**Department of Computer and Electrical Engineering and Computer Science**
**Florida Atlantic University**
**Course Syllabus**

| 1. Course title/number, number of credit hours | |
|---|---|
| Intro to Mechatronics, EGN 1935 | 3 credit hours |

**2. Course prerequisites, corequisites, and where the course fits in the program of study**

Prerequisites: 9$^{th}$ grade high school students with background and interest in Math and Engineering. This is considered to be a Freshman level course; we have proposed to offer it to all Freshman as a good introductory engineering course, since it combines aspects of Math, Computer Engineering, Electrical Engineering, Mechanical Engineering, and Computer Science.

**3. Course logistics**

*Term*: Spring 2012
The students, in groups of 3, will build a robot, using low cost parts and open source tools, during the first half of the semester. The robot is built with an Arduino Uno microcontroller platform and has 1 ultrasound sensor mounted in the front, two infrared sensors mounted on the sides, and also has two H-bridge based driver amplifiers that are used to drive the two motors that power the two wheels on the sides. During the first half of the semester, the students also learn about the principles involved in sensing and actuation, as pertinent to these building blocks, and learn to program the microcontroller to read and write both analog and digital inputs and outputs, respectively. The students use soldering and an extra unpopulated board (shield) to build the additional circuitry and test them. During the second half of the semester, the students calibrate the robot by conducting experimental studies on the sensors and motors. These characteristics are coded into the program as tables and constants, and used to have the robot move along a line a given distance, and make a turn of a given angle. The programming language used is called Sketch and is a high level language that makes it easy to learn programming, without getting unduly concerned with the complex microcontroller architecture (of ATMega 328 from Atmel). The student groups use these as building blocks to draw (with a pen mounted in the middle of the robot) various geometric art drawings. Examples are Stars, English Alphabets, Polygons, Concentric Shapes, etc.
*Class location and time*:   MWF 2 to 3 PM, TR 2 to 3.45 PM
This course is designed to be a design course where students specify, design top-down, use existing/ built components via their APIs, experiment with, and implement robotic systems that function and draw geometric art..

**4. Instructor contact information**

| *Instructor's name* | Dr. R. Shankar, Professor, in collaboration with Prof. McAfee, Arts & |
|---|---|
| *Office address* | Letters |
| *Office Hours* | Engineering East (EG-96) Bldg., Room 513 |
| *Contact telephone number* | TR 10 to 11 AM, F11 AM to 3 PM |
| *Email address* | 561-297-3470 |
| | shankar@fau.edu |

**5. TA contact information**

| Joseph Gundel | PhD Student |
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**6. Course description**

Top-down design methodology for building a robot to create geometric art.  Development using Open Source software and hardware tools, based around  the Arduino initiative, and other compatible hardware components.

## 7. Course objectives/student learning outcomes/program outcomes

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|---|---|
| *Course objectives* | This course is designed to help students develop and prototype simple autonomous robots that can apply Mathematrics and Engineering principles in harmony to draw geometric art. The process encourages social interaction and peer support which has potential to increase interest in STEM for all the participating students. |
| *Student learning outcomes & relationship to ABET a-k objectives:* <br> *We believe that our course addresses all of the ABET sub-criteria a-k, but for (h) and (j), as appropriate at the Freshman level.  The students understand that they have to build something sophisticated within  a limited budget and with pre-ordered components. They learn to work in teams, share responsibilities, design and implement an engineering project, document &  present it, and create a video on it. Everything is documented at their blog sites. See robotics.fau.edu for all the blog site links.* | (a) an ability to apply knowledge of mathematics, science, and engineering <br> (b) an ability to design and conduct experiments, as well as to analyze and interpret data <br> (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability <br> (d) an ability to function on multidisciplinary teams <br> (e) an ability to identify, formulate, and solve engineering problems <br> (f) an understanding of professional and ethical responsibility <br> (g) an ability to communicate effectively <br> (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context <br> (i) a recognition of the need for, and an ability to engage in life-long learning <br> (j) a knowledge of contemporary issues <br> (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. |

## 8. Course evaluation method

| | | |
|---|---|---|
| 5 Quizzes  (drop lowest 1) | 10% | *Note*: The minimum grade required to pass the course is C. |
| Project Assignments (7th week on, 5) | 20% | |
| 1 Mid Term Exam  (8th week) | 20% | |
| 1 lab Video (before 7th week) | 10% | |
| Final Project (on Exam day) | | |
|    Presentation | 5% | |
|    Group Blog | 5% | |
|    Functionality | 20% | |
|    Video | 5% | |
|    Paper (3 to 4 pages) | 5% | |

## 9. Course grading scale

Grading Scale: It will be based on a curve. Expected distribution is given below:
90 and above: "A";  84-89: "A-", 79-83: "B+", 72-78: "B", 67-71 : "B-", 60-66:  "C+", 55-59: "C", 50-54: "C-", 47-49: "D+", 44-46: "D", 41-43:  "D-", 40 and below: "F."

## 10. Policy on makeup tests, late work, and incompletes

*There is a mid-term test in this course. The students will demonstrate their functioning systems at the end of the semester in front of a group of professors.*

*A grace period of 1 week is allowed for submission of assignments. One lowest score quiz will be dropped.*

*Incomplete grades* are against the policy of the department. Unless there is solid evidence of medical or otherwise serious emergency situation incomplete grades will not be given.

## 11. Special course requirements

Students have to work together. That requires certain amount of communication and effort.

## 12. Classroom etiquette policy

Students have to use laptops in the class to conduct tool installation, training, programming, robot assembly, etc . Also, classes will be more problem solving oriented – you will be asked to read and try out tutorials ahead of time. There will be significant interaction among the students, and the TA and the professor during the class room, on a basis to solve problems and gain deeper insight. This will be tested in a weekly quiz in the following week. So, have your laptop ready and be prepared to use it during the lectures.

## 13. Disability policy statement

In compliance with the Americans with Disabilities Act (ADA), students who require special accommodations due to a disability to properly execute coursework must register with the Office for Students with Disabilities (OSD) located in Boca Raton campus, SU 133 (561) 297-3880 and follow all OSD procedures.

## 14. Honor code policy

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high quality education in which no student enjoys unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and place high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. See University Regulation 4.001 at www.fau.edu/regulations/chapter4/4.001_Code_of_Academic_Integrity.pdf

We will use mostly open source tools. Much code, reference designs, etc., are freely available at many sites on line, including our own, robotics.fau.edu (via blog links of students who have taken the course), and that of Arduino, www.arduino.cc. Many vendor sites also will be provided. However, some code and graphics assets may be copyrighted and/or licensed. If so, appropriate permission must be taken before using these. They also should be acknowledged in the list of references in the report submitted and in the credits section of the Application developed.

## 15. Required texts/reading

Physical Computing: Sensing and Controlling the Physical World with Computers, O'Sullivan, D., and Igoe, T., Thomson Publisher, 1$^{st}$ edition, May 2004

## 16. Supplementary/recommended readings

www.arduino.cc - this course is based on open source tools. Also several vendor related websites with component specifications. Also see robotics.fau.edu

## 17. Course topical outline, including dates for exams/quizzes, papers, completion of reading

1. Intro to Robot and accessory parts
2. Electrical principles: Resistance and Ohm's Law, Capacitors, DC and AC signals, Kirchoff's Laws
3. Sensors: Infrared and Ultrasound, speed of light and sound, distance measurement with reflections, and transfer characteristics, nonlinearities, and optimal use. Analog and Digital In for sensor data reading.
4. Actuators: H Bridge and motor driver amplifiers and motors. Analog out (as PWM) for motor and wheel control. Speed estimation, distance traveled. Controlled angular turns with PWM. Use of Optical Encoder and Interrupts (implementations may not use these two advanced ideas).
5. Assembly of the robot and installation of a drawing pen. Strategies for assembly testing and calibration.
6. Programming Concepts: Analog and Digital In and Out; Algorithmic design of the geometric art; Divide and Conquer – Draw Line and Turn Angle. Use these repeatedly to implement. Use of Arduino's API library.
7. Discussion of Proposed geometric art.
8. Lab sessions for programming, troubleshooting, and implementing the proposed geometric art

Dates:        Team  and Individual Quizzes- During Weeks 1 to 5, once per week

      Team Video on a lab topic – Weeks 1 to 5

      Mid-Term exam – Week  8 (1 hour)

      Project Assignments – Weeks 9 to 13, one per week

      Design Report and Documentation – Due on last Friday of the Final Exam week

      Demo, Presentation, & Video – on Exam day at scheduled time (20 minutes)

**18.**  Technical Resolution Policy -  You will be using Blackboard tools for communication. On the Welcome page, once you log in, you have the option to 'Submit a Ticket' (see on the left hand side) to the Online Support Center. They may also be reached at 561-297-3999. However, they will not be able to help you with the installation and use of the tool suite used in the class. We have excellent tutorials at android.fau.edu and many on-line sites. First try these things and if you still have difficulties, feel free to contact Dr. Shankar.