

Answer All Questions:Question 1: (15 points)

- a) Using sketches of input and output characteristics, explain how a BJT can be used as an amplifier.
- b) Using sketches, indicate the relationship between input light and collector current of a phototransistor?
- c) For the circuit shown in Fig. Q1-a, assuming that $R_L = 1\text{K}\Omega$, $R_B = 70\text{K}\Omega$, $V_{CC} = 10\text{V}$ and $\beta = 100$. sketch the output waveform for $t \leq 10\text{ msec}$ if the input voltage is as shown in Fig. Q1-b.

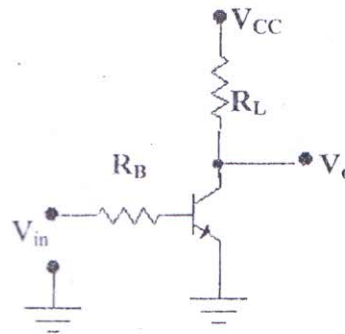


Fig. Q1-a

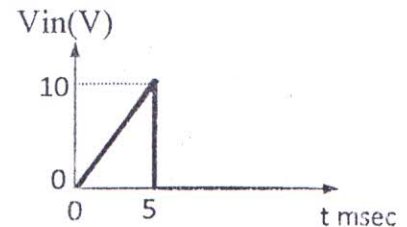


Fig. Q1-b

Question 2 (10 points)

- a) State two fundamental differences between JFET and BJT?
- b) For an n-channel JFET, the parameters are: $I_{DSS} = 2\text{ mA}$, $V_p = -2.5\text{V}$, and $\lambda = 0$. what is the value of V_{GS} when $I_D = 1.2\text{ mA}$, and the transistor is biased in the saturation region?
- c) Sketch two different biasing circuits of an n-channel JFET?

Question 3 (15 points)

- a) Draw a schematic diagram of an NMOSFET and indicate the parasitic capacitance between terminals?
- b) Prove the relationship between I_D , V_{GS} and V_{DS} in a NMOSFET?
- c) The parameters of an n-channel MOSFET are: $V_{TH} = 1\text{V}$, $\mu_n C_{ox} = 36\ \mu\text{A}/\text{V}^2$, and $\lambda = 0.015\ \text{V}^{-1}$. The transistor is to be biased in the saturation region with $I_{DQ} = 2\text{ mA}$.

(i) Calculate the (W/L) ratio such that the transconductance g_m is $3.4\text{ mA}/\text{V}$.

(ii) Calculate r_o for this condition.

Question 4 (25 points)

- Q-4: show a LASCR being used in a flame-detector circuit. Since LASCRs are relatively low-current devices ($\sim 1\text{A}$), the LASCR cannot drive the alarm directly. Here the LASCR is used to trigger the high-current TIAC, which switches power to the alarm.

(a) Describe the circuit operation?

(b) Determine an appropriate value for R_1 if the LASCR has $I_{H1} = 10$ mA, $V_H = 0$ and the TRIAC has an $I_{G(max)}$ rating of 50 mA and minimum Gate turn on = 5 mA, $V_G = 0$.

(c) Why wouldn't a photoconductive cell or phototransistor be used instead of the LASCR?

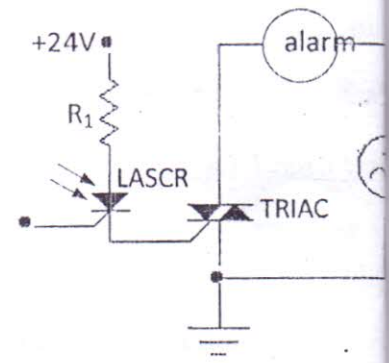


Fig.Q4

Question 5 (35 points)

(a) In the circuit of Fig. Q5-a the four-layer diode has the following

parameters: $V_S = 8$ V, $I_S = 0.5$ mA, $I_H = 1.5$ mA, $V_H = 1$ V, The input voltage E_S is changing according to the waveform shown. Sketch the waveform of V_D in response to this input.

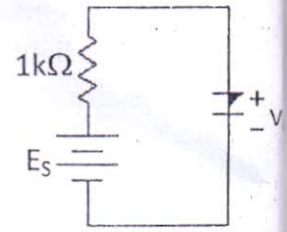
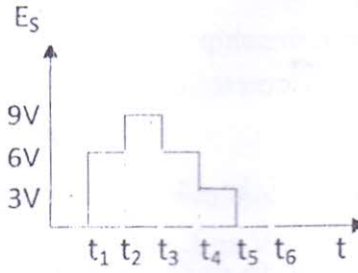


Fig. Q5-a

(b) In Fig. Q5-b the SCR has a holding current of 1 mA and a latching current of 3 mA. How wide must the gate pulse be in order for the SCR to turn "on"? Assume $V_F = 1$ V.

(c) Consider the voltage level detector circuit in Fig. Q5-c with the following values: $V_{GG} = 25$ V, $R_1 = 10$ kΩ, $R_2 = 15$ kΩ and $R_A = 1$ kΩ. The PUT has $I_S = 0.1$ mA, $I_H = 1$ mA and $V_H = 4$ V. Assume V_{in} is as shown. Draw the waveform of voltage across the load R_L .

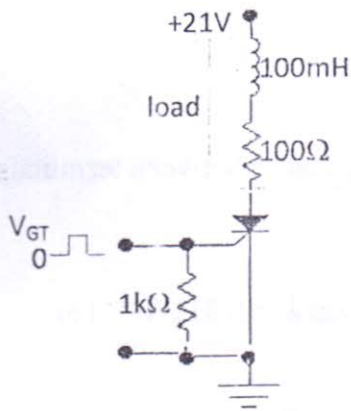


Fig.Q5-b

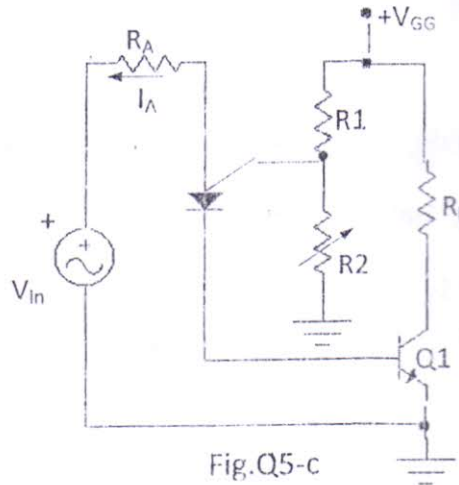
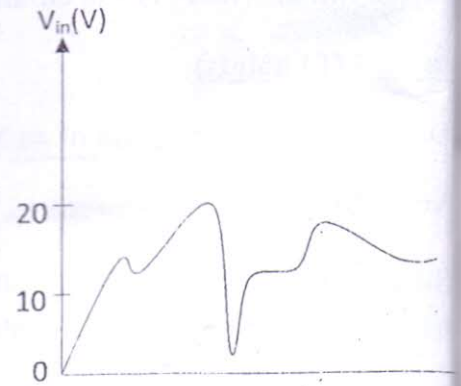


Fig.Q5-c



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