Code: AE25 **Subject: PHYSICAL ELECTRONICS AND SOLID STATE DEVICES**
Time: 3 Hours **Max. Marks: 100**

DECEMBER 2010

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.**
- **The answer sheet for the Q.1 will be collected by the invigilator after half an hour of the commencement of the examination.**
- **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.**

Q.1 Choose the correct or best alternative in the following: **(2×10)**

a. The mean free path in an ideal crystal without imperfections and impurities is

(A) infinite at 0°k **(B)** zero at 0°k
(C) Infinite at all temperatures **(D)** zero at all temperatures

b. The diffusion constant and the mobility of electron are related as

(A) $\frac{D_n}{\mu_n} = \frac{TK}{q}$ **(B)** $\frac{D_n}{\mu_n} = q/KT$

(C) $\frac{D_n}{\mu_n} = KTq$ **(D)** $\frac{D_n}{\mu_n} = \frac{1}{KTq}$

c. Solar cell is a type of

(A) photo-conductive device **(B)** photo-emissive device
(C) photo-voltaic device **(D)** electromotive device

d. Photon absorption due to the capacity of LED material causes

(A) High quantum efficiency **(B)** no change in quantum efficiency
(C) low quantum efficiency **(D)** infinite quantum efficiency

e. The gain bandwidth product of an FET amplifier w.r.t. a BJT amplifier is

(A) Equal **(B)** high
(C) zero **(D)** low

f. At pinch off, the drain current becomes

(A) zero **(B)** infinite
(C) follows ohms law **(D)** constant

g. The emitter efficiency of a junction transistor decreases with

(A) increase of emitter doping **(B)** decrease of emitter doping
(C) decrease of base width **(D)** decrease of base doping

h. The diode which permits remote tuning is

(A) zener diode **(B)** Avlanche diode
(C) Varactor diode **(D)** Gunn diode

i. PN junction capacitance is related with barrier potential as

(A) $C = KV^{-\frac{1}{2}}$ **(B)** $C = KV^{1/2}$
(C) $C = \frac{K}{V}$ **(D)** $C = KV$

j. Depletion width has

(A) negative charge carriers
(B) no charge carriers
(C) positive charge carriers
(D) both positive and negative charge carriers

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

Q.2 a. In a semiconductor it is observed that three quarter of the current is carried by electrons and one quarter by holes. If at this temperature the drift speed of electrons is three times that of holes, determine the ratio of electrons to holes in the semiconductor. **(8)**

b. What is meant by Fermi level in semiconductor and what is the effect of temperature on the position of Fermi-level of a semiconductor. **(8)**

Q.3 a. Describe the two mechanisms of excess charge carriers recombination in a semiconductor. **(8)**

b. What properties of a semiconductor are determined from a Hall effect experiment? Can Hall effect be used for designing a multiplier to find product of two signals. If yes, then how? **(8)**

Q.4 a. Explain the effect of bias at a p-n junction with the help of energy band diagram. **(8)**

b. What is Schottky effect? Why is storage time eliminated in Schottky diode? **(8)**

Q.5 a. Determine the resulting change in emitter current for a change in collector current of 2mA with its $\alpha = 0.98$. **(6)**

b. Explain various mechanisms of a switching cycle of BJT switch with the help of diagrams? **(10)**

Q.6 a. Calculate the mobility of electron in an NMOS transistor with the device parameters as $\frac{W}{L} = 1, V_{GS} = 4V, V_{th} = 1.99V, V_{DS} = 4V$, $\varepsilon_{ox} = 3.97\varepsilon_o$, $I_D = 144\mu A$, $t_{ox} = 400A^\circ$ **(6)**

b. What are the advantages of buried channel CCD over basic CCD. Give various applications of CCDs? **(10)**

Q.7 a. Draw the V-I characteristics of solar cell. What are the limiting conditions of a solar cell? Explain them. **(8)**

b. Explain the transferred electron mechanism and formation of space charge domains in Gunn diodes. Do Gunn diodes have a junction if not then why they are called diodes? **(8)**

Q.8 a. Explain Epitaxy? What is the importance of lattice matching in epitaxial growth? **(8)**

b. Explain various types of packaging for IC's. **(8)**

Q.9 Write short notes (any **FOUR**):

(i) Quasi Fermi levels.
(ii) Photodetectors.
(iii) MOS capacitor.
(iv) Early effect.
(v) IMPATT diode.
(vi) Lattice scattering and impurity scattering. **(4×4)**