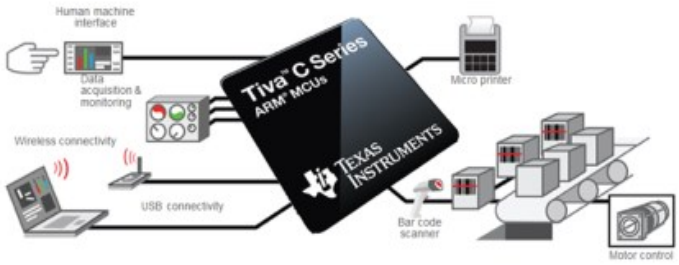
Microcontroller Project Laboratory



Mr. David McLoda
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Remind notifications: go to rmd.at/robomcloda or text @robomcloda to the number 81010

The goal of the Microcontroller Project Laboratory is for students to design and build microcontroller based projects, including robotics. Students will use a variety of microcontroller development boards including the Arduino, Raspberry Pi, LEGO EV3, and Texas Instruments Tiva LaunchPAD.

Although the focus is primarily on electronics, there will be an emphasis on the engineering design process and strategies for effective communication.

In the first semester, teams of students will use LEGO EV3 robotics kits to design and build mobile robots to complete a series of challenges.

In the second semester, students learn the fundamentals of embedded design in the same way an electrical engineering undergraduate student would in college. Students view university lectures online and then build projects in class with instructor help. At the end of the semester each student will have built and programmed a handheld device from basic components. Students then work in teams to explore the "internet of things" by designing and building a unique device. Students will keep a detailed record of their progress and manage their own projects.

Students will prepare themselves for an engineering career by creating **four products**:

1. Prototype Device – the working end product (group project)
2. Lab Book – handwritten entries kept on a daily basis
3. Portfolio – online repository of coursework
4. Business Plan – use software and template to justify the use and marketability of the product

In the process of creating the above products students will develop **five important engineering skills**:

1. Microcontrollers – interface a microcontroller to digital and analog inputs and outputs
2. Electronics – build sensors and use a prototyping breadboard to interface with the outside world
3. Hardware – use of motors, servos, and pneumatics to animate your project
4. Tools – solder parts, drill, cut, and shape your project to your specifications
5. Programming – use special software to design your product, and program your microcontroller using embedded design techniques.

In addition, students develop **two broad skills**:

1. Communication and Collaboration
2. Project Management

KEEP THIS IN THE FRONT OF YOUR BINDER AT ALL TIMES

Students will be able to cite this unique course in their resumes. Entries will show that the student was involved in a rigorous course requiring a great deal of initiative, creativity, and hard work.

EXAMPLE:

Aug 2018 – Jun 2019 Microcontroller Project Laboratory Dallas, Texas

- Used microcontrollers and embedded programming techniques to design and build *a voice controlled robotic arm.* Learned modeling software, 3-D printing techniques and other engineering tools.
- Managed a small product development team working with mentors from research and engineering firms. Met all benchmarks and deadlines set by the instructor by conducting meetings and build sessions outside of class.
- Created a business plan, made frequent presentations, and participated in peer review and feedback. Successfully defended the feasibility and marketability of our product.

Curriculum Schedule (adapted from Valvano, www.edx.org)

Module 1: Welcome and introduction to course and staff

Module 2: Fundamental concepts: numbers, computers, and the ARM Cortex M processor
Example. Develop a system that toggles an LED on the LaunchPad
Lab 2. Run existing project on LaunchPad with switch input and LED output

Module 3: Electronics: resistors, voltage, current and Ohm's Law

Module 4: Digital Logic: transistors, flip flops and logic functions
Lab 4. Debug a system with two inputs and two outputs

Module 5: Introduction to C programming
Example. Develop a system that inputs and outputs on the serial port
Lab 5. Write a C function and perform input/output on the serial port

Module 6: Microcontroller Input/Output
Example. Develop a system that inputs from a switch and toggles an LED output
Lab 6. Write C software that inputs from a switch and toggles an LED output

Module 7: Design and Development Process
Example. Develop a system that outputs a pattern on an LED
Lab 7. Write C functions that inputs from a switch and outputs to two LEDs, which is a simulated pacemaker

Module 8: Interfacing Switches and LEDs
Example. Develop a system with an external switch and LED
Lab 8. Interface an external switch and LED and write input/output software.

Module 9: Arrays and Functional Debugging
Example. Develop a system that debugs by dumping data into an array
Lab 9. Write C functions using array data structures that collect/debug your system.

Curriculum Schedule (Cont'd)

Module 10: Finite State Machines
Example. Develop a simple finite state machine
Example. Develop a vending machine using a finite state machine
Example. Develop a line-tracking robot using a finite state machine
Example. Develop a stepper motor robot using a finite state machine
Lab 10. Interface 3 switches and 6 LEDs and create a traffic light finite state machine

Module 11: UART - The Serial Interface, I/O Synchronization
Example 11. Develop a communication network using the serial port
Lab 11. Write C functions that output decimal and fixed-point numbers to serial port

Module 12: Interrupts
Example 12. Develop a system that outputs a square wave using interrupts
Example 12. Develop a system that inputs from a switch using interrupts
Example 12. Develop a system that outputs to a DC motor that uses pulse width modulation
Lab 12. Design and test a guitar tuner, producing a 440 Hz tone

Module 13: DAC and Sound
Example 13. Develop a system that outputs analog signal with a R-2R digital to analog converter
Lab 13. Design and test a digital piano, with 4 inputs, digital to analog conversion, and sound

Module 14: ADC and Data Acquisition
Example 14. Develop a system that inputs an analog signal with an analog to digital converter
Example 14. Develop an autonomous robot that uses two DC motors and two distance sensors
Lab 14. Design and test a position measurement, with analog to digital conversion and calibrated output

Module 15: Systems Approach to Game Design
Lab 15. Design and test a hand-held video game, which integrates all components from previous labs.
Module 16: Wireless Communication and the Internet of Things
Lab 16. Connect a CC3100 booster pack to the LaunchPad and communicate with an access point. Lab 16 will not be graded, but we will provide a way for you communicate with a class server

Required Supplies
- Graph Composition Notebook (5x5 ruled, 100 sheets, 9 ¾ x 7 ½ in.)
- Blue, black and red pens
- Headphones

Class Rules:
1. Bring the required materials every day
2. Follow directions and lab procedures exactly
3. Stay on task
4. Do your own work (participate in class, never copy someone else's work)
5. No food, No phones (You **must** turn in your phone at the beginning of class)
6. No disruptions, No distractions (**Do not** work on other class's assignments, college essays, etc.)

Grading:
- 40% Daily Work (Homework, Classwork)
- 20% Projects (Labs, Projects)
- 25% Major Grades (Tests)
- 15% Six Weeks Test

- Important assignments may be counted in more than one category.
- Late work is **NOT ACCEPTED unless you have an excused absence.**
- **Parent Portal.** Every student is expected to register and access Parent Portal to keep up with grades and attendance online.

Beginning of Class:

1. **Cell phones must be deposited at the front of the room every day.**
    a. You will not be counted present until your phone is deposited.
    b. In the case of cell phone use in class, student will receive a grade of zero and the phone will be taken up and immediately turned into the office.
2. Take any handouts that are displayed near the door.
3. Check the board for the day's Agenda, Objective, and DOL (Demonstration of Learning).
4. Immediately complete the warm-up or quiz. Timed quizzes often cover the previous night's homework or reading. Quizzes will start exactly on the tardy bell, so be in your seat ready.
5. Do not take out any food while in the classroom, including snacks. Only water in reusable bottles is allowed.

End of Class:

1. Put away your materials, cleanup the work area, turn in applicable work, and gather your belongings.
2. Throw away any trash left behind on the tables or the floor even if it's not yours.
3. Put all chairs and furniture back in their original position.
4. **Return to your seat to await dismissal**.
5. At the end of the period please remain in your seat until I dismiss the class. **Do not line up at the door** at the end of the class period.
6. When required, write a summary and/or **complete the DOL** for the day's lesson.

Lectures, Discussions, and Guided Notes:

1. During class lectures or discussions, remain in your seat and **pay full attention**. You should not be talking, doing work for other classes, or engaging in any other activity that distracts from learning.

2. **Guided notes** or **study guides** are provided. You are required to follow along and use handwritten notes to add information, comments, questions, and calculations. **Keep your laptops away** – handwritten notes help you learn the material better. Study guides outline the material that will be tested and will be collected for a grade on exam day.

Note: Portions not done in class must be finished on your own before the exam day.

Only class materials are allowed on the tables. Keep backpacks and personal items off the tables and out of the aisles.

Turning in Assignments:

1. The following information must appear on the top of all assignments
    a. First and Last Name
    b. Date
    c. Class period
2. Turn in all papers to the "Assignment Box" unless directed otherwise.
3. **Late work is not accepted unless you have an excused absence**.

Restroom/Water breaks:
Students should not enter the room until they have taken care of all social and restroom needs. **Under no circumstances can a student leave the room in the first or last 15 minutes of class.**

Tests:
If a student is absent the day before the test, he/she is still expected to take the test as scheduled. If you miss the day of a test, you are expected to take it the day you return. **The makeup test may consist of a different format and could be more difficult.**

Lab:
Students must follow all laboratory and safety rules. Students must stay in their assigned lab group. Safety rules will be discussed in detail and provided to the student. Before a student is allowed to work in lab, a safety contract must be signed by the student and a parent and returned.

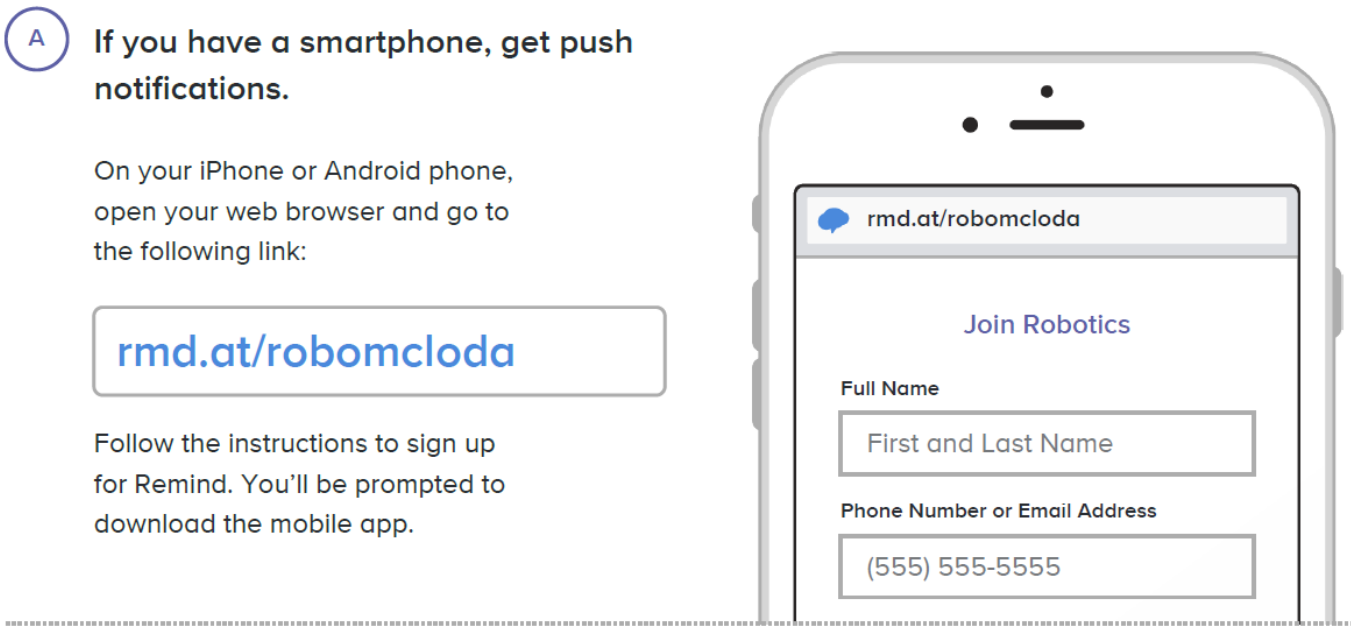
Required Reading and Videos: Students are required to prepare for class by reading the assigned textbook and viewing the required video lessons before class. There will be a quiz after each reading and/or assigned video during the next class period.

Computer Access: Many lessons and activities rely on technology-based instruction. **During class time, students are allowed to access only the websites approved by the teacher.**

Printing in the classroom is not allowed.

Honesty: **Cheating on tests, copying homework or plagiarism will not be tolerated.** Any student caught cheating **or helping another student cheat** will receive a grade of zero without possibility of a make-up grade. Cheating also results in an automatic office referral and phone call to your parents.

Progress Reports: Detailed grade reports are available online at Parent Portal. However, every three weeks printed progress reports will be issued to students. **Students are required to have a parent view and sign each progress report.**



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If you don’t have a smartphone, get text notifications.

Text the message @robomcloda to the number 81010.

If you’re having trouble with 81010, try texting @robomcloda to (972) 961-7412.

** Standard text message rates apply.*

Don’t have a mobile phone?
Go to rmd.at/robomcloda on a desktop computer to sign up for email notifications

Complete and Return

Student: I have read and understood the policies, classroom discipline plan, and safety guidelines. I will honor them as a student under Mr. McLoda's instruction. **I agree to keep track of my own grades on Parent Portal and get all my Progress Reports signed by a parent.**

_____ _____

(*Student Signature)* ***Date***

_____

Name (PRINTED)

Parent/Guardian: My child has discussed the policies and classroom discipline plan with me. I understand them and will support them**. I agree to keep track of my child's grades on Parent Portal and review and sign each Progress Report.**

_____ _____

(*Parent/Guardian Signature)* ***Date***

_____

Name (PRINTED)

CONTACT INFORMATION – Please fill out completely and bring to class.

Student's email (that you actually use)_____

Father/Guardian's Name _____

Phone:_____Email_____

Mother/Guardian's Name _____

Phone:_____Email_____

<u>Parents/Guardians, provide the information below to earn your child 20 bonus points.</u>

Is there anything you would like me know about your child? Please explain:

_____
_____
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_____

USE BACK TO ADD MORE INFORMATION or E-mail *dmcloda@dallasisd.org*