

# S.T.E.M. Integrated Robotics Detailed Outline

## Unit 1: An Introduction to Drones

Time: 4 Days

### Lesson 1.1 Introduction to MINDS-i

Time: 1 days

#### Concepts

1. A brief intro of how MINDS-i defines STEM education and STEM Integrated Robotics, includes a short description of each of the units included in the curriculum.

#### Performance Objectives

*It is expected that students will:*

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### Lesson 1.2 Student Performance Development Process

Time: 1 days

#### Concepts

1. An explanation of the Student Performance Development Process that is to be used to grade the student. Inspired by Tony Wagner, author of The Global Achievement Gap, focusing on the seven survival skills for the new world.

#### Performance Objectives

*It is expected that students will:*

- Understand the criteria that they will be graded on for the class term.

### Lesson 1.3 What is a Drone?

Time: 1 days

#### Concepts

1. A drone is an unmanned aircraft, vehicle or ship that can navigate and perform complex tasks autonomously
2. Drones are primarily grouped based on their method of propulsion (how they move through their environment) such as a UAV - Unmanned Aerial Vehicle, UGV - Unmanned Ground Vehicle or a AUV - Autonomous Underwater Vehicle.
3. Drones can also be grouped based on their primary function, national defense, commercial use, personal use, space exploration, etc...

#### Performance Objectives

*It is expected that students will:*

- Identify examples of related real-world applications or careers

## Unit 2: UGV - Unmanned Ground Vehicles

Time: 10 Days

### Lesson 2.1 Unmanned Ground Vehicles

Time: 1 days

#### Concepts

1. Familiarization with ground based drones, including practical uses of the technologies

#### Performance Objectives

*It is expected that students will:*

- Demonstrate the various uses of UGV's and the associated technology
- Understand the importance of Drones and the roles they play in modern life

### Lesson 2.2 Parts & Purposes

Time: 1 days

#### Concepts

1. Recognizing an object from a detailed description

#### Performance Objectives

*It is expected that students will:*

- Match the correct image of an item to the description

### Lesson 2.3 UGV Chassis Build

Time: 10 days

#### Concepts

1. Building a complex system as a team
2. Organization and Housekeeping
3. Gaining understanding of what the chassis is capable of doing

#### Performance Objectives

*It is expected that students will:*

- Construct a working ground drone chassis

## Unit 3: Electrical Engineering & Energy Transfer

Time: 7 Days

### Lesson 3.1 Energy Types & Transfer

Time: 1 days

#### Concepts

1. Energy comes in many forms including, Chemical, Electrical, Mechanical, Heat and Light
2. Energy can be transferred / transformed into a different type

### **Performance Objectives**

*It is expected that students will:*

- Demonstrate understanding of the various types of energy in the robot system
- Demonstrate understanding of the principles of energy transfer, and apply them to the paths of energy transfer within the robot, such as: chemical, electrical, mechanical and heat

## **Lesson 3.2 Parts & Purposes**

Time: 1 days

### **Concepts**

1. Recognizing an object from a detailed description

### **Performance Objectives**

*It is expected that students will:*

- Match the correct image of an item to the description

## **Lesson 3.3 Electric Motors**

Time: 2 days

### **Concepts**

1. An electric motor converts electrical energy into mechanical energy (motion) through the interaction of magnetic fields
2. The energy that is not transformed into motion is lost due to friction (mechanical) and resistance (electrical)
3. Electrical “friction” is called resistance, the amount of resistance can be calculated if you use Ohm’s Law:  $R = V / \text{AMP}$  or  $\text{AMP} = V / R$

### **Performance Objectives**

*It is expected that students will:*

- Gain an understanding of various forms of energy loss, from both mechanical and electrical systems

## **Lesson 3.4 Volts, Amps & Watts**

Time: 1 days

### **Concepts**

1. Volts is the amount of electrical potential between two points
2. Amps is the number of electrons flowing past any given point in a circuit
3. Watts is a unit of measure of work in an electrical system
4. Discovering the relationships between Volts, Amps and Watts

### **Performance Objectives**

*It is expected that students will:*

- Calculate relationships between amps, volts and watts, through the utilization of division and multiplication of fractions and decimals

## **Lesson 3.5 Batteries**

**Time: 1 days**

### **Concepts**

1. A battery is a device that stores and transforms chemical energy into electrical energy
2. Batteries are composed of two base materials, one with a Positive charge (+) and the other with a Negative charge (-) when connected together electrons flow from one side to the other
3. The imbalance between the two comprises the potential energy of the battery

### **Performance Objectives**

*It is expected that students will:*

- Calculate a comparative study to determine the difference in the amount of amps (electrons) needed to propel the robot under “no-load” and with drive train “simulated-load”; interpret information and draw conclusions based on analysis
- Conduct electrical tests to determine the number of amps (electrons) needed to propelling the robot at full speed, and will calculate battery life and battery charge time

## **Unit 4: Drone Code & Sensors**

**Time: 7 Days**

### **Lesson 4.1 Testing the MicroController**

**Time: 1 days**

#### **Concepts**

1. Familiarization with Micro-controller set-up and operation including menus, buttons, opening and saving new programs

#### **Performance Objectives**

*It is expected that students will:*

- Demonstrate the ability to check for proper instillation of the Arduino program and the MINDS-i Dashboard

### **Lesson 4.2 Parts & Purposes**

**Time: 1 days**

#### **Concepts**

1. Recognizing an object from a detailed description

#### **Performance Objectives**

*It is expected that students will:*

- Match the correct image of an item to the description

## **Lesson 4.3 Core Syntax Review**

Time: 1 days

### **Concepts**

1. Familiarization with the parts that make up a program (Core Syntax) including setup, loops, comments, start and end brackets, etc.

### **Performance Objectives**

*It is expected that students will:*

- Review and demonstrate understanding of the basic Syntax used in the arduino programming language

## **Lesson 4.4 Drone Technologies Part I**

Time: 1 days

### **Concepts**

1. Familiarization with drone technology, sensors and their operation

### **Performance Objectives**

*It is expected that students will:*

- Demonstrate understanding of the basic technologies that are required to make a drone function

### **Lesson 4.4.2 Compass Heading**

Time: 1 days

#### **Concepts**

1. Determining a magnetic heading vs a map heading and converting from one to another

#### **Performance Objectives**

*It is expected that students will:*

- Build a compass fixture and modify a code to keep the compass facing a specific direction
- Demonstrate understanding of the difference between magnetic heading and true north

### **Lesson 4.4.3 Gyro & Accelerometer**

Time: 1 days

#### **Concepts**

1. Orientation detection and correction
2. Comparing the “noise” of the accelerometer to the “drift” of the gyro
3. Combining the accelerometer and gyro to compensate for each other

#### **Performance Objectives**

*It is expected that students will:*

- Build a gimbal and tune the code to balance the platform

### **Lesson 4.4.4 UGV Drone Build**

Time: 1 days

#### **Concepts**

1. Familiarization with the capabilities and performance of the Ground Drone chassis.

#### **Performance Objectives**

*It is expected that students will:*

- Assemble and wire the UGV drone kit to the chassis they selected
- Perform various manual driving tasks with the selected chassis

### **Lesson 4.4.5 Power Level Monitoring**

Time: 1 days

#### **Concepts**

1. Selection of target waypoints and how the terrain will effect performance of the rover

#### **Performance Objectives**

*It is expected that students will:*

- Demonstrate understanding of power consumption through various terrain

### **Lesson 4.5 Drone Technologies Part II**

Time: 1 days

#### **Concepts**

1. Further familiarization with drone technology, sensors and their operation
2. Utilizing GPS waypoints to navigate a drone through various terrain

#### **Performance Objectives**

*It is expected that students will:*

- Demonstrate understanding of the basic technologies that are required to make a drone function
- Plot a course utilizing GPS waypoints

### **Lesson 4.6 Waves & Information Transfer**

Time: 1 days

#### **Concepts**

1. Familiarization with waves including, mechanical waves, electromagnetic waves, wavelength, rarefaction and telemetry sensors and their operation

#### **Performance Objectives**

*It is expected that students will:*

- Design and construct an alternate ping sensor layout for the UGV chassis and program it to perform a specific task

## Unit 5: Applied System Thinking

Time: 13 Days

### Lesson 5.1 Systems Thinking

Time: 1 days

#### Concepts

1. Systems are all around us, they are within us, and they make up everything we see (or don't see) in the physical universe
2. Any system may be thought of as containing subsystems, and as being a subsystem of a larger system
3. Systems have boundaries, that are sometimes hard to define, depending on the level being observed
4. Systems have inputs and outputs, Systems can be open or closed
5. Components within a system rely on "interdependent" relationships
6. Systems break down when the relationships between components becomes unbalanced or broken
7. Systems contain constraints, often they are the limiting factor on the performance as a whole
8. Optimization is the goal of all natural systems, man made systems have to be studied to learn what to change to be better optimized.

#### Performance Objectives

*It is expected that students will:*

- Demonstrate understanding of the different aspects of a system
- Identify and label the components and relationships in a system including constraints

### Lesson 5.2 Interrelationship Diagram

Time: 1 days

#### Concepts

1. Identify, Understand and Label the interrelating Inputs and Outputs between components in a system
2. Identify, Understand and Label the Constraints between components in a system
3. Understand how the components work together as a system, making the whole greater than the sum of the parts.

#### Performance Objectives

*It is expected that students will:*

- Demonstrate understanding of the different aspects of a system
- Identify and label the components and relationships in a system including constraints

## Unit 6: Physics of Flight

Time: 8 Days

### Lesson 6.1 Physics of Flight

**Time: 3 days**

### **Concepts**

1. Basic principals of flight including, Lift, thrust, drag and gravity
2. Airfoil design principals, Flow Deflection, Angle of Attack, Pitch and Airfoil shape

### **Performance Objectives**

*It is expected that students will:*

- Be able to correctly identify the forces that are acting upon an airfoil
- Solve basic word problems involving UAV payload, flight time and lift

## **Lesson 6.2 UAV Build**

**Time: 3 days**

### **Concepts**

1. Building a complex system as a team
2. Organization and Housekeeping
3. Gaining understanding of what the chassis is capable of doing

### **Performance Objectives**

*It is expected that students will:*

- Construct a working air drone chassis

## **Unit 7: Unmanned Aerial Vehicles**

**Time: \_\_ Days**

### **Lesson 7.1 Unmanned Aerial Vehicles**

**Time: \_\_ days**

#### **Concepts**

1. Familiarization with aerial based drones

#### **Performance Objectives**

*It is expected that students will:*

- Demonstrate the various uses of UAV's and the associated technology
- Understand the importance of Drones and the roles they play in modern life

### **Lesson 7.2 Flight Dynamics**

**Time: \_\_ days**

#### **Concepts**

1. Familiarization with frame configurations



2. How manual controls affect flight
3. Contra and counter rotation propellers
4. Gyro effect and how it is used
5. Use of a simulator as both a training tool and as a method of performance assessment

### **Performance Objectives**

*It is expected that students will:*

- Gain understanding on how to operate the controls for proper flight of the UAV airframe
- Practice manual flight of a multirotor in a simulated environment

## **Lesson 7.3 Auto Pilot & PID**

Time \_\_ days

### **Concepts**

1. Familiarization with UAV Auto Pilot Functions
2. Basics of PID tuning

### **Performance Objectives**

*It is expected that students will:*

- Build a PID test rack and tune the MultiRotor PID for optimal flight characteristics

## **Unit 8: Culminating Project**

Time: \_\_ Days

### **Lesson 8.1 Preparing for The Challenge**

Time: \_\_ days

### **Concepts**

1. Development of a project plan to keep track of progress compared to goals
2. Effective use of interpersonal skills
3. Proper communication
4. Group productivity

### **Performance Objectives**

*It is expected that students will:*

- Develop a project plan with specific goals and responsibilities and apply what has been learned to combine, develop and optimize a software program that is capable of
- Manually switching between manual and autonomous navigation through the micro-controller
- Autonomously switching between ultrasound sensors and QTI (line follower) sensors
- Use the time allotted to refine and adjust the robot design as well as programming to complete the presented challenge

## Lesson 8.2 Cleanup/ Organizing

Time: \_\_ days

### Concepts

1. Organization / Housekeeping

### Performance Objectives

*It is expected that students will:*

- Disassemble the MINDS-i kit accounting for all of the parts then organize into bins/totes for storage or the next class to use.

