AMIETE – ET (OLD SCHEME)

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

JUNE 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.**
- **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 the best alternative in the following: (2×10)

a. In a PNP transistor, the saturation current is due to the flow of

(A) electrons from collector to base.
(B) holes from collector to base.
(C) electrons from emitter to base.
(D) holes from emitter to base.

b. Fermi level in an intrinsic semiconductor lies

(A) In the middle of the conduction band.
(B) closer to valence band than conduction band.
(C) in the middle of the forbidden band.
(D) closer to conduction band than valence band.

c. Gallium arsenide belongs to the following group:

(A) II-VI **(B)** III-V
(C) III-IV **(D)** II-III

d. Mobile electrons are found in

(A) Conduction band. **(B)** valence band.
(C) below the valence band. **(D)** in the band gap.

e. Zener break-down depends on

(A) Electric field created across the depletion region.
(B) Velocity of the carriers.
(C) Number of donor ions.
(D) Number of acceptor ions.

f. Solar cell is a type of

(A) photoconductive device. **(B)** photoemissive device.
(C) photovoltaic device. **(D)** electromotive device.

g. p-n junctions are classified as abrupt junctions and linearly graded junctions based on

(A) depletion layer width. **(B)** build-in potential.
(C) doping concentration qradient. **(D)** break-down voltage.

h. A transistor works as a switch between

(A) cut-off and saturation region. **(B)** active and saturation region.
(C) cut-off and active region. **(D)** none of these

i. Storage time in a transistor occurs when it is operating in

(A) active region. **(B)** cut-off region.
(C) saturation region. **(D)** either active or saturation region.

j. A Light Emitting Diode (LED) is a

(A) display device. **(B)** storing device.
(C) zener diode. **(D)** voltage regulator.

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

Q.2 a. With the help of energy band diagram, properly labelled, discuss briefly a metal to n-type semiconductor contact, both for a rectifying and an ohmic contact. Why do same semiconducting specimens form a rectifying contact regardless of the metal used? **(8)**

b. What is the donor concentration in n-type germanium of 1 ohm cm resistivity at $300^{\circ}K$? The mobility of germanium is 3900 $cm^2/V-second$. **(8)**

Q.3 a. Prove that the 'Fermi level' lies approximately at the centre of the energy gap at room temperature in the case of an intrinsic semiconductor. **(8)**

b. Explain the construction of a varactor diode. Give important applications of this diode. **(8)**

Q.4 a. Outline an experimental set-up with necessary precautions for determining Hall coefficient, Hall angle and Hall mobility in a given semiconducting specimen. Establish the relations used. **(8)**

b. Explain the formation of domains in a Gunn diode. **(8)**

Q.5 a. Explain degeneracy in semiconductors. How is it linked with Tunnel diode? Write principle of operation and applications of this diode. **(8)**

b. Describe the principle of working of LED. What are the merits of LEDs? **(8)**

Q.6 a. What is an integrated circuit (IC)? Discuss the relative advantages and disadvantages of ICs over discrete assembly. How will you make a monolithic IC? **(8)**

b. Explain the phenomenon called "Early Effect". **(8)**

Q.7 a. Distinguish between depletion mode and enhancement mode MOSFETs. Explain the mechanism that leads to channel 'pinch off' at higher drain-source voltage drop. **(8)**

b. Discuss in brief the basic principle and applications of change transfer devices. **(8)**

Q.8 a. Consider an abrupt p-n junction solar cell with uniformly doped n-and p-regions. Draw the energy band diagram of the illuminated cell under

(i) the short circuit condition
(ii) the open circuit condition. **(8)**

b. Explain the working of an IMPATT diode. What are the applications of this diode? **(8)**

Q.9 a. Electrons in n-type germanium have a mobility of $3600\,\mathrm{cm}^2/\mathrm{V}-\mathrm{sec\,ond}$ at room temperature. Assume that the effective mass of an electron in the conduction band is $\left(\frac{1}{4}\right)$ m, where m is the mass of a free electron, calculate the time between collisions with the lattice. **(8)**

b. What are semiconductor lasers? How do they provide a portable and easily controlled source of low-power coherent radiation? **(8)**