



Introduction to Principles and Application of Electromagnetism

Teachers Guide & Unit Lesson Plans

UNIT 4

Arduino Design Project Focused on Application of EM

Introduction to Robotics, Design and Arduino | Chapter 1: Lessons 1–4

4.1. Introduction to Robotics

Generate discussion on robots by asking students the question: “What is a robot and why do we need them?” Students should be able to identify the different types of robots and ways they are used during the discussion.

4.2. The Engineering Design Process

Students learn about best practices in engineering design as well as what it means to work as a team.

4.3. Microcontrollers and CPUs

Students learn about the fundamental hardware that allows for the function of robots; this is the central processing unit (CPU).

4.4. Arduino Microcontroller board, Applications and Examples

Following the previous lesson students learn about the Arduino microcontroller board.

Review of Electric Circuits & Arduino Board | Chapter 2: Lessons 5–8

4.5. Electricity, Voltage and Current

Review of the basics of electric circuits and the different approaches of coupling external circuitry with the Arduino devices through breadboard experiments.

4.6. Fundamentals of Circuits

Students learn how to build circuits and to follow basic rules using these components.

4.7. Continuation of Electric Circuits Voltage Dividers

Students learn about voltage dividers and potentiometers.

4.8. Continuation of Electric Circuits (I/O)

Students review concepts learned and in particular the differences between Arduinos’ Input and Output (I/O), and between analog and digital signals.

Computer Programming - Arduino Software | Chapter 4: Lessons 9–12

- 4.9. [Arduino Software–Hello World Program](#)
Overview of basic computer programming and the use of Arduino software.
- 4.10. [Variables, Arithmetic Operations, logical Operations](#)
Students learn how to define variables and different data types (e.g., int, string, float, etc.).
- 4.11. [Conditional Statements, Loops and Iterations](#)
Students learn the use of conditional statements when programming.
- 4.12. [Functions and Calls](#)
This lesson introduces functions, an especially useful tool in programming.

Robot Design & Build | Chapter 5: Lessons 13–16

- 4.13. [Robot Skeleton Chassis](#)
Students learn the various chassis designs and how they differ from robot to robot depending on the primary function of the bot.
- 4.14. [Sensors, Actuators, and Controller](#)
Students learn how the controller of their robots operate and learn how robots’ “sense” the world around them as well as make physical maneuvers.
- 4.15. [Gears and Mechanical systems](#)
Students are introduced to gears an important engineering element.
- 4.16. [Robot Mechanics and Design Models](#)
Overview of the design models for different types of robots.

Robot Design & Build—Advanced Topics | Lessons 17–20

- 4.17. [Robot navigation](#)
Students cover topics regarding robot navigation (sensing distance and direction).
- 4.18. [Line Following Algorithms](#)
Students learn algorithms allowing for automated guided robots capable of following a visual line or pattern.
- 4.19. [Reading external voltages into Arduino Demo](#)
Students are shown how Arduino can be used to read in voltage from a hand crank generator.
- 4.20. [Review and Closing](#)
Students engage in discussion and questions related to course topic of electromagnetism and its applications as explored through the various course projects and what they have learned about its current in the real world and future possibilities.

Unit 4 Teachers Guide (PDF of all Unit 4 lesson plans)

STUDENT WORKSHEETS & HANDOUTS

- A. **Understanding Breadboards (Pptx)**–Lesson 4.3
- B. **Circuit Analysis (Pptx)**
- C. **Computer Programing**–Lessons 4, 9, 10, 11, 12
- E. **Arduino Software Introduction**–Lesson 4.9 Worksheet
- D. **Arduino Cheat Sheet**
- F. **Unit 4 Vocabulary List**

Additional Instructional Notes:

Lesson 4.1 – Student Worksheet

Lesson 4.2 – *Students should build teams or pairs and begin brainstorming what engineering problem they want to solve.*

Lesson 4.3 – *Students should be shown examples of premade functioning Arduino devices to complement the learning of microcontrollers and CPUs.*

Lesson 4.4 – *Access to computers, tablets, or laptops so students can learn to install programs for Arduino programming.*

Lessons 4.5-4.8 – Interactive learning experiment.

Lesson 4.9-4.12 – *Hands-on demo interfacing Arduino and IDE: “Do This” sections are hands on demo that require students to have Arduinos and laptops for programming assignments. Assignments: Led Polarity, Lightshow, Light Loop, Temperature Sensor*

Lessons 4.13-4.16 – *Students should have begun designing their own robots and will learn the mechanics through handout or power point.*

Lessons 4.17-4.20 – *See PowerPoint and hands-on programs for advanced discussion.*

INSTRUCTIONAL RESOURCES

A. Presentation Slides, References & Unit 4 Quiz:

Basic slides can be customized and tailored to the instructor's preference.

1. Understanding Breadboards Lesson 3.pptx
2. Circuit Analysis.pptx
3. Computer Programming Lessons 4, 9, 10, 11, 12.pptx
4. Arduino Cheat Sheet
5. Unit 4 Arduino-based Project Vocabulary List (5a. PDF; 5b. Word doc)
6. Unit 4 Quiz
7. Unit 4 Quiz Graphics

B. MESA Arduino Project Booklet and Project Examples:

1. MESA Project Booklet
 2. MESA NEDC Arduino STEM Solutions Competition Overview & Guidelines (2017-18)
 3. MESA NEDC Arduino STEM Solutions Competition CA Addendum (2018-19)
 4. MS Stick-Together
 5. HS Civil-Structures
 6. HS MESA-Machine
 7. HS Prosthetic-Arm
 8. HS Ultimate-Disc-PILOT
 9. HS MESA Think Tank
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