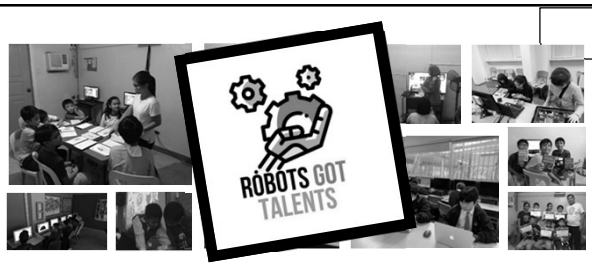
COURSE STUDENT ZONE

This is Robots Got Talents Students Zone, here you will find all the course topics, activities and explanation guides, We wish you enjoy the course, Good Luck

Lesson One	Lesson Two
Lesson Three	Lesson Four
Lesson Five	Lesson Six
Lesson Seven	Course Quiz

PLEASE CHECK THAT YOUR DEVICE CONTAINS THE FOLLOWING SOFTWARE/S:

LEGO DIGITAL DESIGNER SOFTWARE	L-DRAW SOFTWARE	VIRTUAL ROBOTICS TOOLKIT
DOWNLOAD	DOWNLOAD	DOWNLOAD



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Virtual Robotics Toolkit

The Virtual Robotics Toolkit (VRT) is a software from Cogmation Robotics. VRT is a virtual simulator for Mindstorms EV3 & NXT, complete with accurate physics that allow the robot in virtual world to behave exactly like a physical one in real life! You can design your own robot using LEGO Digital Designer (LDD), import it into the software and then control it within the software. You can program the virtual robot using the same LEGO Mindstorms programming environments (EV3-G, NXT-G) to make your new virtual robot come to life.

SPECIAL THANKS TO:

COGMATION ROBOTICS

Justin Papoff
Priyanka Tuteja

From Cogmation Robotics for helping us creating this course.

COURSE INTRODUCTION:

STEM HERO Deluxe with Virtual Robotics Toolkit is a Classroom Course by Robots Got Talents™ for Elementary and Middle school students. Throughout this course participants will learn about Robotics, Programming and AI as They Design and Program their on-screen MINDSTORMS EV3 Robots using Virtual Robotics Toolkit, LEGO DIGITAL DESIGNER and MICROSOFT MAKECODE.

STEM HERO Deluxe consists of 7 main lessons that cover the following topics:

- Robotics Introduction
- Robots Uses & Types
- Lego Mindstorms Introduction
- Mindstorms Ev3
- Main Mindstorms Technic Pieces
- EV3 Motors & Sensors
- VRT User Interface & Remote Control
- Motor Blocks
- Sensor Blocks
- Display Blocks
- Sound Blocks
- Loop Blocks
- Lego Digital Designer
- LDD Models & Controls
- Importing LDD Models to VRT
- Attachment Manager
- Port View
- Microsoft MakeCode Programming UI
- STEM HERO COURSE QUIZ

[redacted]

- Robotics Introduction
  Book Page/s: 3-8
- Robots characteristics
  Book Page/s: 3-4
- Types of robots/Robots Uses
  Book Page/s: 4-7
- Lego Mindstorms Introduction
  Book Page/s: 9-10

STEM HERO
MICROSOFT MAKECODE EDITION

WHAT IS THE FIRST THING THAT COMES TO MIND WHEN YOU THINK OF A ROBOT?

For many people it is a machine that imitates a human—like the androids in Star Wars, Terminator and Star Trek: The Next Generation. However much these robots capture our imagination, such robots still only inhabit Science Fiction. People still haven't been able to give a robot enough 'common sense' to reliably interact with a dynamic world. However, some people all over the world are working on creating such humanoid robots.

The type of robots that you will encounter most frequently are robots that do work that is too dangerous, boring, onerous, or repetitive. Most of the robots in the world are of this type. They can be found in auto, medical, manufacturing and space industries. In fact, there are over a million of these types of robots working for us today. but It is totally wrong to define Robots as machines that do our work or help us finish dangerous tasks, like many simple machines, could just do that for instance, Microwave heaters deals with harmful microwaves and they are not counted as Robots and the crane lifts heavy objects which a human could never deal with and they are defined as robots

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A ROBOT HAS THESE ESSENTIAL CHARACTERISTICS:

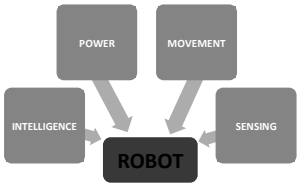
As strange as it might seem, there is no standard definition for a robot. However, there are some essential characteristics that a robot must have and this might help you to decide what is and what is not. It will also help you to decide what features you will need to build into a machine before it can count as a robot.

SENSING: Using the Sensors the robot should be able to sense its surroundings by one or more methods

MOVEMENT: Using Motors the robot should be able to move in its environment

POWER: Using the Power Source the robot should be able power itself

INTELLIGENCE: Using the Microcontroller (Robot's Brain) the robot should be able to take decisions according to its program



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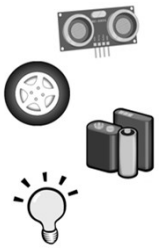
SENSING: First of all a robot should be able to sense its surroundings It would do this in ways that are not similar to the way that we sense our surroundings, but robots need sensors to do that. Giving your robot sensors as light sensors (eyes), touch and pressure sensors (hands), chemical sensors (nose), hearing and sonar sensors (ears), and taste sensors (tongue) will give your robot awareness of its environment.

MOVEMENT: Moreover a robot needs to be able to move around its environment. Whether rolling on wheels, walking on legs or propelling by thrusters or even moving a claw. To count as a robot either the whole robot moves or just parts of the robot moves.

POWER: Also a robot needs to be able to power itself. It might be solar-powered, electrically-powered, or even battery-powered. The way your robot gets its energy will depend on what your robot needs to do.

INTELLIGENCE: Finally A robot needs some kind of Intelligence this is where programming enters the pictures, a programmer is a person who gives the robot its 'smarts.' The robot will have to have some way to receive the program so that it knows what it is to do.



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ROBOTS USES:

INDUSTRY:
Industrial robots are electronically controlled, both programmable and re-programmable to carry out certain tasks with high precision and accuracy. Robots have been extensively used in highly advanced manufacturing facilities or high volume assembly lines for a long time. They are efficient and produce high yields or output.

AEROSPACE:
Another application of robots is in aerospace for outer space exploration. Aerospace robots or unmanned robotic spacecraft play a key role in outer space probe. Scientists can explore in outer space without putting themselves in great danger considering the risks involved if they go to outer space themselves.

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HEALTHCARE:
A highly possible advancement in healthcare is using robots in robotic surgery. Due to technological advancement, this is possible even if the patient is located in remote areas. This possibility defies distance. With the proper tools and set-up in place, proper healthcare could be delivered to the patient even in remote areas without the corresponding risks involved.

MILITARY:
In the military and public safety sectors, robotic technology is being applied in many areas. These machines can be used for surveillance and support operations on the battlefield. Military drones flying over areas of war and conflict, in hostage situations, and for natural and manmade disasters are able to assess danger levels and provide soldiers and first responders with real-time information.

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TYPES OF ROBOTS

Pre-Programmed Robots
Pre-programmed robots operate in a controlled environment where they do simple, monotonous tasks. An example of a pre-programmed robot would be a mechanical arm on an automotive assembly line. The arm serves one function — to weld a door on, to insert a certain part into the engine, etc.

Humanoid Robots
Humanoid robots are robots that look like and/or mimic human behavior. These robots usually perform human-like activities (like running, jumping and carrying objects), and are sometimes designed to look like us, even having human faces and expressions.

Autonomous Robots
Autonomous robots operate independently of human operators. These robots are usually designed to carry out tasks in open environments that do not require human supervision.

Human Controlled Robots
Human Controlled Robots are usually directly controlled by humans via a method of wired/wireless connection. These robots usually work in extreme geographical conditions, weather, and circumstances.

Augmenting Robots
Augmenting robots either enhance current human capabilities as the exoseclons built by Hyundai to curry heavy objects or robots that replace the capabilities a human may have lost as Robotic arms and legs. Some examples of augmenting robots are robotic prosthetic limbs or exoskeletons used to lift hefty weights.

MINDSTORMS INTRODUCTION:

The Lego Mindstorms robots may not be a the type of robots that will go buy the breakfast every day or take care of your grandfather, but it could teach many things that will help you in your life from computational thinking to building Lego models. Each version of the system includes an intelligent brick computer that controls the system, a set of modular sensors and motors, and Lego parts from the Technic line to create the mechanical systems, So in this course we will discuss both.

Since creation, there have been four generations of the Mindstorms platform: the original Robotics Invention System, NXT, NXT 2.0, and EV3. With each platform release, the motor and sensor capabilities expanded. The latest system, Lego Mindstorms EV3, was released on September 1, 2013. Some robot competitions use this set, such as the First Lego League and the World Robot Olympiad.

LEGO MINDSTORMS EV3:

Lego Mindstorms EV3 is the third generation robotics kit in Lego's Mindstorms line. It is the successor to the second generation Lego Mindstorms NXT 2.0 kit. The "EV" designation refers to the "evolution" of the Mindstorms product line. "3" refers to the fact that it is the third generation of computer modules first was the RCX and the second is the NXT. The Lego Mindstorms EV3 consists of 1X Smart Brick, 2X Large Motors, 1X Medium Motor, 1X color sensor, 1X ultrasonic sensor, 2X touch sensor, 1X Gyro Sensor and 540+ Lego technic pieces.

The Lego Mindstorms EV3 has the 4 main characteristics of robots mentioned before, so you can see that motors are responsible for movement, sensors are responsible for sensing, batteries are responsible for power and the Smart Brick is responsible for Intelligence.

- [x] **Main Mindstorms Pieces**
  Book Page/s: 15-20 (18 Not Included)
- [x] **VRT User Interface & Remote Control**
- [x] **Exercise-1**
- [x] **Algorithms and Programming**
  MakeCode MiniBook

STEM HERO
MICROSOFT MAKECODE EDITION

LEGO MINDSTORMS EV3 Main Pieces

INTELLIGENCE
Lego Mindstorms EV3 Smart Brick

SENSING
Mindstorms EV3 Touch Sensor

MOVEMENT
Mindstorms EV3 Large Motor

POWER
Mindstorms EV3 Battery

THE EV3 BRICK:
The main component in the kit is a brick-shaped computer called the EV3 Smart Brick. It can take input from up to four sensors and control up to four motors. Motors (Outputs) are plugged in letters (A, B, C, D) and sensors (Inputs) are plugged in numbers (1,2,3,4) via a modified version of RJ12 cables. Moreover, the brick features an illuminated six-button interface that changes colour to indicate the brick's active state, a high-resolution black and white display, built-in speaker, USB port, a mini SD card reader. The brick also supports USB, Bluetooth and Wi-Fi communication with a computer and has a programming interface that enables programming and data logging directly onto the brick.

EV3 MOTORS:
The LEGO®MINDSTORMS® EV3 set includes 2 large motors and 1 Medium Motor, but you can add an extra motor as the brick can hold up to 4 motors, plugged in the Output borts (A, B, C, D).A motor is an electrical machine that converts electrical energy distributed by the battery in the Brick into mechanical energy, also the MINDSTORMS Motor includes an encoder, which determines the degrees turned by the motor, and that is the main reason we can not refer to the EV3 motors as Outputs, as they do also send an input to the Brick.

COLOUR SENSOR:
The digital EV3 Colour Sensor distinguishes between seven different colours and can also detect the absence of colour. It also serves as a light sensor by detecting light intensities. To detect the colour the Sensor starts a built-in light source to illuminate the material surface, a surface whose colour has to be detected and the receivers which can measure the reflected wavelengths.

GYRO SENSOR:
The EV3 Gyro Sensor detects rotational motion indicated by the arrows on the top of the sensor. The digital EV3 Gyro Sensor measures the robot's angular velocity (degrees/second), how fast does a change in angle occur using, which is then calculated using a certain formula to give the final sensor turning value in degrees.

TOUCH SENSOR:
The EV3 Touch sensor gives your robot a sense of touch. The touch sensor detects when it is being pressed or released. The Touch sensor uses a circuit to detect whether the button (orange part) is pressed. When the button is pressed it completes the circuit and when it's in the default state (i.e. released) the circuit is broken.

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ULTRASONIC SENSOR:
The EV3 Ultrasonic Sensor measures distance in centimetres and inches. It is able to measure distances from 0 to 255 centimetres with a precision of +/- 1 cm.The Ultrasonic Sensor generates sound waves and reads their echoes to detect and measure the distance from objects. Using the same scientific principle as bats: it measures distance by calculating the time it takes for a sound wave to hit an object and return – just like an echo.

IR REMOTE & BEACON:
The digital EV3 Infrared Seeking Sensor detects proximity to the robot and reads signals emitted by the EV3 Infrared Beacon. Students can create remotely-controlled robots, navigate obstacle courses and learn how infrared technology is used in TV remotes, surveillance systems and even in target acquisition equipment. Cables sold separately: Proximity measurement of approximately 50-70 cm, Working distance from the beacon of up to two meters. Note: The IR Remote and Beacon are only available in the Ev3 Home Edition Set

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BEAMS: Beams are used to hold cross-axles and other LEGO® components together, so they are the framework of most TECHNIC and MINDSTORMS® models. There are 2 main types of beam: Straight and Angular. Straight beams are usually found only with circular holes in them while angular beams have a mixture of circular and cross-shaped holes, normally with the cross-shaped ones at either end. The straight beams come in sizes from 2 to 15M. These two groups can then be condensed down again into half-beams, beams and bricks.

CONNECTOR PEGS: Connector pegs are used to hold many LEGO® TECHNIC constructions together. There are 3 types of connector pegs:

- Round Pegs
- Cross-shaped Pegs
- Half-half Pegs

The round pegs can be used to connect beams together so that they can both swing freely. The second cross-shaped peg can be used to hold two beams together so that they cannot move, and the last peg can be used to connect a free-spinning beam to a fixed beam. There are also longer versions of the round pegs that can be used to connect multiple beams together. A longer version of the cross-shaped peg is an axle. Some pegs might also be different colours. The black and blue connectors are friction connector pegs, while the other pegs are smooth.

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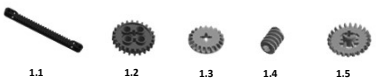
CROSS AXLES: Cross-Axles are cross-shaped rods that can be used to hold wheels, gears beams etc. They are colour coded by their length or you can measure it using a counting the holes of a beam the same size, even numbered lengths (2M,4M,6M etc) are black while odd numbered lengths (3M,5M,7M etc) are grey. You can place a cross-axle through a circular hole so it can spin freely. This is a handy connection for building with gears and wheels.

GEARS: A gear is a piece that conveys rotational force to another gear or appliance. The smallest gear in a pair is called the Pinion; the larger gear the gear or the wheel. There are many types of gear that are currently used in LEGO® constructions as: Spur Gear, Bevel Gear, Crown, Worm Gear and Rack Gear:



1.1 1.2 1.3 1.4 1.5

1.1 Rack Gear
1.2 Spur Gear
1.3 Bevel Gear
1.4 Worm Gear
1.5 Crown Gear

STEM HERO DELUXE COURSE

VRT USER INTERFACE:

The Virtual Robotics Toolkit has a customizable user interface, There are three main ways you can set up your screen:

Default UI

Condensed UI

Fully Expanded UI

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Fig 1.1

DEFAULT USER INTERFACE

Upon startup of the software, the default interface (Shown in fig 1.1) is the first screen users will see. It includes the Virtual Robotics Toolkit in the top left, the Learning Environment in the top right, and the EV3 Programming environment on the bottom. We don't need the learning environment in this Course, The default user interface can be manipulated to hide the Learning Environment by clicking the button

STEM HERO DELUXE COURSE

CONDENSED USER INTERFACE

As shown in Fig 1.2 In this view, the Virtual Robotics Toolkit is featured on the top, while the EV3 Programming environment can be seen on the bottom. This will be the view that we will be working with throughout the course.

Fig 1.2

FULLY EXPENDED USER INTERFACE

To fully expand the Virtual Robotics Toolkit window, click the VRT button or the maximize icon in the top right corner of its window. Doing this will hide the EV3 Programming environment as shown in Fig 1.3.

Fig 1.3

VRT SIMPLE TOOLBAR:

Fig 2.0

2.1 **2.2** **2.3** **2.4** **2.5** **2.6** **2.7** **2.8** **2.9** **2.10** **2.11** **2.12**

2.1- New Project Button: Starts a new project

2.2- Play Button: Start the Simulation

2.3-Pause Button: Stop the Simulation

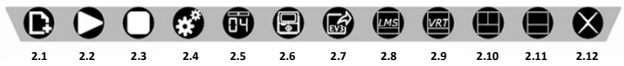
2.4-Robot Settings: Manage robot attachments

2.5-Scoreboard Button: View the Scoreboard

2.6-Ev3 Brick: Shows or Hide the EV3 Virtual Brick

VRT SIMPLE TOOLBAR:

Fig 2.0



2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 2.10 2.11 2.12

2.7-Ev3 Programming Button: Maximizes the EV3 Programming environment

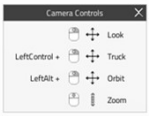
2.8- Learning Environment Button: Maximizes the Learning Environment

2.9- VRT Button: Maximizes the Virtual Robotics Toolkit Simulator

2.10- Default User Interface: Opens the Default Interface

2.11- Condensed User Interface: Opens the Condensed Interface

2.12-Close Button: Closes the program



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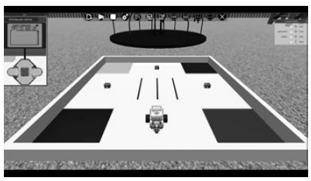
REMOTE CONTROL:



W = MOVES THE ROBOT FORWARDS

A = TURNS THE ROBOT LEFT

S = MOVES THE ROBOT BACKWARDS

D = TURNS THE ROBOT RIGHT

In Physical Robots you can control your Ev3 robot using the IR Sensor and IR Beacon or by Connecting a Bluetooth Device, But in Virtual Robotics Toolkit it's much easier, as you can control the virtual Ev3 Robot just using your keyboard buttons.

To generate the Keyboard Control Mode Start a new project then press the play button, without downloading any Mindstorms Code and use the Controls above to Move your robot:

STEM HERO DELUXE COURSE

STEM HERO EXERCISE ONE

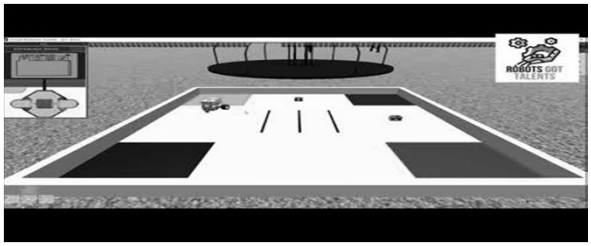
Use Virtual Robotics Toolkit Remote Control feature to put all the 3 cubes into the **Green Square** then go park in the **Black Square** in the SANDBOX (EV3) Map.

PRESS THE ARROW TO VIEW THE TIPS:

- **A green bar appear along near the top of the screen, it indicates that the simulation is active**
- **press the stop button to reset the simulation**

STEM HERO DELUXE COURSE

VIEW EXERCISE ONE:



UNDERSTAND ONLY

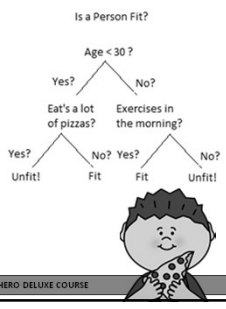
ALGORITHMS:

Of course a robot won't be a robot without a program or in other words a code, so let us know more about coding, briefly we could say that a program is set of instructions made by a computer to do a certain task according to an algorithm, but what is an Algorithm?

The word "algorithm" may not seem relevant to you, but the truth is that algorithms are all around us, governing everything from the technology they use to the mundane decisions they make every day. Algorithms are fascinating and, although some are quite complex, the concept itself is actually quite simple. An algorithm is a detailed step-by-step instruction set or formula for solving a problem or completing a task. In computing, programmers write algorithms that instruct the computer how to perform a task. For example the algorithm written below using the Pseudocode is made up for a program that add two positive numbers and output the total;

```
1. PRINT "Please enter 2 positive numbers to be added together"
2. INPUT Num1, Num2
3. Total = Num1+Num2
4. PRINT Total
```


UNDERSTAND ONLY



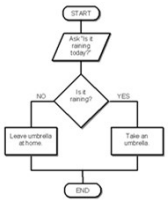
Algorithms are not just related to Programming or Computer Science they are everywhere. A recipe for making food is an algorithm, the method you use to solve addition or long division problems is an algorithm, the process of folding a shirt. Even your morning routine could be considered an algorithm, but in this book we will mainly talk about Algorithms related to programming.

If a programmer wrote an algorithm for a robot to do a certain mission, then he gave it to another person to work on the code, If that algorithm isn't written in a way that anyone could understand, other programmers won't be able to work on the code, and That's why Global Algorithm Presenting Methods such as Pseudocode and FlowChart were made, these methods of writing algorithms follow a set of rules that all the programmers use and understand and that is what we will see now.

UNDERSTAND ONLY

PRESENTING ALGORITHMS:

FLOWCHART



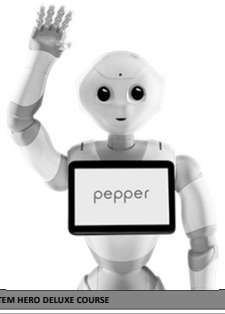
PSEUDOCODE

```
1. PRINT "Please enter the length of the side in cm "
2. INPUT Side
3. Area = Side * Side
4. PRINT Area " cm²"
```

```
1. PRINT "Please enter the length of the side in cm "
2. INPUT Side
3. Area = Side * Side
4. PRINT Area " cm²"
```

STEM HERO DELUXE COURSE

UNDERSTAND ONLY



PROGRAMMING:

Programming is a process that leads from an original formulation of a computing problem to executable computer programs. Programming involves activities such as analysis, developing understanding, generating algorithms, verification of requirements of algorithms including their correctness and resources consumption, and implementation (commonly referred to as coding) of algorithms in a target programming language. Source code is written in one or more programming languages. The purpose of programming is to find a sequence of instructions that will automate performing a specific task or solving a given problem.

Programming Language: In order for you to communicate with a computer (and to get it to execute your instructions) you must speak its language. In programming, a language is made up of a vocabulary and set of grammatical rules where it gets a little tricky is that each language is based on its own unique syntax (grammatical structure) and semantics (meaning).

STEM HERO DELUXE COURSE

[redacted]

- ☑ **Microsoft MakeCode Introduction**
  MakeCode Mini Book
- ☑ **Motor Blocks**
  MakeCode Mini Book
- ☑ **Exercise 2**
- ☑ **Exercise 3**

STEM HERO
MICROSOFT MAKECODE EDITION

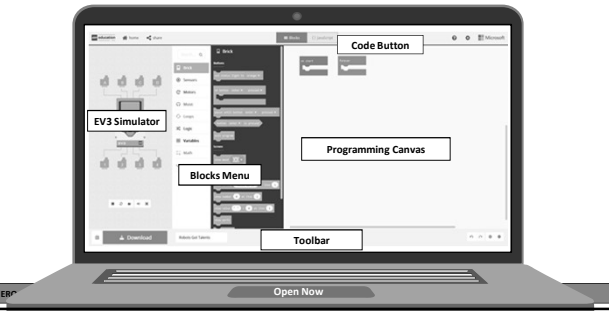
PROGRAMMING MINDSTORMS EV3

Without a program/code, a robot is just a nice looking model, which does nothing but standing in its place. When you program a robot you give it abilities to move, follow lines, avoid objects, make mathematical calculations, and much more. **Microsoft MakeCode** is a new method of programming MINDSTORMS EV3 Robots using Scratch-based Blocks and JavaScript all online which was first introduced in 2018. Although there are many other ways of programming your Mindstorms creations as SCRATCH 3.0, MicroPython, EV3 Classroom and the original EV3-G Programming Software.


```
brick.buttonEnter.onEvent(ButtonEvent.Bumped, () => {
    motors.largeA.run(50)
})
```

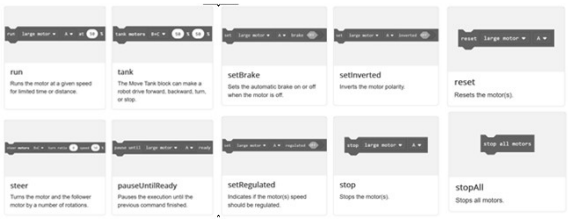
In this course we will be covering the Microsoft MakeCode Blocks Programming. This Language is based on graphical commands or in other words "Blocks", each Block does a particular command including varies variables which could be adjusted. The sequence of the program runs from top to down, starting with the green labelled loop blocks "On Start" and "Forever", and when each block is completed, the next one is started.

MICROSOFT MAKECODE MINDSTORMS UI



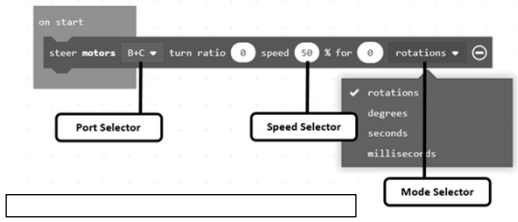
MOTOR BLOCKS

Remember, Movement is one of the main Robotics Characteristics. For moving the robot or any part of it, you will need the Motor blocks. There are two main types of Motor Blocks, Motion Motor Blocks which directly control the Motors and Counters Motor Blocks which links the Motor settings to another Block.



MOTOR BLOCK DIAGRAM:

MICROSOFT MAKECODE MINDSTORMS

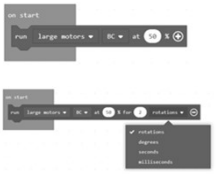


GENERAL RULES:

Port Selector:
Use the Port Selector to choose the motors from the ports (A, B, C, or D) that you want to control, According to the block chosen.

Mode Selector:
When maximizing the block (press (+)), the mode chosen will appear. Use the Mode Selector to choose how you want to control the motors. The modes are constant in all the Motor Blocks. **Modes: Seconds, Degrees, Rotations, and Milliseconds** Although it is not included in the Mode Selector, you can still control your motors to move forever, by not maximizing the block and selecting a mode.

Speed Selector:
Use the Speed Selector to setup the speed as a percentage of the fill which you want the motor/s to rotate with. The Speed could be from -100% to 100%. A negative value runs the motor in the reverse direction.



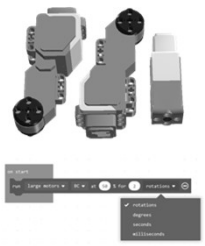
Move Modes:

Forever: The Forever mode turns the selected motor/s on, then immediately continues to the next block in the program. You can control the speed and direction of the motors using the Power Left and Power Right inputs. The motors will run until they are stopped or changed by another block later in the program, or until the program ends.

Seconds/Milliseconds: The Seconds turns the selected motor/s on for the number of seconds in the Seconds input, then turns them off. The block will wait until the time has passed before the program will continue to the next block.

Degrees: The Degrees mode turns the selected motor/s on, waits until one of them has turned for the number of degrees of rotation in the Degrees input, and then turns both motors off. This can be used to make your robot travel a specific distance or turn a specific amount. 360 degrees of rotation corresponds to one full turn of a motor.

Rotations: The Rotations turns the selected motor/s on, waits until one of them has turned for the number of rotations in the Rotations input, and then turns both motors off. This can be used to make your robot travel a specific distance or turn a specific amount.



INPUT VALUES:

For Move Blocks

Input	Type	Parameters	Notes
Power	Numeric	-100 to 100	Motor power level
Milliseconds	Numeric	> 0	Movement time in milliseconds
Seconds	Numeric	> 0	Movement time in seconds
Degrees	Numeric	Any Number	Amount of Movement in degrees (360 degrees = 1 rotation)
Rotations	Numeric	Any Number	Amount of Movement in Rotations (360 degrees = 1 rotation)
Steering	Numeric	-100 to 100	Steering Direction

MOTOR RUN BLOCK:

The Run Block controls one or two EV3 Motor/s, which could be either one Large Motor, two Large Motors or a single Medium Motor. Select the motor/s (A, B, C, or D) which you want them to run using the Port Selector, then select any speed and the direction of Rotation from the Speed Selector. Use the Mode Selector to select the way in which you want the motor/s to operate from On, Seconds, Microseconds, Degrees and Rotations, after selecting the mode, you can choose values for the inputs depending on the mode. For moving the motor/s forever, minimize the block and deselect any mode.

Example Explanation: The Large Motors B and C will rotate clockwise for 3 Rotations with a power 50% of the full power.

MOTOR TANK BLOCK:

The Tank block is mainly used for robot vehicles which have two Large Motors, with one motor driving the left side of the vehicle and the other the right side. You can make the two motors go at different speeds or in different directions to make your robot turn. Select the two motors (A, B, C, or D) that you want the Tank Block to control by using the Port Selector then select the speed and direction of Rotation for each motors from the Speed Selector. Use the Mode Selector to select how you want to control the motors from On, Seconds, Microseconds, Degrees and Rotations. After selecting the mode, you can choose values for the inputs. The inputs available will change depending on the mode.

Example Explanation: The Large Motors A will move for 90 degrees with a power of 40%, while Motor B will move for the same distance with a power of -40%.

MOTOR STEER BLOCK:

Use the Steer block for robot vehicles that have double motors, with one motor driving the left side of the vehicle and the other the right side. The Steer block will control both motors at the same time, to drive your vehicle in the direction that you choose or in other words to turn or steer. Select the two motors (A, B, C, or D) that you want the Steer Block to control by using the Port Selector then select the speed and direction of Rotation for both of them using the Speed Selector. Use the Mode Selector to select how you want to control the motors from On, Seconds, Microseconds, Degrees and Rotations. After selecting the mode, you can choose values for the inputs. The inputs available will change depending on the mode. Adjust the turn ratio using the slider to manage the direction and angle which the EV3 Robot will turn with.

Example Explanation: Motors B and C will move for 1 second with a power of 50%, and a turn ration of positive 55.

MOTOR STOP BLOCKS:

Stop Block: The Stop Block stops one or two EV3 Motor/s, which could be either one Large Motor, two Large Motors or a single Medium Motor. Select the motor/s (A, B, C, or D) which you want them to pause using the Port Selector. Note that if you are driving your brick and then stop the motors, it will coast for a while before stopping. If you want the brick to stop immediately, use set brake to stop them.

Stop All Block: The Stop Block Stops all motors currently running on the brick.

SetBrake Block: When a motor is stopped, it can still rotate if an external force is applied to it. This can happen, for example, if you're tanking your brick on an inclined surface and stop the motors. Gravity will push down on the brick and might cause it to start rolling again. You can prevent this movement by setting the brake. The SetBrake Block stops one or two EV3 Motor/s, which could be either one Large Motor, two Large Motors or a single Medium Motor. Select the motor/s (A, B, C, or D) which you want them to pause using the Port Selector.

Opening Microsoft MakeCode in the Virtual Robotics Toolkit:

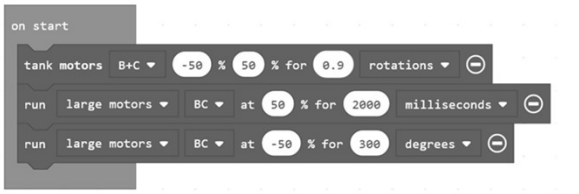
STEM HERO EXERCISE TWO

Program your Ev3 robot to hit the tower, in the Cleanup Challenge (Ev3) Map, By Moving left **0.9 Rotations** then Forward for **2 seconds**, and go back **300 degrees** to park in the Black Square.

PRESS THE ARROW TO VIEW THE TIPS:

- **1 rotation = 360 degrees**
- **A green bar appear along near the top of the screen, it indicates that the simulation is active**
- **press the stop button to reset the simulation**

EXERCISE TWO BLOCKS:



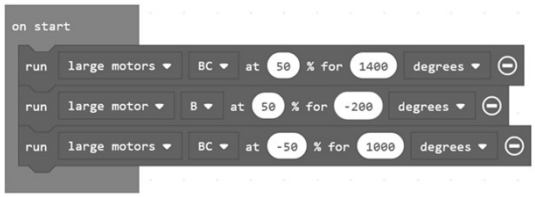
STEM HERO EXERCISE THREE

Program the Robot to move Forward till the end of the map, then go backward to hit the tower and park in the black Square.
Try and Error Method

PRESS THE ARROW TO VIEW THE TIPS:

- **1 rotation = 360 degrees**
- **A green bar appear along near the top of the screen, it indicates that the simulation is active**
- **press the stop button to reset the simulation**
- **You are allowed only to use Action Blocks**

EXERCISE THREE BLOCKS:

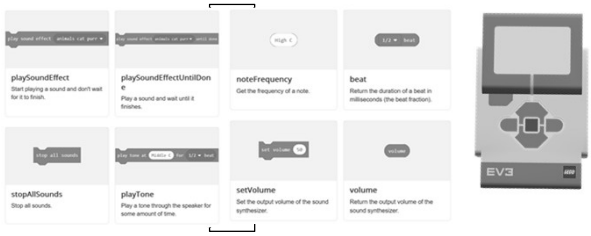


- [x] **Brick Blocks**
  MakeCode Mini Book
- [x] **LEGO DIGITAL DESIGNER**
  Book Page/s: 21
- [x] **LDD Modes & Controls**
  Book Page/s: 22-25
- [x] **LDD Exercise 1**

STEM HERO
MICROSOFT MAKECODE EDITION

BRICK BLOCKS

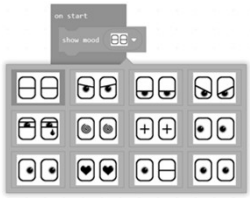
The Brick Blocks are the blocks directly responsible for managing the EV3 Brick Functionalities, so that they do include Brick Screen Blocks, Brick Buttons Blocks, and Sound Blocks.



SHOW MODE BLOCK:

Show Mode Block, Activates a chosen mood on the EV3 brick. A mood will have an image on the display along with a sound and solid or flashing light. You can choose one of several moods to show on the display from the Mode Selector. Here are some of the available modes: sleeping, awake, tired, angry, sad, dizzy, knockedOut, middleLeft, middleRight, love, winking and neutral.

Example Explanation: When the code starts the Sleep Mode, would be activated, displaying the closed eyes image on the EV3 Screen Brick, blinking the Brick Buttons having an orange light and playing the sleeping sound effect.



SHOW IMAGE BLOCK:

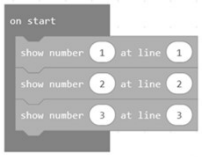
Show Image Block, Shows a chosen image on the EV3 brick. You can choose one of several Images to show on the brick screen from the Image Selector.

Example Explanation: When the code starts the two Large EV3 Motor B and C will move with a power of 50% for 3 seconds, then the EV3 icon will be displayed on the Brick's screen.

SHOW STRING BLOCK:

Show String Block, Shows a typed text on the EV3 brick screen. You can type anything which you want to display on the screen and use select the line that you want it to be shown on you can choose from lines 1 to 10, 1 is at the top of the screen and 10 is at the end of the screen.

Example Explanation: When the code starts the string "Robots Got Talents" would be shown on the middle of the brick's screen, and the string "Courses" would be shown below.



SHOW NUMBER BLOCK:

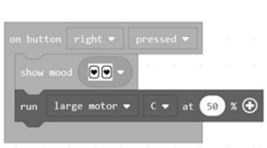
Show Number Block, Shows a typed value/number on the EV3 brick screen. You can type any number which you want to display on the screen and use select the line that you want it to be shown on you can choose from lines 1 to 10, 1 is at the top of the screen and 10 is at the end of the screen.

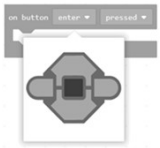
Example Explanation: When the code starts the number 1 would be displayed at the top of the brick's screen, on the first line, than the number 2 would be displayed on the second line followed by the number 3 on the third line.

SHOW PORTS BLOCK: The Show Ports Block, Shows the status of everything connected to the ports.

CLEAR SCREEN BLOCK: Clear Screen Block, clears any text, Image or numbers displayed on the screen. The screen will be blank.

ON BRICK EVENT BLOCK:





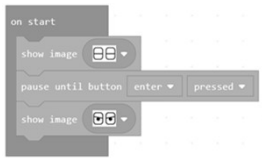
The On Brick Event Block is an example of code starters meaning that the blocks inside of it won't be done unless the condition happens, or in other words unless the chosen button is pressed, bumped or released. Use the Button Selector to select which button you want it to be pressed from the EV3 Brick buttons, and use the condition selector to choose the condition that you want it to occur, and as the conditions of the Touch Sensor the Brick Buttons could be (pressed, bumped and released).

Example Explanation: When the right brick button is pressed, the Love Mode would be activated and the Large Motor C would move forever with a power of 50%. If no the button was not pressed or another one was pressed the code won't start.

PAUSE UNTIL BRICK BUTTON BLOCK:

The Pause until Brick Button Block Pauses the code then wait for the selected EV3 Brick Button to sense a touch. Use the Button Selector to select which button you want it to be pressed from the EV3 Brick buttons, and use the condition selector to choose the condition that you want it to occur, as mentioned before the conditions are: pressed, bumped and released.

Example Explanation: The Sleeping Image would be displayed on the EV3 Brick's screen until the enter button is pressed, the Angry Image will display. As if you woke up the Mindstorms EV3 Robot.



SET STATUS LIGHT BLOCK: Sets the light on the brick to a solid or flashing color.

PLAY SOUND BLOCK:

The play Sound Effect Block, Sets a chosen sound effect to be played by the EV3 Brick built-in speakers. There are several sound effects which you can play. Use the sounds list in the block to select the sound you want to play. When the sounds starts, your program continues on and doesn't wait for the sound to finish. This lets your program do other things while your sound plays in the background.

Example Explanation: The sound Effect "Activate" will be played while the two Large Motors B and C are moving with a power of 50% for 3 rotations.

PLAY SOUND UNTIL DONE BLOCK:

The play Sound Effect Until Done Block, Sets a chosen sound effect to be played by the EV3 Brick built-in speakers. There are several sound effects which you can play. Use the sounds list in the block to select the sound you want to play. When the sounds starts, **your program pauses until the sound effect is done**, then it continues the sequence of the code. That means that the sound plays then the next block is started, and the sound effect does not play in the background as the Play Sound Block.

Example Explanation: The sound Effect "EV3" will be played then the EV3 Icon is displayed on the EV3 screen's brick, but when the sound effect is done.

Stop All Sounds: Stops all the sounds that are playing right now and any others waiting to play.

LEGO DIGITAL DESIGNER

LEGO Digital Designer (LDD) is a freeware computer program produced by the Lego Group as a part of LEGO Design byME. It is available for macOS and Windows. The program allows users to build models using virtual Lego bricks, in a computer-aided design like manner. Until January 16, 2012, these could be uploaded, along with instructions and a box design, to the Lego Design byME website, from where the models could be ordered for delivery as a real, packaged set. Users can also take screenshots of their models and store the models on their computer in an .LXF file.

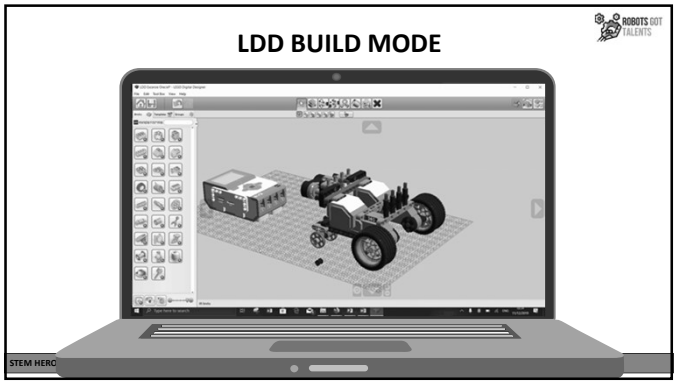
The Lego Digital Designer could be also used to build up Lego Mindstorms Robotics Models, and that's what we will learn in this course

LEGO Digital Designer has 3 operation modes:

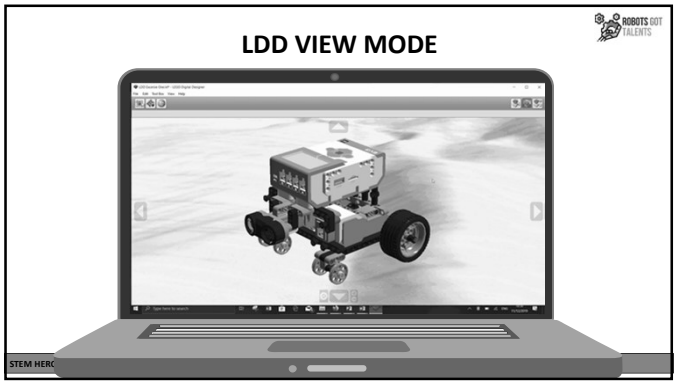
1.Build mode
2.View mode
3.Building guide mode

You can switch between modes by clicking one of the three mode icons located in the bar at the top of the application.

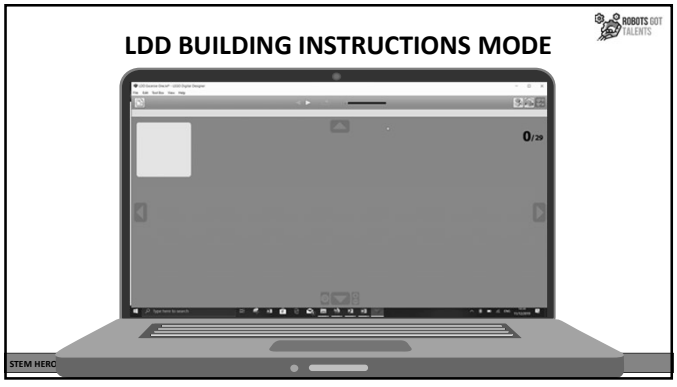
LDD BUILD MODE



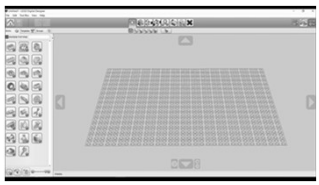
LDD VIEW MODE



LDD BUILDING INSTRUCTIONS MODE



LDD BUILDING TOOLS:



SELECTION TOOL
Used to select brick/s in your model

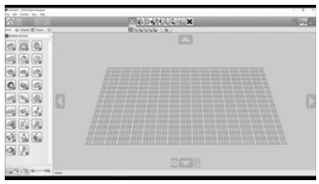
CLONE TOOL
Used to duplicate brick/s from the model

HINGE TOOL
Used rotate bricks that are connected with a hinge or a single stud connection.

HINGE ALIGN TOOL
Used to automatically connect two separate connection points.

STEM HERO DELUXE COURSE

LDD BUILDING TOOLS:



FLEX TOOL
Used to bend and twist flexible elements

PAINT TOOL
Used to change the color or material of bricks in the model

HIDE TOOL
Used to hide brick/s in your model

DELETE TOOL
Used to delete brick/s from the model

STEM HERO DELUXE COURSE

LDD CONTROLS:

Mouse Controls
Left mouse: selects a brick or move it around on the scene if clicked & dragged.
Right mouse: rotates the scene's camera view.
Mouse wheel scroll: Used to zoom in and out in the scene.

Camera Controls
Rotate view: (Num Lock, numbers 8, 2, 4, 6). You can rotate the camera view using either the buttons on the Camera control or your keyboard
Zoom view: (Num Lock, + and keys). Select the + and keys onyour keyboard or the + and buttons on the Camera control to zoom in or out.
Reset view: (Num Lock, number 5). Click Reset to return the view point to its standard position, with all bricks and models visible and centered on the scene.
Pan view: (shortcut only) (Shift+right click). Hold down the Shift key and click the right mouse button to pan your model from the left, right, top or bottom.

STEM HERO DELUXE COURSE

Helpful Keyboard Shortcuts

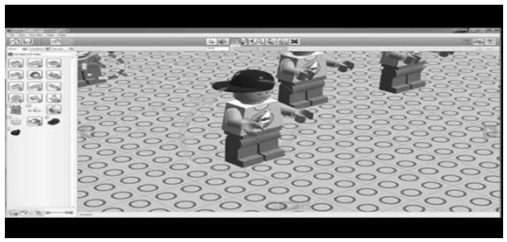
TASK	WINDOWS OS	MAC OS (may vary according to the country/ version)
Rotate view left	4 Key (NumLock: ON)	4 Key (NumLock: ON)
Rotate view right	6 Key (NumLock: ON)	6 Key (NumLock: ON)
Rotate view up	8 Key (NumLock: ON)	8 Key (NumLock: ON)
Rotate view down	2 Key (NumLock: ON)	2 Key (NumLock: ON)
Reset view	5 Key (NumLock: ON)	5 Key (NumLock: ON)
Hinge tool	HKey	HKey
Hinge Align tool	Shft+H	Shft+H
Clone tool	CKey	CKey
Paint tool	BKey	BKey
Hide tool	LKey	LKey
Delete tool	DKey	DKey

Helpful Keyboard Shortcuts

TASK	WINDOWS OS	MAC OS (may vary according to the country/ version)
Group	Ctrl+G	Cmd+G
Create a template	Ctrl+Alt+G	Cmd+Alt+G
Open	Ctrl+O	Cmd+O
Save	Ctrl+S	Cmd+S
Print	Ctrl+P	Cmd+P
Undo	Ctrl+Z	Cmd+Z
Redo	Shft+Ctrl+Z	Shft+Cmd+Z
Upload to Gallery	Shft+Ctrl+B	Shft+Cmd+B

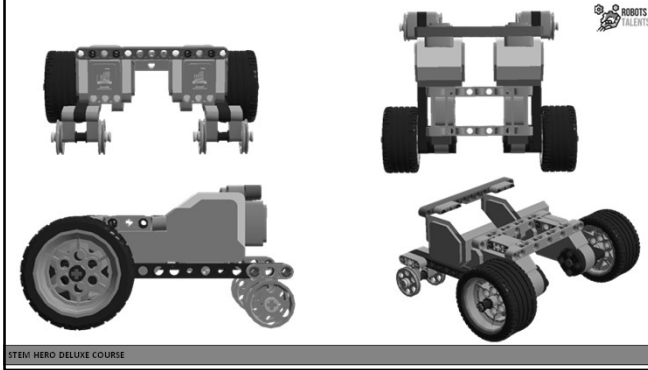
LDD VIDEO TUTORIAL

TUTORIAL BY: Virtual Robotics Toolkit (YouTube)



LDD EXERCISE

After you have learned the main functionalities of LEGO DIGITAL DESIGNER, It's know time to practice your skills. In this exercise you need to build the Simple robot base shown in the diagram below and the diagrams on the next pages. The base is the most important part of all the mobile robots as it's responsible for it's movement.



IMPORTING LDD MODELS

TUTORIAL BY: Virtual Robotics Toolkit [YouTube]

- [x] **Sensor Blocks**
  MakeCode Mini Book
- [x] **Exercise 4**
- [x] **Robot Settings (Attachment Manager)**
- [x] **Exercise 5**

STEM HERO
MICROSOFT MAKECODE EDITION

SENSOR BLOCKS

As sensing is one of the Robotics Characteristics, it is really important for your EV3 robot to be able to sense the environment which it is placed in. Microsoft MakeCode includes Sensor Blocks for almost all of the originally created by LEGO.

BLOCKS FOR COLOR SENSOR:

BLOCKS FOR TOUCH SENSOR:

STEM HERO DELUXE COURSE

SENSOR BLOCKS

As sensing is one of the Robotics Characteristics, it is really important for your EV3 robot to be able to sense the environment which it is placed in. Microsoft MakeCode includes Sensor Blocks for almost all of the originally created by LEGO.

BLOCKS FOR GYRO SENSOR:

BLOCKS FOR ULTRASONIC SENSOR:

BLOCKS FOR INFRARED SENSOR:

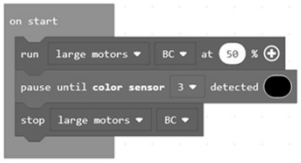
STEM HERO DELUXE COURSE

ON COLOR SENSOR BLOCK:

The On Color Sensor Block is an example of code starters meaning that the blocks inside of it won't be done unless the condition happens, or in other words unless the selected color is detected. Use the Port Selector to select the port in the EV3 Brick (1, 2, 3, and 4) which the color sensor is plugged in, and use the color selector to choose which color should be seen by the robot from (red, blue, green, brown, black and yellow) to start the code.

Example Explanation: If the color sensor in port 3 recognizes a blue color, the Large Motor A would move will a power of 50%

PAUSE UNTIL COLOR DETECTED BLOCK:



The Pause until Color Detected Block Pauses the code then wait for the EV3 Color Sensor to recognize a selected color. Use the Port Selector to select the port of the EV3 Brick (1, 2, 3, and 4) which the color sensor is plugged in, and use the color selector to choose which color should be seen by the robot from (red, blue, green, brown, black and yellow) to complete the code.

Example Explanation: Large Motors B and C which are moving with a power of 50% won't stop until the color sensor plugged in port 3 recognizes a black color.

ON TOUCH SENSOR BLOCK:

The On Touch Sensor Block is an example of code starters meaning that the blocks inside of it won't be done unless the condition happens, or in other words unless the touch sensor is pressed, bumped or released. Use the Port Selector to select the port in the EV3 Brick (1, 2, 3, and 4) which the touch sensor is plugged in, and use the condition selector to choose the condition that you want it to occur, as taught previously the touch sensor could be (pressed, bumped and released).

Example Explanation: If the touch sensor in port 1 is bumped, the Large Motors B and C would move will a power of 50%.

PAUSE UNTIL TOUCH BLOCK:

The Pause until Touch Block Pauses the code then wait for the EV3 Touch Sensor to sense a touch. Use the Port Selector to select the port of the EV3 Brick (1, 2, 3, and 4) which the touch sensor is plugged in, and use the condition selector to choose the condition that you want it to occur with could either be pressed, bumped or released.

Example Explanation: Large Motor D which is moving with a power of 50% won't stop until the touch sensor plugged in port 1 is pressed.

ON ULTRASONIC SENSOR BLOCK:

The On Ultrasonic Sensor Block is an example of code starters meaning that the blocks inside of it won't be done unless the condition happens, or in other words unless the ultrasonic sensor detects an object. Use the Port Selector to select the port in the EV3 Brick (1, 2, 3, and 4) which the ultrasonic sensor is plugged in, and use the condition selector to choose the condition that you want it to occur which could either be near or detected;

Example Explanation: If the ultrasonic sensor in port 4 detects an object, the Medium Motor A would move will a power of 50%.

PAUSE UNTIL ULTRASONIC DETECT BLOCK:

The Pause until Ultrasonic Detect Block Pauses the code then wait for the EV3 Ultrasonic Sensor to see an object. Use the Port Selector to select the port of the EV3 Brick (1, 2, 3, and 4) which the ultrasonic sensor is plugged in, and use the condition selector to choose the condition that you want it to occur which could either be near or detected.

Example Explanation: Motors B and C which are moving with a power of 50% for B and Power of -50% for C won't be rested until the ultrasonic sensor plugged in port 4 detects an object.

MORE SENSOR BLOCKS:

Color Block: The Color Block is an example of counter blocks, it gets the current color detected by the sensor. Use the Port Selector to select the port of the EV3 Brick (1, 2, 3, and 4) which the color sensor is plugged in.

Light Block: The Color Block is an example of counter blocks, it gets the amount of ambient or reflected light measured by the sensor. Use the Port Selector to select the port of the EV3 Brick (1, 2, 3, and 4) which the color sensor is plugged in.

Touch Block: The Touch Block checks whether the touch sensor plugged in the selected port is pressed.

Distance Block: The Distance Block measures the distance between the ultrasonic sensor and the nearer object in centimeters.

Gyro Angle Block: Gets the current rotation angle of the selected gyro sensor.

Gyro Rate Blocks: Gets the current rotation rate from the selected gyro sensor.

Gyro Rest Blocks: rests all the gyro measurements setting the current position and rotation angle to be zero.

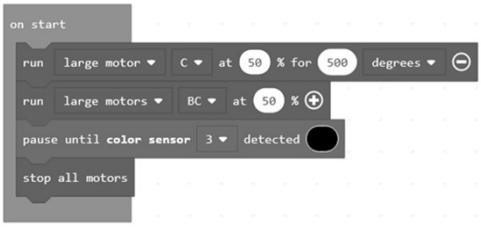
STEM HERO EXERCISE FOUR

Program your robot to turn 500 degrees Left then **move forward until seeing the Black colour** in the SandBox (EV3) Map

PRESS THE ARROW TO VIEW THE TIPS:

- **Make sure the sensor port in the robot is the same sensor mentioned in the program**
- **A green bar appear along near the top of the screen, it indicates that the simulation is active**
- **press the stop button to reset the simulation**

EXERCISE FOUR BLOCKS:



ATTACHMENT MANAGER:

The Virtual Robotics Toolkit enables you to control the Robot's Attachments & Positions. Most EV3 robots in Virtual Robotics Toolkit have additional attachments that you can add or remove manually from the Attachment Manager or the Robot Settings.

To add any attachment to your robot, select it in the Available Attachment, then press the add button and it will be added to the Current Attachments Menu.

To Remove an attachment from the robot, select it from in the Current Attachment Menu, then press the remove button.

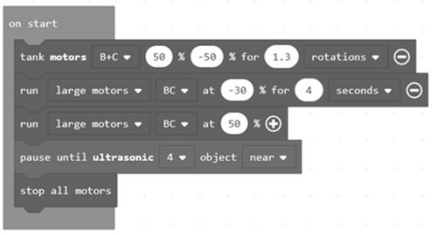
STEM HERO EXERCISE FIVE

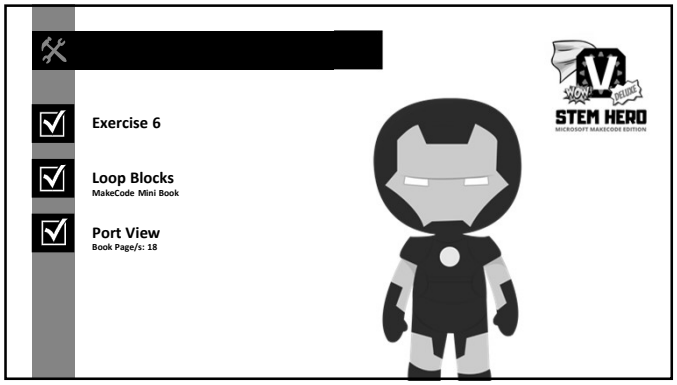
Program your robot in the SandBox (EV3) Map to turn **1.5 Rotations** Left, Move Backward for **4 seconds** with a **speed of 30**, then move forward until the distance between the robot and the wall is **less than or equal 5 cm .** Removing Both Colour Sensors from the Attachment Menu would improve the mission.

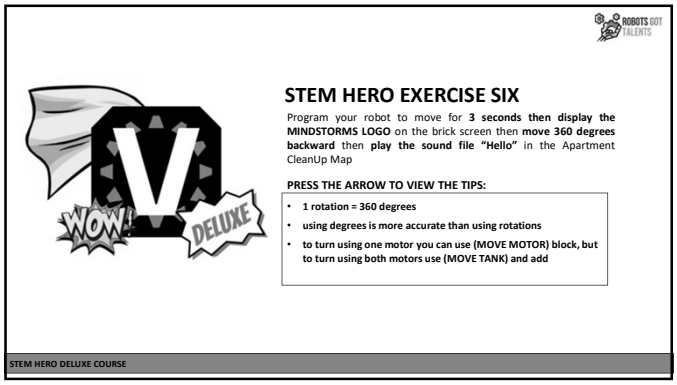
PRESS THE ARROW TO VIEW THE TIPS:

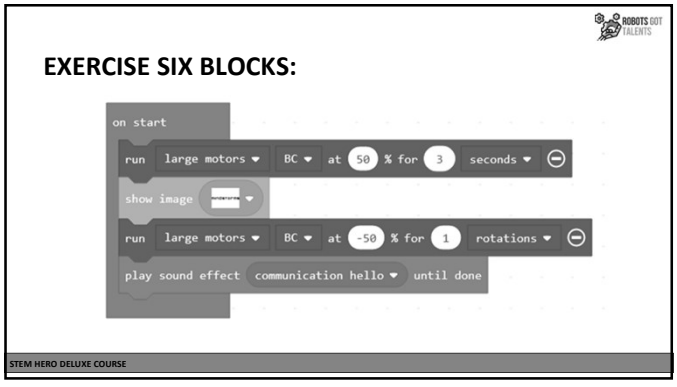
- **Make sure the sensor port in the robot is the same sensor mentioned in the program**
- **A green bar appear along near the top of the screen, it indicates that the simulation is active**
- **press the stop button to reset the simulation**

EXERCISE FIVE BLOCKS:

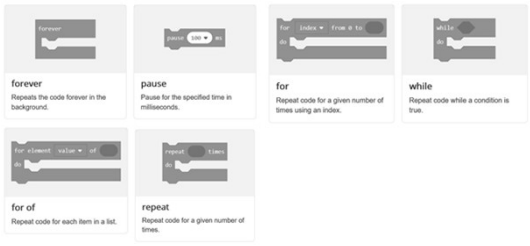



Exercise 6
Loop Blocks
MakeCode Mini Book
Port View
Book Page/s: 18
STEM HERO
MICROSOFT MAKECODE EDITION


ROBOTS GOT TALENTS
STEM HERO EXERCISE SIX
Program your robot to move for 3 seconds then display the MINDSTORMS LOGO on the brick screen then move 360 degrees backward then play the sound file "Hello" in the Apartment CleanUp Map
PRESS THE ARROW TO VIEW THE TIPS:
1 rotation = 360 degrees
using degrees is more accurate than using rotations
to turn using one motor you can use (MOVE MOTOR) block, but to turn using both motors use (MOVE TANK) and add
STEM HERO DELUXE COURSE


ROBOTS GOT TALENTS
EXERCISE SIX BLOCKS:
on start
run large motors BC at 50 % for 3 seconds
show image
run large motors BC at -50 % for 1 rotations
play sound effect communication hello until done
STEM HERO DELUXE COURSE

LOOP BLOCKS:

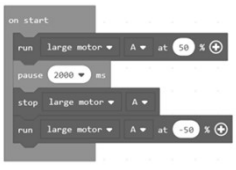


LOOP FOREVER BLOCK: :

The Forever Block is an example of code starters, it makes the sequence of blocks inside it to repeat forever. The code you have in a forever loop will run and keep repeating itself the whole time your program is active. Code in other parts of your program won't stop while your forever loop is running. This includes other forever loops and the run in parallel block.

Example Explanation: : The Brick will show the smiley face on its screen and the Large Motor A will move with a speed of 50% forever.

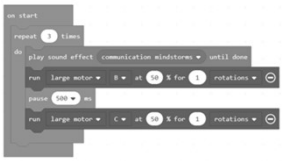
PAUSE BLOCK:



The Pause Block waits for an inputted time (in milliseconds) before completing the code. Milliseconds: the number of milliseconds that you want to pause for. So, 100 milliseconds = 1/10 second, and 1000 milliseconds = 1 second.

Example Explanation: The Large Motor A will Move forever with a power of 50% Clockwise than waits for 2000 milliseconds = 2 seconds and then stops and move forever with a speed of 50% anticlockwise, this code could also be done by expanding the Run Block and directly Selecting the Large Motor A to operate for 2 seconds, then stops and change its direction, Do not forget there are many algorithms for every task.

REPEAT BLOCK:



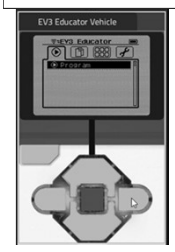
The Repeat Block acts as a container that can hold some blocks inside. It will make the sequence of blocks inserted in it to repeat for a chosen number of times, that you can type in the block. Only the blocks inside the loop will be repeated. After the loop ends, the program will continue with the blocks that are after the loop.

Example Explanation: The Sound Effect "Mindstorms" will be played by the EV3 Brick and when it is done, the Large Motor B will move one rotation, with a power of 50%, then the code will be paused for 500 Milliseconds/0.5 Seconds, and then Large Motor C will move one rotation, with a power of 50%, All of that will be repeated for three, so you will be hearing the sound effect three times, and each motor will be moving for three times.

PORT VIEW TOOL:

The Port View tool, is a built in feature in all Mindstorms robot that display the Sensors or Motor input on the Ev3 Brick screen. Most people think of the Ev3 motors as an output device, but actually it has a built in sensor (Encoder) that measures the number of degrees moved by the motor, so the Ev3 Motors are both an **OUTPUT** & **INPUT** device, while Ev3 Sensors are **INPUT** DEVICES.

EV3 SENSORS =	EV3 MOTORS =
INPUT ONLY	**INPUT & OUTPUT**



USING THE PORT VIEW IN VRT:

You can access the Mindstorms Port View feature from the tools menu in the Ev3 Brick Simulation, in the top menu, the 4 motors ports are displayed (A,B,C,D), and in the bottom menu the 4 sensors ports (1,2,3,4) are displayed.

To measure the Inputs of each port, we should first move the robot using the Virtual Robotics Toolkit Remote control feature, as the robot move the Base Motors (B,C) input increase and the other sensors values also change as the environment varies.

[redacted]

- LDD Exercise 2 & Importing
- Course Quiz

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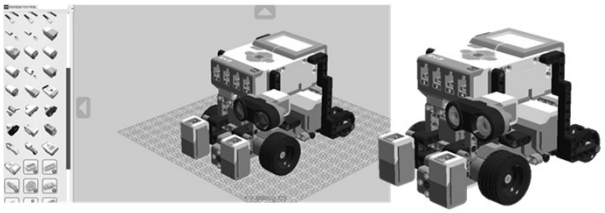
LDD EXERCISE 2

This is your second Lego Digital Designer Building Exercise, you can also add any additional pieces that could improve the robot's design, You will find more View for the robot in the next pages:



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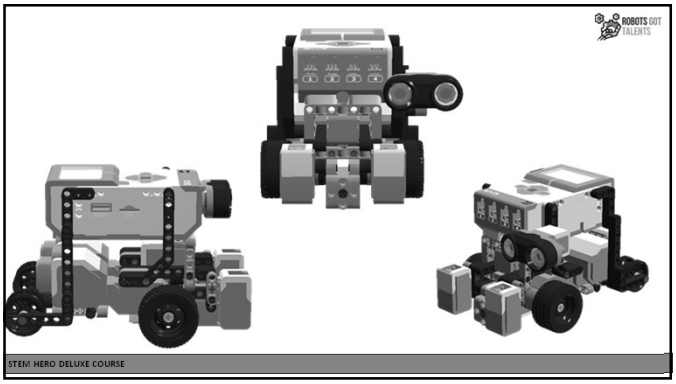
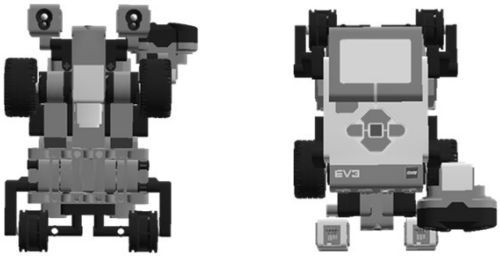


STEM HERO DELUXE COURSE



IMPORTING THE LDD FILE:

Although, Importing LDD Models is not covered in details in this course, as it's in the Advanced Mode but we would like you to try importing the robot you have just built on the Lego Digital Designer to the Virtual Robotics Toolkit Simulator, As we learnt in Session 4 to Import an LDD Model to the VRT we need 2 main programs 1. LEGO DIGITAL DESIGNER, 2. LDRAW. Here are the steps you should follow to import your model, you will find a video in the next page that could guide you by details:

1. Saving your LDD Model in the LDraw format
2. Switch to Advanced Mode in VRT by Clicking F12
3. Patching LEGO Digital Designer from the help menu
4. Ensure LDraw is Available
5. Delete the Robot in the Simulator
6. Importing the New Robot from the Import Button
7. Naming Attachments
8. Port Setup
9. Setting Up Keyboard
10. Finishing the robot's settings

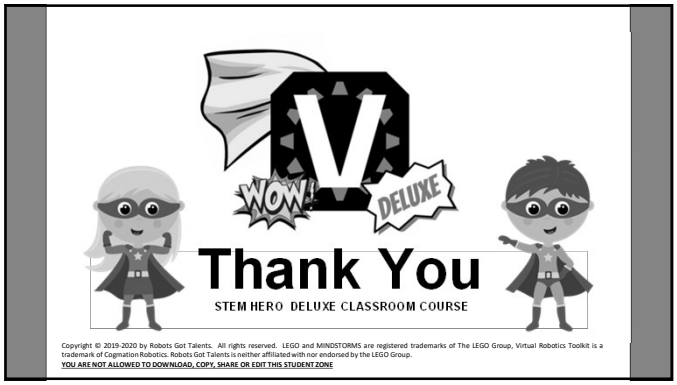
START THE QUIZ

STEM HERO DELUXE QUIZ:

It is now time for STEM HERO Deluxe Quiz by Robots Got Talents, this quiz cover all the topics you have learned throughout this course, Please put in mind that this quiz is just for fun and it won't be added to your certificate or affect your course progress. The quiz will be automatically checked after submitting it, so please keep it to calculate your total score.

QUIZ DURATION: 25 MINUTES
NUMBER OF QUESTIONS: 9 QUESTIONS

YOU MAY USE THE PRINTED VERSION OF THE QUIZ


WOW!
DELUXE
Thank You
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