

DECEMBER 2006**Code: A-25****Subject: PHYSICAL ELECTRONICS AND SOLID STATE DEVICES****Time: 3 Hours****Max. Marks: 100****NOTE: There are 9 Questions in all.**

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
 - **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
 - **Any required data not explicitly given, may be suitably assumed and stated.**
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Q.1 Choose the correct or best alternative in the following: (2x10)

- a. In a metal, the conductivity is very large because
- (A) the mobility of charge carriers is very high.
 - (B) the number of charge carriers is very high.
 - (C) positive as well as negative charge carriers contribute to current.
 - (D) all electrons in the metal contribute to the conduction current.
- b. In a laser, the following processes have to be minimized
- (A) Absorption only.
 - (B) Absorption and spontaneous emission.
 - (C) Absorption and stimulated emission.
 - (D) Stimulated emission only.
- c. In a tunnel diode oscillator, the diode bias is
- (A) small and forward.
 - (B) large and forward.
 - (C) Zero.
 - (D) Reverse.
- d. The band gap E_g in a semiconductor corresponds to the energy difference between
- (A) The top of the conduction band and the top of the valence band.
 - (B) The top of the conduction band and the bottom of the valence band.
 - (C) The bottom of the conduction band and the top of the valence band.
 - (D) The bottom of the conduction band and the bottom of the valence band.
- e. Make the choice of the correct one from the following statements:
- (A) Direct recombination is normally radiative.
 - (B) All radiation is due to direct recombination.

- (C) Both of the above statements are true.
 (D) Neither of the above statements are true.
- f. Crystal defects in a semiconductor tends to
- (A) Reduce majority carrier concentration in a semiconductor.
 (B) Reduce equilibrium minority carrier concentration in a semiconductor.
 (C) Increase the rate of indirect recombination in a semiconductor.
 (D) Increase radiative recombination in a semiconductor.
- g. The low field electron mobility depends on
- (A) Doping. (B) Electric field.
 (C) Temperature. (D) None of the above.
- h. If the quasi-fermi levels F_n and F_p are such that F_n lies above F_p , it indicates that
- (A) excess carriers are present in the semiconductor.
 (B) the semiconductor is n type.
 (C) the semiconductor is p type.
 (D) the region under consideration is in depletion.
- i. Under reverse bias, the capacitance of the junction
- (A) Reduces with increasing applied voltage.
 (B) Increases with increasing applied voltage.
 (C) is independent of applied bias.
 (D) First increases then decreases with increasing magnitude of applied bias.
- j. The potential well formation in a CCD structure occurs when the surface of the semiconductor is in
- (A) Deep depletion. (B) Strong inversion.
 (C) Weak inversion. (D) Accumulation.

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

- Q.2** a. Sketch the conduction and valence bands before and after diffusion of carriers in a PN junction. (8)
- b. For what voltage will the reverse current in p-n junction Ge diode reach 90% of its saturation value at the room temperature? What is the ratio of the current for a forward bias of 0.05V to the current for same magnitude reverse bias? (8)

- Q.3** a. Discuss the variation in semiconductor parameters with temperature. (8)
- b. Explain the continuity equation and its significance. (8)
- Q.4** a. Discuss metal-semiconductor junctions. How are they different from semiconductor-semiconductor junctions? Explain with examples. (8)
- b. Determine the conversion efficiency of a solar cell of input power = 900 mW, open circuit voltage = 600 mV, short circuit current density = 40 mA/cm^2 , fill factor = 75% and area = 6 cm^2 . (8)
- Q.5** a. Describe Early effect and punch through in practical BJT devices. (8)
- b. Explain short channel effects in MOSFETs. (8)
- Q.6** a. Discuss the differences between transferred electron devices and avalanche transit time devices. (12)
- b. A Gunn diode has a drift length of $2 \mu\text{m}$. What minimum voltage is required to initiate the Gunn mode? (4)
- Q.7** a. Discuss the characteristics of microwave transistors. (12)
- b. Calculate the bandwidth of an LED which has a rise time of 20nsec. (4)
- Q.8** a. Describe various steps of IC fabrication process. (8)
- b. Compare and contrast monolithic and hybrid circuits. (8)
- Q.9** a. The Hall coefficient of a certain silicon specimen was found to be $-7.35 \times 10^{-5} \text{ m}^3 \text{ C}^{-1}$ from 100 to 400 K. Determine the nature of the semiconductor. Further the electrical conductivity was found to be $200 \Omega^{-1} \text{ m}^{-1}$. Calculate the density and mobility of charge carriers. (8)
- b. Explain the various capacitances associated with p-n junctions. (8)