# CHAPTER - 1

## INTRODUCTION

A satellite is an object in space that orbits or circles around a bigger object. There are two kinds of satellites: Natural (such as the moon orbiting the Earth) or Artificial (such as the International Space Station orbiting the Earth).

There are dozens upon dozens of natural satellites in the solar system, with almost every planet having at least one moon. Saturn, for example has at least 53 natural satellites and between 2004 and 2017, it also had an artificial one, the Cassini spacecraft, which explored the ringed planet and its moons.

Artificial satellites, however, did not become a reality until the mid-20th century. The first artificial satellite was Sputnik, a Russian beach-ball-size space probe that lifted off on Oct 4, 1957.

### 1.1 Why Are Satellites Important?

The bird's-eye view that satellites have allows them to see large areas of Earth at one time. This ability means satellites can collect more data, more quickly, than instruments on the ground. Satellites also can see into space better than telescopes at Earth's surface. That's because satellites fly above the clouds, dust and molecules in the atmosphere that can block the view from ground level.

Before satellites, TV signals didn't go very far. TV signals only travel in straight lines, so they would quickly trail off into space instead of following Earth's curve. Sometimes mountains or tall buildings would block them. Phone calls to faraway places were also a problem. Setting up telephone wires over long distances or underwater is difficult and costs a lot.

With satellites, TV signals and phone calls are sent upward to a satellite. Then, almost instantly, the satellite can send them back down to different locations on Earth.

### 1.2 Objectives

- To understand the concept of Geo-stationary and Polar orbits.
- Design 3D satellite-globe model using Autodesk (Fusion 360).
- Controlling operations of the model using microcontroller Arduino UNO Rev3 and L298N Motor Driver IC.
- To illustrate how the Satellites revolve in their respective orbits around the Earth.

# CHAPTER - 2

## LITERATURE REVIEW

A satellite is a moon, planet or machine that orbits a planet or star. For example, Earth is a satellite because it orbits the sun. Likewise, the moon is a satellite because it orbits Earth. Usually, the word "satellite" refers to a machine that is launched into space and moves around Earth or another body in space.

Earth and the moon are examples of natural satellites. Thousands of artificial or man-made satellites orbit Earth. Some take pictures of the planet that help meteorologists predict weather and track hurricanes. Some take pictures of other planets, the sun, black holes, dark matter or faraway galaxies. These pictures help scientists better understand the solar system and universe.

### 2.1 Classification of artificial satellites

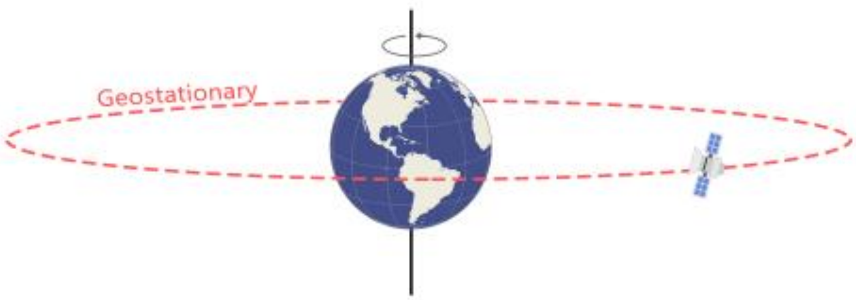
Satellites can be classified by their function since they are launched into space to do a specific job. The satellite must be designed specifically to fulfill its role. There are nine different types of satellites:

- Communications Satellite
- Remote Sensing Satellite
- Navigation Satellite
- Geocentric Orbit type satellites - LEO, MEO, HEO
- Global Positioning System (GPS)
- Geostationary Satellites (GEOs)
- Drone Satellite
- Ground Satellite
- Polar Satellite
- Nano Satellites, CubeSats and Small Satellites

In general, there are two groups of artificial satellites:

The satellites that **orbit the equator (Geo-stationary satellites)**, and those that **orbit from pole to pole (polar satellites)**.

### 2.1.1 Geo-stationary Satellites




A geo-stationary satellite is an earth-orbiting satellite, placed at an altitude of approximately 35,800 kilometers (22,300 miles) directly over the equator, that revolves in the same direction the earth rotates (west to east). At this altitude, one orbit takes 24 hours, the same length of time as the earth requires to rotate once on its axis. The term "geostationary" comes from the fact that such a satellite appears nearly stationary in the sky as seen by a ground-based observer.

Geo-stationary satellites have two major limitations. First, because the orbital zone is an extremely narrow ring in the plane of the equator, the number of satellites that can be maintained in geostationary orbits without mutual conflict (or even collision) is limited. Second, the distance that an electromagnetic (EM) signal must travel to and from a geostationary satellite is a minimum of 71,600 kilometers or 44,600 miles. Thus, a latency of at least 240 milliseconds is introduced when an EM signal, traveling at 300,000 kilometers per second (186,000 miles per second), makes a round trip from the surface to the satellite and back.

Some of the advantages of geo-stationary satellites are to get high temporal resolution data, tracking of the satellite by its earth stations is simplified, Satellite always stays in the same position. The disadvantage of geo-stationary satellites is the incomplete geographical coverage, since ground stations at higher than roughly 60 degrees latitude have difficulty reliably receiving signals at low elevations. Satellite dishes at such high latitudes would need to be pointed almost directly towards the horizon. The signals would have to pass through the largest amount of atmosphere, and could even be blocked by land topography, vegetation or buildings.

Broadcasting (Mainly Television), Point to Multi point communications, Mobile services are some of the applications of geo-stationary satellites.

### 2.1.2 Polar Satellites


Polar satellite is a satellite whose orbit is perpendicular or at right angles to the equator or in simple words it passes over the north and south poles as it orbits the earth. It can be at any height from the earth, typically at 500–800 Kms. As the earth rotates under it, the earth presents a different face at every pass, making it possible to map / scan the entire earth surface with Polar satellite over time. This property makes them excellent tool as earth observation or spy satellite.

A polar orbit travels north-south over the poles and takes approximately an hour and a half for a full rotation. As the satellite is in orbit, the Earth is rotating beneath it. As a result, a satellite can observe the entire Earth’s surface in the time span of 24 hours.

Some of the advantages of polar satellites are the orbit is lower than Geostationary satellites, so the data resolution is higher, they provide global coverage, necessary for NWP models and climatic studies. The main disadvantage of polar satellites is that it cannot provide continuous viewing of one location. Polar satellites are often used for applications such as monitoring crops, forests and even global security.

## 2.2 Geo-stationary Orbit

A geostationary orbit, also referred to as a geosynchronous equatorial orbit (GEO), is a circular geosynchronous orbit 35,786 kms (22,236 miles) above Earth's equator and following the direction of Earth's rotation.

The concept of a geostationary orbit was popularized by Arthur C. Clarke in the 1940s as a way to revolutionize telecommunications, and the first satellite to be placed in this kind of orbit was launched in 1963.

A typical geostationary orbit has the following properties:

- Inclination: 0°
- Period: 1436 minutes (one sidereal day)
- Eccentricity: 0
- Argument of perigee: undefined
- Semi-major axis: 42,164 km

**Inclination**

An inclination of zero ensures that the orbit remains over the equator at all times, making it stationary with respect to latitude from the point of view of a ground observer.

**Period**

The orbital period is equal to exactly one sidereal day. This means that the satellite will return to the same point above the Earth's surface every (sidereal) day, regardless of other orbital properties. For a geostationary orbit in particular, it ensures that it holds the same longitude over time. This orbital period, T is directly related to the semi-major axis of the orbit through the formula

$$T = 2\pi\sqrt{\frac{a^3}{\mu}}$$

where:

**a** is the length of the orbit's semi-major axis

**μ** is the standard gravitational parameter of the central body

**Eccentricity**

The eccentricity is zero, which produces a circular orbit. This ensures that the satellite does not move closer or further away from the Earth, which would cause it to track backwards and forwards across the sky.

### 2.2.1 Derivation of geostationary altitude

For circular orbits around a body, the centripetal force required to maintain the orbit ($F_c$) is equal to the gravitational force acting on the satellite ($F_g$)

$$F_c = F_g$$

From Isaac Newton's Universal law of gravitation,

$$F_g = G\frac{M_E m_s}{r^2}$$

where,

$\mathbf{F_g}$ is the gravitational force acting between two objects

$\mathbf{M_E}$ is the mass of the Earth, $5.9736 \times 10^{24}$ kg

$\mathbf{m_s}$ is the mass of the satellite,

**r** is the distance between the centres of their masses

**G** is the gravitational constant, $(6.67428 \pm 0.00067) \times 10^{-11}$ $m^3$ $kg^{-1}$ $s^{-2}$.

The magnitude of the acceleration (a) of a body moving in a circle is given by:

$$a = \frac{v^2}{r}$$

where **v** is the magnitude of the velocity (i.e. the speed) of the satellite. From Newton's Second law of Motion, the centripetal force $\mathbf{F_c}$ is given by:

$$F_c = m_s \frac{v^2}{r}$$

As $\boldsymbol{F_c = F_g}$,

$$m_s \frac{v^2}{r} = G \frac{M_E m_s}{r^2}$$

so that

$$v^2 = G \frac{M_E}{r}$$

Replacing **v** with the equation for the speed of an object moving around a circle produces:

$$\left(\frac{2\pi r}{T}\right)^2 = G \frac{M_E}{r}$$

where T is the orbital period (i.e. one sidereal day), and is equal to 86164.09054s. This gives an equation for **r**:

$$r = \sqrt[3]{\frac{G M_E T^2}{4\pi^2}}$$

The product GME is known with much greater precision than either factor alone; it is known as the geocentric gravitational constant μ = 398,600.4418 ± 0.0008 km3 s−2. Hence

$$\mathbf{r} = \sqrt[3]{\frac{\boldsymbol{\mu} \mathbf{T}^2}{\mathbf{4}\boldsymbol{\pi}^2}}$$

The resulting orbital radius is 42,164 kms (26,199 miles). Subtracting the Earth's equatorial radius, 6,378 kms (3,963 miles), gives the altitude of 35,786 kms (22,236 miles).

The orbital speed is calculated by multiplying the angular speed by the orbital radius:

$$v = \omega r \quad \approx 3074.6 \text{ m/s}$$

## 2.3 Arduino IDE

### 2.3.1 A Brief History

In 2005, building upon the work of Hernando Barragan (creator of Wiring), Massimo Banzi and David Cuartielles created Arduino, an easy-to-use programmable device for interactive art design projects, at the Interaction Design Institute Ivrea in Ivrea, Italy. David Mellis developed the Arduino software, which was based on Wiring. Before long, Gianluca Martino and Tom Igoe joined the project, and the five are known as the original founders of Arduino. They wanted a device that was simple, easy to connect to various things (such as relays, motors, and sensors), and easy to program. They selected the AVR family of 8-bit microcontroller (MCU or µC) devices from Atmel and designed a self-contained circuit board with easy-to-use connections, wrote bootloader firmware for the microcontroller, and packaged it all into a simple integrated development environment (IDE) that used programs called "sketches". The result was the Arduino.

### 2.3.2 Brief about Arduino IDE

Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

## 2.4 Arduino Uno Rev3

**Arduino Uno** is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything which are needed to support the microcontroller.

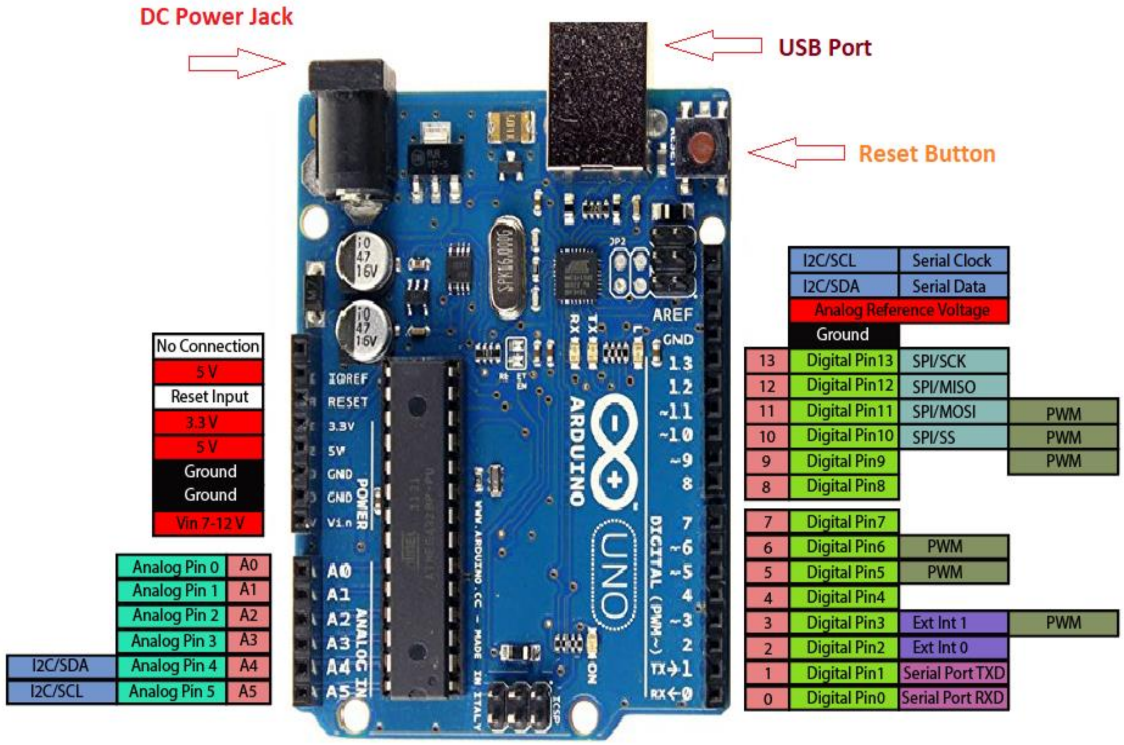


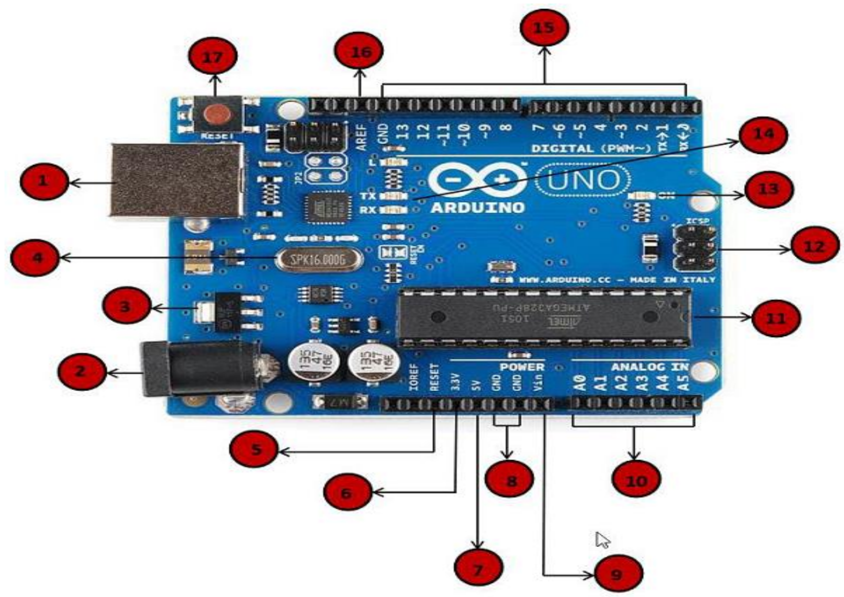

Fig 1. Pin diagram of Arduino UNO Rev3

### 2.4.1 Specifications of Arduino Uno Rev3

| | |
|---|---|
| Microcontroller | ATmega328P |
| Operating Voltage | 5V |
| Input Voltage (recommended) | 7-12V |
| Input Voltage (limit) | 6-20V |
| Digital I/O Pins | 14 (of which 6 provide PWM output) |
| PWM Digital I/O Pins | 6 |
| Analog Input Pins | 6 |
| DC Current per I/O Pin | 20 mA |
| DC Current for 3.3V Pin | 50 mA |
| Flash Memory | 32 KB (ATmega328P) of which 0.5 KB used by bootloader |
| SRAM | 2 KB (ATmega328P) |

| | |
|---|---|
| EEPROM | 1 KB (ATmega328P) |
| Clock Speed | 16 MHz |
| LED_BUILTIN | 13 |
| Length | 68.6 mm |
| Width | 53.4 mm |
| Weight | 25 g |

### 2.4.2 Components of Arduino Uno R3




| | |
|---|---|
| 1 | **Power USB**<br>Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection. |
| 2 | **Power (Barrel Jack)**<br>Arduino boards can be powered directly from the AC mains power supply by connecting it to the Barrel Jack. |
| 3 | **Voltage Regulator**<br>The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements. |

<table>
<tr><td>4</td><td>Crystal Oscillator<br>The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz.</td></tr>
<tr><td>5,17</td><td>Arduino Reset<br>You can reset your Arduino board, i.e., start your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).</td></tr>
<tr><td>6,7<br>8,9</td><td>Pins (3.3, 5, GND, Vin)<ul><li>3.3V (6) − Supply 3.3 output volt</li><li>5V (7) − Supply 5 output volt</li><li>Most of the components used with Arduino board works fine with 3.3V and 5V.</li><li>GND (8) (Ground) − There are several GND pins on the Arduino, any of which can be used to ground your circuit.</li><li>Vin (9) − This pin also can be used to power the Arduino board from an external power source, like AC mains power supply.</li></ul></td></tr>
<tr><td>10</td><td>Analog pins<br>The Arduino UNO board has six analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.</td></tr>
<tr><td>11</td><td>Main microcontroller<br>Each Arduino board has its own microcontroller (11). You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. You must know what IC your board has before loading up a new program from the</td></tr>
</table>

| | |
|---|---|
| | Arduino IDE. This information is available on the top of the IC. For more details about the IC construction and functions, you can refer to the data sheet. |
| 12 | **ICSP pin**<br>Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the SPI bus. |
| 13 | **Power LED indicator**<br>This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection. |
| 14 | **TX and RX LEDs**<br>On your board, you will find two labels: TX (transmit) and RX (receive). They appear in two places on the Arduino UNO board. First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led (13). The TX led flashes with different speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process. |
| 15 | **Digital I/O**<br>The Arduino UNO board has 14 digital I/O pins (15) (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labeled “~” can be used to generate PWM. |
| 16 | **AREF**<br>AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins. |

## 2.5 Geared DC Motor

### 2.5.1 What is a Geared DC Motor?

Geared DC motors can be defined as an extension of DC motor. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM. The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction.

Fig 2. Geared DC Motor

### 2.5.2 Specifications

| | |
|---|---|
| Motor Type | DC with Gear Box, Metal Gears |
| Base Motor | DC 3000 RPM |
| Shaft Type | Circular 6mm diameter with internal hole for coupling, 23 mm shaft length. |
| Maximum Torque | ~3 Kg-cm at 12V |
| RPM | 60 RPM at 12V |
| Weight | 130 Grams |
| Max Load Current | ~330mA at 12V |

## 2.6 Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.

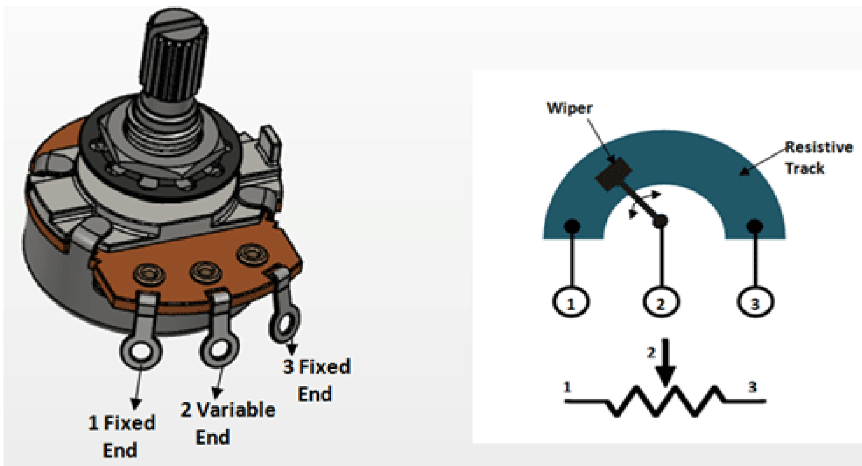
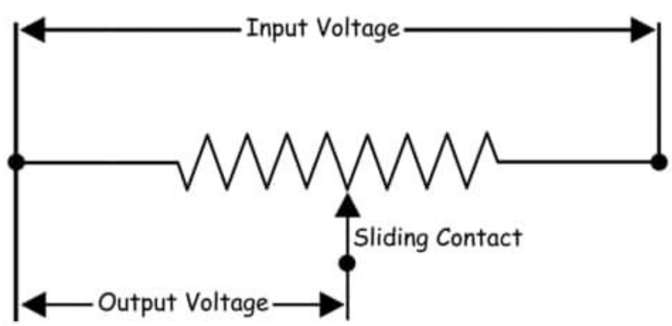


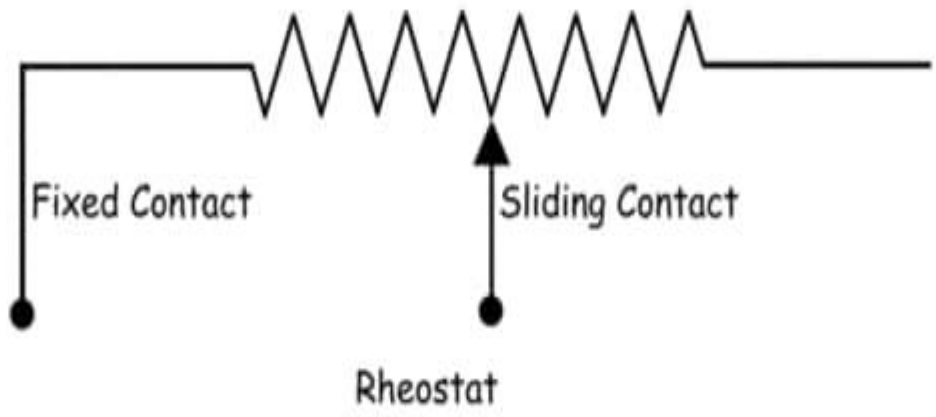

Fig 3. Three Pin Potentiometer

### 2.6.1 How Does a Potentiometer Work?

A potentiometer is a passive electronic component. Potentiometers work by varying the position of a sliding contact across a uniform resistance. In a potentiometer, the entire input voltage is applied across the whole length of the resistor, and the output voltage is the voltage drop between the fixed and sliding contact as shown below.

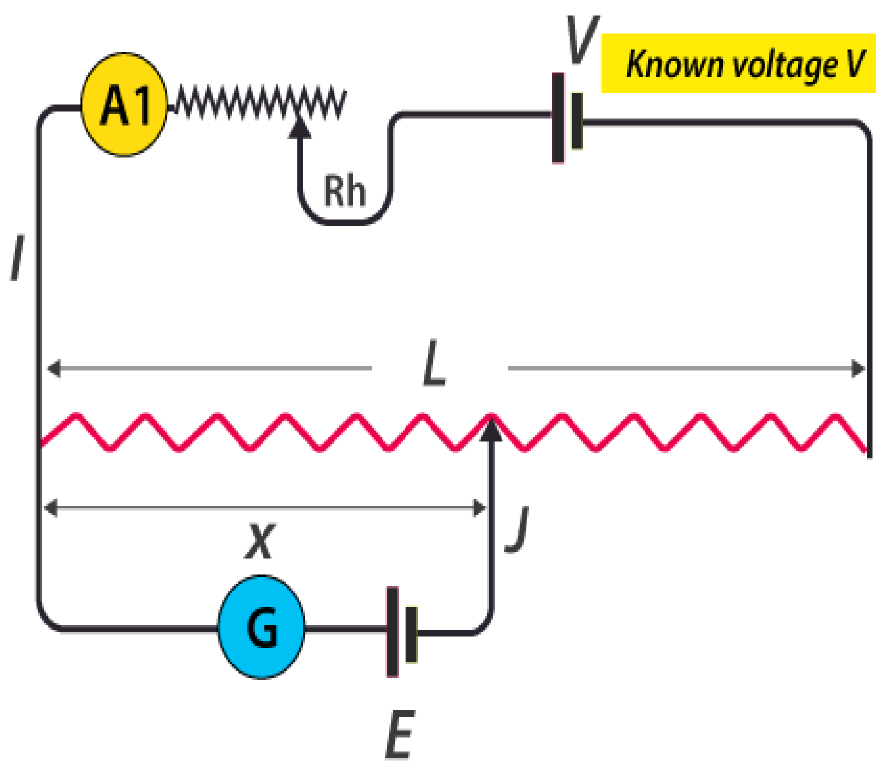



A potentiometer has the two terminals of the input source fixed to the end of the resistor. To adjust the output voltage the sliding contact gets moved along the resistor on the output side. This is different to a rheostat, where here one end is fixed and the sliding terminal is connected to the circuit, as shown below.




**2.6.2 Working Principle of Potentiometer**

The potentiometer consists of L which is a long resistive wire and a battery of known EMF V whose voltage is known as driver cell voltage. Assume a primary circuit arrangement by connecting the two ends of L to the battery terminals. One end of the primary circuit is connected to the cell whose EMF E is to be measured and the other end is connected to galvanometer G. This circuit is assumed to be a secondary circuit.



The working principle depends on the potential across any portion of the wire which is directly proportional to the length of the wire that has a uniform cross-sectional area and current flow is constant. Following is the derivation of used to explain the potentiometer working principle:

$V = I * R$ (Ohm’s law)

Where,

I: Current

R: Total resistance

V: Voltage

$R = \rho / (L * A)$

$V = I * (\rho / (L * A))$

Where,

ρ: Resistivity

A: Cross-sectional area

With ρ and A constant, I is constant too for a rheostat.

$(L * \rho) / A = K$

$V = K * L$

$E = (L * \rho * x) / A = K * x$

Where,

x: Length of potentiometer wire

E: Cell with Lower EMF

K: Constant

The galvanometer G has null detection as the potential difference is equal to zero and there is no flow of current. So, x is the length of the null point. Unknown EMF can be found by knowing x and K.

Since the EMF has two cells, let L1 be the null point length of the first cell with EMF E1 and L2 be the null point length of the second cell with EMF E2.

Therefore,

$E1 / E2 = L1 / L2$

## 2.7 L298N Motor Driver IC

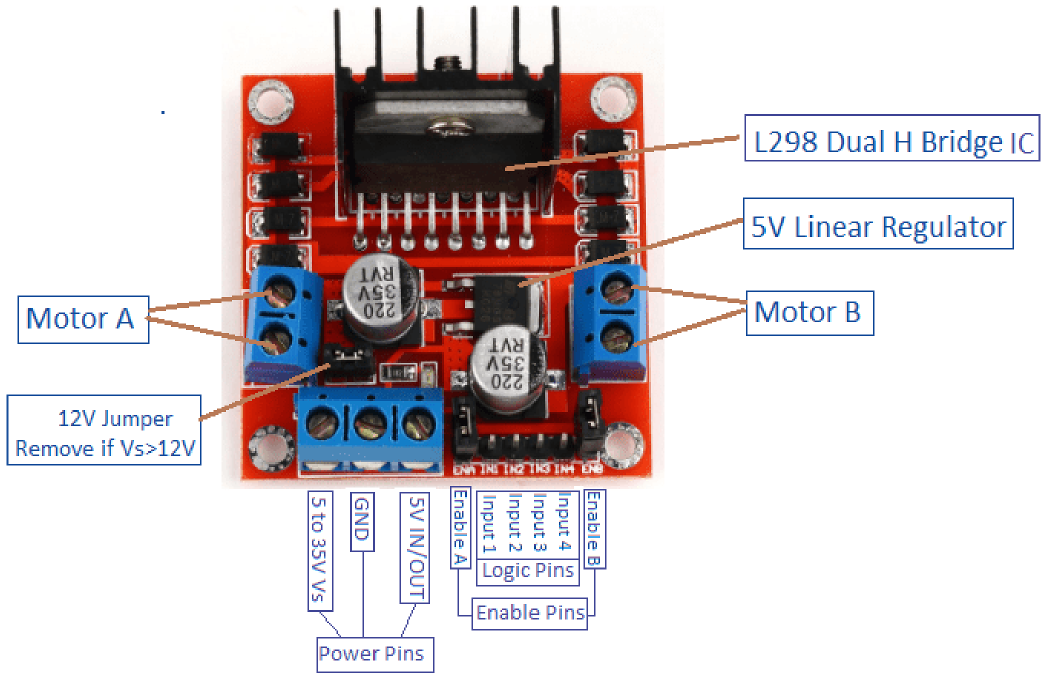



Fig 4. Pin configuration of L298N Motor Driver IC

The L298N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A.

### 2.7.1 Specifications

1. Operating voltage: 5V (All logic pins)
2. Working current: 0.35mA
3. Motor Voltage: 5V to 35V
4. Motor current: 2A per H-Bridge
5. Maximum Power: 25W

### 2.7.2 How Does H-Bridge Work?

This is a dual H-Bridge controller, which means it can control up to two motors simultaneously. Each motor has its respective positive and negative terminal to which it has to be connected. These are usually labelled OUT_1 and OUT_2. The direction of each motor can individually be controlled with two input pins:

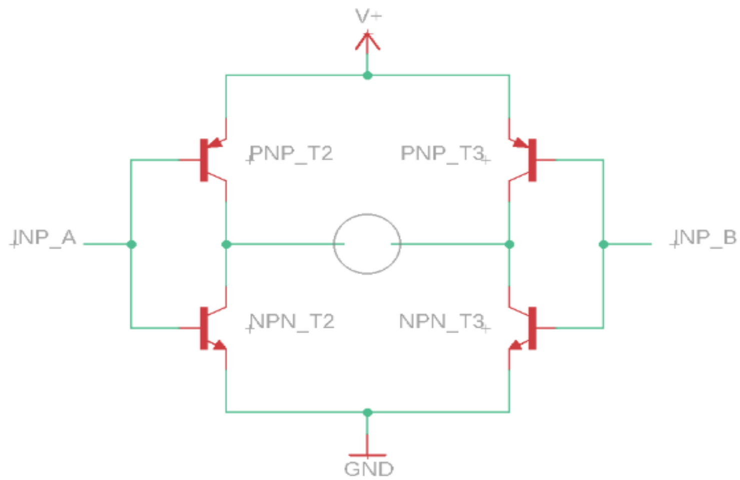
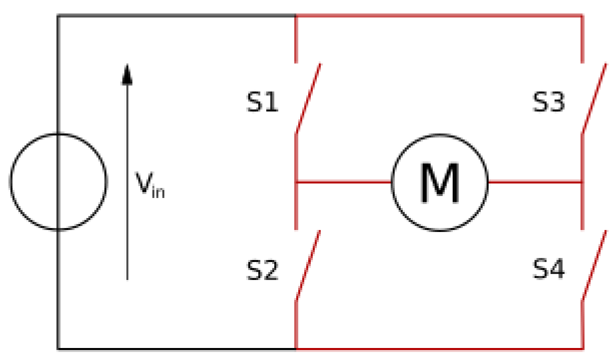



Fig 5. The H-Bridge circuit diagram.

When both, INP_A and INP_B, are low, the motor is off. If either of the pins is HIGH while the other one is LOW, the motor will spin in one direction. To reverse the motor, reverse the states of the inputs. If both pins are pulled high, the motor will stop again.

### 2.7.3 Structure of H-Bridge

| S1 | S2 | S3 | S4 | Result |
|---|---|---|---|---|
| 1 | 0 | 0 | 1 | Motor moves right |
| 0 | 1 | 1 | 0 | Motor moves left |
| 0 | 0 | 0 | 0 | Motor coasts |
| 1 | 0 | 0 | 0 | |
| 0 | 1 | 0 | 0 | |
| 0 | 0 | 1 | 0 | |
| 0 | 0 | 0 | 1 | |
| 0 | 1 | 0 | 1 | Motor brakes |
| 1 | 0 | 1 | 0 | |
| x | x | 1 | 1 | Short circuit |
| 1 | 1 | x | x | |



# CHAPTER - 3

## DESIGN

The design of the whole model is done using AutoCAD (Computer Aided Design) tool of student version, developed by Autodesk (Fusion 360). It is computer-aided design (CAD) software that architects, engineers and construction professionals rely on to create precise 2D and 3D drawings. Draft and edit 2D geometry and 3D models with solids, surfaces and mesh objects. Annotate drawings with text, dimensions, leaders and tables.

### 3.1 Advantages of Autodesk (Fusion 360):

Autodesk (Fusion 360) is a computer-aided software drafting program. It is used for a number of applications like creating blueprints for buildings, mechanical designs, bridges and computer chips, etc. It is 2D and 3D computer aided drafting software application. It is commercial and developer software.

### 3.2 Applications of Autodesk (Fusion 360):

- Autodesk (Fusion 360) as an architectural planning tool.
- It can be used as engineering drafting tool.
- Used as a graphic design tool.
- Used in 3D Printing.
- Used in the fashion industry.
- Used in industrial design tool.

### 3.3 Features of Autodesk (Fusion 360):

- 3D Modeling and Visualization.
- Photorealistic Rendering.
- Solid, Surface and Mesh Modeling.
- Visual Styles.
- PDF and DGN Import/Export/Underlay.
- Section Planes.
- 3D Scanning and Point Clouds.
- 3D Navigation.

and many more…

# CHAPTER – 4

## METHODOLOGY

### 4.1 3D diagram of the Model

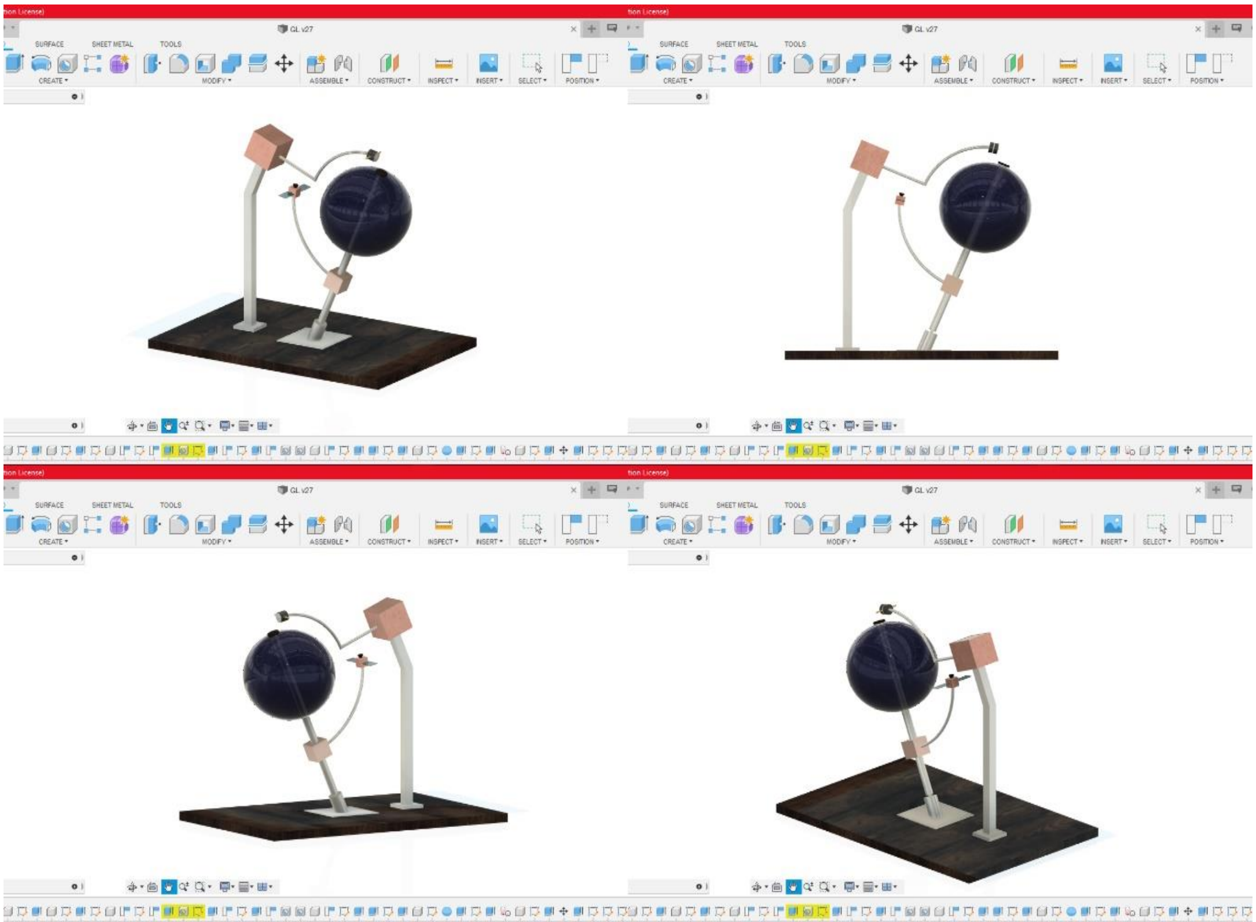


Fig 6. 3D representation of Globe-Satellite model.

The 3D visualization helps to match the design with the real product. It gives an overall view of how the product looks. The Three-dimensional model of the future mechanism accelerates and facilitates the work of the design engineer, saving him from the drafting process. The visualization process helps to demonstrate the design solution.

## 4.2 Individual design scale

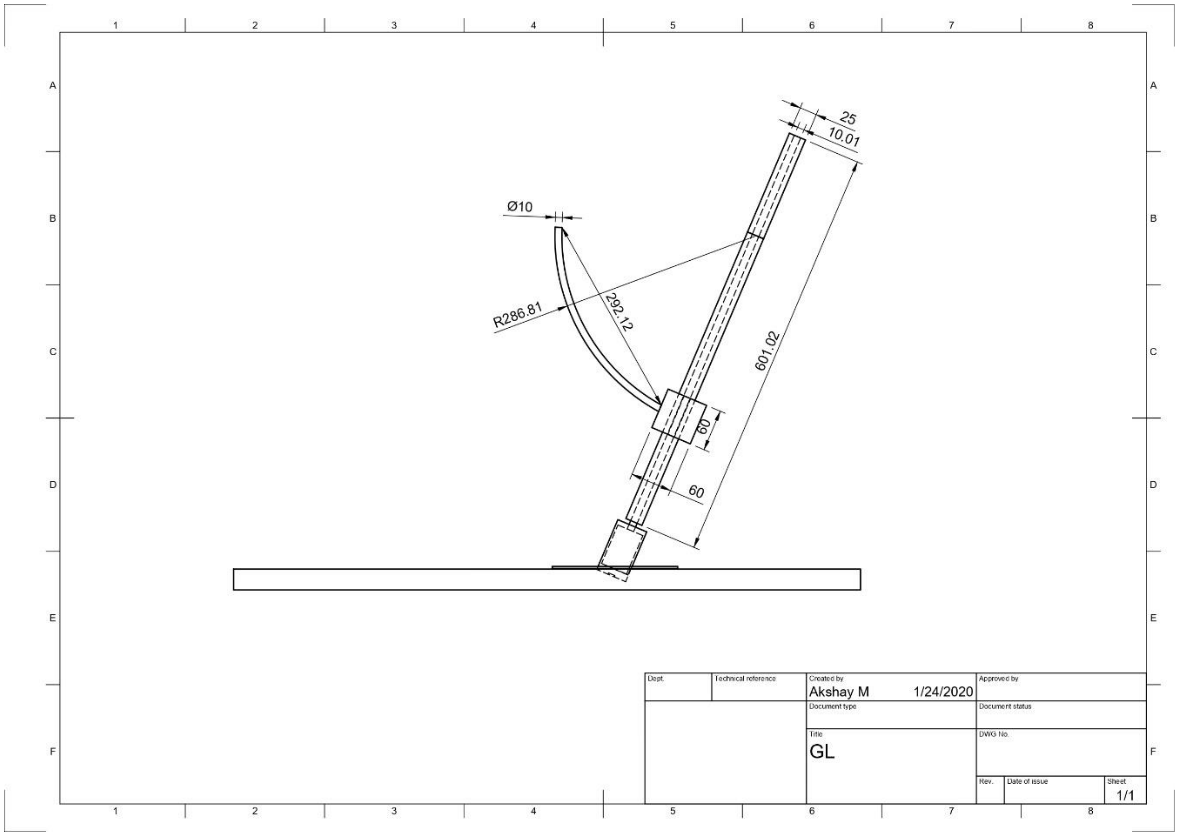



Fig 7. The above figure shows the arrangement to place globe and Geo-Stationary SAT.

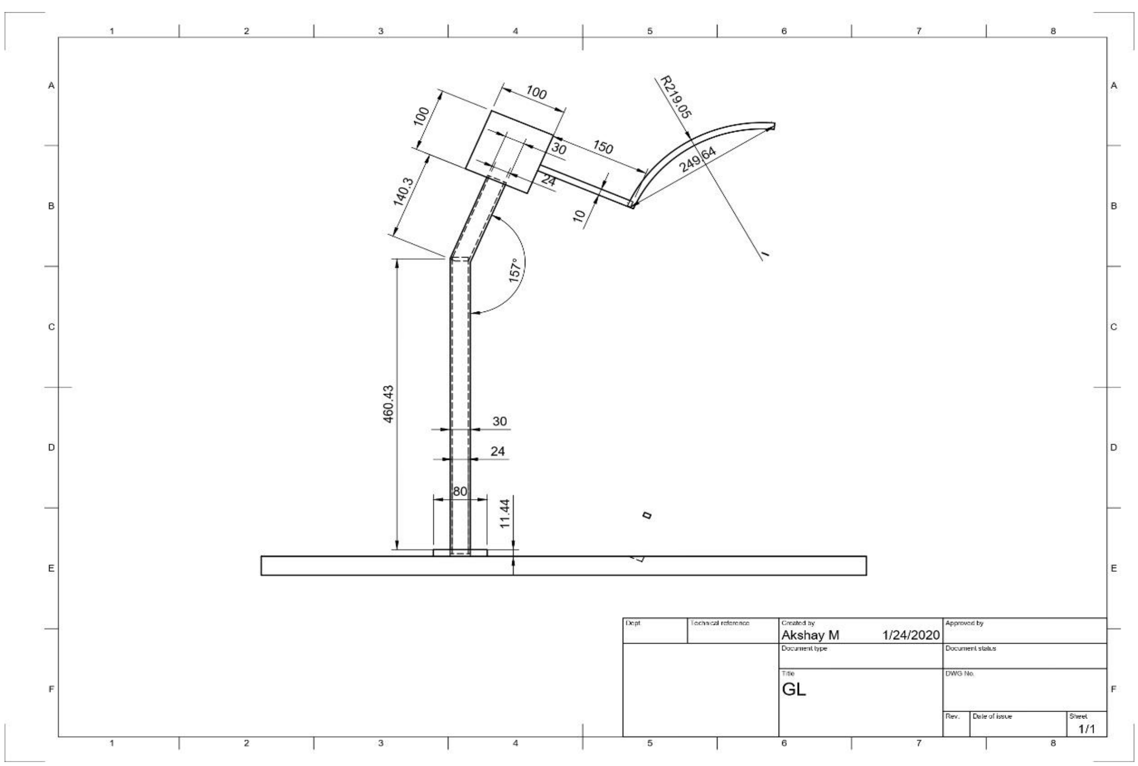



Fig 8. The above figure shows the arrangement for polar SAT.

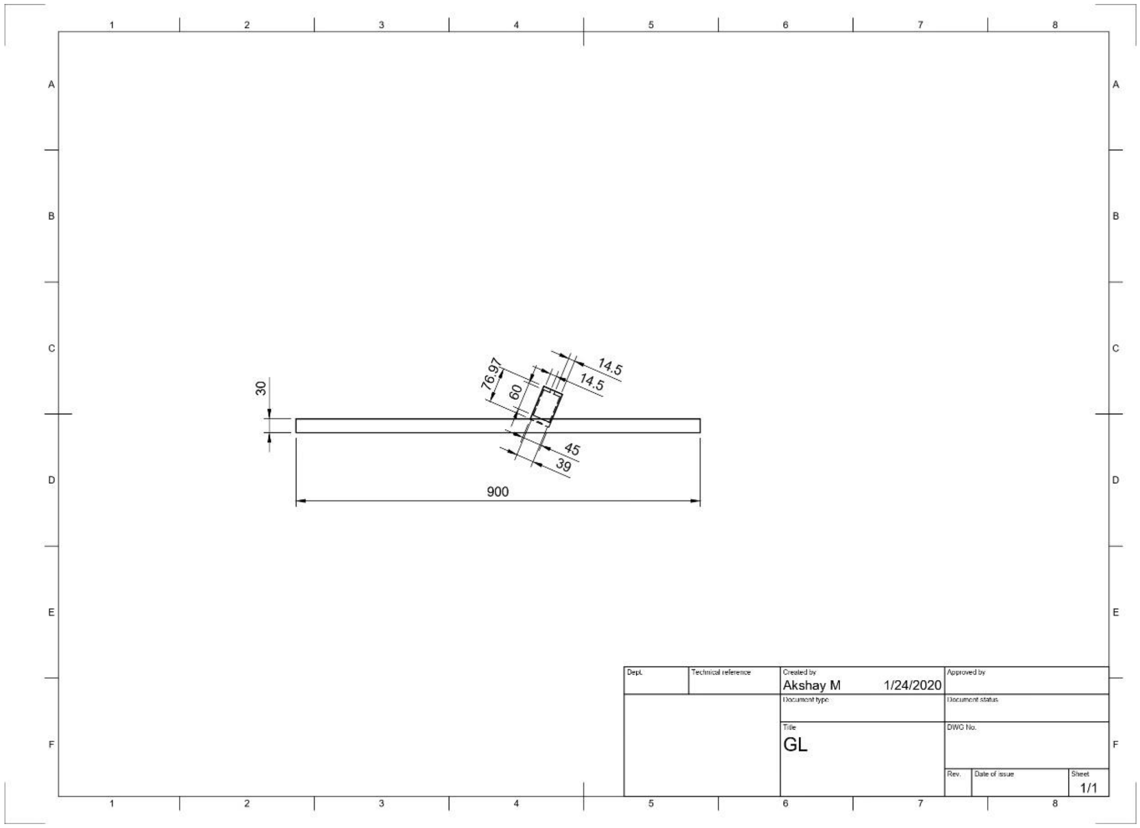



Fig 9. The above figure shows the setup of the container to illustrate Geo-Stationary SAT.

## 4.3 Block diagram of GS-Model Circuit

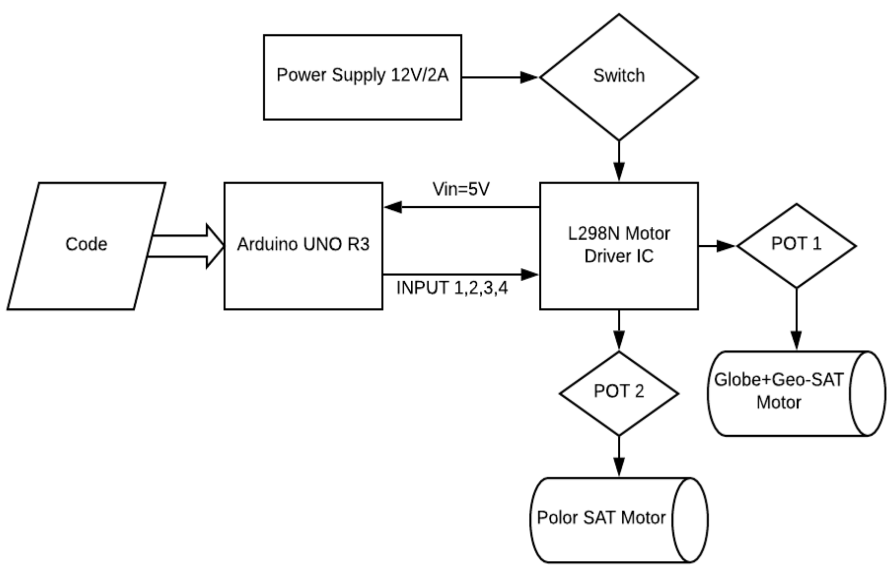



Fig 10. Block diagram shows the interconnections of components.

Fig10 shows arrangement and the interconnections between different components included in the model. The 12V/2A power supply is given to L298N Motor driver, the Arduino UNO R3 is used as microcontroller which controls overall operation and is powered by L298N motor driver with 5V. The motor driver IC is used to drive two geared DC motors of 60 RPM for Geo SAT and of 45 RPM for Polar SAT which helps to illustrate the working of Geo-stationary and Polar satellite. One of the Geared DC motor is used to drive both globe and geo-satellite since the orbital period of the Geo-Stationary satellite is same as the Earth's rotation period, other Geared DC motor is used to drive polar satellite alone. The input pins present in the Motor Driver IC (IN1, IN2, IN3, IN4) are connected to Arduino uno which sets the speed and direction of rotation of the Geared DC Motors. The two 1K potentiometers POT 1 and POT 2 are used to control the speed of the motors manually. The switch block represents the Toggle Switch which is used to on /off the supply to the model.

## 4.4 Circuit diagram of GS-Model

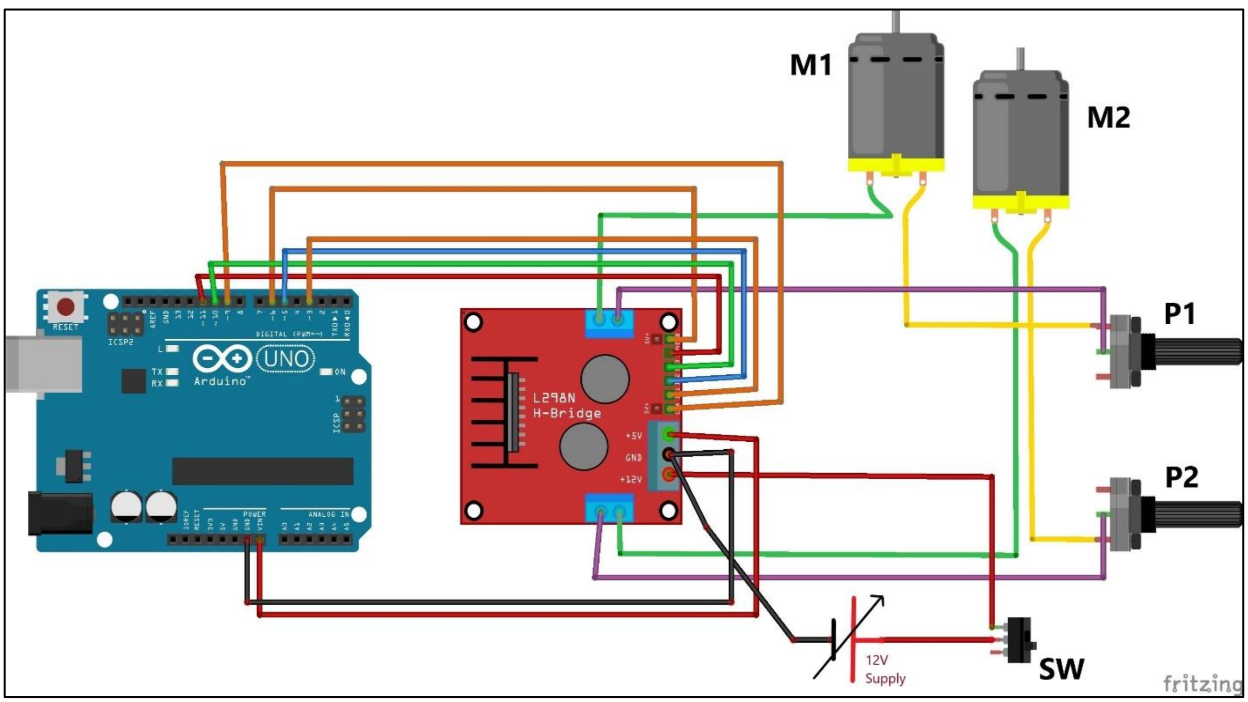



Fig 11. Circuit diagram showing interconnection of components

### 4.4.1 Pin Connections

- Enable pins of motor M1 and M2 in L298N IC are connected to the pins 6 and 9 of Arduino respectively.
- The input pins IN1, IN2, IN3, IN4 in L298N IC are connected to the pins 11, 10, 5 and 3 of Arduino respectively.
- 5V supply for Arduino is given by L298N IC from +5V pin.
- One end of the motor M1 and M2 are connected to M1 slot and M2 slot respectively in L298N IC and the other end of motors M1 and M2 are connected to Potentiometers P1 and P2 respectively, now the other end of potentiometers P1 and P2 are connected to the slots M1 and M2 in L298N IC.
- The 12V supply from Adaptor is given to L298N IC with the help of Barrel jack.
- The Toggle switch SW is connected in series with the supply for on/off operation.

### 4.4.2 Circuit Explanation

- The enable pins for both the motors are made high for enabling and controlling speed of the motors.
- In two input pins for each motor, one of the pins is made high and the other one made low.
- Since Arduino requires 5V supply for its operation, the +5V supply pin is given to Vin pin of Arduino from L298N IC.
- By using Arduino speed and direction of motor can be set using the input pins and by varying potentiometers P1 and P2, the speed of the motor M1 and M2 can increased/decreased accordingly.
- To make any changes in the code, the updated code must be dumped to the Arduino board through USB port, so that the previous code will be replaced by new updated code.
- The power consumed by a motor is around 4 Watts and for Arduino is around 5 Watts, So the Total power consumption by the circuit is around 13 Watts i.e

  $P = V * I$

  $P = (12*0.33)*2 + (5*1) = 13$ Watts.

## 4.5 Led-Battery circuit for Satellite

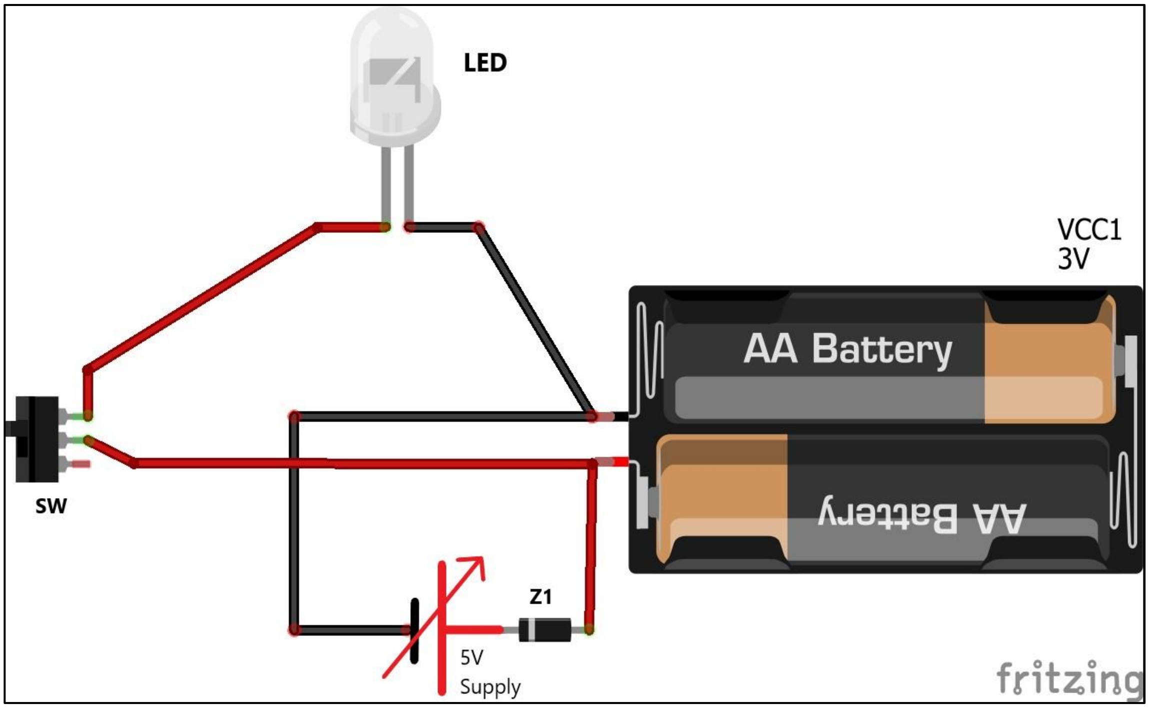



Fig 12. Led-Battery circuit for satellite

### 4.5.1 Circuit Explanation

- Anode (-ve) end of the led is connected to negative terminal of the 3V battery.
- One end of toggle switch SW is connected to positive terminal of the battery and other end is connected to the cathode (+ve) end of led to on/off the led.
- 5V supply is connected across the rechargeable battery through Barrel jack.
- The negative terminal of IN4007 Diode is connected the supply and other end to the positive terminal of the battery.
- The battery will take about half an hour to fully charge and will take about 2 to 3 hours to drain by keeping led in on state.
- Separate charging circuit is given for Geo-stationery satellite (Green led) and Polar satellite (Red led).

### 4.6 Code for GS-Model

```
int en1 = 9; //Enable pin for G motor1
int en2 = 6; //Enable pin for G motor2
int in1 = 3; //G motor1 clockwise
int in2 = 5; //G motor1 Anticlockwise
int in3 = 10; //G motor2 clockwise
int in4 = 11; //G motor2 Anticlockwise
void setup ()
{
// put your setup code here, to run once:
//All the above pins are of OUTPUT configuration, so pinmode is of the type OUTPUT
pinMode (en1, OUTPUT);
pinMode (en2, OUTPUT);
pinMode (in1, OUTPUT);
pinMode (in2, OUTPUT);
pinMode (in3, OUTPUT);
pinMode (in4, OUTPUT);
}
void loop ()
{
// put your main code here, to run repeatedly:
analogWrite (en1,255); //Enable1 pin is made high which is of pwm range (0 - 255)
analogWrite (en2,255); //Enable2 pin is made high which is of pwm range (0 - 255)
analogWrite (in1,1023); //in1 is made high which is of the range (0 - 1023)
analogWrite (in2,0); //in2 is made low
analogWrite (in3,1023); //in3 is made high which is of the range (0 - 1023)
analogWrite (in4,0); //in4 is made low
}
```

The code is written in embedded C language with Arduino IDE for Arduino UNO Rev3 Board. The code uses 1024 bytes of 32K bytes memory (3% of Total memory) present in the Arduino UNO Rev3. The speed of two Geared DC Motors (Mot1 & Mot2) can be varied with the help of two potentiometers (Pot1 & Pot2) respectively.

# CHAPTER - 5

## BUSINESS ANALYSIS

### 5.1 Budget

| Sl no. | Date | Items->Shop name | Cost (in Rs.) |
|---|---|---|---|
| 1. | 15/2/20 | Electronics->Kiran Embedded | 1375 |
| 2. | 11/2/20 | Al pipes & Sheets->Nakoda Metals | 745 |
| 3. | 21/2/20 | Al pipe->Nakoda Metals | 60 |
| 4. | 2/3/20 | Al sheet->Nakoda Metals | 300 |
| 5. | 3/3/20 | Bearings->Bhavesh T B C C | 200 |
| 6. | 7/2/20 | Soldering wire->Dinesh Electricals | 80 |
| 7. | 29/2/20 | Al sq pipe->Reckon Metal Industries | 442 |
| 8. | 4/3/20 | Globe->Himalaya Book World | 980 |
| 9. | 6/3/20 | Spray paint->Fortune Steel Industries | 236 |
| 10. | 6/3/20 | Manufacturing | 6000 |
| 11. | 5/3/20 | Nut-Bolts | 50 |
| 12. | 5/3/20 | Sandpapers | 50 |
| 13. | 13/3/20 | Spray paint->Kisan Enterprise | 350 |
| 14. | 13/3/20 | Potentiometer->Sri Mateshwari Electricals | 150 |
| 15. | 13/3/20 | Stationary->Sneha Plywood and Hardware | 81 |
| 16. | 13/3/20 | Carpentry | 100 |
| 17. | ------------- | Stationary | 250 |
| 18. | ---------- | Travelling | 2500 |
| 19. | 16/3/20 | DC motor+ Glue stick->Sushil Electronics | 165 |
| 20. | 18/3/20 | DC motor + Cell-> Sushil Electronics | 178 |
| 21. | 18/3/20 | Spray paint->Teja Enterprises | 180 |
| 22. | 18/3/20 | Foam board | 200 |

**TOTAL = ₹14672/-**

## 5.2 How to make this product cost effective?

- All of the metal required can be purchased online, thus travelling charges can be avoided.
- The electronic and electrical products is recommended to purchase from the available local vendors.
- It is always better to look for a workshop where most of the machines required are already available. This can fasten the fabrication process productively.
- It is always recommended to check online and local markets to compare the prices.

## 5.3 Future Enhancements

- The satellites can be rotated even smoother and slow by changing the current DC motors with the 24V, 50 RPM Geared DC motors (link given below). L298N motor driver IC even supports higher voltage DC motors than 12V by removing 12V jumper clip.

  [Recommended motor: https://www.amazon.com/uxcell-DFGA37RG-97-2i-Cylinder-Shape-Geared/dp/B00HG8D8OO/ref=sr_1_1?dchild=1&keywords=24v+50+rpm+geared+dc+motor&qid=1584555762&sr=8-1]
- The satellites can be crafted even beautifully using foam boards.
- The noise of the geared dc motors can be lowered by reducing load on it, which can be done by choosing higher grade aluminum pipes.

## 5.4 Challenges and counters to it

- As we are from Electronics background, the challenge we had was that project involved lot of mechanical works, the counter to it was we designed the model in Autodesk Fusion 360 and then understood mechanics in it. It is recommended to have a group of students from various backgrounds required, as it will be helpful for the work to be done easier and faster.
- As we were new to this city, we wasted lot of time in searching and buying the materials. It is recommended to have at least one of a team-member who knows the city, it would save time and money.

# CHAPTER - 6

## CONCLUSION

This model illustrates and helps us understand the concept of Geo-stationary satellite and Polar satellite. The geo-stationary satellite is one which when observed from the Earth looks stationary that is it has time period same as Earth, hence it can be seen all day long, while a polar satellite revolves around Earth near the poles and has time period of 100 minutes, hence it can be seen twice a day at a same position by an observer on the Earth. The design is stimulated on Autodesk (Fusion 360) software and analyzed the different parameters. This also helps others to understand the theory behind different orbits in which satellites revolve around us. The electronic circuit for this model consists of two Geared DC Motors, two Potentiometers, L298N Motor Driver IC to drive the motors, Arduino UNO Rev3 microcontroller which controls the overall operation of the model and a switch to on/off the supply. The material used for this model is Aluminum because of that load applied to the Geared DC Motor is reduced. Autodesk Fusion 360 and Arduino IDE were able solve the problems whenever countered one. With the completion of the model the concept behind Geo-stationary satellite and the polar satellite can be understood clearly.

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