Code: A-25 Subject: PHYSICAL ELECTRONICS AND SOLID STATE DEVICES
Time: 3 Hours Max. Marks: 100

NOTE: There are 11 Questions in all.

Question 1 is compulsory and carries 16 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.
Answer any THREE Questions each from Part I and Part II. Each of these questions carries 14 marks.
Any required data not explicitly given, may be suitably assumed and stated.

Q.1 Choose the correct or best alternative in the following: (2x8)

a. LCDs are not operated from ac supply of frequency lower than 25 Hz because

(A) a visible flicker will occur.
(B) current drawn will be large.
(C) power dissipated will be large.
(D) of large transient voltages developed across the device.

b. Processing of MOS ICs is less expensive than bipolar ICs primarily because they

(A) use inexpensive materials.
(B) need no component isolation.
(C) require less number of diffusion steps.
(D) have very high packing density.

c. The main factor which differentiates a depletion-MOS from an enhancement-MOS is the absence of

(A) insulated gate. **(B)** electrons.
(C) channel. **(D)** P-N junctions.

d. The main reason why electrons can tunnel through a P-N junction is that

(A) they have high energy.
(B) the barrier potential is very low.
(C) the depletion layer is extremely thin.
(D) the impurity level is low.

e. Silicon is the preferred material for manufacturing Zener diodes because it

(A) is relatively inexpensive.
(B) needs low doping level.
(C) has high temperature and current capacity.
(D) has low break-down voltage.

f. Fermi level represents the energy level with the following probability of its occupation:

(A) zero. **(B)** 50%.
(C) 75%. **(D)** 100%.

g. In Hall effect the output voltage produced across the crystal is due to the

(A) movement of charge carriers towards one end.
(B) induced voltage by the applied magnetic field.
(C) drop across the crystal due to current through it.
(D) increased generation of charge carriers.

h. For a given emitter current, the collector current can be increased by

(A) reducing the recombination rate in the base region.
(B) doping the emitter region lightly.
(C) reducing the minority carrier mobility in the base region.
(D) widening the base region.

PART I
Answer any THREE Questions. Each question carries 14 marks.

Q.2 a. Differentiate between direct and indirect semiconductors. Give one example of applications of each type of semiconductor. **(8)**

b. What is the concentration of holes in Si crystals having donor concentrations of $1.4 \times 10^{24} / cm^3$ when the intrinsic carrier concentration is $1.4 \times 10^{18} / m^3$? Find the ratio of electron to hole concentration. **(6)**

Q.3 a. Discuss breakdown mechanisms in semiconductors. **(8)**

b. Determine ac resistance for a semiconductor diode having a forward bias of 200 mV and reverse saturation current of 1 μA at room temperature. **(6)**

Q.4 a. Discuss briefly various secondary effects in a practical BJT device. **(8)**

b. Derive the relation between the parameters α and β for a BJT. **(6)**

Q.5 a. Draw the schematic of Band profiles of isolated metal, oxide and semiconductor. How would the band profiles modify for a MOS junction? **(7)**

b. For an $Al - SiO_2 - Si$ MOS device, the work function of Al is 4.1eV, the electron affinity for SiO_2 is 0.9 eV and that of Si is 4.15 eV.
Calculate the potential V_{fb} if the Si doping is $N_a = 10^{14} cm^{-3}$. **(7)**

Q.6 a. Explain the working principle of a Tunnel diode. Give two applications of the device. **(8)**

b. Discuss the advantages and disadvantages of monolithic circuits over hybrid circuits. **(6)**

PART II

Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. Discuss briefly the scattering mechanisms that influence electron and hole mobility. **(8)**

b. In an N-type semiconductor, the Fermi-level lies 0.3 eV below the conduction band at $27^{\circ}C$. If the temperature is increased to $55^{\circ}C$, find the new position of the Fermi-level. **(6)**

Q.8 a. How does a diode respond to a square wave input? Explain the concept of storage delay in this context. **(6)**

b. Show schematically the effects of forward and reverse bias on a p-n junction. Also give the energy band diagram and the mechanism of particle flow within the junction width. **(8)**

Q.9 a. Explain various static performance parameters for a BJT. **(6)**

b. Explain latch-up in CMOS. How can it be prevented? **(8)**

Q.10 a. What is meant by Gunn effect? Discuss why a Gunn diode exhibits a negative differential resistance. **(8)**

b. Write a note on semiconductor lasers. **(6)**

Q.11 a. Explain the various steps involved in manufacturing silicon wafers. **(6)**

b. Discuss briefly various types of packaging for ICs. **(8)**

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