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**EML 4806**  
**MODELING & CONTROL OF ROBOTS**  
**Fall 2009**

**Instructor: Dr. Sabri Tosunoglu**  
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**[www.eng.fiu.edu/mme/robotics](http://www.eng.fiu.edu/mme/robotics)**

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**Course Description:**

Fundamentals of kinematics and mechanism design; study of the mechanisms used in machinery. Robot models in terms of geometric parameters. Kinematic and dynamic modeling of robots. Static and dynamic force equilibrium. Robot programming, control algorithms and simulations.

**Lectures:**

MW 7:50-9:05 pm, EC 1112.

**Office Hours:**

MW 5:00-6:00 pm. For other times, by appointment via e-mail.

**Reference Books (Students are not required to purchase these books):**

Kinematics, Dynamics and Design of Machinery, Kenneth J. Waldron, and Gary L. Kinzel, Second Edition, John Wiley & Sons, Inc., New Jersey, 2004.

Introduction to Robotics: Mechanics and Control (2nd Edition), John J. Craig, Addison Wesley.

Robot Analysis and Control, by H. Asada, J.-J. E. Slotine, Interscience.

Robot Dynamics and Control, Mark W. Spong, M. Vidyasagar, John Wiley & Sons.

Handouts will be provided for the robotics section.

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### **Course Outline:**

- Introduction to mechanisms and robotics.
- Position, velocity, acceleration analysis of mechanisms.
- Planar linkage design.
- Introduction to multi degree-of-freedom systems, robotic arms, and mobile platforms.
- Kinematic analysis of robotic arms. The Jacobian matrix. Position, velocity and acceleration analysis.
- Dynamic equations of motion and numerical solution of dynamic system models.
- Computed-torque method to control robots.
- Team-based project and video presentation.

### **Course Objectives:**

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

### **ABET MME Program Outcomes Supported by the Course:**

MME departmental program outcomes that are supported by this course are as follows:

- (a) Ability to apply knowledge of mathematics including statistics, multivariable calculus and differential equations, science including physics, and engineering.
- (c) Ability to design a system, component, or process to meet desired needs.
- (d) Ability to function on multi-disciplinary teams.
- (e) Ability to identify, formulate and solve engineering problems.
- (g) Ability to communicate effectively.

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- (j) Knowledge of contemporary issues.
  - (k) Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

**Note Regarding ABET MME Outcomes:**

ABET program outcomes are defined for the MME program that must be achieved by graduating students. Each course supports several of the outcomes incrementally but must not necessarily achieve them fully.

**Grading:**

<u>Activity</u>	<u>Percent</u>	
Attendance	5%	
Quizzes	20%	
Exam	15%	Closed book. 1 page of formula sheet allowed.
Projects	40%	Individual and team-based projects.
Final Exam	20%	Closed book. 2 pages of formula sheets allowed. Comprehensive test.

**Dates:**

Project due dates will vary between one to several weeks depending on the amount of work required. However, the due dates will be announced in class as the projects are distributed. Exam dates will be announced at least one week earlier than the exam date. It is the student's responsibility to follow announcements closely.

**Correspondence via E-mail:**

Each student is required to provide a reliable e-mail address for correspondence. Various 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.

**Attendance:**

Attendance will be monitored throughout the semester.

**Ethics:**

All work prepared and submitted in this course in the form of projects, presentations, 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

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be clearly identified and referenced to indicate the original author along with the title of the work, and where and when it appeared. It is extremely important to realize that not doing so may result in an accusation of plagiarism.

Projects must contain the following statement and include student's signature:

Author's 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 of the engineering drawings, computer programs, formulations and related files submitted on the accompanying CD are also original and prepared by NAME LASTNAME.

NAME LASTNAME

(Include Signature)

### **Exams:**

Midterm and final exams will be closed book. One letter-size sheet of formulas is allowed in the mid-term exam, two pages in the final exam. Class notes and problem solutions will not be allowed. Sharing of calculators and formula sheets during the exams and quizzes is not permitted.

### **Quizzes:**

Unannounced quizzes will be frequently given throughout the semester. On average, expect one quiz per week although on several occasions, more quizzes per week may be given. Under no circumstances make-up quizzes will be offered. In case you miss a class, be prepared to receive a grade of zero for the quiz. No excuse will be accepted for missing quizzes. At the end of the semester, the lowest quiz grade will be dropped.

### **Late Projects:**

Project due dates will be strictly enforced. Late project submissions will not receive full credit, and the following policy will apply: Submissions after the class hour on due date or the following day will lose 10 points out of 100. Submissions on the second or third day after the due date will lose 10 additional points each day.

### **Make-up Exams:**

Make-up exams will be allowed only after the student provides a medical doctor's original report describing the problem and a statement that it was an emergency. The

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report must include the doctor's address and phone number. The Department will contact and verify the situation before a test day is scheduled.

### **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. The reason for failure to fulfill the requirement in time must be officially proved by the student (e.g., a medical doctor's official letter), and verified by the Department in order to receive an "incomplete" grade.

The University requires that a student must fill out an "Incomplete Grade Form" before the incomplete grade is assigned. This University policy and the related form are printed below.

#### **Policy for Assigning an Incomplete "I" Grade**

An incomplete grade is a temporary symbol given at the discretion of the instructor for work not completed because of serious interruption not caused by the student's own negligence. An incomplete must be made up as quickly as possible but no later than two consecutive semesters after the initial taking of the course or it will automatically default to an "F" or the grade that the student earned in the course. There is no extension of the two semester deadline. The student must not register again for the course to make up the incomplete. Students who have incomplete grades on their records must remove the incomplete by the end of the fourth week of the term in which they plan to graduate. Failure to do so will result in a cancellation of graduation .

In such cases where the course instructor determines that it appropriate to award a student a grade of "I" (incomplete) the following steps must be followed.

Using an Official University Form the course instructor will report the following:

1. The grade earned by the student to date
2. The missing work and the percentage of the final grade it represents (this requires the details of the specific missing assignment)
3. The date the instructor expects the missing work to be submitted or in the case of an examination made up
4. The justification for awarding the grade of "I"
5. Have the student sign the form
6. Submit this form to the Department Chair and Dean and maintain a copy for instructor records and provide a copy for the student
7. Upon satisfying the requirements for a grade the instructor will sign off on the form and attach it to the change of grade form she or he will submit.

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### Incomplete Grade Form

Student Name: \_\_\_\_\_ Panther ID: \_\_\_\_\_

Course Number: \_\_\_\_\_ Section Number: \_\_\_\_\_

Date: \_\_\_\_\_ Grade earned to date: \_\_\_\_\_

Specific missing assignments:

Percent of grade based on missing assignments: \_\_\_\_\_

Date by which missing assignments will be submitted: \_\_\_\_\_

Justification for assigning an I:

\_\_\_\_\_  
Professor Date Student Date

Copies to: Professor, Student, Department Chair, Dean

Final Grade \_\_\_\_\_ based on all work completed.

\_\_\_\_\_  
Professor Date

Copies to: Professor, Department Chair, Dean, Registrar