COURSE SYLLABUS

INTRODUCTION

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TAs	Adnan Munawar TA Office: AK 105 amunawar@wpi.edu		
SAs	TBD		
Course Website	http://users.wpi.edu/~dberenson/courses/c2015rbe3001/		
Lectures	M T R F 11-11:50am in Salisbury Labs 104		
Labs	C01: R 9-10:50am in Atwater Kent (AK), Room 120 C02: W 10-11:50am in Atwater Kent (AK), Room 120		
Office Hours	See the course website		
Textbooks	1. *C Programming, A Modern Approach,* 2ed, by K. N. King, Norton & Company, 2008. (or other C reference, on reserve in the library) 2. *Springer Handbook of Robotics,* B. Siciliano, O. Khatib (eds.), Springer, 2008. (available free online as pdf through library, on reserve in the library)		
References	1. *Introduction to Robotics: Mechanics & Control,* 3ed, J. Craig, Prentice Hall, 2004. (on reserve in library) 2. *Robot Modeling and Control,* M. Spong, S. Hutchinson, M. Vidyasagar, Wiley, 2005. (on reserve in library) 3. *Fundamentals of Robotics: Analysis and Control*, Robert J. Schilling, Prentice Hall, 1990. (on reserve in library) 3. Theory of Applied Robotics 2nd Ed., R. Jazar, Springer, 2010. (available online, on reserve in library)		

Course Description

Third of a four-course sequence introducing foundational theory and practice of robotics engineering from the fields of computer science, electrical engineering and mechanical engineering. The focus of this course is actuator design, embedded computing and complex response processes. Concepts of dynamic response as relates to vibration and motion planning will be presented. The principles of operation and interface methods various actuators will be discussed, including pneumatic, magnetic, piezoelectric, linear, stepper, etc. Complex feedback mechanisms will be implemented using software executing in an embedded system. The necessary concepts for real-time processor programming, re-entrant code and interrupt signaling will be introduced. Laboratory sessions will culminate in the construction of a multi-module robotic system that exemplifies methods introduced during this course.

Recommended background: RBE 2002, ECE 2801, CS 2102, MA 2051, MA 2071

Course Objectives

Upon completion of this course, students will be able to:

1. Demonstrate knowledge of different types of actuators used in robotic systems.
2. Analyze the position and velocity kinematics of a robot arm, implement in 2D.
3. Analyze the dynamics of a robot arm, implement in 2D.
4. Model and simulate systems using Matlab.
5. Analyze sensor signals to implement real-time control algorithms.
6. Demonstrate knowledge of error propagation in electrical, mechanical and computational systems.
7. Write moderately involved programs in C to perform a specified task with a robotic system in real-time.
8. Construct, program, and test the operation of a robotic system to perform a specified task.

Expected Background

1. All topics covered in RBE2001-2002.
    a. Position, velocity, and acceleration analysis.
    b. Kinematics of four-bar mechanisms.
    c. Concepts of stress and strain.
    d. DC and AC electrical circuit analysis.
    e. DC motors principles.
2. Foundations of embedded systems.
3. C programming.
4. First and second-order linear differential equations with constant coefficients.
5. Topics from controls; Laplace transforms, linear systems.
6. Basic linear algebra; matrix addition, multiplication, transpose, inverse, determinant.
7. Familiarity with Maple & MATLAB.
8. Familiarity with CAD (Pro/E or Solidworks).
9. Topics from probability; expected value, Gaussian distribution, mean, variance.

Ground Rules

1. *The instructors reserve the right to modify the course outline and policies mentioned in this syllabus at any time during the term.*

2. **Homework and Quizzes:** Homework will be assigned regularly throughout the term. All homework will have a due date and no late homework will be accepted. Selected homework problems will be graded for credit. Announced and unannounced quizzes may be given during the term. Homework and quizzes are worth 15% of the total score in the course. Homework is to be turned in at (or uploaded prior to) the beginning of class on the date due unless otherwise specified. ***Unless otherwise specified, homework must be neatly hand-written or typed on single-sided, letter-size paper (for example, engineering paper) and must be submitted on time.***

3. **Exams:** Three exams will be given as shown on the course schedule. Make-ups will only be granted to the students who have an acceptable excuse approved in advance. Each exam is worth 15% of the total score.

4. **Laboratories:** Students are required to attend all of their scheduled lab sections and must complete all the lab activities. Lab grade will be based on assignments, quizzes, reports, and performance in the lab. Pre-lab assignments are due at the beginning of each lab session and are graded on an individual basis. Overall lab grade will make up 40% of the total score with equal weight for each week (i.e. a 2-week lab counts twice as much as a 1-week lab). A detailed handout on lab policies including guidelines for report writing and grading rubrics will be provided during the first lab session.

5. **Grading:** <u>You must complete all the labs and the final project, and you must take all the exams to receive a passing grade in the course</u>. You are expected to complete all homework assignments and quizzes and actively participate in class.

Requirement	Weight
Homework and Quizzes	**20%**
Exams	**40%**
Labs	**40%**
TOTAL	**100%**

6. **Attendance and participation:** Class attendance, active participation and interaction are expected both during the lectures and in the lab. Attendance and participation in lab is required.

7. **Calculator Policy:** Only models of calculators approved by The National Council of Examiners for Engineering and Surveying (NCEES) are permitted in the exams (Same requirements as for the EIT/PE Exams). You are responsible for bringing an approved calculator to exams, others (e.g. programmable calculators, pdas, tablets, laptops, phones, etc.) will not be allowed.

   For more information: http://www.ncees.org/Exams/Exam-day_policies/Calculator_policy.php

8. **Academic Honesty Policy:**
   Review WPI's Academic Honesty Policies at: http://www.wpi.edu/Pubs/Policies/Honesty/policy.html

   <u>Rule of thumb:</u> ***Any work you present as your own should represent your own understanding of the material.***

Following are examples of acceptable and unacceptable actions under this policy:

Homework

Acceptable:

- Discussing a homework problem with someone else to gain a better understanding.
- Looking at a similar problem from solutions of previous problem sets to get an idea of how to approach the problem.

Unacceptable:

- Copying material from someone else's solution and handing it in as your own
- Copying a solution from a previous set, and handing it in as your own.

Exams

Acceptable:

- Looking at exams and exam solutions from previous offerings of the course (if available).
- Using a calculator (as specified in course policies) or other digital assistant to perform numerical calculations.

Unacceptable:

- Using calculator or other digital assistant to access stored formulas or notes, or to access any other resource or collaboration during exam.

Pre-lab/Lab/Post-lab

Acceptable:

- Discussing the pre-lab with someone else to gain a better understanding.
- Partners dividing tasks in lab; for example, one person makes measurements and the other records data.
- Checking with another lab group to see if your data makes sense.
- Looking at lab reports from previous RBE courses to get an idea of the report format or content.

Unacceptable:

- Copying material from someone else's pre-lab and presenting it as your own.
- One person does all the work; the other lab partner never shows up or makes minimal contribution.
- Putting someone else's name on a lab write-up when they made no contribution.
- Using other data or write-up in place of your own.
- Using material from previous reports (data, discussions, etc.) and presenting it as your own.

9. **Student Disability Services:** If you need course accommodations because of a disability, or if you have medical information to share with the instructor, you must inform your instructor within the first week of classes. If you have not already done so, students with disabilities, who believe that they may need accommodations in this class, should contact the Disability Services Office (DSO), as soon as possible to ensure that such accommodations are implemented in a timely fashion. More information: http://www.wpi.edu/offices/disabilities.html
10. Students are encouraged to use campus support services, which include the:
    - Academic Resources Center
    - Writing Center
    - M*A*S*H (Math and Science Help)

TENTATIVE SCHEDULE

See the course website