SET-01

(a) What is power electronics? Write down the application of power electronics. (3)

Solⁿ

Power electronics:- is the branch of engineering that deals with the conversion, control and conducting of electric power into using electronics devices into one form to another and how to utilization of power at high efficiency.

Application of power electronics:

- Mobile charger, TV, A.C, Washing machine.
- Industrial Application, blowers fans, pumps and compressors.
- Used in satellite power supplies.
- Used in transportation system.

(b) What are the basic constituent elements of transducer. Give example of some active and passive transducers. (3)

Solⁿ

Any transducer basically consist of two constituent elements.

1. Sensing element:- Which sense or responds to a physical quantity or a change in a physical quantity in transducer.

2. Transduction element:- Which transforms the response of the sensing element into an electrical signal.

Example of some active and passive transducers.

Active Transducers:-

1. Converts temperature difference into voltage.
2. Converts light into electrical energy.
3. Converts mechanical stress/pressure into voltage.
4. Converts rotational speed into voltage.
5. Converts motion into an induced voltage

Passive Transducers:-

1. Resistance changes with temperature.
2. Resistance changes with applied strain.
3. Inductance changes with displacement.
4. Capacitance changes with pressure.
5. Resistance changes with light intensity.

(c) Derive the expression for the gauge factor of a typical strain gauge. (6)

Soln

Step 1: Definition of Gauge factor

The Gauge Factor (GF) is defined as the ratio of the fractional change in resistance to the strain applied:

$$GF = \frac{\Delta R/R}{\varepsilon}$$

Where, R = Original resistance of the gauge.

ΔR = Change in resistance due to strain.

$\varepsilon = \Delta L/L$ = Strain (relative change in Length)

Step 2: Resistance of a conductor

The resistance of a wire (or foil) is given by:

$$R = \rho \frac{L}{A}$$

Where, ρ = Resistivity.

L = Length

A = Cross-sectional area

Step 3: Differentiate R

$$\frac{\Delta R}{R} = \frac{\Delta \rho}{\rho} + \frac{\Delta L}{L} - \frac{\Delta A}{A}$$

Step4:- ~~Area~~ Area change due to ~~poisson~~ poisson's effect

For a wire of circular cross-section:

$$A \propto d^2 \Rightarrow \frac{\Delta A}{A} = 2\frac{\Delta d}{d}$$

Now, when the wire is stretched, diameter decreases due to Poisson's ratio (ν):

$$\frac{\Delta d}{d} = -\nu \frac{\Delta L}{L} = -\nu\varepsilon$$

So,

$$\frac{\Delta A}{A} = 2(-\nu\varepsilon) = -2\nu\varepsilon$$

Step5:- Substitute Back.

$$\frac{\Delta R}{R} = \frac{\Delta \rho}{\rho} + \varepsilon - (-2\nu\varepsilon)$$

$$= \frac{\Delta \rho}{\rho} + \varepsilon(1+2\nu)$$

Step6:- Final Gauge Factor expression.

Dividing by strain ε:

$$GF = \frac{\Delta R/R}{\varepsilon}$$

$$= \frac{\frac{\Delta \rho}{\rho} + \varepsilon(1+2\nu)}{\varepsilon}$$

$$= \frac{\Delta \rho}{\rho} \cdot \frac{1}{\varepsilon} + (1+2\nu)$$

(d) What is Shottky diode? Explain with necessary Diagram. (4)

Soln

Schottky Diode:- Schottky diode is a type of diode with a low forward voltage drop and fast switching speed.

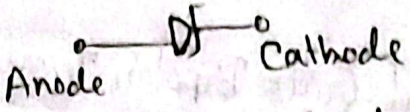
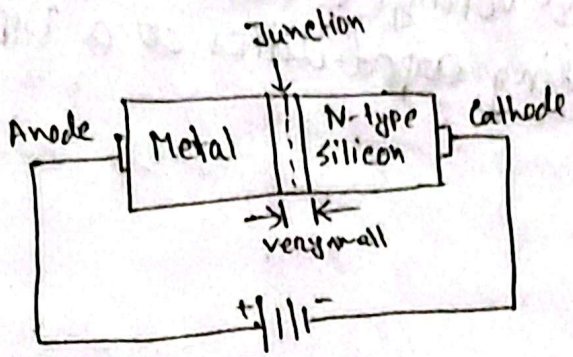


fig: Symbol of Schottky.

Operation:-



- A Schottky diode is formed by joining a metal with an N-type semiconductor, typically silicon.
- A metal contact serves as the anode, and the N-type semiconductor acts as the cathode.
- When forward voltage is applied across the Schottky ~~did~~ diode the current flows through diode so fast, because potential drop (0.03-0.5 ev)
- Here, switching is fast.
- In the forward-biased state, electrons are injected from the ~~P-N~~ N-type semiconductor into the metal, forming the current flow.

Last Part

-When the diode is switched off, there are no minority carriers to be removed or stored, unlike in a P-N junction

SET-02

(a) What is IGBT? Draw the cross sectional view of IGBT.

Solⁿ

IGBT:- An Insulated Gate Bipolar Transistor (IGBT) is a high-power semiconductor switch that combines the high input impedence and voltage control of a MOSFET with the higher current handling capabilities of a Bipolar Junction Transistor. (BJT).

(6) Write ~~the~~ down the operation principle of LVDT with figures.

Soln

LVDT → Linear variable Differential Transformer.

LVDT → operates on the principle of electromagnetic induction to convert linear displacement into an electrical signal.

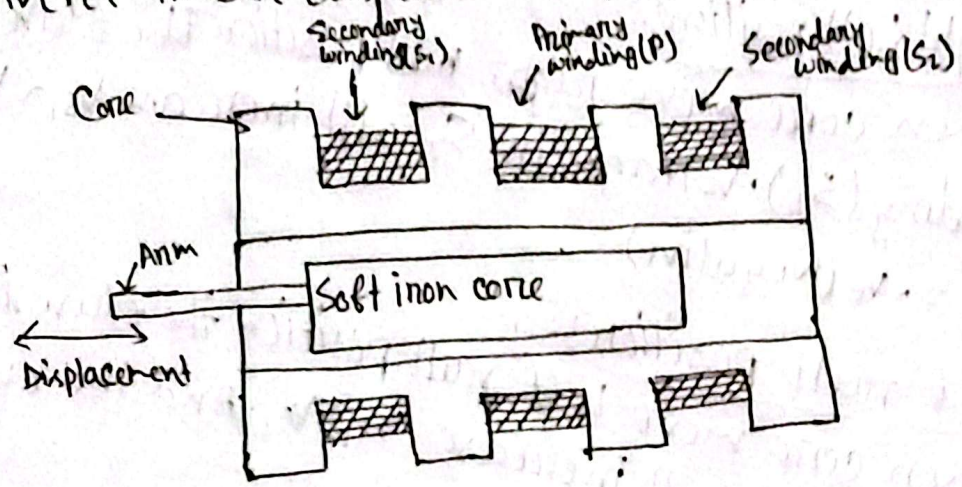


fig: Construction of LVDT

- LVDT consist of one primary winding (P) and two secondary winding S_1 and S_2. The two secondary windings have equal no of turns. Symmetrically placed either side of the winding (P). And moveable soft iron core is placed along the axis of the ~~cylin~~ cylindrical former.

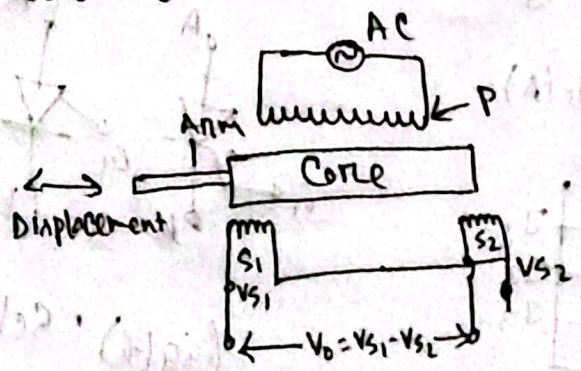


fig: LVDT ckt Diagram.

Null position:-

- When core in the central or null position, the magnetic flux linking with the two secondary windings S_1 and S_2. Hence equal voltage across them that's why output voltage $V_0 = 0$

Right null position:-

- When core move right null position the flux linkage with winding (S_2). Voltage in S_2 will increase $V_{S_1} < V_{S_2}$. Output voltage $V_0 = -Ve$ (Negative)

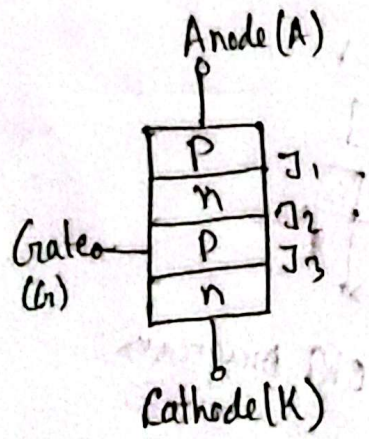
Left null position:-

- When core move left null position the flux linkage with S_1. Voltage in S_1 will increase $V_{S_1} > V_{S_2}$. And the output voltage $V_0 = +Ve$ (Positive)

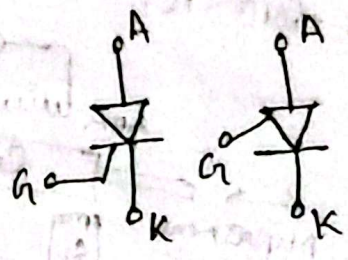
(c) Define SCR. Write down the operation principle of SCR. (5)

Solⁿ

SCR (Sillicon Control Rectifier) is a four layer pnpn three junction, single gate, and silicon switching device.



fig(a): Schematic structure.

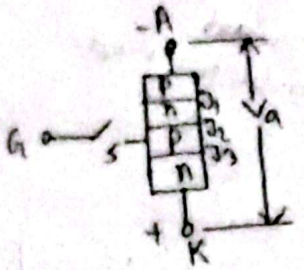


fig(b): Schematic structure.

Operation of SCR :-

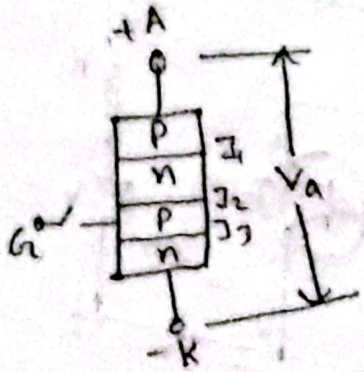
They operated in various mode like

- Reverse Blocking mode :- When cathode is made positive with respect to Anode. Junction J_2 gets forward biased. Where J_1, J_3 gets reversed biased.



fig(c): V_a negative, J_2 forward biased, J_1, J_3 reversed biased.

- Forward blocking mode :- Anode is made positive with respect to Cathode J_1 and J_3 are forward biased and J_2 is reversed biased.



fig(d) V_a negative, J_2 reversed biased J_1 and J_3 forward biased.

- Forward to Conduction Mode:- Thyristor shifts from forward blocking mode forward conduction mode by gate signal

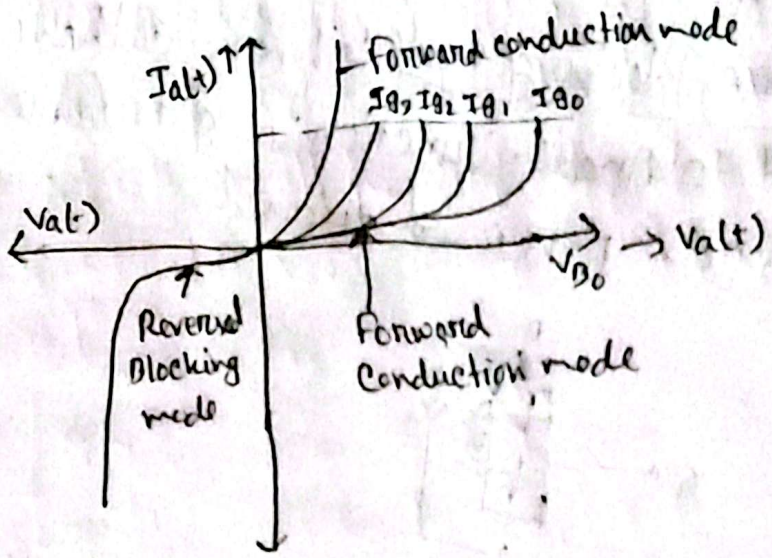
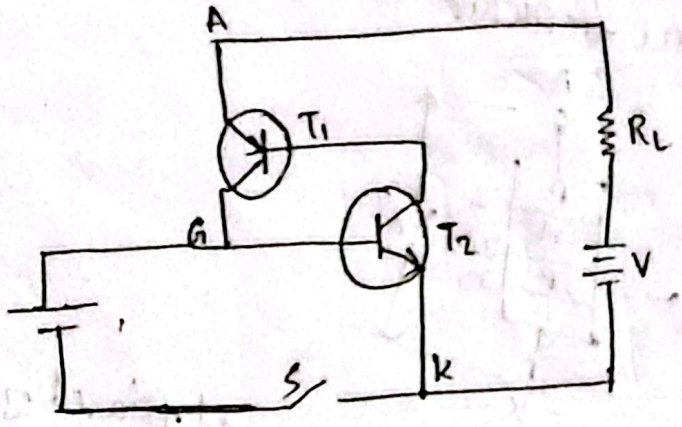
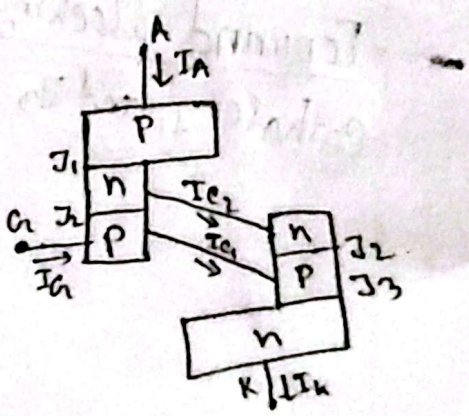


Fig: I-V characteristics of SCR

(d) Draw and explain two transistor model of Thyristor. (4)

Soln





Two transistor model of SCR Definition:-

The two transistor model of SCR is defined as a representation of an SCR using two interconnected transistors, one pnp and one npn, to explain its operation.

SCR structure:- An SCR consists of four layer (pnpn) and can be split into two transistors, making its function easier two understand.

Anode Current analysis:- The anode current in an SCR is analyzed by considering the currents and gains of the two transistors involved.

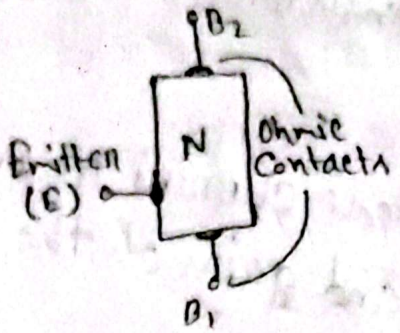
Gate current impact:- Applying gate current (I_g) increase the cathode current (I_k), affecting the overall anode current.

~~Positive feedback Effect:- The positive feedback~~

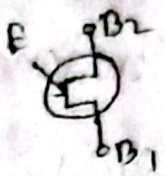
3. (a) Define UJT. Explain the operation principle of UJT.

Soln

UJT- Unijunction Transistor, A UJT consist of a lightly doped n-type silicon bar provided with ohmic contacts at each end and to which small heavily doped p-type emitter is allowed into one side of the bar at one end.



(a) Basic structure



(b) Circuit symbol.

Operation of UJT:-

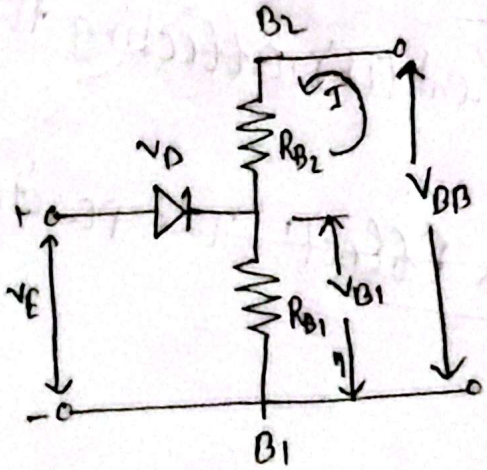


fig: equivalent circuit of UJT.

- No voltage is applied UJT the Inter Base Resistance.

$$R_{BB} = R_{B_1} + R_{B_2}$$

- If a voltage is applied between bases (B_1 and B_2). emitter is open the voltage across R_{B_1} is, V_{B_1}

$$I = \frac{V_{BB}}{R_{B_1} + R_{B_2}}$$

$$V_{B_1} = I R_{B_1} = \frac{R_{B_1}}{R_{B_1} + R_{B_2}} V_{BB}$$

$$V_{B_1} = \eta V_{BB}$$

~~Instan~~ Intrensic stand-off Ratio, $\eta = \frac{V_{B_1}}{V_{BB}}$

- When voltage is applied across emitter (E) the diode be forward biased, but no current will flow through diode, because $V_E < V_{B_1}$.

But, current will flow through diode, if

$$V_E \geq V_D + V_{B_1}$$

$$V_P \approx V_E = V_D + V_{B_1} \text{ (current will flows).}$$

- At this point UJT be activated and voltage drop across registen will be necessary and current will increasing.

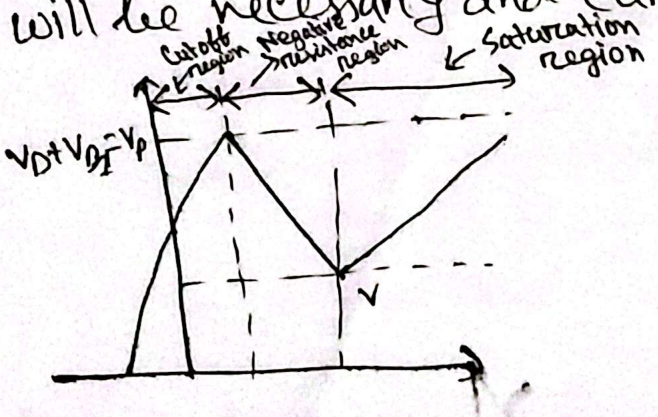


fig: V-I characteristics of UJT.

(c) Write down about negative resistance effect.

Soln

The negative resistance effect is a property of certain electronic devices where, over a specific region of their voltage-current (V-I) characteristic, the current increases while the voltage ~~to~~ decreases (or vice-versa)

- In other words, $\frac{dv}{di} < 0$
- This means the device exhibits a falling voltage with rising current, opposite to what happens in normal resistor

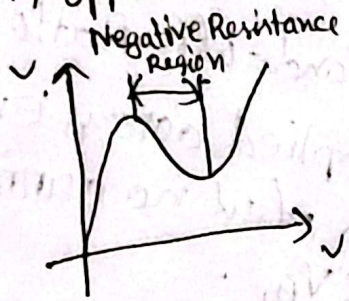


fig: Negative resistance