

Generating Electricity Through Speed Breakers

IIP Batch 6

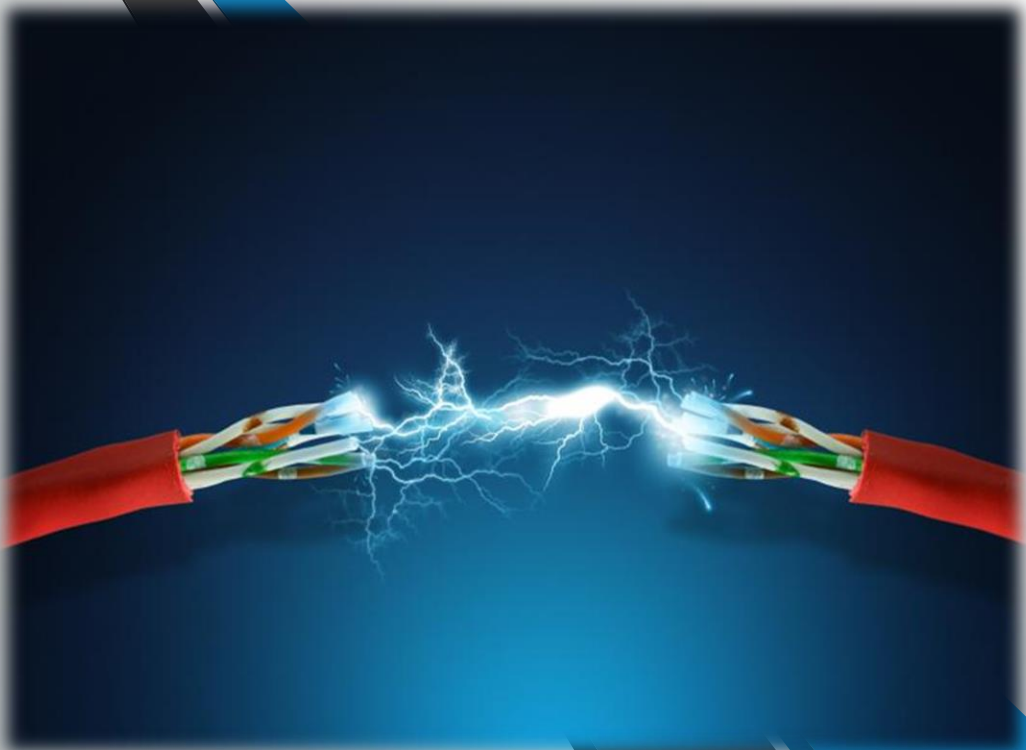
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Intro

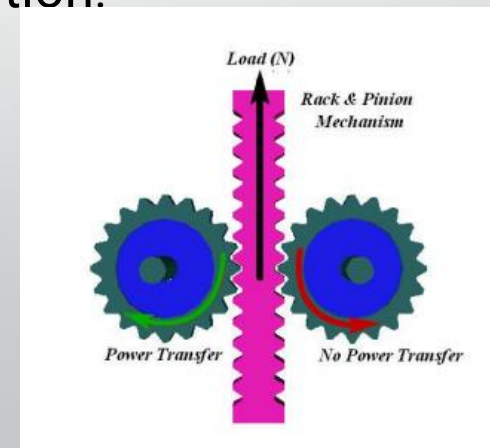
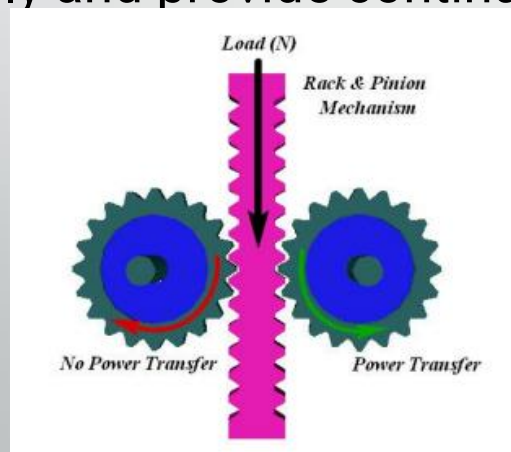
- The demand of electricity is increasing rapidly day by day but the production rate is not according to meet the need.
- Establishing new power plants to produce more electrical energy is not a solution to this problem as per economical point of view.
- The government and the electricity generating companies is suffering huge losses in electrical power production due to inefficient methodology and various other constraints especially in thermal power plants.
- The existing huge gap between demand and production can be filled by producing electricity at individual level in order to meet various household needs.
- To generate electricity to satisfy daily or basic needs various sources can be used that are normally overlooked in daily life, one of these sources include mechanical pressure of vehicles on speed breaker

METHOD OF WORKING

- When a car reaches on speed breaker, rack moves downward to generate linear motion. Two pinions are attached to a rack which converts the linear motion of rack into rotary motion. Both pinions have unidirectional motion, like as bicycle sprocket.
- Two gears are mounted on pinion shaft to transfer mechanical power to the common shaft having one gear. At final shaft, a flywheel is used to provide uniform motion.
- A belt is used to transfer mechanical motion of the common shaft to DC generator. The complete gearbox is dipped in lubrication oil sump to minimize frictional losses.
- There are no chances of slipping between rack and pinions due to guide slots. DC generator generates DC power which is stored in batteries same as in solar technology.
- The generated power can be used for the domestic purpose or commercially, which are present near the speed breaker.

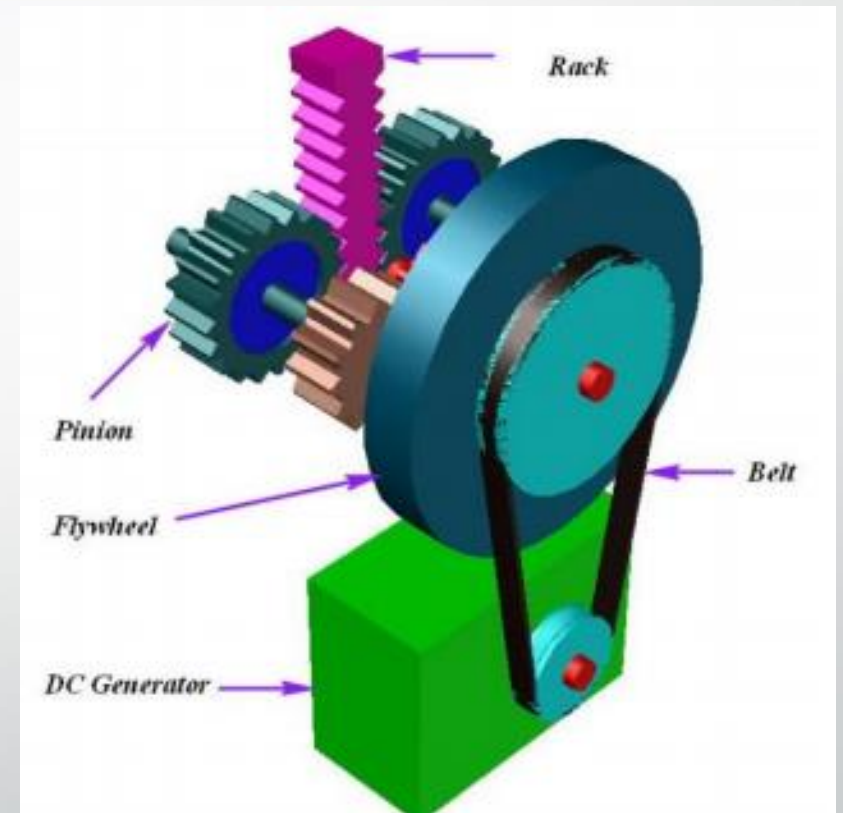
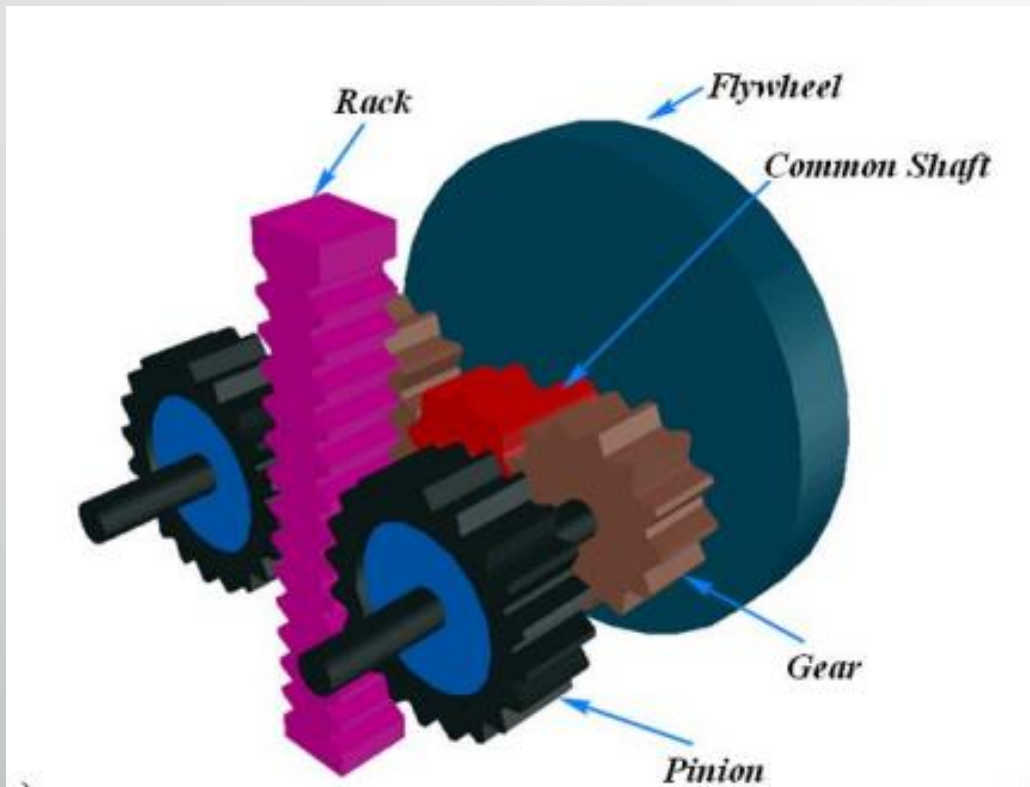
Rack and pinion mechanism

- When a car reaches on the speed breaker, it applies its weight on the speed breaker. The rack is connected with the speed breaker and two pinions mesh across the rack.
- Due to the weight on the speed breaker, rack moves downward and linear motion is obtained. It rotates the pinions which are attached on the both sides of the rack.
- At this point, linear motion of rack converts into angular motion.
- Restoring force engages another side of the pinion and first side of pinion disengage.
- They transfer power in forward as well as the reverse stroke of speed breaker respectively and provide continuous angular motion.



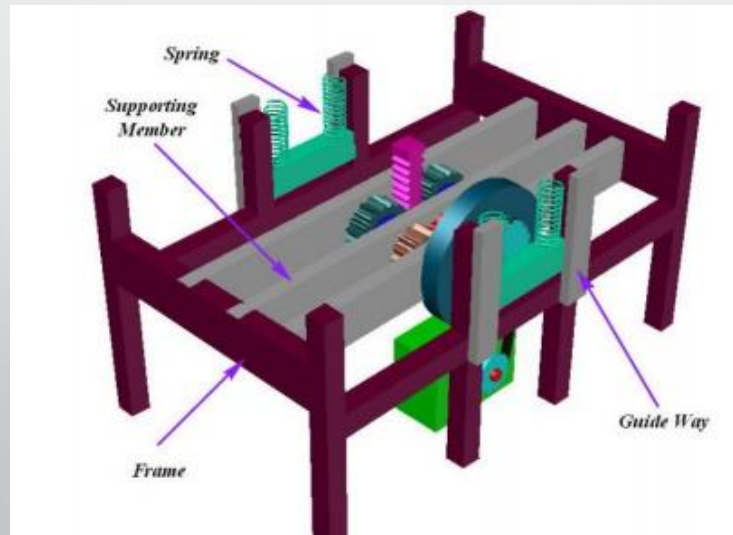
Working

- Gear of different teeth and diameter are mounted on both pinion's shaft to maximize the number of revolutions.
- A gear mounted on the common shaft is placed between both pinion's shafts. The flywheel is mounted on the common shaft.
- It keeps the rotation of the shaft in uniform angular motion. It stores the jerky rotations of pinion's shaft.
- Mechanical rotation is used to rotate the shaft of the generator through a belt.
- The shaft of maximum RPM (common shaft) is coupled with DC generator. A DC generator produces direct current .
- According to Faraday's law of induction when coil moves inside the magnetic field, it generates electric current.
- It rotates the rotor of the generator and in this way, the electricity is generated.

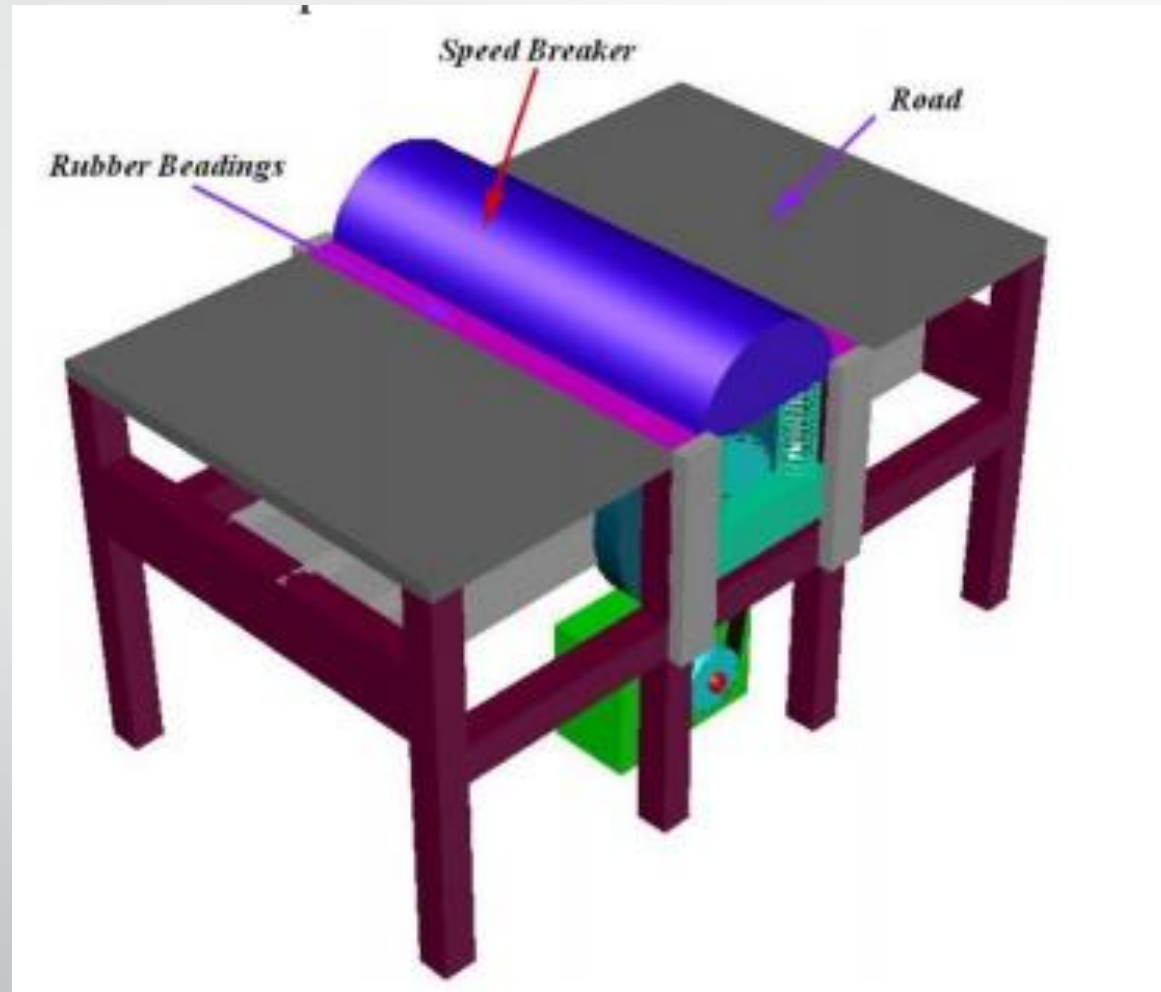


Working

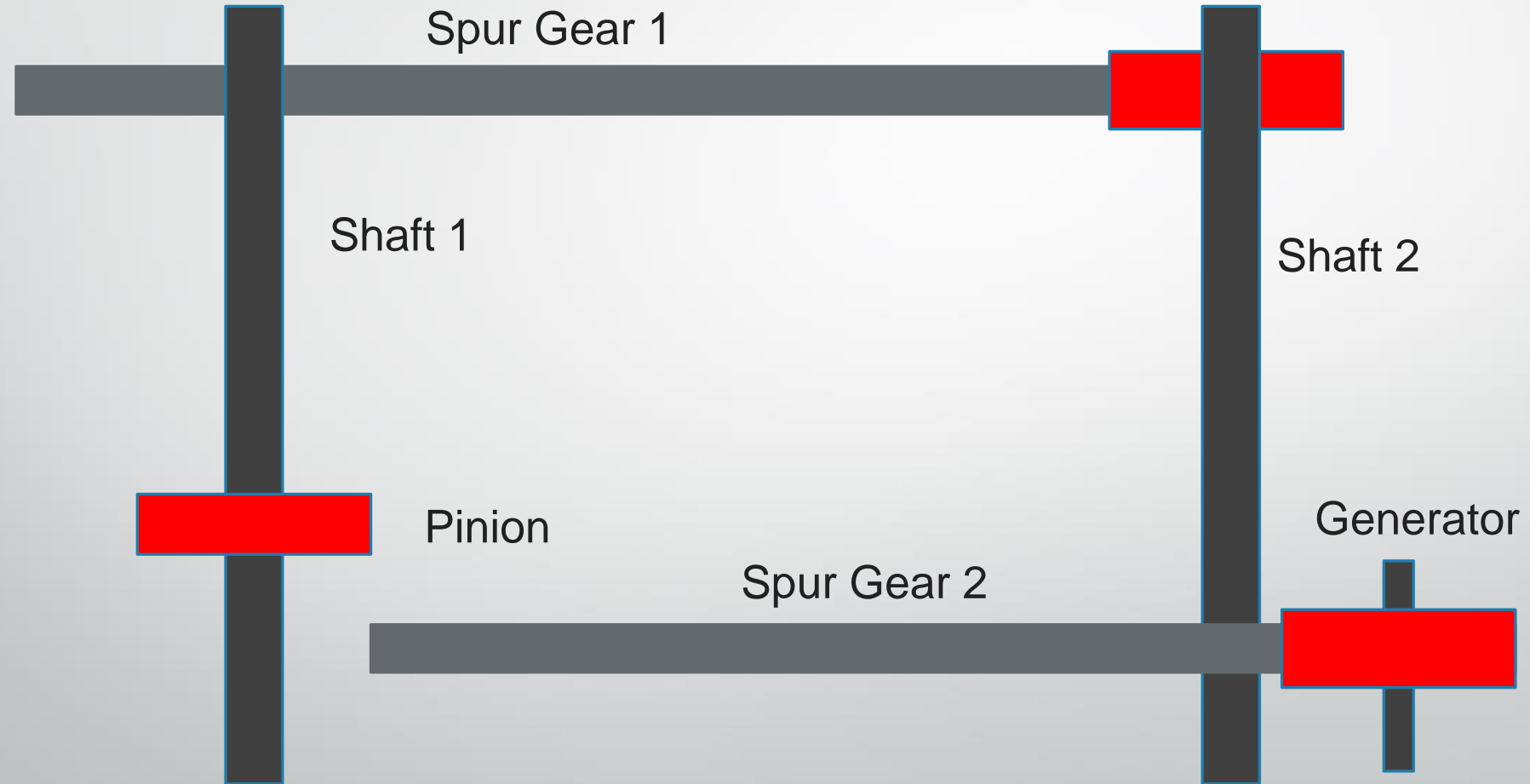
- Four springs are used to provide the upward motion.
- Utilizing energy (under the application of restoring force when the load is removed) rack moves upward and regain its original position.
- Two Support platforms for spring are welded to the frame to support the springs.
- Three supporting bars support whole mechanism.
- Guide slots lead speed breaker in the straight line and save it from trouble.
- Rubber beadings are used around the edges to prevent water and dust from entering into it.



Final Prototype



Mechanism





Details of components

- **SPUR GEAR:**

It is a positive power transmission device with definite velocity ratio. In involute teeth profile is preferred for adjusting some linear misalignment. It should have high wear and tear, shock-absorbing capacity.

- ❖ **Gear Specifications :-**

1. Outside Diameter (D_o) = 155 mm
2. Number of Teeth (N) = 76
3. Pitch Circle Diameter (D) = $D_o / (1 + 2/N) = 155 / (1 + 2/76) = 151$ mm
4. Module = $D/N = 151/76 = 2$ mm
5. Pressure angle of gear (Φ) = 14.5°
6. Diametral Pitch (P) = $N/D = 76/151 = 0.5$ mm

Details of components

- **PINION SPECIFICATIONS:**

- Outside Diameter (D_o) = 40 mm
- Number of Teeth (N) = 18
- Pitch Circle Diameter (D) = $D_o / (1 + 2/N) = 40 / (1 + 2/18) = 36$ mm
- Module = $D/N = 36 / 18 = 2$ mm
- Pressure angle of pinion (Φ) = 14.5°

- **DESIGN OF GEARS:-**

- Power to be transmitted from 1st shaft to 2nd shaft (P) = 0.18 KW
- Number of teeth on gear (z_2) = 76
- Number of teeth on pinion (z_1) = 18
- Speed of gear (n_2) = 70 rpm
- Speed of pinion (n_1) = 280 rpm
- Velocity Ratio (i) = $n_1/n_2 = Z_2/Z_1 = 4$

Details of components

- **SHAFTS:**

It is a rotating element, which is used to transmit power from one place to another place. It supports the rotating elements like gears and flywheels. It must have high torsional rigidity and lateral rigidity.

SHEAR STRESS IN THE SHAFT :-

It is calculated using the torsion equation-

$$1. T/J = \tau / r$$

Where, T – Torque Transmitted (N-mm)

J – Polar Moment of Inertia (mm⁴)

Details of components

τ - Shear stress (N/mm²)

r – Radius of the shaft (mm)

$$T / (\pi d^4 / 32) = \tau / (d/2)$$

Torque Transmitted (T) = Force x Radius of shaft

$$= 150 \times 9.81 \times 19$$

$$= 27958.5 \text{ N-mm}$$

$$27958.5 / [\pi (19^4) / 32] = \tau / (38/2)$$

$$\text{Shear stress } (\tau) = 41.51 \text{ N/mm}$$

Consider 100 cars of mass 400kg pass over a speed breaker in an hour. The height of rack is 14cm, the diameter of the final pulley is 18mm and having revolution speed (N) is equal to 37 RPM. Down word motion of speed breaker is due to the weight of moving the vehicle and upward motion of speed breaker is take place due to the utilization of energy from springs. Each car pushes speed breaker two times.

$$\text{Force} = F = mg \quad (1)$$

$$F = 400 \times 9.8 = 3920\text{N}$$

$$r = 9\text{mm}$$

$$T = r \times F \text{ (Nm)} \quad (2)$$

$$T = 9 \times 10^{-3} \times 3920$$

$$T = 35.28 \text{ (Nm)}$$

$$P = T \cdot \omega \quad (3)$$

$$P = 35.28 \times 2\pi N/60$$

$$P = 35.28 \times (2 \times 3.14 \times 37)/60$$

$$P = 136.62 \text{ W}$$

Total generated in forward and reversed stroke.

$$P = 2 \times 136.62 \text{ W}$$

$$P = 273.24 \text{ W}$$

$$\text{Revolution in one minute} = 200/60 = 3.33\text{rev/min}$$

$$\text{Power generated per minute} = 273.24 \times 3.33$$

$$= 909.89 \text{ W (minute)}$$

$$\text{Power generated in one Hour} = 909.89 \times 60$$

$$= 54.59 \text{ KW (hour)}.$$

Different masses are applied on the speed-breaker and the measured the electrical power. Fig 5 shows the linear relationship between the load and produce power.

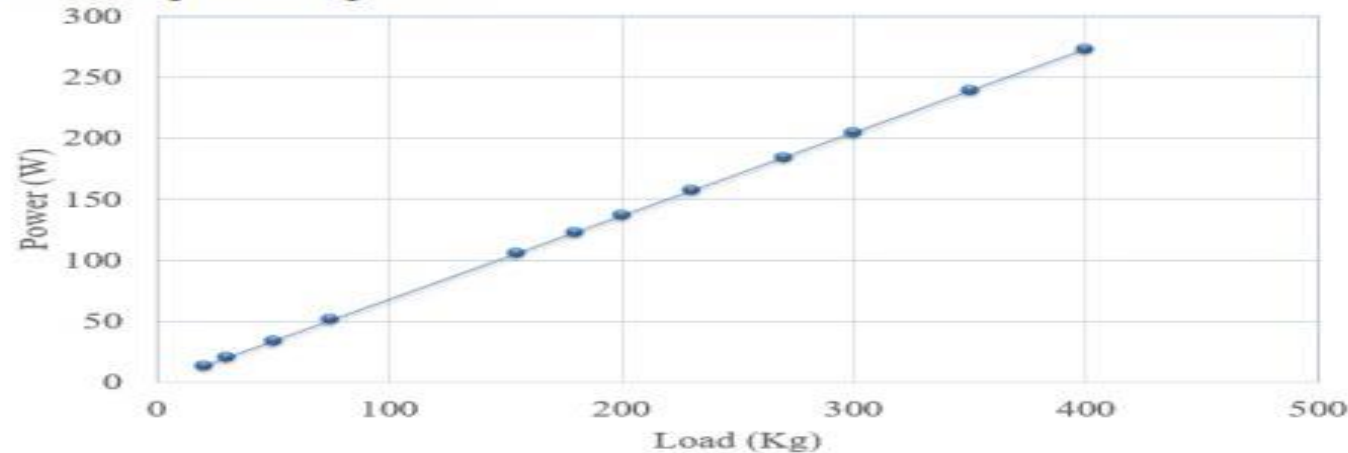


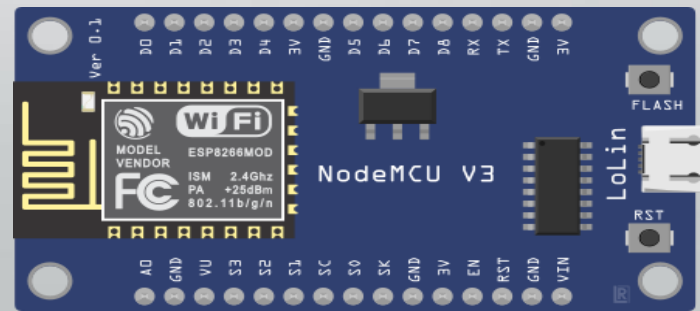
Fig. 5. Power variation due to load (kg)



IoT Part of Our Project

Electronic module – NodeMCU ESP8266

- **NodeMCU esp8266** is low cost open source IOT platform.
- ESP8266 chip having 32-bit LX106 RISC(Reduced instruction set computing) microprocessor which operates at 80 to 160 MHz adjustable clock frequency and supports RTOS(real-time operating system).
- It also has **128kb ram** and **4mb flash memory**, which gives easy connectivity and fast working which is perfect for small operations like pushing notifications and IoT functionalities.
- **ESP8266** Integrated 802.11b/g/n HT40 WIFI transceiver not only connect with network but also support self configuration for network.
- This make chip very versatile and it will connect according to WIFI's configuration for protocols.
- So nodemcu is a chip with microcontroller with WIFI transmission. Also it can integrate with SIM card for network.



LDR sensor - Light dependent resistor

- This is most common sensor for photodetection . This is light dependent resistor.
- It is mostly used with Arduino boards and Nodemcu circuits.
- These sensors can be used as day and night detector for circuit.
- **LDR** sensors are using to make automatic dusk to dawn light system.
- We are using **LDR** sensor to make lights automatic.



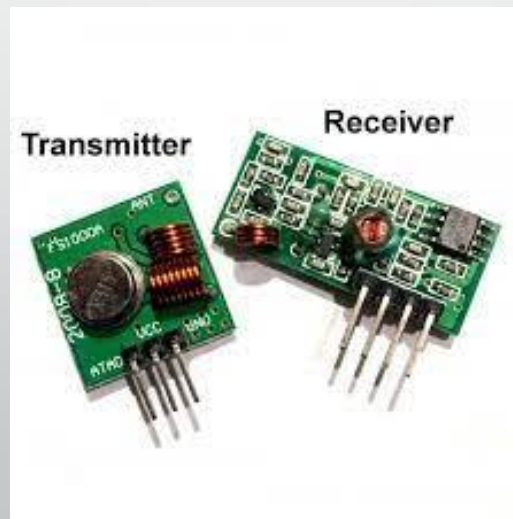
Ultrasonic Sensor

- This sensor is used for short range detection. Up to 11 meters only.
- It uses ultrasonic sound implementation to detect distance from object .
- It is very useful in short range detection .
- It is easily integrate with Arduino and nodemcu.
- We are ultrasonic sensor to detect short distance between cars for detection of malfunctioning of speed breakers.
- It will inform to cars using Nodemcu over network.



Radio Frequency Sensors

- These sensors for long range detection. Up to 500 feet and some can be extend up to 1000 feet
- These sensors uses Radio frequency for detection.
- But these are more costly than ultrasonic and main problem with these sensor is sensitivity.
- Radio frequency sensors are mainly used for early detection of distance .
- So this functionality is limited to some special conditions like accident.
- Radio frequency sensor contains two modules basically so Radio frequency Transmitter can used to transmit SOS to Radio frequency receiver .

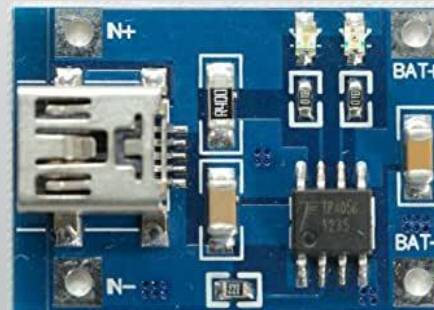


Our Contribution

- Our plan to implement IoT with generation of electricity.
 - This will increase effectivity of source also.
 - It may reduce consumption of electricity also .
1. Using **IoT** technology Display battery information which is located near speed breaker.
 2. Activate different controls over network like switching between battery and regular supply of electricity for street lights.

Battery Aspects With NodeMCU Esp8266

- It is more important part for battery life and consumption . We can actually manipulate and use this information for efficient use of battery capacity.
- We are using BMS technique to check battery parameters using nodemcu. It is mainly used in electric vehicles.
- **Battery Charger** (TP4056) :- chip in between nodemcu & battery to detect battery usage and power.
- **TP4056** :- is actually a battery charging & monitoring module but it is more efficient and correct in detection of battery charged percentage.



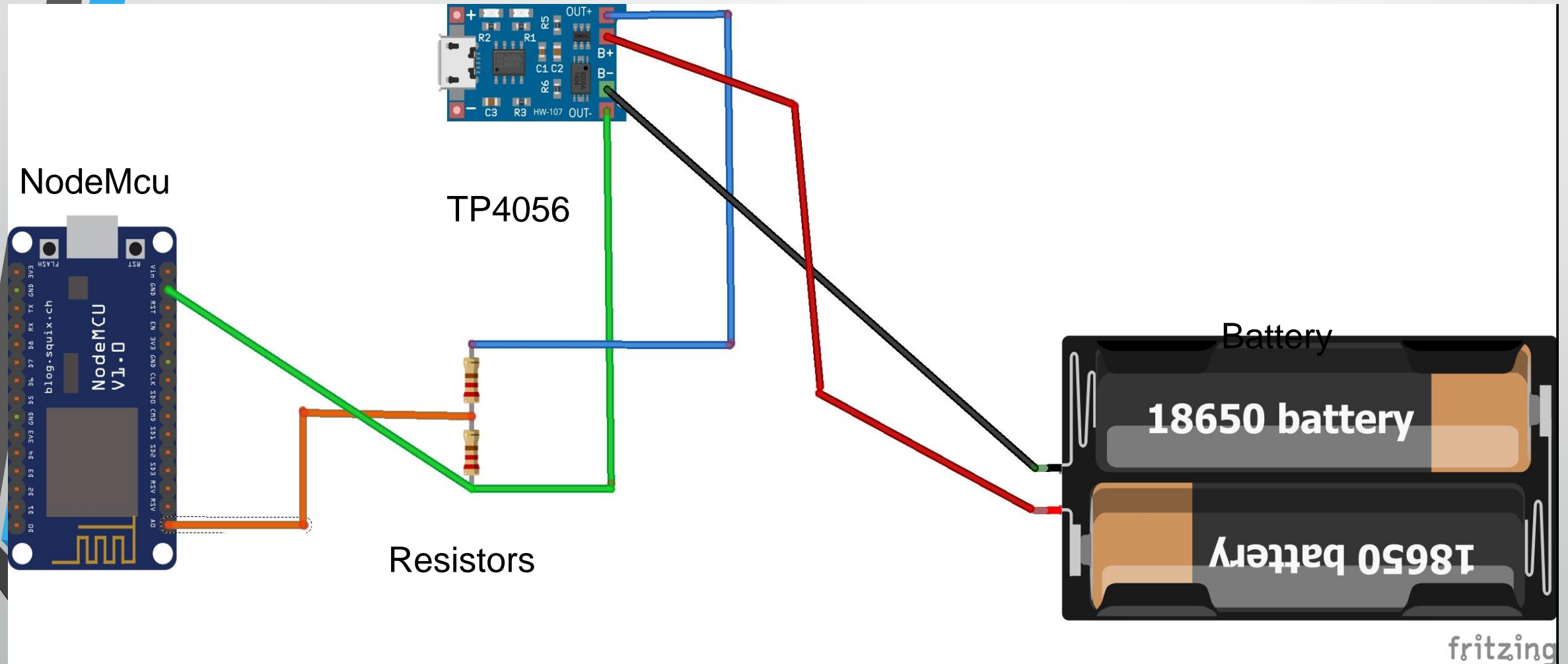
Working & Functionality

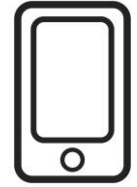
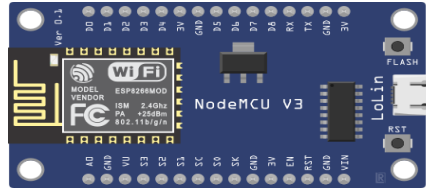
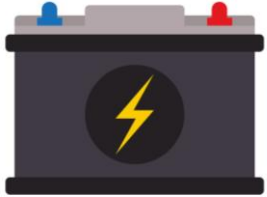
- Battery level indicator Calculate the electricity required for one night on a particular road And then we'll calculate the electricity the speed breakers generate.
- If electricity generated is less than required electricity then we have to borrow the electricity for that night from govt.
- So we can use battery power more effective and this increases battery life also.
- Also these values can be store in real time database so according to that values we can further more schedule battery usage according to that data.

Calculating Battery Voltage

- NodeMCU analog pin can withstand only 3.3v, so we have to make an arrangement to convert high input voltage within the range of NodeMCU analog pin and then write code to compute the actual voltage being measured.
- The arrangement that will convert the voltage is **Voltage divider circuit**. The voltage divider decreases the voltage being measured within the range of the NodeMCU analog input which is 3.3v.
- We have to find the values of the required resistors for the circuit. The maximum input voltage will depend on the values of the resistors.
- So, we choose **R1=44k and R2=10k** . Some times it may change according to circuit.
- Voltage dividing formula :-
 1. $V_{out} (A0) = (V_{IN} * R1) / (R1 + R2)$
 2. $Max\ V_{in} = V_{out} * (R1 + R2) / R1$

Circuit Diagram





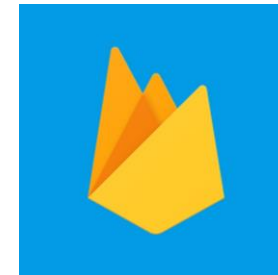
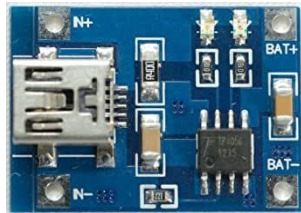
Battery

TP4056

Nodemcu

Real – time
server

Mobile
device

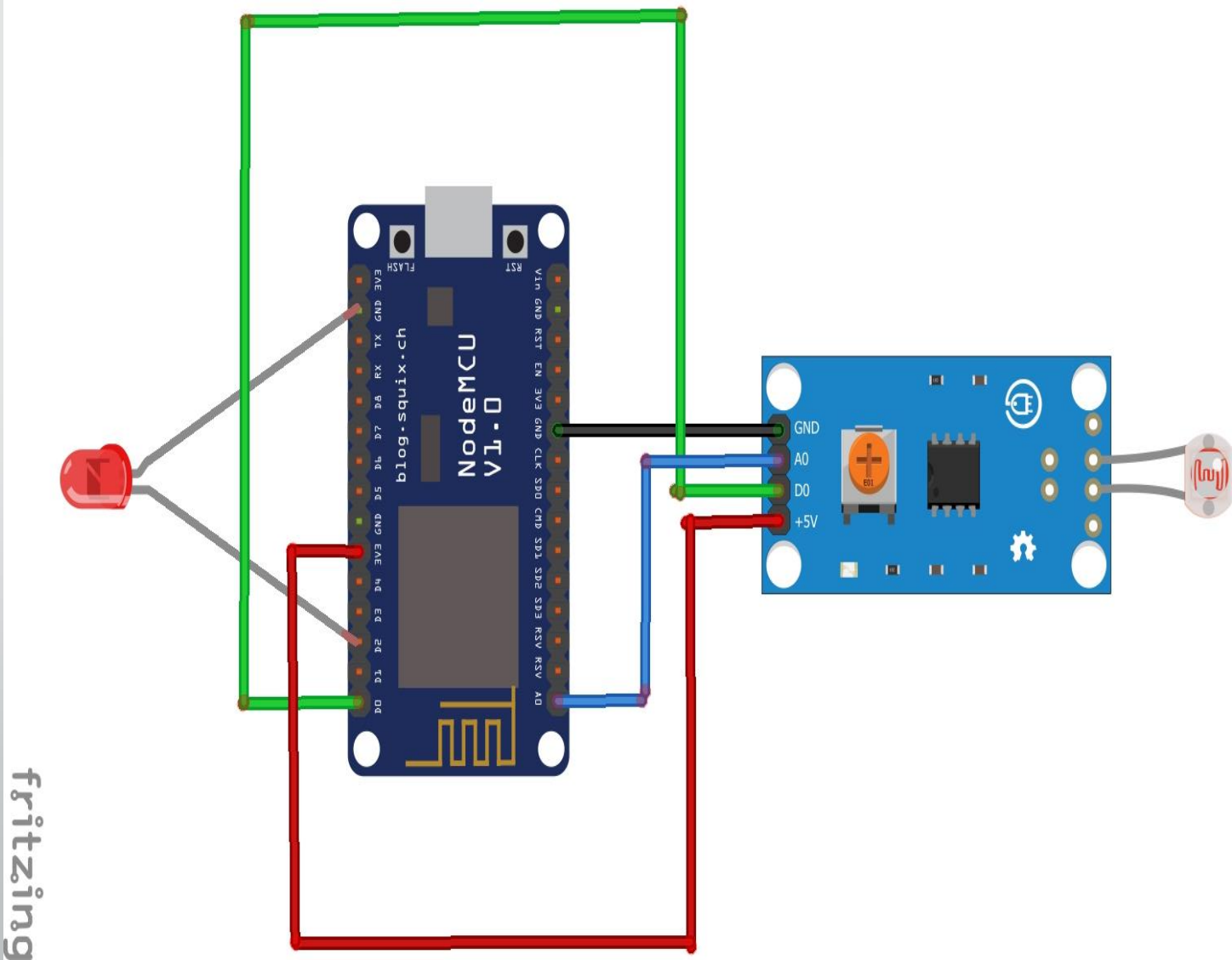


**Firestore - Real time
cloud server**

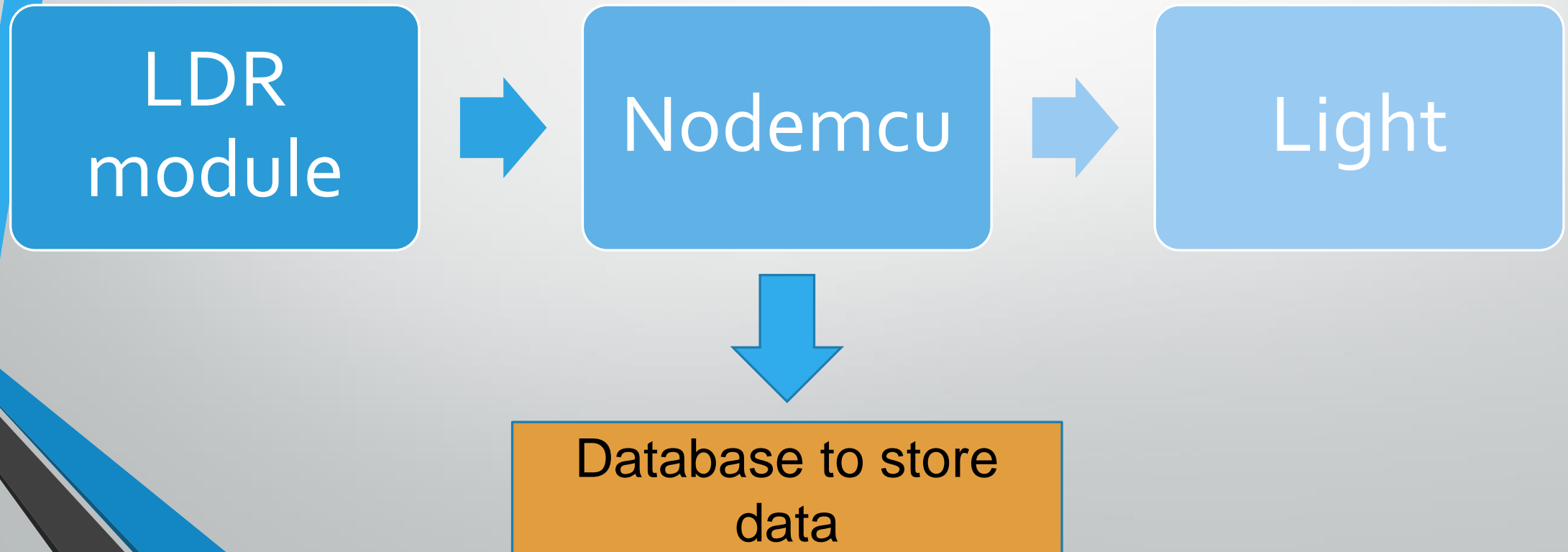
LDR module – Automatic Light system

- As we know **LDR** module is light dependent circuit so we can use it with nodemcu to make smart light.
- As we are using electricity generated through speed breaker for lights and other purposes. We should minimize excessive used of power.
- **LDR** circuit will detect light conditions in environment according to that it will control light depend on battery of speed breaker

Circuit Diagram

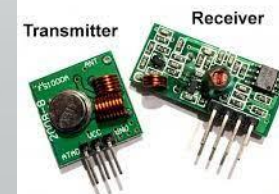


Connectivity diagram – LDR circuit

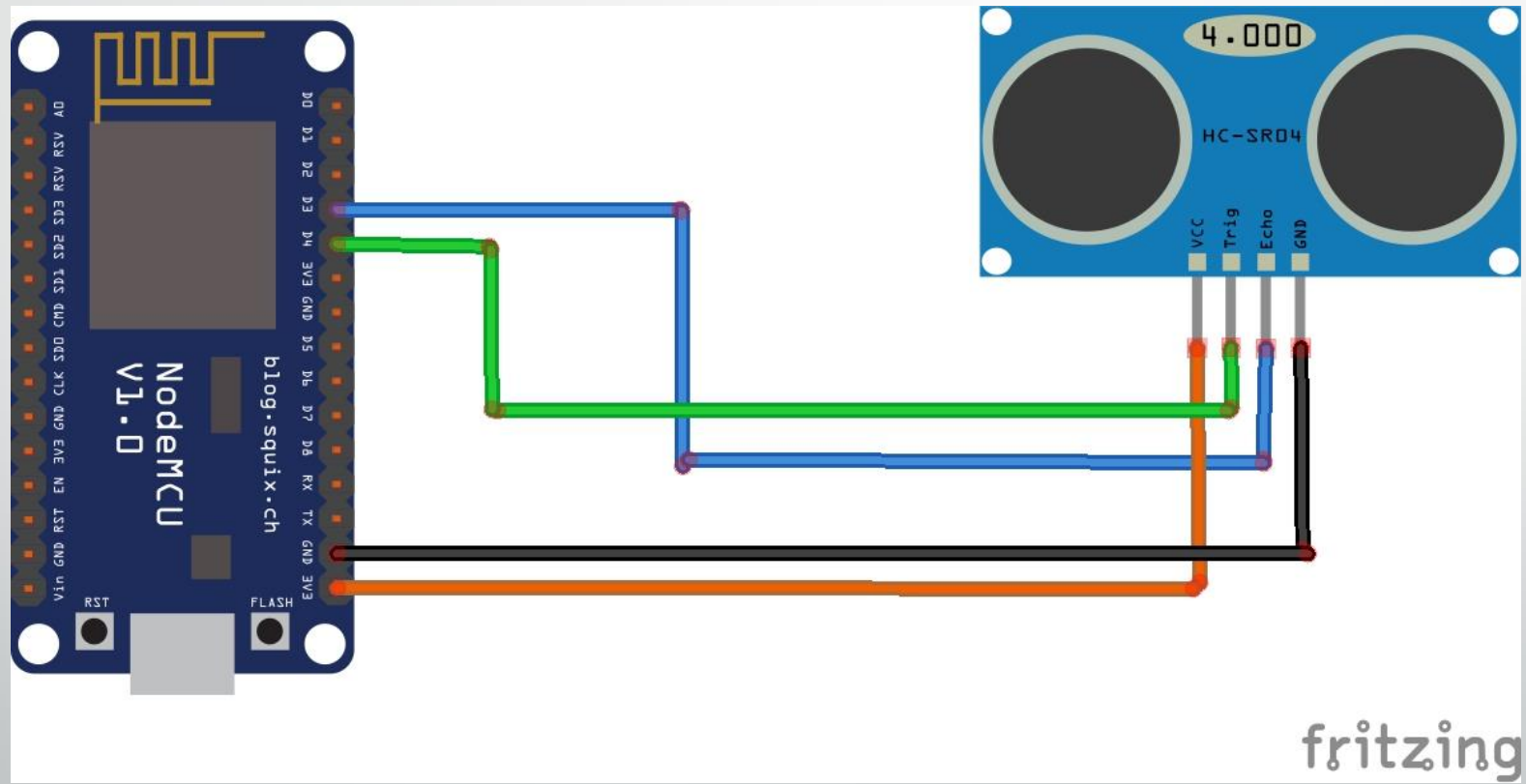


Ultrasonic Sensor with NodeMcu

- **HC-SR04** widely known as Ultrasonic Sensor , we are using this sensor with nodemcu to develop an IoT functionalities for car detection and further more like for accident detection.
- This part is under development category. It is not fully working . But we can explain its working and functionalities.
- Also we are planning to integrate RF module chip for early alarm and notification system.
 1. Ultrasonic sensor can used to detect vehicles count and desistance measurements near speed breaker .
 2. This will help in efficient use of this power source.
 3. If traffic is less in that area so we can update other vehicles in such cases.



Circuit Diagram



Conclusion of our project – Advantages & Disadvantages

• Advantages :-

1. Require simple construction methods
2. Free from all types of pollutions
3. It is economical and easy to install
4. Maintenance cost is low.
5. No consumption of fossil fuel which is nonrenewable.
6. No manual work necessary during generation.
7. Also we can add some more advanced IoT functions in current project.

• Disadvantages :-

1. Shafts are required to be mounted properly otherwise it creates balancing problem.
2. Mechanical vibration causes problem.
3. It will produce considerable amount of output mainly with heavy vehicles hence is not much suitable for light vehicles. So heavy traffic is required.
4. May get damaged in rainy season if not shielded properly.
5. Maintenance on regular basis is needed to check fault in either mechanical system.
6. Initial costing is also more.
7. IoT functions may cause some errors due to environment . So testing in real world is main aspect for this project.
8. As this one a non-conventional type of producing the energy , it may not be adequate for replacement of conventional source . But it can reduce energy consumption in respective places.

Future planning & Advancements in project

- Making more efficient design for our prototype.
- Reducing maintenance in our project using different kind of rigid materials like PVC for small parts and some 3d printed parts.
- Also planning for reduction of total cost using recycled materials.
- Advancement in IoT functionalities .
- Also integrate some AI road accident detection module .

Notification & Message services

- As we are using firebase a real time database in our project we are using notification and message services of firebase only.
- But in some cases we require some other backend functionality also in emergency services .
- For this purpose we decided to used MQTT services.
- **MQTT** – It is standard IoT messaging protocol. It is free to use up to some aspects and it is also open source . So it is easy to integrate with nodemcu.
- There are many services which provides MQTT service.
- Main advantage of this is we can send message or SOS to multiple devices.
- So it one to many services.
- Further more we can create machine to machine communication with this for future advancements.
- MQTT is lightweight publish / subscribe method for communication so more than one device can connect to this



Thank You