New Jersey Institute of Technology
ENGR 330 Application of Microcontrollers and IoT devices

COURSE NUMBER	ENGR 330
COURSE NAME	Application of Microcontrollers and IoT devices
COURSE STRUCTURE	(2-2-3) (lecture hr/wk - lab hr/wk – course credits)
COURSE COORDINATOR/ INSTRUCTOR	Dr. J. Sodhi/ Prof. Amit Patel
COURSE DESCRIPTION	Microcontrollers are an integral part of many modern technological devices. This course will familiarize students to microcontrollers and its exciting applications in the fields of Internet of Things (IoT) and Robotics using a project-based hands-on approach. The microcontroller will be used as a component part of a broader design activity to introduce students to coding, logic, and automation in the wider context of product design. Students will work on multiple mini-projects to integrate a programmable system into a prototype such as a heart monitor, step counter, electronic scoreboard or a food temperature probe. Overall, this course will provide a basic understanding of software design and coding, microcontroller interfacing with sensors, actuators, motors etc., and robotics. Students will also develop modeling and prototyping skills and will be inspired towards making and service-learning.
PREREQUISITE(S)	None.
COREQUISITE(S)	None.
TEXTBOOK	Instructor's Lecture Notes
COURSE OUTCOMES (CO)	By the end of the course students should be able to: 1. Describe the hardware and software architecture of a typical microcontroller. 2. Explain sensors, actuators and motors and its interfacing with microcontrollers. 3. Explain the relationship between hardware and software and how they work together to accomplish a task. 4. Gain knowledge of IoT communication protocols and get familiar with internet security and other enabling technologies associated with IoT. 5. Develop and analyze flow charts and hardware schematics to deduce or describe the operation and functions of microcontrollers. 6. Use Python programming to program the microcontrollers and auxiliary equipment. 7. Design, implement and test microcontroller based programmable systems into multiple working product prototypes. 8. Apply written, oral, and graphical communication in both technical and non-technical environments; and identify and use appropriate technical literature 9. Function effectively as a member of a technical team.

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CLASS TOPICS

Basics of Microcontrollers, Sensors and Actuators; Internet of Things; Embedded Systems; Physical Computing; Python Programming: Variables, Lists, Loops, Functions, Dictionaries, Modules, Classes, Tuples, Slicing, Dictionaries; Micro:bit Buttons; Micro:bit Sensors; Micro:bit Radio Communication; Data Analysis; Data Visualization; Micro:bit: Data Collection and Analysis; Microbit: Programmable LEDs, Ultrasonic Sensors, Servo Motors.

STUDENT OUTCOMES

The Course Outcomes support the achievement of the following EAC Student Outcomes:

Student Outcome (1) - an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
Related CO – 1 thru 7
Student Outcome (2) - an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
Related CO – 7
Student Outcome (3) - an ability to communicate effectively with a range of audiences.
Related CO – 8
Student Outcome (5) - an ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives.
Related CO – 9
Student Outcome (6) - an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
Related CO – 7

GRADING POLICY

Programming HW & assignments	25%
Mini Projects	35%
Mid-Term Project	20%
Final Project	20%
ePortfolio (Bonus)	Up to 5%

ACADEMIC INTEGRITY

NJIT has a zero-tolerance policy regarding cheating of any kind and student behavior that is disruptive to a learning environment. Any incidents will be immediately reported to the Dean of Students. In the cases the Honor Code violations are detected, the punishments range from a minimum of failure in the course plus disciplinary probation up to expulsion from NJIT with notations on students' permanent record. Avoid situations where honorable behavior could be misinterpreted. For more information on the honor code, go to https://www.njit.edu/dos/university-code-academic-integrity

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GENERATIVE AI

Student use of artificial intelligence (AI) is permitted in this course for certain assignments and activities. It is not permitted to be used in the assignments noted by the instructor, as doing so would undermine student learning and achievement of course learning outcomes. Additionally, if and when students use AI in this course, the AI must be cited as is shown within the NJIT Library AI citation page for AI. 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.

STUDENT BEHAVIOR

- No eating or drinking is allowed at the lectures, recitations, workshops, and laboratories.
- Cellular phones must be turned off during the class hours – if you are expecting an emergency call, leave it on vibrate. No cell phone during exams
- No headphones can be worn in class. No video or audio recording.
- Unless the professor allows the use during lecture, laptops should be closed during lecture.
- During laboratory, if you are finished earlier, you must show the professor your work before you leave class
- Class time should be participative. You should try to be part of a discussion

GROUND RULES

1. Attending class, completing assignments on time, and keeping up with the class material is important for success in this course and in college. Generally, late or missed assignments will not be accepted except for legitimate (pre-approved when possible) reasons as determined by the instructor. Examples of legitimate reasons are: illness, death in family, etc. The method of handling late or missed work is determined by the instructor.
2. Missing more than 2 classes will lead to an 'F' grade in the course. Exceptions will only be made for cases of excused absences supported by relevant documentation submitted to and verified by the office of Dean of Students.
3. The class time is 6 pm – 10:05 pm, leaving early will be marked as an absence, if due to any issues you are not able to attend the listed class duration please register for a different section.
4. ANY FORM OF CHEATING ON ASSIGNMENTS, PROJECTS OR EXAMS WILL RESULT IN AN 'F' FOR THE COURSE. This includes looking at another person's exam or copying another person's work for exams or assignments.
5. Weekly assignments are due BEFORE the start of Lecture. Assignments turned in after the lecture starts are counted as late.
6. Assignments that are more than 2 weeks late will not be accepted.
7. Point deduction – Late Assignments: 1 week late -20%, 2 weeks late -30%
8. At least 70% of the mini projects have to be submitted for a passing grade.

9. Not submitting the midterm and final project will lead to an 'F' in the course.
10. Attendance, attitude, class participation and effort can and will be used to change borderline grades up or down.
11. For special allowances associated with disabilities student must approach the Disability Resource Center.

MODIFICATION TO COURSE The Course Outline may be modified at the discretion of the instructor or in the event of extenuating circumstances. Students will be notified in class of any changes to the Course outline.

CLASS HOURS

Thursday 6 – 10:05 PM GITC 2302

OFFICE HOURS (TBD)

By appointment: amit.patel@njit.edu

GRADING LEGEND

GRADE	NUMERIC RANGE
A	90 to 100
B+	85 to 89
B	80 to 84
C+	75 to 79
C	70 to 74
D	60 to 69
F	0 to 59

NJIT ONLINE INFORMATION

The instructor will discuss these requirements on the first day of the course and/or post on their Learning Management System (LMS). Please become familiar with:

- Canvas: https://canvas.njit.edu/
- Zoom: https://njit-edu.zoom.us/
- Online Proctoring: https://ist.njit.edu/online-course-exam-proctoring

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COURSE OUTLINE

WEEK	TOPIC
1	Basics of Microcontrollers, Sensors and Actuators Introduction to the Internet of Things, Embedded Systems and Physical Computing
2	Python Programming: Variables, Lists, Loops. Micro:bit Buttons
3	Micro:bit Sensors: Accelerometer, Thermometer and Light Sensors, Compass, Speaker, I/O Pins
4	Python Programming: Functions, Lists, Dictionaries. Micro:bit: Radio Communication.
5	Makerspace Trainings, Mini Project I
6	Python Programming: Modules and Classes. Stop:bit Traffic Light. Mini-Project II
7	Microbit: Programmable LEDs, Ultrasonic Sensors, Servo Motors.
8	**MIDTERM EXAM**
9	Python Programming: Tuples, Slicing and Dictionaries. Data Analysis using Python Libraries – Numpy, Matplotlib
10	Data Analysis using Python Libraries – Numpy, Matplotlib Data Visualization using Python using Pandas, Mini-Project III
11	Micro:bit: Soil Moisture Sensor. Collecting and Analyzing Data using Accelerometer. Relays. Mini Project – IV.
12	Micro:bit: Smart homes – temperature, humidity, analog gas sensors, PIR motion sensor. Mini Project – V
13	Make-up week/Work on Final Projects/Extra Robotics Project
14	**FINAL PROJECT PRESENTATIONS**

Final Project

Students will work as a team on a final project where they will use all the skills acquired over the semester to either build upon and improve one of the mini-projects or come up with a new project that utilizes programmable components and microcontrollers.