times or locations, appointment via e-mail is encouraged.

Course Description:

Kinematic analysis of mechanisms and robot arms, analytical and numerical methods to address robot kinematics. Robotic arm and mobile platform design including a review of major design components such as actuators, sensors, and controllers. Computer-based design, analysis and project assignment. Course number 16059; 3 credits.

Prerequisite: EML 4806 or EML 5808; or EML 3222, EML 3262 and EML 4501; 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 will 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.

Course Schedule:

This course will be offered concurrently with EML 4840 and will thus share lecture materials and topics. Quizzes and the exam may be more advanced for this graduate section. If time permits, additional topics may be included that are of interest to the class.

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

Tentative Schedule

Date	Topics/Activities
January 7 & 9, 2014	Course Overview, Introductions; Review of robot architectures and configurations (industrial, mobile, humanoid, etc.); Overview of robot components and tools
January 14 & 16	Review of kinematics from previous course; Flow charts and programming considerations
January 21 & 23	Velocity analysis; Microcontroller programming
January 28 & 30	Jacobians matrix methods; Power considerations (batteries, wiring, etc.)
February 4 & 6	Inverse velocity analysis and singularities; Sensors
Wednesday, February 12	Project 1 due
February 11 & 13	Acceleration analysis
February 18 & 20	Static analysis; Review of Kinematics; Motors and linear actuators
Wednesday, February 26	Project 2 due, along with Project 3 descriptions
February 25 & 27	Dynamic analysis – part 1; Motor Control
March 4 & 6	Dynamic analysis – part 2; Project 3 initial presentations
March 11 & 13	No Class – Enjoy a Safe Spring Break!!
March 18 & 20	Control (more extensive than undergraduate section) and review of dynamics; Alternative drive systems;
March 25 & 27	Comprehensive Review; Human-robot interaction or Class-selected topic (TBD)
April 1	**Comprehensive Exam**
April 3	Project 3 progress reports
April 8 & 9	Introduction to parallel manipulators; Robot ethics and industrial design or Class-selected topic (TBD)
Wednesday, April 16	Project 3 progress report (mostly complete draft) due
April 15 & 17	Class-selected topics (TBD) or review
Wednesday, April 23	Project 3 final report due
Thursday, April 24 **9:45-11:45 am**	Final Project 3 Presentations

Students are responsible for monitoring the official calendar for deadlines regarding registration and payment dates

Course Objectives:

1. 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. Literature review on robot design
6. Hands-on experience in designing a robotic system.

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.

Materials and Computing

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 they have access to any necessary computing equipment for design and producing publications and video presentations. The EIC maintains labs that provide free access during specified hour with all of the necessary software. Graduate students have limited remote access to EIC applications (details located at: http://www.eic.fiu.edu/apps/). To obtain other software on personal computers, students will need to purchase this software or use free equivalents. Students may also need to download other specialty software for the hands-on 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. If you do not use your FIU e-mail account, please notify the instructor of your preferred e-mail upon enrollment. 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 must frequently monitor course website for announcements and materials. Students may wish to access the course DropBox folder in order to receive auxiliary course materials and submit work electronically. All registered students will receive an invitation to join the course shared folder through the e-mail provided above. Use of DropBox is not mandatory, but encouraged.

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	10%
Activities/Participation	10%
Midterm Exam	15%
Project 1	20%
Project 2	15%
Project 3	30%

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:

Attendance during lectures is expected, though be aware that some lectures may be pre-recorded and posted online. There will be graded in-class activities and hands-on demonstrations that do not allow for make-ups. 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 (bounding in a binder or with a 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 electronic devices will not 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 rubrics) 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. No hard copies of reports are required. Feedback will be provided electronically.

Project 1: Individual literature review on robotics topic. It is preferred if topic aligns with Project 3.

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

Project 3: Individual or 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 submission to a technical conference.

Note on team project:
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 testing needs or religious observances need to contact the instructor ASAP. 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 only 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 not excuse students from submitting plagiarized work or diminish the penalties from such action.

Distribution of Course Materials:

Recording devices of any kind are not 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 not 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:

2013 October 30: Initial posting on instructor's personal website.
2014 January 6: Added final presentation time (FIU released final exam period information)