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. Monocrystallisation of silicon or germanium is obtained through the process called

(A) zone refining. **(B)** seed pulling.
(C) epitaxial growth. **(D)** diffusion.

b. The cells in a solar-cell module

(A) are grouped in series.
(B) are grouped in parallel.
(C) occur in series-parallel combinations.
(D) are not grouped at all.

c. Current flow in a semiconductor depends on the phenomenon of

(A) drift. **(B)** diffusion.
(C) recombination. **(D)** drift, as well as diffusion and recombination.

d. The depletion region of a semiconductor diode is due to

(A) reverse biasing. **(B)** forward biasing.
(C) crystal doping. **(D)** migration of mobile charge carriers.

e. A diode that has no depletion layers and operates with hot carriers is the

(A) Tunnel diode. **(B)** Gunn diode.
(C) IMPATT diode. **(D)** Schottky diode.

f. In a properly-biased NPN transistor, most of the electrons from the emitter

(A) recombine with holes in the base.

(B) recombine in the emitter itself.
(C) pass through the base to the collector.
(D) are stopped by the junction barrier.

g. For the operation of enhancement only N-channel MOSFET; value of gate voltage has to be

(A) high positive. **(B)** high negative.
(C) low negative. **(D)** zero.

h. In the context of IC fabrication, metallisation means

(A) connecting metallic wires.
(B) forming interconnecting conduction pattern and bonding pads.
(C) depositing SiO_2 layer.
(D) covering with a metallic cap.

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

Q.2 a. In usual practice, a semiconductor material is doped such that the extrinsic range extends beyond the highest temperature at which the device is to be used. Explain why. **(8)**

b. A sample of Si is doped with 10^{17} phosphorus atoms/cm^3. What would be its approximate resistivity? What would be the Hall voltage in a sample 100 μm thick if $I_x = 1mA$ and $B_z = 10^{-5}$ wb/ cm^2 ? **(6)**

Q.3 a. For a Si diode, discuss how the characteristics change with variations in temperature. **(7)**

b. Contact potential in a p-n junction is an equilibrium quantity and no net current can result from it. Justify. **(7)**

Q.4 a. Discuss briefly the various specifications for switching transistors. **(7)**

b. Explain "Early effect" in BJT. **(7)**

Q.5 a. Discuss the operation of charge transfer devices. Explain any two applications of the device. **(8)**

b. Assume that the inversion in an MOS capacitor occurs when the surface potential is twice the value of $e\phi^F$. What is the maximum depletion width at room temperature of a structure where the p-type silicon is doped at $N_a = 10^{16}\ cm^{-3}$

? **(6)**

Q.6 a. In what ways is an LCD better than a seven segment LED display? **(6)**

b. Discuss Czochralski method of crystal growth. **(8)**

PART II

Answer any THREE Questions. Each question carries 14 marks.

Q.7 a. Give schematic diagrams of Fermi-Dirac distribution for intrinsic and extrinsic semiconductors at thermal equilibrium. Explain the variation in Fermi level with temperature in a doped semiconductor. **(8)**

b. A Si sample is doped with 10^{17} As atoms/cm^3 . What is the equilibrium hole concentration at 300 K? Where is E_F relative to E_i? **(6)**

Q.8 a. Discuss briefly rectifying and ohmic contacts in semiconductors. **(8)**

b. What is meant by the term reverse-recovery time? Is it due to the majority carriers or the minority carriers? **(6)**

Q.9 a. Discuss various high frequency limitations of the BJT. **(6)**

b. Explain the various mechanisms of a switching cycle for a CE transistor. **(8)**

Q.10 a. Discuss the three regions of biasing in a MOS capacitor. **(8)**

b. Explain subthreshold characteristics in a MOS transistor. **(6)**

Q.11 a. What is a varactor diode? How does it realize a voltage variable capacitance? Explain its working principle. **(8)**

b. Scaling is the reason behind evolution of ICs from SSI to VLSI. Justify. **(6)**