

Total No. of printed pages = 4

ECE 181302

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2023

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B.Tech. 3rd Semester End-Term Examination

ETC and PEI

SEMICONDUCTOR DEVICES AND CIRCUITS

(New Regulation and New Syllabus)

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Answer the following (MCQ/ Fill in the blanks) : (10 × 1 = 10)

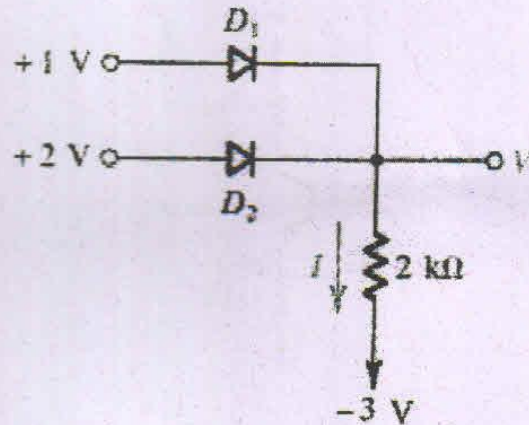
- (i) In which of the following semiconductor, the concentration of the holes and electrons is equal?
- (a) Intrinsic (b) Extrinsic
(c) Compound (d) Elemental
- (ii) According to the Einstein relation, for any semiconductor the ratio of diffusion constant to mobility of carriers.
- (a) Depends upon the temperature of the semiconductor
(b) Depends upon the type of the semiconductor
(c) Varies with life time of the semiconductor
(d) Is a universal constant
- (iii) In an intrinsic semiconductor, the Fermi level
- (a) Lies at the center of forbidden energy gap
(b) Is near the conduction band
(c) Is near valence band
(d) May be anywhere in the forbidden energy gap
- (iv) For $\alpha = 0.9$ value of β is
- (a) 9.9 (b) 49
(c) 99 (d) 100

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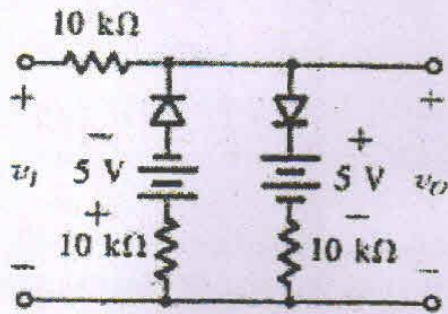
- (v) A BJT is said to be operating in the saturation region, if
- Both junctions are reversed biased
 - Base-emitter junction is reversed biased and base –collector junction is forward biased
 - Base-emitter junction is forward biased and base-collector junction is reverse biased
 - Both junctions are forward biased
- (vi) MOSFET can be used as a
- Current-controlled capacitor
 - Voltage-controlled capacitor
 - Current –controlled inductor
 - Voltage-controlled inductor
- (vii) In a Zener diode
- Only the P-region is heavily doped
 - Only the N-region is heavily doped
 - Both P and N regions are heavily doped
 - Both P and N regions are lightly doped
- (viii) The maximum peak to peak output voltage swing is obtained when Q point of a circuit is located
- Near saturation point
 - Near cutoff point
 - At the center of the load line
 - At least on the load line
- (ix) A forward potential of 10 V is applied to a si diode. A resistance of 1 K Ω is also in series with the diode. The current is
- 10 mA
 - 9.3 mA
 - 0.7 mA
 - 0
- (x) The Early – Effect in a bipolar junction transistor is caused by
- Fast turn on
 - Fast turn off
 - Large collector – base reverse bias
 - Large emitter – base forward bias
2. (a) In a N type semiconductor, the Fermi level is 0.3 eV below the conduction band at a room temperature of 300 K. If the temperature is increased to 360 K, determine the new position of Fermi level. (5)
- (b) Consider a PN junction in equilibrium at room temperature ($T = 300\text{K}$) for which the doping concentrations are $N_A = 10^{18}/\text{cm}^3$ and $N_D = 10^{16}/\text{cm}^3$ and the cross-sectional area $A = 10^{-4}$. Calculate the barrier potential voltage (V_0) and the width of the depletion region. Use $n_i = 1.5 \times 10^{10}/\text{cm}^3$. (5)
- (c) Explain the Continuity equation. (5)

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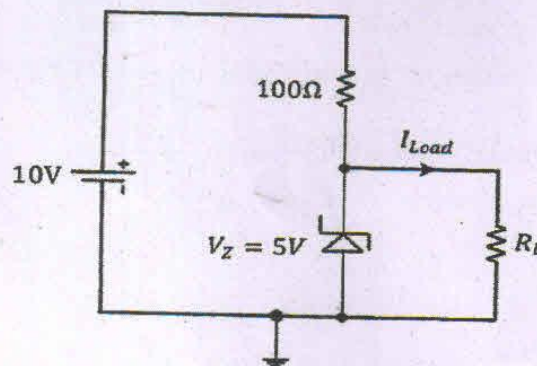
3. (a) For the circuits shown in Figure 1 using ideal diodes, find the values of voltage, V and current I . (5)



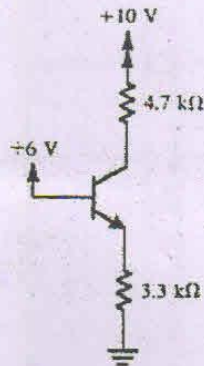
- (b) Assuming the diodes to be Silicon, determine the output of the circuit shown in Figure 2 for an input voltage of sine wave of peak to peak voltage of 20 V. (10)



4. (a) In the circuit shown in Figure 3 the knee current of the ideal Zener diode is 10 mA. Calculate the minimum value of R_L , and the minimum power rating of the Zener diode to maintain 5 V across R_L . (5)



- (b) Calculate the voltages at all nodes and currents through all branches of the circuit shown in Figure 4. Consider $\beta = 50$ and the transistor as Si. (10)



5. (a) Illustrate the differences between dc load line and ac load line. (5)
 (b) What is thermal runaway? How can it be avoided? (2 + 2 = 4)
 (c) For an N channel JFET, $I_{DSS} = 8.4 \text{ mA}$, $V_P = -3 \text{ V}$ and $V_{GS} = -1 \text{ V}$. Find the value of I_D , g_{m0} and g_m . (6)
6. (a) A CE amplifier with $h_{fe} = 100$ biased at $I_C = 0.5 \text{ mA}$ and has a collector resistance $R_C = 12 \text{ k}\Omega$ and a resistance $R_E = 250 \Omega$ connected in the emitter. If the amplifier is fed with a single source having a source resistance of $10 \text{ k}\Omega$, and a load resistance $R_L = 1 \text{ k}\Omega$ is connected to the output terminal, calculate the following if a input voltage of 5 mV sine wave appears between the base and emitter of the transistor.
- (i) I_i
 (ii) Z_i
 (iii) V_o
 (iv) A_v (10)
- (b) Explain the operation of N channel Enhancement MOSFET. (5)
7. Write short notes on (any three) (3 × 5 = 15)
- (a) Ebers Moll Model
 (b) Bridge rectifier
 (c) JFET
 (d) LED.

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