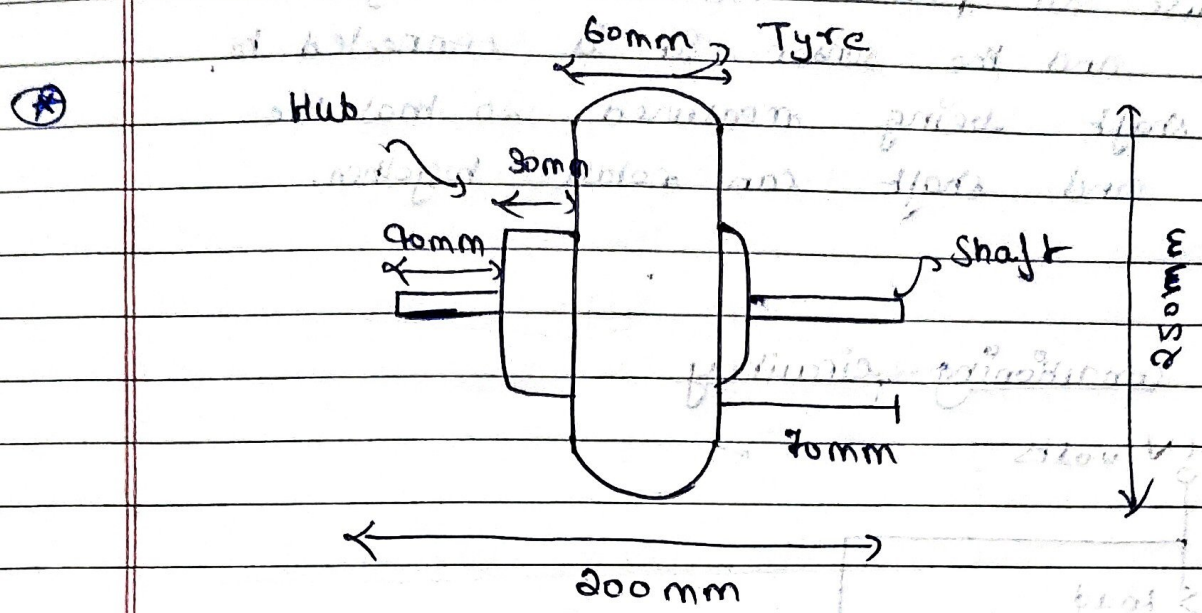
Mechanical Subsystem

TASK → 1



Let's assume that the shaft diameter is 10mm which is common in most designs.

→ We will use optical encoder which is simple to install and provides high accuracy.

→ Encoder will consist of:

(A) A rotating disc (code wheel) mounted on the shaft.

(B) A stationary optical sensor (LED-photodiode pair) mounted on the hub.

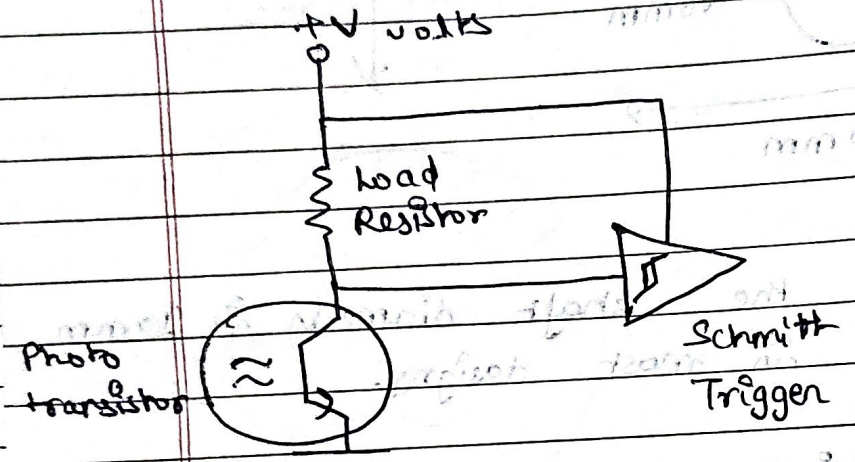
The light source is a LED which emits infrared light

Because photodiode pair is sensitive to infrared energy, ~~[illegible]~~ By small or minimal light it can have a good effect.

Optical disc

A disc is placed between the light source and the sensor. It is connected to the shaft being measured so that the disc and shaft can rotate together.

Signal conditioning circuitry



→ There are two situation when light passes through the slot and another one when it doesn't.
Let's explore both:

(i) Light present.

When light passes through the slot the following conditions occurs.

(a) The transistor turns on. Since there is a minimal resistance, the voltage drop accross the transistor is near 0 volts.

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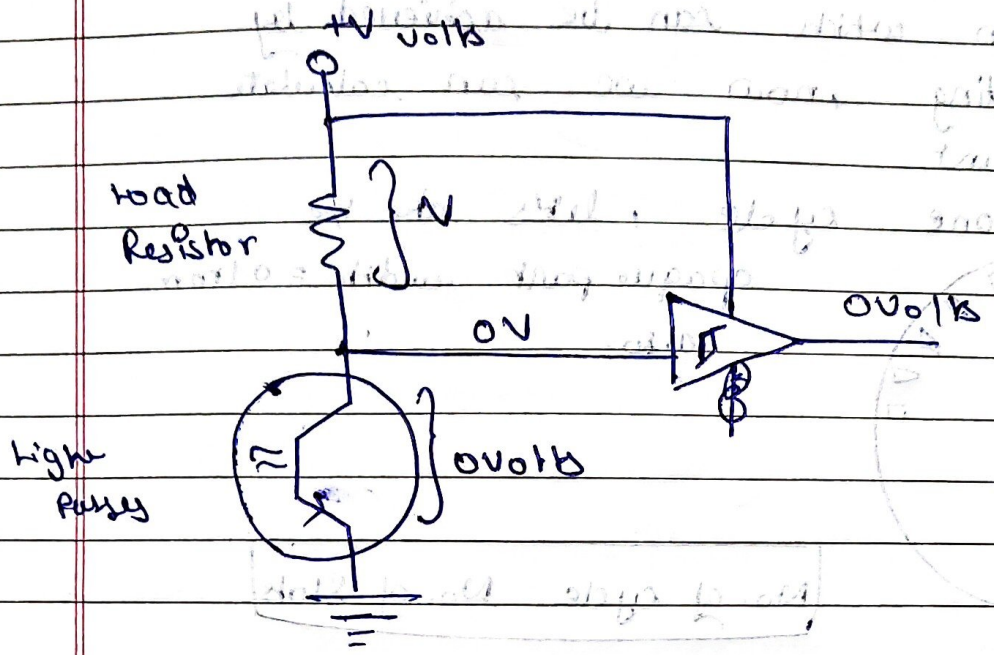
* The 0-volt potential at the transistor's collector is fed to the input of the schmitt trigger which result in a 0-volt potential at its output.

* The near +V volt from the power source drops accross the load resistor.

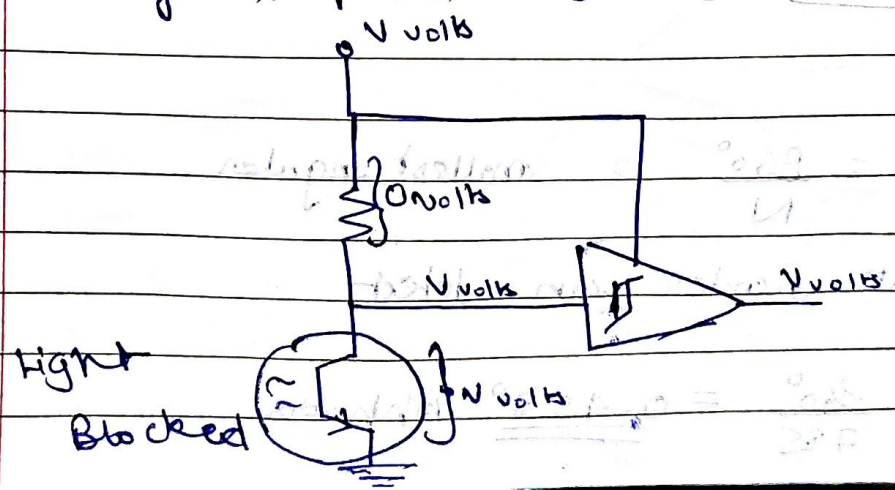


Schmitt trigger convert pulses into square waves.

Basically they clean up and stabilize digital output signal.

iii) Light Absent

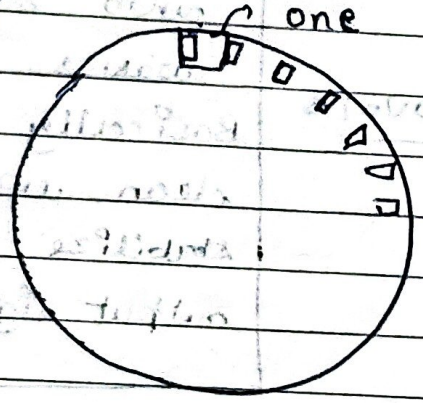
* The transistor turns off since it acts like an open so there is large resistance, whole voltage nearly drops accross the transistor.



ENCODER DESIGN

(*) Let take encoder disc of diameter 50mm and thickness 0.5mm for simplified design

Now if we assume slot width to be 0.1mm which can be achieved by laser cutting, now we can calculate least count



one cycle, let's take the opaque part width = 0.1mm also.

$\boxed{\text{No. of cycle} = \text{No. of Slots}}$

Let N be no. of slots

$$(N)(0.2\,mm) = \text{circumference of circle}$$

$$N = \frac{\pi \times 50mm}{0.2\,mm}$$

$$\boxed{N = 785}$$

$$\text{least count} = \frac{360^\circ}{N}$$ → smallest angular displacement encoder can detect

$$= \frac{360^\circ}{785} = \underline{\underline{0.459^\circ}} \text{ Approx}$$

Encoder Disc

→ Diameter → 50 mm

→ Thickness → 0.5 mm

→ Slots → 735 evenly spaced, alternating transparent (0.1mm) and opaque (0.1mm)

→ Centre Hole → 10mm → diameter to fit in the shaft.

LED → A standard infrared LED (5mm diameter)

Photo diode → A matching photo diode to detect the infrared light

→ The Disc is mounted on the shaft at 7-8 mm ~~from~~ to the left of Hub.

→ Housing: A small custom or off the shelf enclosure (eg. 10x2x5) to hold the LED and photodiode

→ Mounting Bracket: An L-shaped bracket (15x10x2) with a 4mmhole for bolting to the hub

(*) Sensor Housing → 10 mm → length along the disc path

5mm width

2mm Height

(*) Internal gap of atleast 1mm (to allow 0.5mm disc to pass through without contact).

position

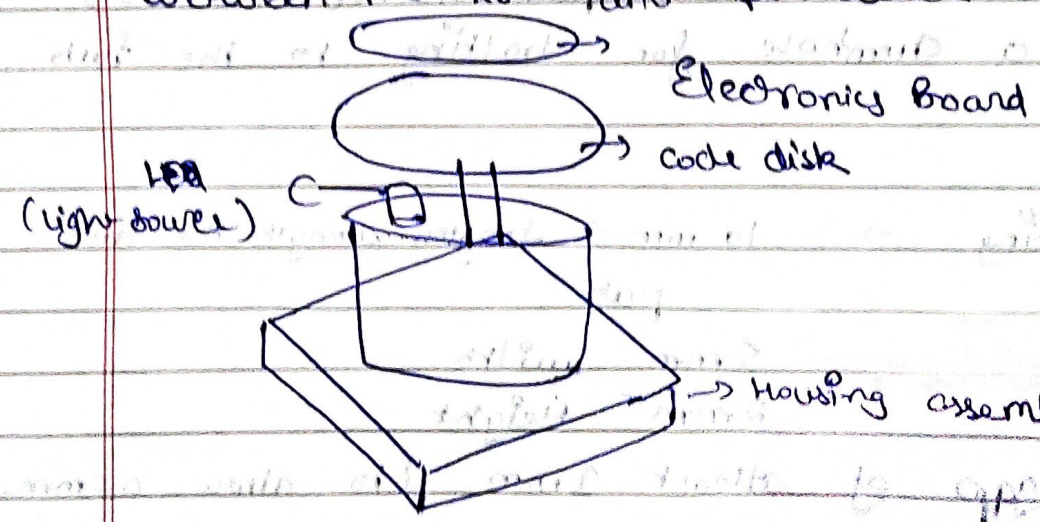
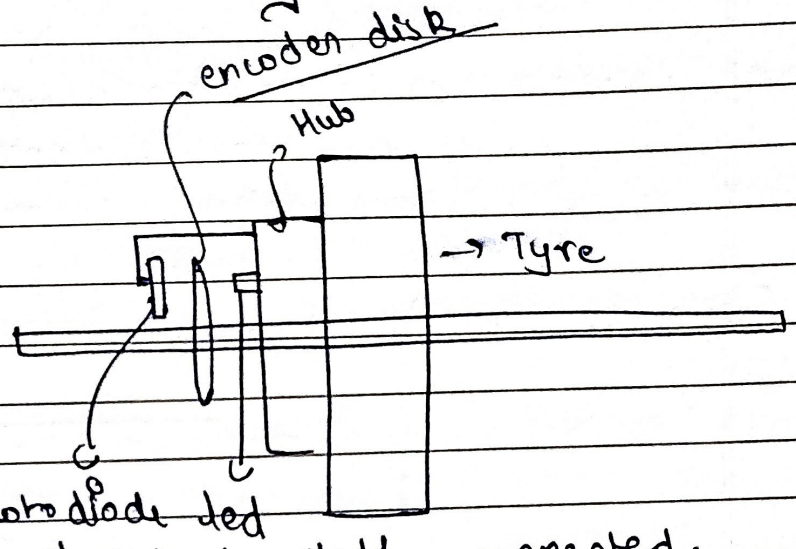
- Mounted on the hub's side at 15 mm
- Detection point at 20mm radius; at 95mm aligned with the disc.
- Gap sensor and disc: 1mm.

Mounting:

→ The bracket is bolted to the hub using an M4 bolt.

→ The sensor housing is attached to the bracket's vertical arm with screws or adhesive.

→ The disc passes through the 1mm gap between the LED and photodiode



A side profile view of how encoder will be connected.