Mechanics and Electronics:

ID-312 | Fall 2024

Monday/Wednesday 10:00-11:20 AM	Guttenberg Info Tech Center 1404
Professor Mathew Schwartz	cadop@njit.edu
OFFICE HOURS:	Monday 9:00-9:50 AM by appointment (Weston 675)

Overview:

In this revised course, students will focus on designing and building a beetleweight robot (1.5kg) starting from a Robot Car Kit. The course will introduce the fundamentals of mechanical design, electronics, and programming through hands-on experience with tools like Fusion 360 and Isaac Sim for virtual simulations. Students will learn to model a robot entirely in Fusion 360, create joints for simulated mechanical systems, and optimize at least one part using generative design or automated design features. The class will cover basic electronics, including the use of microcontrollers (Arduino Nano), motors, sensors, and wireless control.

By the end of this course, students will be equipped to:

- Design and simulate mechanical systems in Fusion 360 and Isaac Sim.
- Understand and apply basic electronics and microcontroller programming.
- Utilize 3D printing for creating chassis and weapon parts.
- Implement sensor-based automation and control systems.
- Present a fully functional robot with integrated mechanical, electronic, and control systems.
- Extra credit opportunities include setting up a physics simulation and robot control in Isaac Sim and participating in a virtual competition.

As the class is scheduled for the first semester of the second year, students should have ample time to apply the knowledge, or take additional classes to improve their knowledge before graduation. Additionally, the class will focus more on ensuring students reach a basic competency in various aspects of mechanics and electronics.

Students with disabilities or academic accommodations should see me at the start of the semester to discuss any needs as the letters from the Dean of Students does not always arrive in a timely fashion.

Semester Robot Project Outline

- Beetleweight = 1.5kg
- First modeled entirely in fusion
    - Create joints etc. to have simulated mechanical system in isaacsim
- Make at least one part with generative design, shape optimization, or 'automated design' fusion features
    - Chassis is an in-class example
- Must use the motors provided in the kit
- Use arduino nano for control
- Any chassis and weapons must be 3d printed
- Use provided RF controller
    - Individuals buy RF receiver
- Use at least 1 sensor to control something "useful", automatically
- Make an RGB LED show the robot status
    - Green - doing nothing but turned on
    - Yellow - driving
    - Red - using weapon
    - Blue - students choice (e.g. within certain distance of another robot, e.g. voltage sensor, rpm tachometer for weapon)
- Point system standardized

- Extra credit:
    - Setup physics simulation and control in isaacsim, with "blast" for breaking things, do competition in that software

Schedule

Week	Date	Topic	Information
1	Sept 4	Introduction to Robotics and Course Overview	Introduction to robotics, course objectives, and project overview. Introduction to the kit and tools (Fusion 360, Arduino Nano).
2	Sept 9, 11	Introduction to Fusion 360 and 3D Modeling	Basics of Fusion 360, modeling robot components, joints, and assemblies.
3	Sept 16, 18	Generative Design and Shape Optimization in Fusion 360	Using Fusion 360 features for optimizing robot parts.
4	Sept 23, 25	Robotics	Introduction to kinematics (URDF)
5	Sept 30, Oct 2	Isaac Sim Introduction and Setup	Basics of Isaac Sim, setting up robot simulation environments.
6	Oct 7, 9	Electronics Fundamentals	Introduction to electronic components and circuit diagrams. Hands-on soldering session.
7	Oct 14, 16	Actuators and Motors	Understanding motors and their integration into the robot design. Demo: Motor control using Arduino.
8	Oct 21, 23	Sensors and Input Devices	Analog vs. Digital Signals. Types of sensors, interfacing with Arduino, and practical applications.
9	Oct 28, Oct 30	Microcontroller Programming	Introduction to Logic (Truth Tables, Gates)
10	Nov 4, 6	Microcontroller Programming	Advanced Arduino programming and integrating with the robot's systems.
11	Nov 11, 13	Wireless Control and Communication	Implementing wireless control with the provided RF controller.
12	Nov 18, 20	Working Session	Prototype building and testing sessions.

13	Nov 25	Competition Preparation	Fine-tuning the robot design and preparing for virtual competition.
	Nov 30 Dec 2	**No Classes**	
14	Dec 2, 4	Competition Day	Presentation of robot design and functionality.
15	Dec 9, Dec 11	Final Presentations and Project Documentation	Final presentations and submission of project documentation and portfolio. Last day of classes.

Projects

Mechanical Project

Build a custom gear ratio and chassis mechanism to move a robot.

Electronics Project

Receive wireless signals to control LEDs, integrating a sensor as part of the logic.

Robot Project

Make a working robot with arduino, 3D printed chassis, and automated controls.

Submission

- The Projects are submitted on **CANVAS**,
- Canvas is used for grading. For COAD Students, all work submitted on canvas must be submitted on Kepler by the end of the semester to receive a grade (Defaults to F).

Grading:

10% Participation + Attendance

10% Exercise

10% Project 1

20% Project 2

30 % Project 3

20% Final Portfolio

Submission of Work: Per the School of Art & Design rules, all work must be uploaded to Kepler at the end of the year. A grade of **F** is given until this requirement is satisfied. Please note, I used to use an incomplete in the past, but the Dean of Students has made it clear that incompletes cannot be used for this.

Grading Criteria for Projects

Novelty

How unique is your project? Does it do something other projects do not (both in class and in the world)? Does it achieve something other people have not, or does it explain something unique?

Relevance

Is the project based on the guidance given in the class? Does it achieve the goals of the project? Is it related to Design (or Architecture)?

Submission

Are the submission guidelines followed? Are files named correctly?   This includes submitting all components.

Late Work:

Late work is accepted with a half letter-grade reduction for every 12 hours after the deadline. Please note this applies for all submissions after the deadline (even 1 minute late will be half a letter-grade, so you can use the next 12 hours to improve your submission). In the case of a presentation or quiz, this policy does not apply and make-up presentations are not accepted.

This policy will be held as-is without exceptions. No one should feel others in the class receive special treatment, or that they are being unfairly treated. Maintaining this clear guideline is one way to help foster that environment. The only exceptions to the late work policy occur when the Dean of Students (not the dean of the college), provides a medical/excused absence letter. However, in the interest of unexpected circumstances, there is a one-time-use 'get out of late card'-- 24 hour extension usable for one project submission (which cannot be applied to presentations meant to be done in front of the class).

Readings

Suggested readings will be provided, but no books are required for purchase. Most of the reading for this class will be decided by the student (under specific parameters) to individualize the reading to their project and interest.

Plagiarism

Plagiarism refers to text, visual, and intellectual property. Not citing work, misleading during a presentation or submission on where the idea came from, or using words from a paper without quotations will be reported to the dean of students.

Generative AI
The usage of artificial intelligence (AI) is permitted in this course and no citation is necessary. If you have any questions or concerns about AI technology use in this class, please reach out to your instructor prior to submitting any assignments.

Lates/Absents

Arrival to class on time, and remaining for the duration of class, is mandatory. Attendance is taken at the beginning of class. If a student is late they must notify the professor at the class break (1.5 hours after the start) and have their name recorded as late, or immediately at the end of class (for 1.5 hour classes). Not doing this will count as an absence and will affect the grade. For a 3 hour class, arrival later than 1.5 hours into class is recorded as absent. For a 1.5 hour class, arrival after 30 minutes is absent.

Remember, the college rules are provided below. Importantly, you have 3 "free" absences in which you do not have to worry about your grade.

University/College Rules

Academic integrity and honesty are of paramount importance in this class. The NJIT "University Code on Academic Integrity" will be upheld and any violation can, and will be, brought to the immediate attention of the Dean of Students by either a faculty member or student.

Regular attendance is expected. When possible, please give advance notice of your absence. NJIT requires attendance for ALL students. After 3 recorded absences, your grade will be lowered by ONE (1) letter grade for each additional absence, if you are not carrying a medical, school or religious related excuse. This means that any student who would have received an "A" will now receive a "B", a "B+" reverts to a "C+", etc. No excuses will be accepted without a written note from the Dean or a doctor. Students with particular needs and foreseen absences should present them to their instructor within the first week of class. Attendance for student athletes: No student athlete may miss any regularly scheduled classes for any practice activities. This means students can neither miss nor leave class early (or arrive late) to attend a practice. While student athletes may miss class when participating in intercollegiate competition, it is the responsibility of the student athlete to proactively inform the instructor well in advance to make appropriate arrangements to complete or make up any assignments or exams in a timely fashion.

Students with disabilities should see me at the start of the semester to discuss any needs. I strongly support students with accommodations to ensure OARS communicates them to me at the start of the semester, regardless if the student initially does not want to use those accommodations.

The syllabus is an outline for the class, and subject to change. Students are required to regularly check changes of the syllabus.

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at:

http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf*.*

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. **Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.** *If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at* dos@njit.edu*"*