

# EML 4806 - Modeling of Robots

Summer A 2014

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:** Monday, Wednesdays & Fridays\* 5:00-7:15pm in EC 1105  
*\*Most Friday lectures will be prerecorded and not held in-person during this time*

**Office Hours:** Mondays & Wednesdays 7:30-8:30pm in EC 3435  
For other times or locations, appointment via e-mail is encouraged.

### Course Description:

Robot models in terms of geometric parameters. Kinematic and dynamic modeling of robots. Static and dynamic force equilibrium. Robot programming, control algorithms, simulations.  
Course Number 56908; 3 credits.

**Prerequisite:** EGN3321 (Dynamics) and EML2032 (Programming) – or permission of 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.

- *Kinematics, Dynamics, and Design of Machinery*, Kenneth J. Waldron and Gary L. Kinzel
- *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:

The following outline is **subject to change** including project due dates and exam dates. Updates will be posted when possible but otherwise noted in class.

### Tentative Schedule

Date	Topics/Activities
Monday, May 12	Course Overview, Introduction to mechanisms and robotics, DoF
Wednesday, May 14	Position analysis of mechanisms
Friday, May 16 (Prerecorded)	Velocity analysis of mechanisms
Monday, May 19	Acceleration analysis of mechanisms
Wednesday, May 21	Planar linkage design
Friday, May 23 (Prerecorded)	Review of mechanisms
Monday, May 26	<b>No Class</b> – Enjoy a safe Memorial Day weekend!
Wednesday, May 28	Exam 1
Friday, May 30 (Prerecorded)	Spatial descriptions and transformations
Sunday, June 1	Project 1 Report and Animation Due
Monday, June 2	Project 1 Presentations
Wednesday, June 4 (Prerecorded)	Manipulator position kinematics
Friday, June 6 (Prerecorded)	Jacobians and singularities
Monday, June 9	Velocity analysis
Wednesday, June 11	Acceleration analysis
Friday, June 13 (Prerecorded)	Control of robots
Monday, June 16	Review of kinematics and control
Wednesday, June 18	Exam 2
Thursday, June 19	Project 2 Report and Animation Due
Friday, June 20 (In-person)	Project 2 Presentations

Students are responsible for monitoring the official calendar for deadlines regarding registration and payment dates. Visit the FIU Registrar's website for more information.

## Course Objectives:

1. Introduction to mechanisms and robotics.
2. Kinematic analysis of mechanisms and robotic arms including position, velocity and acceleration analysis.
3. Computer-assisted mechanism and robot motion analysis and design.

## 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

### Computing Resources:

Students should ensure that within each team they have access to any necessary computing equipment for design, report writing and producing animations and presentation materials. The EIC maintains several labs that provide free access during specified hours as well as loans laptops to registered students. These computers have all of the necessary software for the course tasks. Students wishing to work from their own computers may need to use the EIC's remote access (details located at: <http://www.eic.fiu.edu/apps/>), purchase necessary software, or use free equivalents.

### Electronic Correspondence:

Each student is required to provide a reliable e-mail address for correspondence. If you do not use your FIU e-mail, please notify the instructor of your preferred e-mail upon registration.

Announcements and reminders will be sent via e-mail and Blackboard 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 sites such as DropBox or GoogleDocs to submit work electronically. Students should frequently access and monitor the course Blackboard site to gain access to all lecture materials and videos.

## 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	5%
Exam 1	15%
Project 1	20%
Exam 2	20%
Project 2	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:

Attendance during lectures is expected, though be aware that some lectures will 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.

### Exams:

Two exams will be given during the course. The first will focus on mechanisms and the second will focus on robot kinematics [details will be provided during the course]. 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 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 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. No hard copies are required. Feedback will be provided electronically. Teams will be limited to no more than three members.

Project 1: Team-based mechanism design exercise.

Project 2: Team-based robot design exercise.

### Late Work:

Late work is accepted unless solutions have been released, but are subject to penalties.

### 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 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 work will be retained and may be used for "in-house" and accreditation-review purposes.

**All videos, photos and project reports that are submitted for this course may be made publicly available.**

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

### *Revision History:*

*2014 April 30: Document created.*