Vishwakarma Institute of Technology
Department of Engineering, Sciences and Humanities

FY: 2022-2023: Semester I

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Experiment No. 1

TITLE: Mechanical components
AIM: Study of the basic Mechanical components in robotics
APPARATUS: All Mechanical components.

A) **Nut – Bolt and Screw:** As shown in figure 1.1 a **nut** is a type of fastener with a threaded hole. Nuts are almost always used in conjunction with a mating bolt to fasten multiple parts together. A **bolt** is a form of threaded fastener with an external male thread. Bolts are closely related to screws. The two partners
are kept together by a combination of their threads' friction (with slight elastic deformation), a slight stretching of the bolt, and compression of the parts to be held together.

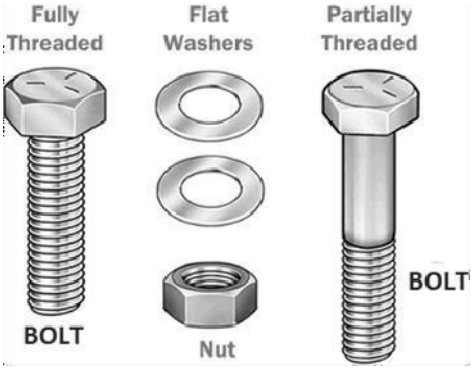


Figure 1.1 “Nut & Bolt”

As shown in figure 1.2 - a **screw** is a type of fastener, in some ways similar to a bolt, typically made of metal, and characterized by a helical ridge, known as a *male thread* (external thread). Screws are used to faster materials by digging in and wedging into a material when turned, while the thread cuts grooves in the fastened material that may help pull fasten materialsand
prevent pull-out. There are many screws for a variety of materials; those commonly fastened by screws include wood, sheet metal, and plastic.

(a) Screw compared to Nut-Bolt (b) Right hand and Left-hand Threads

Figure 1.2 “Screw and type of threads”

B) **Shaft:** In machinery, the general term "shaft" refers to a member, usually of circular cross-section as shown in figure 1.3, which supports gears, sprockets, wheels, rotors, etc., and which is used to transmit power from one part to another or from a machine which produces power to a machine which absorbs power. The material used for is alloy steel such as nickel chromium or chromium vanadium.

Figure 1.3 "Example of Shaft and key"

C) **Keys:** A key is a machine element as shown in figure 1.3 and 1.4 is fitted in an axial direction into the mating member such as pulleys, gears. The primary function of key is to prevent the relative rotation between the shaft and the mating member. Sunk keys are having keyways both in the shaft and the hub. These keys are suitable for heavy duty since they rely on positive drive. It is uniform in width and thickness throughout. There are two types of sunk keys as square and rectangular keys.

i) ***Square key:*** A square key is sunk half in the shaft and half in the hub of a gear, pulley or crank. In general, a square key has its sides equal to one-fourth of the shaft diameter.

ii) ***Rectangular key:*** Rectangular key is also called as the flat key. It is used where the weakening of the shaft is serious and where added stability of the connection is desired. Flat keys with uniform cross section are called Feather keys. Feather key permits axial movement of the hub on the shaft. There is one more type of the flat keys available called as Gib head flat key. Where it is provided with a Gib head which facilities their removal.

D) **Couplers:** It is a mechanical device that joins two rotating shafts to each other for the purpose of transmitting power and absorb the misalignment between them. Couplers are generally

categorized in the following varieties.

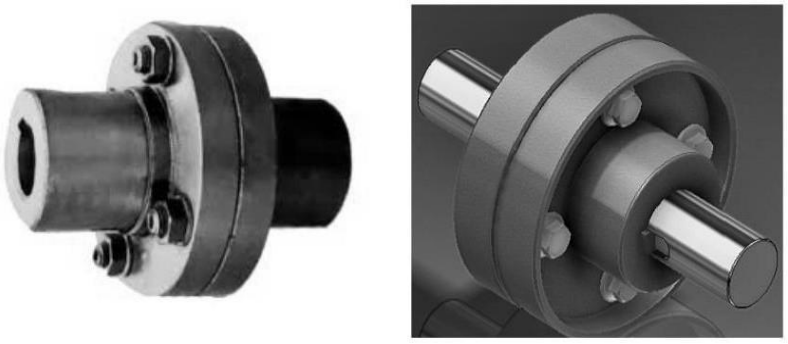
i) <u>Rigid Couplings:</u> Rigid Couplings are mainly used in areas where the two shafts are coaxial to each other. There are following types of couplings that fall under the rigid coupling's category.

a) *Rigid Sleeve or Muff Couplings* – This is the basic type of coupling. This consists of a pipe whose bore is finished to the required tolerance based on the shaft size. Based on the usage of the

coupling a keyway in made in the bore in order to transmit the torque by means of the key. Two threaded holes are provided in order to lock the coupling in position. The figure 1.5 shows a type of the rigid sleeve or muff coupling.

Figure 1.5 "Muff Coupling"

b) *Flanged Coupling*– The coupling basically consists of two flanged end pieces as shown in the figure 1.6. The flanges are connected firmly by means of fitted bolts which are tightened accordingly to the torque to be transmitted. Further there are 02 types of flanges couplings as protected and un protected.



(a)Unprotected flange coupling (b) Protected Flange Coupling

Figure 1.6 "Types of Flange Couplings"

E) **Gears:** A gear is a kind of machine element in which teeth are cut around cylindrical or cone shaped surfaces with equal spacing. By meshing a pair of these elements, they are used to transmit rotations and forces from the driving shaft to the driven shaft. Gears are machine elements that transmit power by means of successively engaging teeth. Smaller Gear of the Pair is known as Pinion and Larger is known as Gear.

According to the position of axes of the shafts, there are following types of gears:

a. Parallel
   1. Spur Gear
   2. Helical Gear
   3. Rack and Pinion

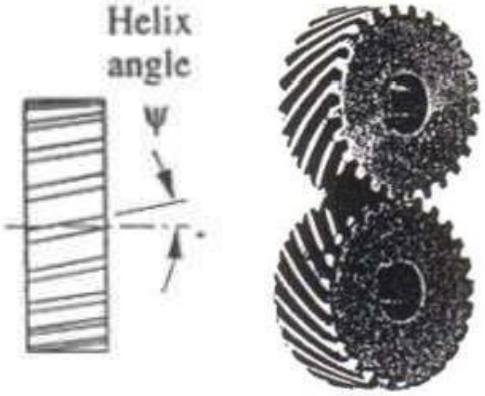
b. Intersecting
   1. Bevel Gear

c. non-intersecting and non-parallel
   1. Worm and worm gears

i) ***Spur Gear:*** in spur gears as shown in figure 1.7, the teeth are parallel to the axis of the gear. These are cost effective, easy to manufacture. But spur gears only work with mating gear and it needs to have the axis of each gear parallel.

Figure 1.7 “Spur Gear”

ii) ***Helical Gear:*** In Helical gears as shown in figure 1.8 teeth are at an angle to the gear axis (usually 10° to 45°) hence called helix angle (see figure 1.6-a). Helical gears are smoothand quite due to gradual tooth engagements. More tooth engagement allows greater power transmission for given gear size. But Helical gears are more expensive and results in axial thrust.



a) Helix angle b) Parallel axis helical gear

Figure 1.8 “Helix angle and type of helical gears”

iii) ***Bevel Gear:*** Bevel gears are very similar to spur gears except they are intended to transfer rotation through a 90 degree translation. The bevel gears make a 90 degree transition easy but it does require a strong gear box. The speed and torque are treated the same in a bevel gear as they are in a spur gear..

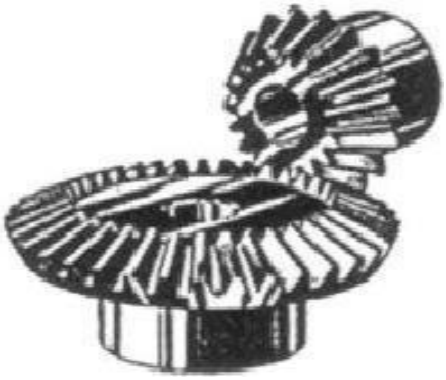


Figure 1.9 “Bevel Gear”

iv) ***Rack & Pinion:*** Rack and pinion, mechanical device consisting of a bar of rectangular cross section (the rack), having teeth on one side that mesh with teeth on a small gear (the pinion). The pinion may have straight teeth, as in the figure, or helical (twisted) teeth that mesh with teeth on the rack that are inclined to the pinion-shaft axis.

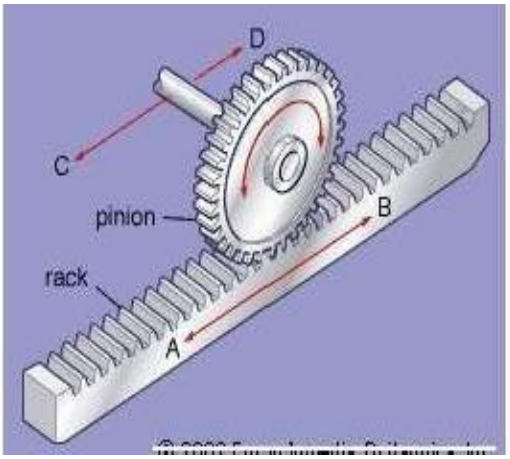


Figure 1.10 "Rack and pinion mechanism"

If the pinion rotates about a fixed axis, the rack will translate; i.e., move on a straight path, as shown by the arrow AB in the Figure. Some automobiles have rack-and-pinion drives on their steering mechanisms that operate in this way.
If the rack is fixed and the pinion is carried in bearings on a table guided on tracks parallel to the rack, rotation of the pinion shaft will move the table parallel to the rack as shown by the arrow CD in the Figure. On machine tools, rack-and-pinion mechanisms are used in this way to obtain rapid movements of worktables; the pinion shaft is usually rotated with a hand crank.

v) ***Worm and Worm Gears:*** A worm drive as shown in figure 1.11 is a gear arrangement in which a worm (which is a gear in the form of a screw) meshes with a worm gear (which is similar in appearance to a spur gear). The two elements are also called the worm screw and worm wheel. Worm gear has self-locking property.

Figure 1.11 "Example of Worm and Worm Gear"

F) **Chain & Sprocket:** Sprockets and chain as shown in figure 1.12 can be used to change the speed, torque, or original direction of a motor. In order for sprockets and chain to be compatible with each other they must both have the same thickness and pitch. In order for the sprockets and chain to work effectively, all of the sprockets should be on parallel shafts with their corresponding teeth on the same plane.

A **sprocket** is a toothed wheel that fits onto a shaft. It is prevented from rotating on the shaft by a key that fits into keyways in the sprocket and shaft.

A **chain** is used to connect two sprockets. One sprocket is the driver sprocket. The other sprocket is the driven sprocket. Motion and force can be transmitted via the chain from one sprocket to another, therefore from one shaft to another. Chains that are used to transmit motion and force from one sprocket to another are called **power transmission chains.**

Figure 1.12 "Chain and Sprocket Mechanism"

G) **Belt Drives:** A belt is a looped strip of flexible material used to mechanically link two or more rotating shafts. A belt drive offers smooth transmission of power between shafts at a considerable distance. **Belt drives** are used as the source of motion to transfer to efficiently transmit power or to track relative movement. In a two-pulley system, depending upon the direction the belt drives the pulley, the belt drives are divided into two types. They are open belt drive and crossed belt drive.

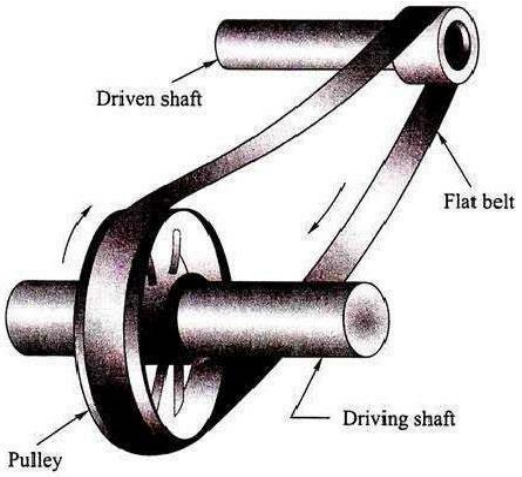


Figure 1.13 "Open and Cross Belt Drives"

As shown in figure 1.13 An open belt drive is used to rotate the driven pulley in the same direction of driving pulley. A crossed belt drive is used to rotate driven pulley in the opposite direction of driving pulley. Belt drives are simple and very economical. They don't need parallel shafts. They are lubrication-free. They require less maintenance cost. Belt drives are

highly efficient in use (up to 98%, usually 95%). They are very economical when the distance between shafts is very large. On the other hand, in belt drives Heat build-up occurs. Speed is limited to usually 35 meters per second. Power transmission is limited to 370 kilowatts. Operating temperatures are usually efficient belt drives. restricted to –35 to 85°C. Figure 1.14 shows some types of highly

Figure 1.14 "High - Efficiency Belt Drives"

H) **Bearings:** Mechanical systems have moving parts that transmit motion and force. The system may also convert one type of motion into another type of motion, e.g. rotary motion into reciprocating motion. In the ideal mechanical system, all the input motion and force is converted into output motion and force. However, friction between various parts of the mechanism results in heat being generated, wearing of surfaces in contact and loss of efficiency of the mechanical system. Lubricants and bearings are used to counteract the effects of friction in mechanisms.

Bearings are used to reduce the effects of friction. There are three main categories,

1. Bush bearing
2. Ball Bearing
3. Roller Bearing

Figure 1.15 "Types of Bush Bearings"

As shown in figure 1.15, **plain bearing**, also called bushes, consist of a tube-like sleeve. Some plain bearings have a flange at one end. Plain bearings are made from materials that have a low coefficient of friction.

Figure 1.16 "Ball Bearings"

As shown in figure 1.16 **ball bearing** is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of an ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least three races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Figure 1.17 "Roller Bearings"

As shown in figure 1.17 roller bearing consist of a number of truncated conical rolling elements held in a cage between the inner and outer races. Taper roller bearings have a high load bearing capacity due to the line contact between each of the roller bearings and the inner and outer races. Taper roller bearings can support radial and axial loads. This conical geometry creates a linear contact patch which permits greater loads to be carried than with spherical (ball) bearings, which have point contact. The geometry means that the tangential speeds of the surfaces of each of the rollers are the same as their raceways along the whole length of the contact patch and no differential scrubbing occurs

I) **Springs:** A spring is a mechanical device which is used for efficient storage and release of energy.It is defined as an elastic body whose function is to distort when loaded and to recover its originalshape when the load is removed. Helical spring is a spiral wound wire with a constant coil diameter and uniform pitch. Function of helical spring are,

- To apply force in valves brakes and clutches
- To absorb shock Used to store energy and subsequently release it.
- e.g clock springs, toys
- For supporting moving masses
- To maintain a force between contacting surfaces e.g. Cam

a) **Compression spring:** These are designed to operate with a compressive load and found in shock absorbers, spring mattresses, mechanical pencils, and retractable pens, ball pens as shown in figure 1.18.

Figure 1.18 “Compression Spring”

b) **Extension spring:** These are designed to operate with a tensile load. An archetypical example is a Slinky, but these are also found in luggage scales and garage door mechanisms. A typical example is bicycle stand spring as shown in figure 1.19.

Conclusion:
Different mechanical components of various shapes and sizes are required for the proper functioning of any machine in the field of robotics.

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Experiment No. 2

TITLE: Electrical and Electronic components
AIM: Study of basic electrical and electronic components used in robotics.
APPARATUS: Various types of wires, cables, switches, sockets, fuses, lugs, resistors, capacitors, diodes, Light Emitting Diodes, Infra-Red LEDs, transistors, relay, connectors, cables, Digital Multi Meter, breadboard.

Theory:

1. **Wires :** There are many types of wires among which P.V.C. (Poly Vinyl Chloride) wires are most commonly used. These have conductors with P. V. C. insulation. P. V. C. is non-hygroscopic, tough, durable, resistant to corrosion and chemically inert. However, P. V. C. softens at high temperature and hence is not used where extremes of temperature occur. e.g. In heating appliances.

2. **Cables :** These consist of a number of individually insulated conductors, which are put together inside a protective mechanical covering. There can be two types of cables: 1) Aerial cables 2) Underground cables. The construction of a typicalcable is shown in figure

3. **Switches:** These are used to make the circuits ON or OFF. The different types are ---
   1) SPST (single pole single throw)
   2) SPDT (single pole double throw) also called Two-way switch.
   3) DPDT (double pole double throw)
   4) DPST (double pole single throw)
   5) SPDT with center OFF.
   6) Intermediate switch.
   7) Emergency switch
   8) Push button switch
   9) Roller type switch
   10) Hinge lever type switch
   11) Plunger type switch

   For various types of switches refer figure X.

4. **Sockets:** These are the points from which electricity can be tapped. Generally sockets have three terminals namely I) phase ii) neutral iii) earth. Sockets can be classified depending upon the current carrying capacity such as 5 Amp or 15 Amp. or upon single phase, three phase (industrial sockets) etc. Refer figure X.

5. **Fuses:** A fuse is a device, which disconnects and protects the circuit from short circuit and overload. It consists of a porcelain base with a fuse wire, which melts at high temperature. When excess current flows, the fuse wire melts and disconnects the circuit from the supply. Two types of the fuses are available.
   1. Rewirable fuse
   2. H. R. C. fuse (High Rupturing capacity). (Refer figure X)

The rewirable fuse is also called as Kit Kat fuse. The types of H. R. C. fuse are Pin type, Bottle type and Screw type. Rewirable fuses are cheap and HRC fuses are costly. But they are very much useful in hazardous area like Chemical plants, LPG filling plants. Figure X shows HRC cartridge fuse.

6. Lugs

Lugs are used to make firm connection of wires or cables and to increase the life of joints. The lugs can be classified as

3. Eye or hole type
4. U type,
5. Pin type.

Generally, copper or aluminum lugs are used. Many times they are silver coated, as silver is the best conductor. A crimping tool is used to make a firm connection of a wire and lug. Nut bolting is used to make a firm joint of two lugs. For various types of lugs, refer figure X.

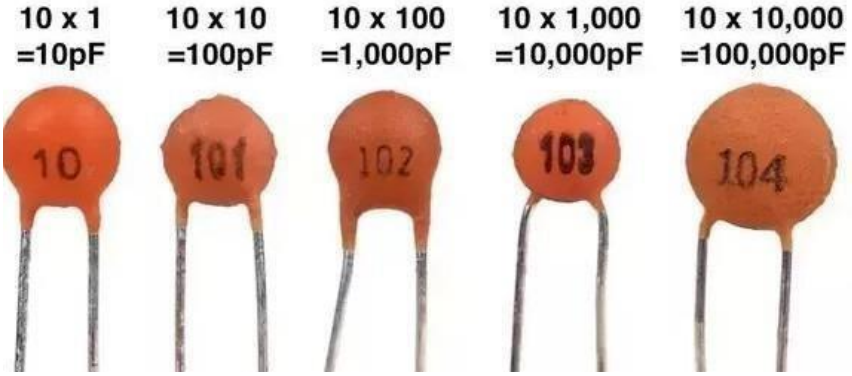
7. Resistors: Resistors offer a resistance to the flow of current. There are two types of resistors – fixed and variable. Potentiometer is the variable resistor which is used to vary the resistance by rotating the shaft. For various types of resistors, refer figure X.

How to calculate the value of a resistor? Resistor value is calculated by the color code. Following table illustrates the color codes of resistor.

Color	1st Band	2nd Band	3rd Band	Decimal Multiplier	Tolerance
Black	0	0	0	1	
Brown	1	1	1	10	±1%
Red	2	2	2	100	±2%
Orange	3	3	3	1K	
Yellow	4	4	4	10K	
Green	5	5	5	100K	
Blue	6	6	6	1M	
Violet	7	7	7	10M	
Gray	8	8	8	100M	
White	9	9	9	1000M	
Gold				0.1	±5%
Silver				0.01	±10%
None					±20%

8. Capacitors: Capacitors are used to store the charge. Capacitors can be fixed or variable. In robotics, mostly fixed capacitors are used. The capacitors are available with or without polarity. Ceramic and mica capacitors are of no-polarity and electrolytic capacitors come with polarity. Various types of capacitors are shown in figure X.

How to calculate the value of ceramic capacitor? For example, what is the value for 104 ceramiccapacitors?



Capacitances vary from 22pF to about 15000µF. Values <0.1µF are mainly mica and ceramic capacitors and values C>= 1µF are electrolytic capacitors.

9. Diodes: Diode is the basic two terminal component that allows the flow of current only in one direction. Most diodes are made of semiconductor materials like silicon, germanium or selenium. Diodes can be used as rectifiers, voltage regulators, signal limiters, switches, signal modulators and oscillators. In robotics, mainly, LEDs, IR LEDs and photo diodes are used. Regular diodes and Zener diodes are rarely used. Various types of diodes are shown in figure X.

10. Transistors: A transistor is a semiconductor device that exhibits all the properties of a switch, allowing or blocking the flow of electrons. It has three terminals, one for input, one for output and one for controlling switching. It is the fundamental building block of modern electronic devices and is commonly found in circuit boards as discrete parts or embedded into integrated circuits. Refer figure X for symbol and various types of transistors.

11. Relays: A relay is a device that opens or closes the contacts to cause the operation of the other electric control. It detects the intolerable or undesirable condition with an assigned area and gives the commands to the circuit breaker to disconnect the affected area. Thus protects the system from damage. The pole and throws are the configurations of the relay, where the pole is the switch, and the throw is the number of connections. The single pole, the single throw is the simplest type of relay which has only one switch and only one possible connection. Similarly, the single pole double throw relay has a one switch and two possible connections. Figure X shows standard relay.

12. Connectors: An electronic connector is an electro-mechanical device whose purpose is to quickly and easily disconnect or interrupt a circuit path. Connectors come in a variety of sizes, shapes, complexities and quality levels. Their function dictates their design and

different features are added to adjust the ease of connection, mating type, durability, insulation between pins, etc. In addition, because many connectors must perform their job in rugged conditions, their construction is often adjusted to provide protection from vibrations, extreme temperatures, dirt, water, contaminants, and more. Refer figure X for various connectors.

13. Cables: Cable is a conductor or group of conductors for transmitting electric power or telecommunication signals from one place to another. Electric communication cables transmit voice messages, computer data, and visual images via electrical signals to telephones, wired radios, computers etc. Refer figure X for construction of a cable.

14. Digital Multi Meter: A digital multi meter or DMM is a test tool used to measure two or more electrical values—principally voltage (volts), current (amps) and resistance (ohms). It is a standard diagnostic tool for technicians in the electrical/electronic industries.

The face of a digital multi meter typically includes four components:

1. Display: Where measurement readouts can be viewed.
2. Buttons: For selecting various functions; the options vary by model.
3. Dial (or rotary switch): For selecting primary measurement values (volts, amps, ohms).
4. Input jacks: Where test leads are inserted.

15. Breadboard: A breadboard is a solder less device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connects the holes on the top of the board. Figure X shows breadboard.

Assignment Questions: (Solve the questions on paper and attach)

1. Calculate following resistor values with the help of color codes.
    1) Red-red-yellow
    2) Brown-black-orange
    3) Yellow-violet-red
    4) Orange-orange-red
    5) Red-red-black
2. Which type of connector is used in DMM sockets?
3. Which connector is used for VGA socket to connect display device and computer/laptop?

Conclusion : Electrical and electronic components are crucial for the functioning of robotics. understanding basic components like diodes, transistors, and relays is important for design and implementation its practical use is essential. knowledge of this components is useful in troubleshooting issues. this serves as building block of robotics

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Experiment No. 3

TITLE: Know your kit - LEGO® MINDSTORMS® EV3

Theory: The EV3 Core kit: This kit consists of 1 EV3 programmable brick, 2 Large Motors, 1 Medium Motor, 2 Touch Sensors, 1 Colour Sensor, 1 Gyroscopic Sensor, 1 Ultrasonic Sensor, connector cables, USB cable, 1 Rechargeable battery.

1) **EV3 Brick: -** This is the microcontroller. It is basically the brain that runs all operations. It controls execution of commands such as to give signals to run the motors, detect the signals coming from sensors (touch, colour etc.), load the program downloaded from the computer and saving it in memory etc. It also has a display and interface that allows the user to select and run different programs.

The brick also has a status light which tells you the current status of the EV3 brick. These can be red, green, orange and can be pulsating. The indications of these colours are:
Red = Start-up, Updating, Shutdown

Red pulse = Busy

Orange = Alert, Ready

Orange pulse = Alert, Running

Green = Ready

Green pulse = Running program

The brick also has different types of ports as shown below.

2) **Connector cables :-** They are flat black cables with connectors similar to telephone plugs. They are used to transmit AC signals from the sensors (or other input devise) to the EV3 Brick through the input ports (1,2,3 or 4) and from Brick to the motors (or other output device) through the output ports (A, B, C or D).

3) **USB cable: -** It is used to download an EV3 program from the computer to the EV3 Brick and allows the computer to communicate with the EV3 Brick. It can also be used to connect upto 4 Bricks together to allow them to communicate.

4) **Motors: -** There are 2 Large Motors and 1 Medium Motor in the kit. The large motors are mainly used for driving the robot. They have a built-in Rotation Sensor with a 1° resolution. Large motors can run upto a speed of 160-170 rpm at a torque of 20-40 N-cm.

The medium motor can be used for picking and placing objects. It also has a built-in Rotation Sensor with a 1° resolution. It is smaller, lighter and faster than the large motor, but is less powerful. It can run upto a speed of 240-250 rpm with a torque of 8-12 N-cm.
Note that torque and speed are trade-offs between one another, in accordance with the basic Power equation

$P=r\times\omega$ Watts

where r is the torque and ω is the angular velocity.

How to turn the robot by adjusting speed of the motor?

When viewing the robot from top, the speed of the motor on that side of the robot to which it must turn should be less than the speed of the motor on the other side.
For example, if the robot must turn left, then the speed of the left motor should be 0 and the speed of the right motor should be 20 rpm. It may also be 5 rpm (left motor) and 15 rpm (right motor). Conversely, if the robot must turn right, then the speed of the right motor should be 0 and the speed of the left motor should be 20 rpm.

How to download the program in the EV3 Brick?

For downloading the software in the EV3 Brick, go to the bottom-right corner of the screen, where the following pane is visible. The EV3 text in the small vertical window will turn red when an EV3 Brick is connected to your computer.
The buttons in the vertical section showing EV3 in red has the following functionality:
1) Download—Downloads the program to the EV3 Brick.
2) Download and Run—Downloads the program to the EV3 Brick
and runs it immediately.
3) Download and Run Selected—Downloads only the highlighted
blocks to the EV3 Brick and runs them immediately.

Brick Information Tab

The Brick Information tab displays important information about the EV3 Brick that is currently connected, such as EV3 Brick name, battery level, firmware version, connection type, and memory bar. It also gives access to the Memory Browser and Wireless Setup tools.

Port View Tab

The Port View tab displays information about the sensors and motors connected to the EV3 Brick. When your EV3 Brick is connected to the computer, this information is automatically identified and the live values can be seen.

Available Bricks Tab/Options Tab

The Available Bricks tab shows the EV3 Bricks that are currently available for connection. The user can choose which EV3 Brick they want to connect to and the type of communication (USB/Bluetooth/Wi-Fi).

Sensors: -

Sensors provide robots with information about their environment. With the sensors that come with the EV3, the user can make a robot respond to being touched, react when someone or something comes too close, follow a line, or measure how far it has turned.

1) Tactile (touch) Sensor - The touch sensor gives your robot a sense of touch. The touch sensor detects when it is being pressed or released. It can even be programmed to wait until it is both pressed and released (or bumped).

2) Colour Sensor (colour, light) - The colour sensor can detect either the colour or intensity of light. The colour sensor has three different modes: colour, reflected light intensity, and ambient light intensity

Colour – In this mode, the colour sensor can differentiate up to seven different colours : black, blue, green, yellow, red, white, and brown plus No colour.
Note: For best results, the colour sensor needs to be 1-2 cm away from the colour you are trying to detect, and have consistent lighting.

Reflected light intensity – In this mode, the colour sensor emits a red light and measures the amount of light reflected back into itself from the surfaceyou are testing. The intensity of the light is measured as a percentage from 0 to 100, with 0 being very dark, and 100 being very bright.

Ambient light intensity –In this mode, the colour sensor measures the amount of light in its environment, without producing its own light source.

3) Ultrasonic Sensor - The ultrasonic sensor measures distance to an object up to a maximum of 255cm (or 100 inches) away. It does this by sending out high frequency sound waves that bounce off any object in range, and measuring how long it takes the sound to return to the sensor.

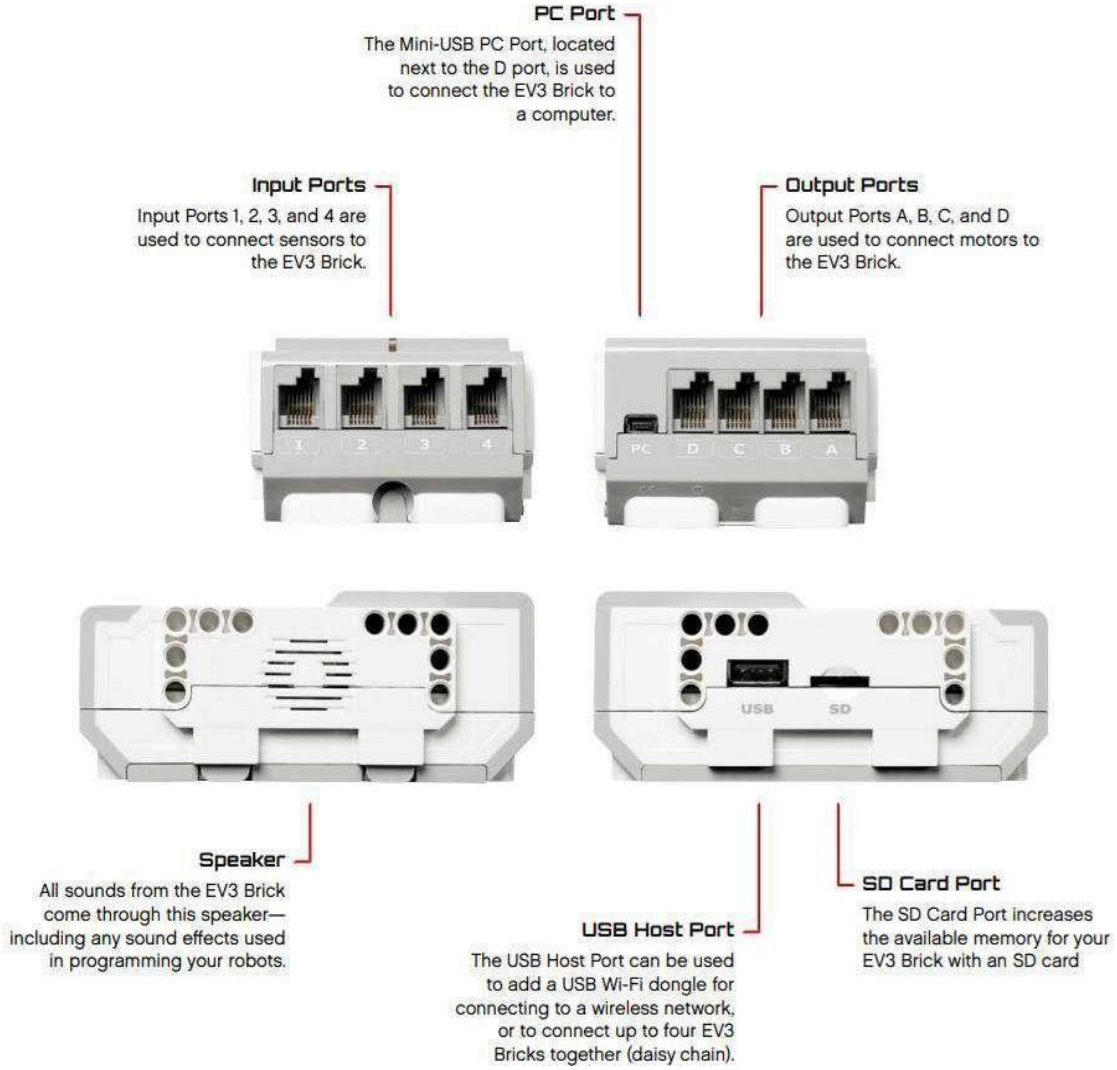
4) Gyro Sensor (rotation/orientation) - The gyro sensor detects rotational motion in the plane indicated by the arrows on the top of the sensor housing. The sensor measures the rate of rotation in degrees per second and keeps track of the total angle of rotation in degrees.

5) Infra Red Sensor - The Infrared Sensor is a digital sensor that can detect infrared light reflected from solid objects. It can also detect infrared light signals sent from the Remote Infrared Beacon. The Infrared Sensor can be used in three different modes: Proximity Mode, Beacon Mode, and Remote Mode. Here, we shall discuss only the Proximity Mode because the other 2 modes require a separate device called Remote Infrared Beacon.

In Proximity Mode, the Infrared Sensor uses the light waves reflected back from an object to estimate the distance between the sensor and that object. It reports the distance using values between 0 (very close) to 100 (far away), not as a specific number of centimeters or inches. The sensor can detect objects up to 70 cm away, depending on the size and shape of the object.

CONCLUSION:

LEGO MINDSTORM EV3 CORE KIT PROVIDES ALL THE NECESSARY COMPONENTS FOR BUILDING AND PROGRAMMING ROBOTS.THE BRICK ACTS AS THE BRAIN OF THE ROBOT.THE MOTOR ALLOWS THE ROBOT TO MOVE AND SENSORS PROVIDE INFORMATION OF THE SURROUNDING. WITH RIGHT PROGRAMMING THESE COMPONENTS CAN CREATE COMPLEX ROBOTS THAT CAN PERFORM VARIETY OF TASK


PC Port
The Mini-USB PC Port, located next to the D port, is used to connect the EV3 Brick to a computer.
Input Ports
Input Ports 1, 2, 3, and 4 are used to connect sensors to the EV3 Brick.
Output Ports
Output Ports A, B, C, and D are used to connect motors to the EV3 Brick.
1
2
3
4
PC
D
C
B
A
USB
SD
Speaker
All sounds from the EV3 Brick come through this speaker—including any sound effects used in programming your robots.
USB Host Port
The USB Host Port can be used to add a USB Wi-Fi dongle for connecting to a wireless network, or to connect up to four EV3 Bricks together (daisy chain).
SD Card Port
The SD Card Port increases the available memory for your EV3 Brick with an SD card

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Experiment No. 4

TITLE: Square path follower.

AIM: To program the robot to follow a square path.

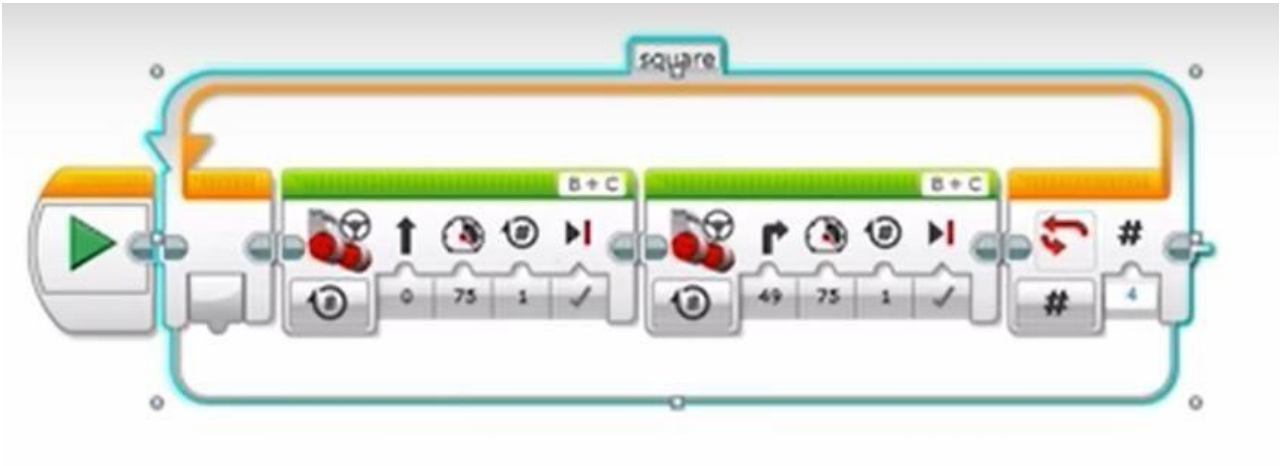
APPARATUS: Assembled robot, USB cable.

TASK: i) To move the robot on a square path.

ii) Any other task as instructed

iii)

PROGRAM CODESCREENSHOT (Paste photograph here)



Theory/ Elements of code:(Explain the functioning of each block used in the program)

Note: Edit the content in red color suitably

Block1: Start block starts the flow of execution

Block2: Loop block keeps repeating the set of statements for the specified number of times.

Block3: Move steering (rotations 0) moves the brick in the straight direction.

Block4: Move steering (rotations 49) moves the brick towards right, i.e., approximately 90 degrees.

Logical flow of operation as per the blocks :

1. Start
2. Loop (4 times)
3. Move steering straight
4. Move steering (By 49 rotations or 90 degrees)
5. End

Result: (Photograph/ Screenshot of Robot while doing the task)

Description:

Fig1:
The brick moves straight.

Fig2:
The brick makes a right turn and then keeps on moving straight.

Fig3:
The brick again makes a right turn and then moves straight.

Fig4:
The brick makes the final right turn to complete the square.

Conclusion: (Write a conclusion in your language in 2 to 3 lines)

The programmed robot thus moves in a square block due to the code being looped 4 times. We can now apply same concept with some changes and we can perform the activity for different shapes or a particular path to follow

.

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Experiment No. 5

TITLE: Ultrasonic Sensor

AIM: To interface Ultrasonic Sensor to control motion of a mobile robot.

APPARATUS: Assembled LEGO robot (EV3), Ultrasonic sensor, USB cable.

TASK: To detect an obstacle and avoid it using Ultrasonic Sensor.

PROGRAM CODE SCREENSHOT (Paste photograph here)

Theory/ Elements of code:(Explain the functioning of each block used in the program)

Note: Edit the content in red color suitably

Block1: Start block starts the flow of execution.

Block2: Move steering (rotation 0) moves the brick in the straight direction.

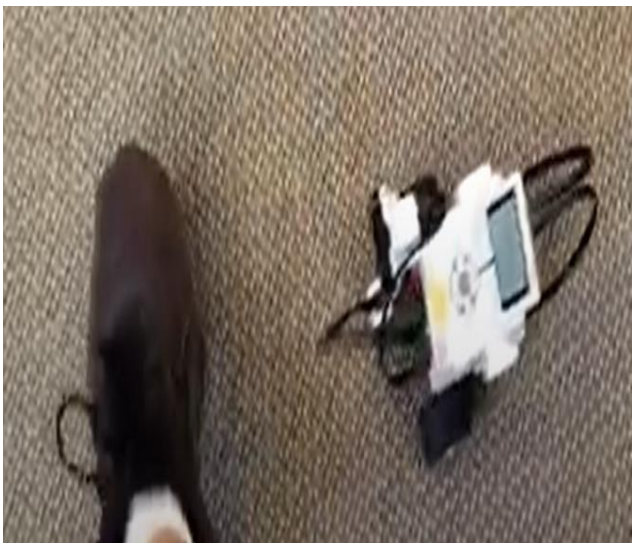
Block3: Wait (Ultrasonic sensor) compares the distance in front of the brick with 5 cm.

Block4: If the distance is less, then this block stops the moving brick.

Logical flow of operation as per the blocks :

1. Start
2. Move Steering
3. If distance is less than 5 cm, stop steering.
4. End

Result: (Photograph/ Screenshot of Robot while doing the task)



Description:

Fig1: The moving brick encounters an object at a distance of less than 5 cm.

Fig2: The ultrasonic sensor detects it and stops the moving block.

Conclusion: (Write a conclusion in your language in 2 to 3 lines)

The robot stops when it is 5 cm or less than 5 cm away from the object. We have learnt how to use an uv sensor. We can use this to identify the obstacles in the robots path.

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Experiment No. 6

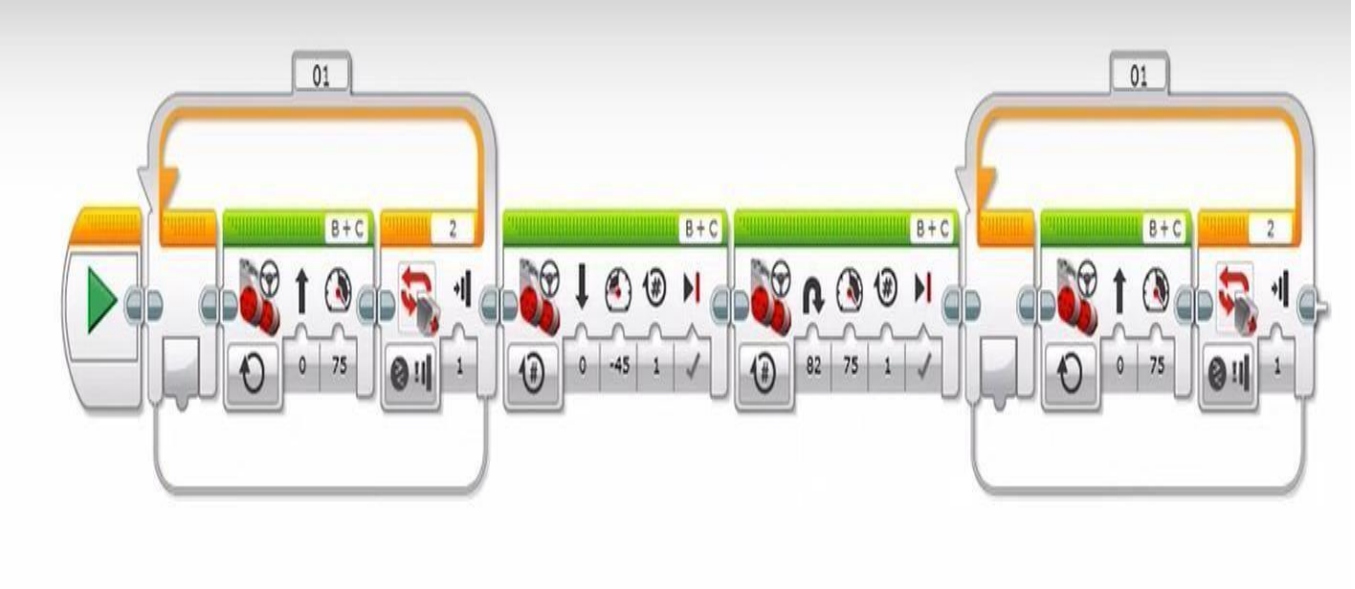
TITLE: Touch Sensor

AIM: To interface Touch Sensor to control motion of a mobile robot.

APPARATUS: Assembled LEGO robot (EV3), Touch sensor, USB cable.

TASK: To Programme a robot to move in straight line and tap the Touch Sensor using hand.

PROGRAM CODESCREENSHOT (Paste photograph here)



Theory/ Elements of code:(Explain the functioning of each block used in the program)

Note: Edit the content in red color suitably

Block1: Start block starts the flow of execution.

Block2: In the loop block, the touch sensor condition is that until the sensor is bumped the statement will get executed.

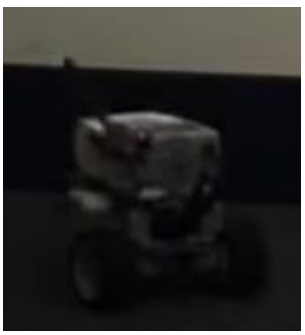
Block3: This block moves the brick in the opposite direction after it is bumped.

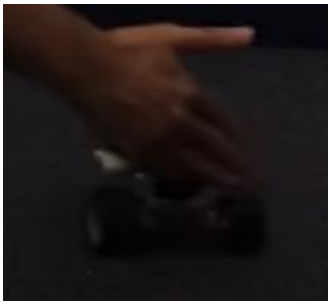
Block4: The next loop again runs until the touch sensor is bumped.

Logical flow of operation as per the blocks :

1. Start
2. Move steering until touch sensor bumped
3. When bumped, move steering in opposite direction.
4. Move steering until again the touch sensor is bumped.
5. End

Result:(Photograph/ Screenshot of Robot while doing the task)





Description:

Fig1: The brick starts moving in the forward direction.

Fig2: The touch sensor of the brick gets bumped by the wall.

Fig3: The brick starts moving in the opposite direction.

Fig4: The touch sensor is bumped by hand and that stops the brick.

Conclusion: (Write a conclusion in your language in 2 to 3 lines)

The robot moves in the opposite direction when it is first bumped and when it is bumped again it stops its motion. We can program it such that it can change the path of the robot

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FY: 2022-2023: Semester I

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Experiment No. 7

TITLE: Path Tracing using color sensor

AIM: To interface Color Sensor to control motion of a mobile robot.

APPARATUS: Assembled LEGO robot (EV3), Color sensor, USB cable.

TASK: To follow the given line using color sensor.

PROGRAM CODE SCREENSHOT (Paste photograph here)

Theory/ Elements of code:(Explain the functioning of each block used in the program)

Note: Edit the content in red color suitably

Block1: Start block starts the flow of execution.

Block2: The large motor switches ON and the brick starts moving forward

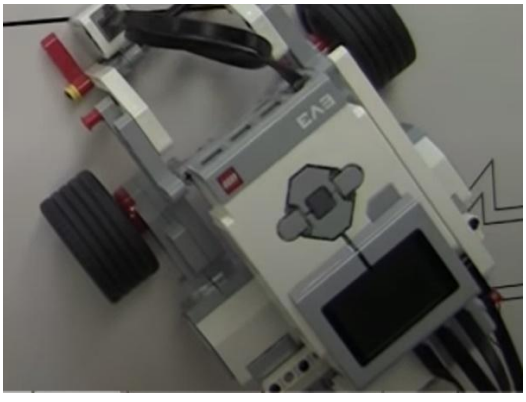
Block3: Reflected light intensity falls to less than 20.

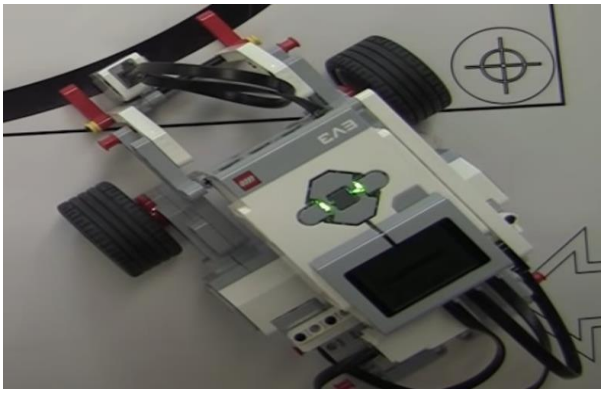
Block4: Color sensor detects it and large motor switches OFF.

Logical flow of operation as per the blocks :

1. Start
2. Large Motor – ON (Power 50)
3. Wait – Colour sensor – Compare reflected light intensity (Less than 20)
4. Large Motor - OFF
5. End

Result:(Photograph/ Screenshot of Robot while doing the task)





Description:

Fig1:
The large motor switches ON and the brick starts moving forward.

Fig 2:
The colour sensor receives reflected light intensity of less than 20 and the large motor switches OFF and the brick stops moving.

Conclusion: (Write a conclusion in your language in 2 to 3 lines)

The robot stops its motion when the color sensor receives reflected light of intensity less than 20 percent. We have learnt how t use the color sensor.

Name of the Student: Varad Nitin Kulkarni

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Experiment No. 8

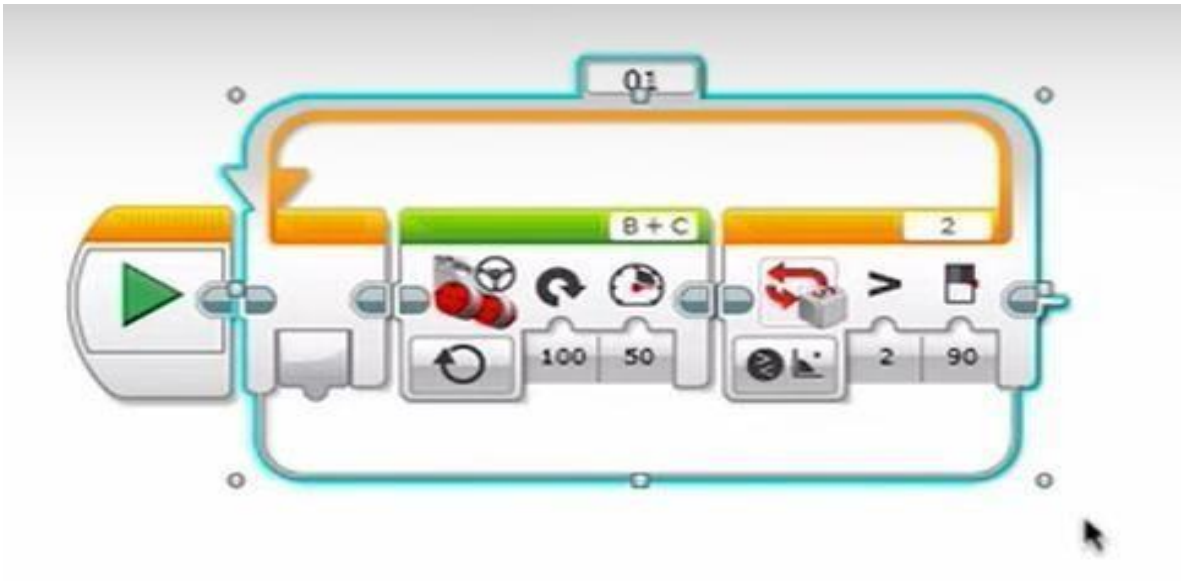
TITLE: Measurement of orientation using Gyro sensor

AIM: To interface Gyro Sensor to calculate orientation of a mobile robot.

APPARATUS: Assembled LEGO robot (EV3), Gyro sensor, USB cable.

TASK: To calculate the orientation of a mobile robot using Gyro sensor.

PROGRAM CODE SCREENSHOT (Paste photograph here)



Theory/ Elements of code:(Explain the functioning of each block used in the program)

Note: Edit the content in red color suitably

Block1: Start block starts the flow of execution

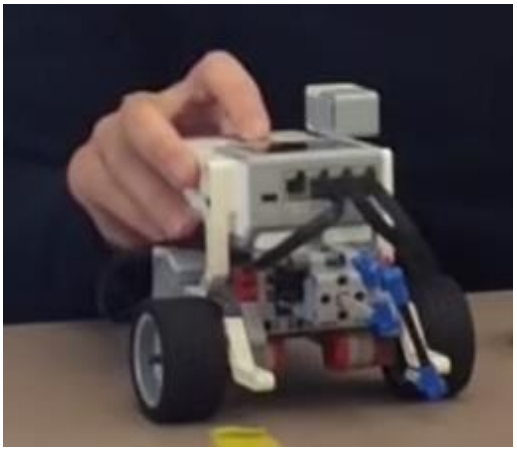
Block2: Loop block repeats the set of instructions until an angle of 90 is moved.

Block3: This block keeps moving the brick for 100 rotations continuously.

Logical flow of operation as per the blocks :

1. Start
2. Loop (Till the angle moved is greater than 90 degrees)
3. Move steering (100 rotations)
4. End

Result:(Photograph/ Screenshot of Robot while doing the task)



Description:

Fig1:

The brick and gyro sensor are being set up.

Fig2:

The brick moves an angle of 90 degrees and then stops.

Conclusion: (Write a conclusion in your language in 2 to 3 lines)

The gyro sensor helps the driving base to change its motion by navigating it through a 90 degree angle. We have learnt how to use a gyro sensor .we can create a program that can help the robot to do specific degree wise rotation and many more.

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Experiment No. 9

TITLE: Application of Transistor as a Switch
AIM: To switch on/off DC motor using transistor and relay circuit.
APPARATUS: Transistor (BC548), Resister 1K, Relay, DC Motor.

THEORY:
A Transistor can be used for opening or closing a circuit when it is used as a switch in the electronic circuits. The use of transistor in switch mode is possible only for low voltage applications because of its low power consumption. Transistor works as a switch when it is in cutoff (fully-OFF) and saturation regions (fully-ON).
Now, if we want to switch ON a circuit working on high voltage like 230 V AC, then also a transistor can be used as a switch indirectly. We need to use a relay for this. Refer to the circuit diagram shown below. The relay coil works on 5 V or 12 V DC and needs a very low current. A transistor can supply this much of current and thus the coil of the relay is connected in series with the collector of the transistor. The transistor is switched ON by triggering its base by proper voltage, which further switches ON the coil of the relay.
The relay has an NO and an NC contact. As the relay coil becomes ON, it closes the NO and opens the NC contact. The pole (common) carries the supply required for the motor. If the motor is connected through the NO contact, then the motor becomes ON. With transistor in OFF condition, the motor also would remain OFF.
Exactly opposite would happen if the supply to the motor is given through the NC contact of the relay. The motor will rotate when the relay is in OFF state.

CIRCUIT DIAGRAM:
Transistors cannot carry AC or high voltages (such as 230 V AC) and they cannot be for switching large currents of the order of 5 A. Relays are suitable for all these situations. It must be noted that even a low power transistor can be used to switch ON the coil of the relay. The only condition is that the transistor should be capable of carrying the current required for the coil of the relay.

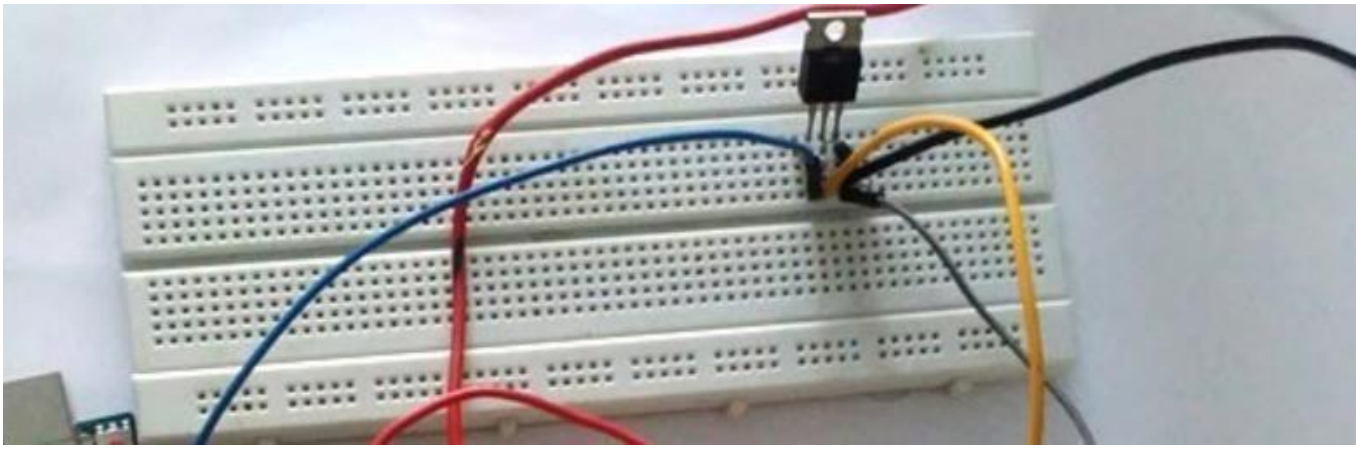
Fig - Circuit diagram of Transistor as a switch using relay

If a Transistor – Relay combination is used to switch ON a load, such as a motor, a diode in reversed biased mode must be connected across the coil to protect the transistor from the high voltage getting induced (Eb) when the load is switched ON or OFF. This diode is called as freewheeling diode.

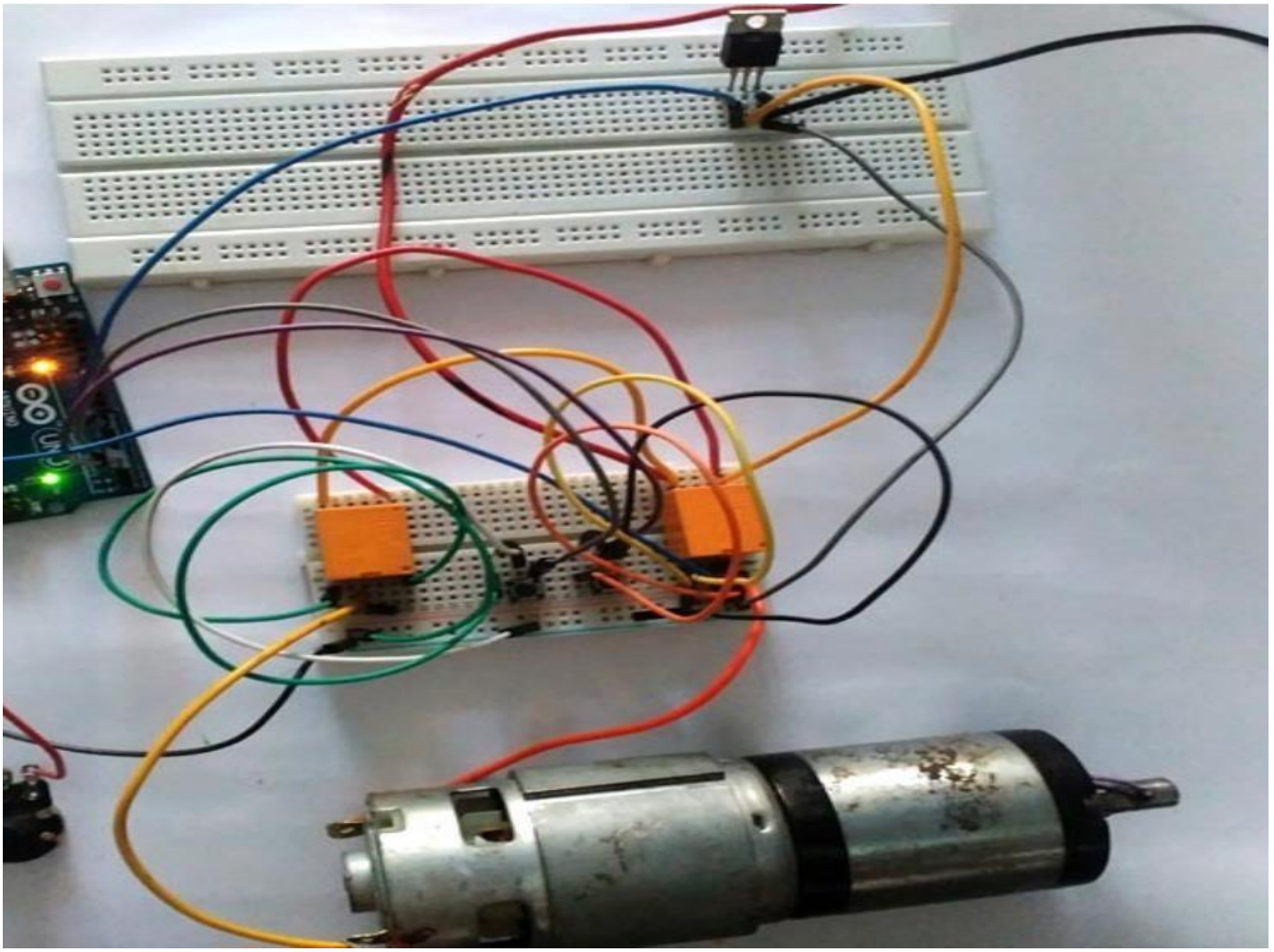
WORKING:

- In the example, external circuit contains a DC motor. It gets power from the Vcc via. Normally Open (NO) contact of the relay.
- Resistor RB is a current limiting resistor which protects the transistor BC548 from over current.
- Consider no voltage is applied to the base of the transistor, then the transistor remains OFF and no current would flow through the collector. Hence the relay also remains in OFF state.
- Power to the DC motor if fed from the Normally Open (NO) contact of the relay, so the motor will rotate when the relay is in ON state.
- Application of proper voltage at the base of the transistor BC548 causes turning ON of the transistor and the relay coil gets energize.
- When we want to stop the motor, supply to the base of the transistor is switched OFF.

Output (Actual photograph of the connected circuit on the breadboard):



Result: (Paste photograph of rotation of motor)



Conclusion:

When the motor is connected through NC contact it will rotate when the relay is in OFF state.
When the motor is connected through NO contact it will rotate when the relay is in ON state.
We have learned to use a transistor as a switch.

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Experiment No. 10

TITLE: LOGIC GATES.

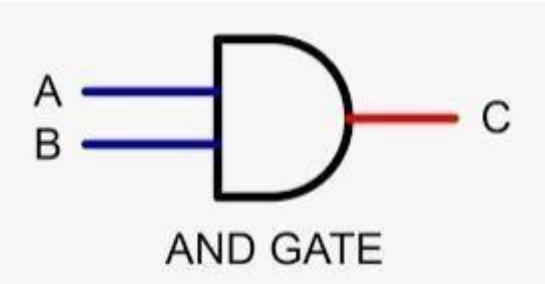
AIM: To verify the truth table for Basic Logic gates (AND, OR & NOT), Universal gates (NAND & NOR), and Ex-OR gate.

APPARATUS: Breadboard, Connecting wires, IC 7400, IC 7402, IC 7404, IC 7408, IC 7432.

Theory: Logic gates are the basic components in digital electronics. They are used to create digital circuits and even complex integrated circuits. For example, microprocessors and microcontrollers are implemented using several logic gates. A gate is a digital electronic circuit having only one output but one or more inputs. The output or a signal will appear at the output of the gate only for certain input-signal combinations. There are many types of logic gates; such as AND, OR and NOT, Other popular gates are the NAND and the NOR gates; which are simply combinations of an AND or an OR gate with a NOT gate inserted just before the output signal. Other gates include the Ex-OR (Exclusive-OR) and the Ex-NOR (Exclusive NOR) gates. All the logic gates used below are known as TTL (transistor-to-transistor logic). These have the convenient property that the output of any gate can be used directly as input to another gate. All these TTL circuits are operated from a 5 V power supply, the binary digits 0 and 1 are represented by low and high voltages on the gate terminals.

Basic Gates:

1. **AND Gate**: The AND gate is an electronic circuit that gives a high output (1) only if all its inputs are high. A dot (.) is used to show the AND operation i.e. X.Y. This dot can be omitted sometimes i.e. XY Logic expression is given by, Z=X.Y

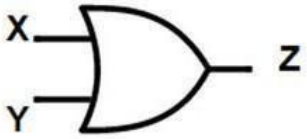


Truth Table:

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

2. **OR Gate**: The OR gate is an electronic circuit that gives a high output (1) if one or more of its inputs are high. A plus (+) is used to show the OR operation.

Logic expression is given by, Z=X+Y



OR gate

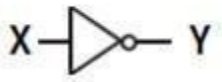
Truth Table:

Inputs		Output
A	**B**	**C**
0	0	0
0	1	1
1	0	1
1	1	1

3. **NOT Gate**: The NOT gate is an electronic circuit that produces an inverted version of the input at its output. It is also known as an inverter. If the input variable is X, the inverted output is known as NOT X.

Logic expression is given by,

$$Y = \overline{X}$$



Truth Table:

Input	Output
X	Y
0	1
1	0

Universal Gates:

1.NAND Gate: This is a NOT-AND gate which is equal to an AND gate followed by a NOT gate. The output of a NAND gate is high if any of the inputs are low. The symbol is an AND gate with a bubble on the output. The bubble represents inversion. Logic expression is given by,

$X = \overline{A}\,\overline{B}$

Truth Table:

Inputs		Output
X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	0

3. NOR Gate: This is a NOT-OR gate which is equal to an OR gate followed by a NOT gate. The output of a NOR gate is low if any of the inputs are high. The symbol is an OR gate with a bubble on the output. The bubble represents inversion.

Logic expression is given by Z = $\overline{X} + \overline{Y}$

Truth Table:

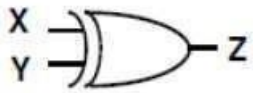
Inputs		Output
X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0

Advanced Gate:

Ex-OR Gate: The 'Exclusive-OR' gate is a circuit which will give a high output if either, but not both, of its two inputs are high. An encircled plus sign is used to show the Ex-OR operation.

Logic eqn.

$$Z = X \oplus Y$$



Truth Table:

Inputs		Output
X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

Diagrams: Pin Configurations of ICs:
AND Logic (IC 7408)

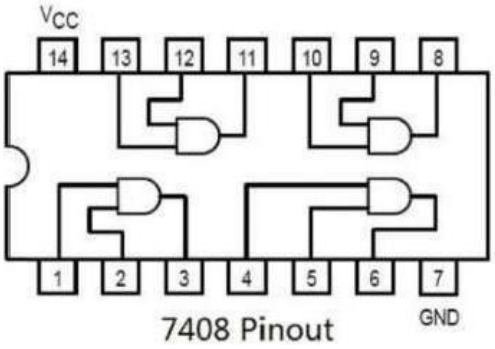


Fig. Pin Configuration of IC7408

OR Logic (IC 7432)

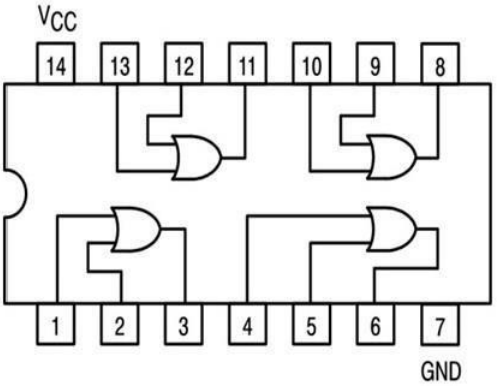


Fig. Pin Configuration of IC 7432

NOT Logic (IC 7404):

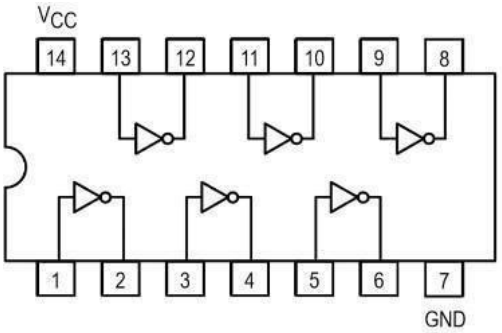


Fig. Pin Configuration of IC7404

NAND Logic (IC 7400):

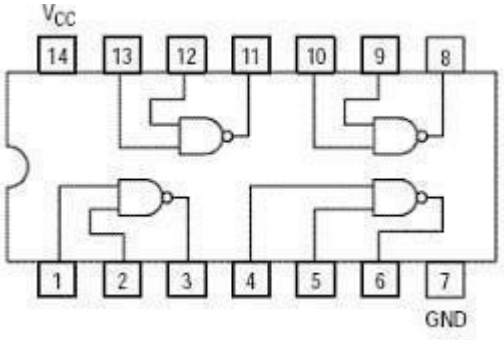


Fig. Pin Configuration of IC7400

NOR Logic(IC 7402):

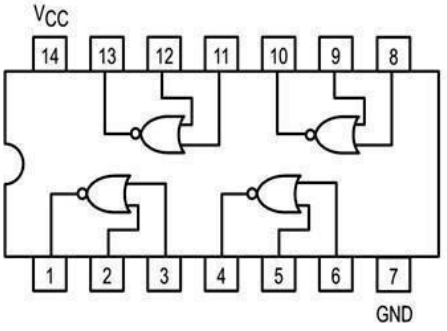


Fig. Pin Configuration of IC7402

Ex-OR Logic (IC 7486):

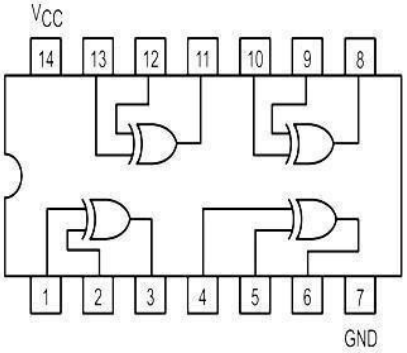


Fig. Pin Configuration of IC7486

Procedure:

1. Give 5 V D.C. power supply to the breadboard and ICs.

2. Connect the inputs and observe outputs on LEDs.

3. Verify the truth tables of all the above logic gates.

Conclusion:

The logic gates AND, OR, NOT, NAND, NOR and XOR can be depicted by a combination of a Breadboard, an Integrated Circuit and an LED. We can use this to create complex circuit like the ones used in the IC's.