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18/ENG02/044
Computer Engineering

Question One

1 A zener diode :-

It is always operated in its reverse biased condition. As such a simple voltage regulator circuit can be designed using a zener diode to maintain a constant DC output voltage across the load in spite of variations in the input voltage or changes in the load current.

- Zener diode Regulator :- (Description gotten from diagram at (1ii))

Resistor, R_s is connected in series with the zener diode to limit the current flow through the diode with the voltage source, V_s being connected across the combination. The stabilised output voltage V_{out} is taken from across the zener diode.

The zener diode is connected with its cathode terminal connected to the positive rail of the DC supply so it is reverse biased and will be operating in its breakdown condition. Resistor R_s is selected so to limit the maximum current flowing in the circuit. With no load connect to the circuit, the load current will be zero, ($I_L = 0$), and all the circuit current passes through the zener diode which in turn dissipates its maximum power. Also a small value of the series resistor R_s will result in a greater diode current when the load resistance R_L is connected and large as this will

increase the power dissipation requirement of the diode so care must be taken when selecting the appropriate values of series resistance so that the Zener's maximum power rating is not exceeded under this no-load or high-impedance condition.

The load is connected in parallel with the Zener diode, so the voltage across R_L is always the same as the Zener voltage, $(V_R = V_Z)$. There is a minimum Zener current for which the stabilisation of the voltage is ~~value operating under load within~~ effective and the Zener current must stay above this value operating under load within its breakdown region at all times. The upper limit of current is of course dependant upon the power rating of the device. The supply voltage V_S must be greater than V_Z.

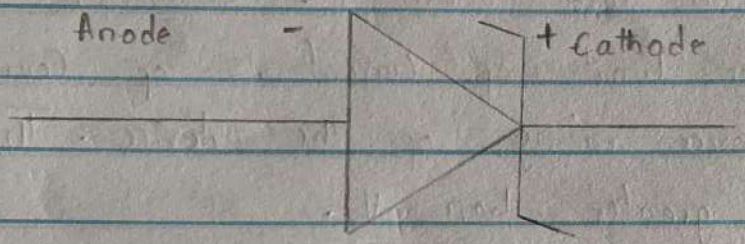
One small problem with zener diode stabiliser circuits is that the diode can sometimes generate electrical noise on top of the DC supply as it tries to stabilise the voltage. Normally this is not a problem for most applications but the addition of a large value decoupling capacitor across the zener's output may be required to give additional smoothing.

Then to summarise a little, a zener diode is always operated in its reverse biased condition. As such a simple voltage regulator circuit can be designed using a zener diode to maintain constant DC output voltage across the load in spite of variations in the input voltage or

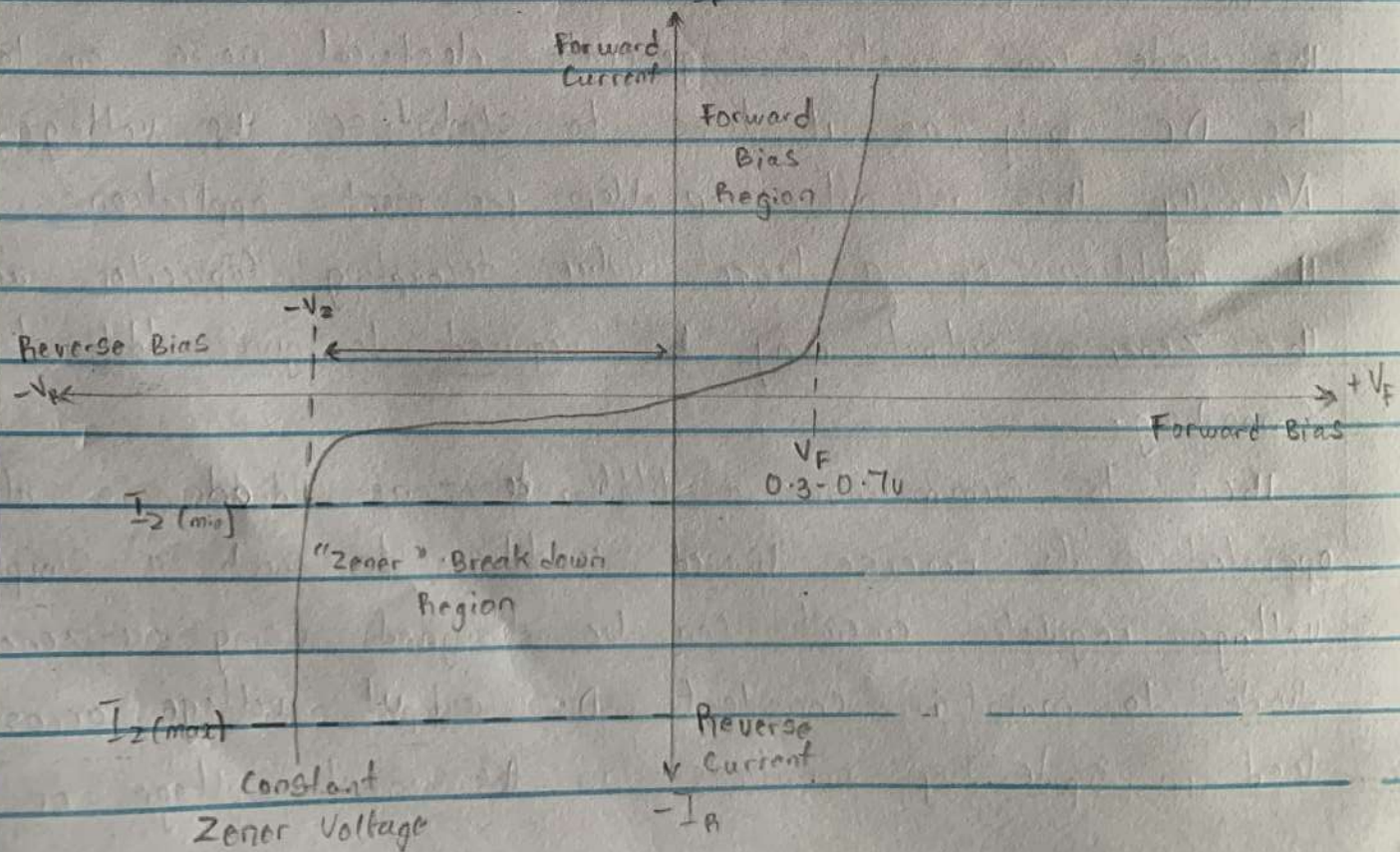
changes in load current.

The zener voltage regulator consists of a current limiting resistor R_s connected in series with the input voltage V_s with the zener diode connected in parallel with the load R_L in this reversed biased condition. The stabilised output voltage is always selected to be the same as the breakdown voltage V_z of the diode.

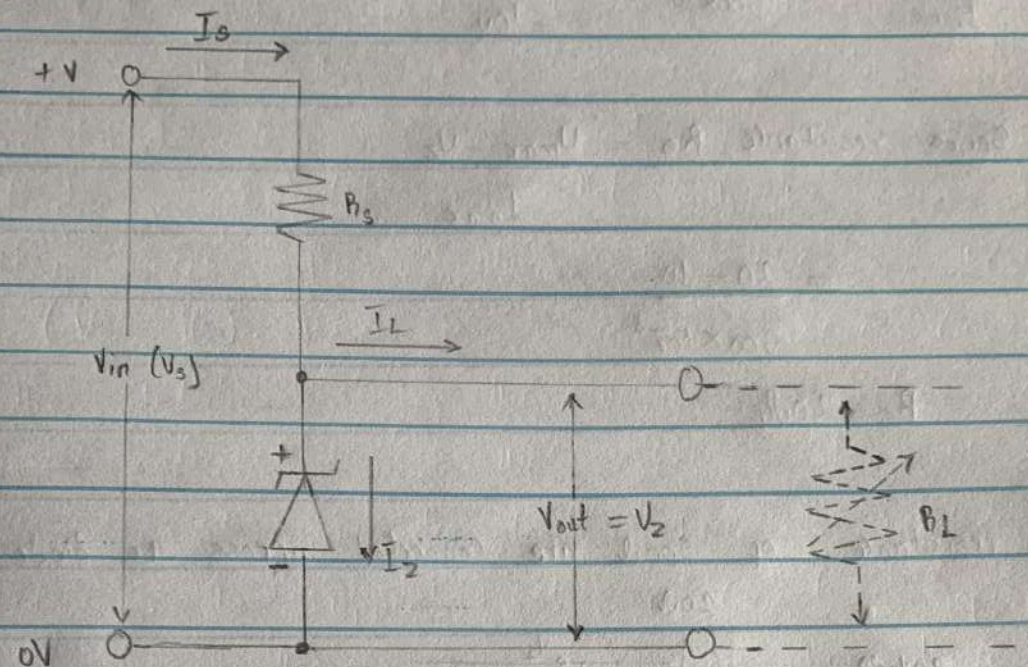
ii Sketch of symbol



- And I-V characteristics curve

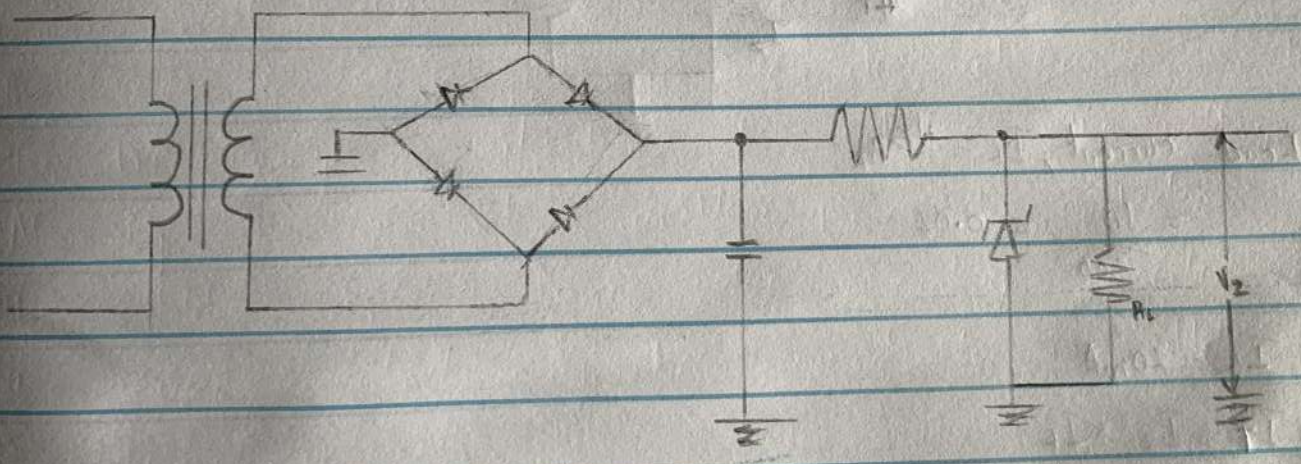


1ii The circuit diagram:-

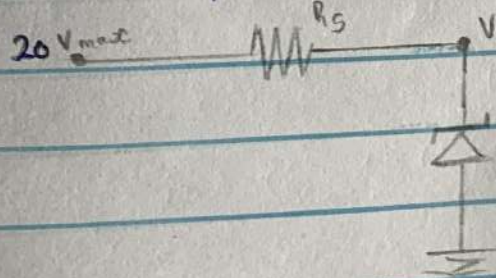


Question Two

2



i Considering the output circuit



$P = 5w$

$I_{max} = 500mA$

$$V_z = \frac{P}{I_{max}} = \frac{9}{500 \times 10^{-3}} = 10V$$

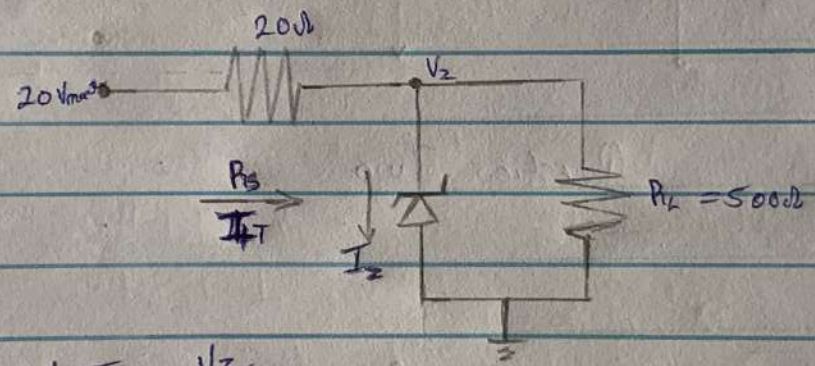
∴

Series resistance, $R_s = \frac{V_{max} - V_z}{I_{max}}$

$$= \frac{20 - 10}{500 \times 10^{-3}}$$

$$R_s = 20\Omega$$

ii) Load resistance of 500Ω are connected across the diode.



Load current, $I_L = V_z / R_L$

$$= \frac{10}{500} = 0.02$$

$I_L = 20mA$

$I_T = I_z \times I_L$

$$\frac{20 - 10}{20} = I_z + 20 \times 10^{-3}$$

$$0.5 = I_z + 0.02$$

$$I_z = 0.5 - 0.02 = 0.48$$

$$I_z = 480\ mA$$