ROLL NO. _____

Code: AE25 Subject: PHYSICAL ELECTRONICS AND SOLID STATE DEVICES

AMIETE – ET (OLD SCHEME)

Time: 3 Hours **JUNE 2012** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

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 45 minutes 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 the best alternative in the following: **(2×10)**

a. What occurs when a conduction-band electron loses energy and falls back into a hole in the valence band?

(A) Doping **(B)** Recombination
(C) Generation **(D)** None of the above

b. Total emitter current is

(A) $I_E - I_C$ **(B)** $I_C + I_E$
(C) $I_B + I_C$ **(D)** $I_B - I_C$

c. Hall Effect can be used

(A) to find the type of semiconductor
(B) to find carrier concentration
(C) to measure conductivity
(D) all of the above

d. Transistor is a

(A) Current controlled current device
(B) Current controlled voltage device
(C) Voltage controlled current device
(D) Voltage controlled voltage device

e. What is the current gain for a common-base configuration where $I_E = 4.2$ mA and $I_C = 4.0$ mA?

(A) 16.80 **(B)** 1.05
(C) 0.2 **(D)** 0.95

f. The normal operating region for a zener diode is the

(A) Forward-Bias region **(B)** Reverse-Bias region
(C) Zero-Crossing region **(D)** Reverse-Breakdown region

g. Which diode operates only with majority carriers?

(A) Laser **(B)** Tunnel
(C) Schottky **(D)** Step Recovery

h. Midpoint bias for a D-MOSFET is I_D = _____, obtained by setting $V_{GS} = 0$.

(A) $I_{DSS} / 2$ **(B)** $I_{DSS} / 3.4$
(C) I_{DSS} **(D)** None of the above

i. LED is forward-biased. The diode should be on, but no light is showing. A possible trouble might be

(A) the diode is open
(B) the series resistor is too small.
(C) none, the diode should be off if forward-biased.
(D) the power supply voltage is too high.

j. The process of emitting photons from a semiconductive material is called

(A) photoluminescence **(B)** electroluminescence
(C) Radiation **(D)** Simulation

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

Q.2 a. Draw and explain the energy band diagrams of a direct band gap and indirect band gap semiconductors. Mention the suitable applications of both. **(8)**

b. Explain the significance of Hall Effect in determining the mobility of charge carriers in extrinsic semiconductors. The resistivity of a bar is 230,000 Ω-cm when a magnetic flux of 0.1 Wb/m^2 is applied to the bar. For semiconductor bar d=w=3 mm. Current measured is 10 μA and Hall Voltage is 50 mV. Determine the mobility of holes. **(8)**

Q.3 a. Explain the different capacitive effects existing in p-n junction diodes. **(8)**

b. A conducting line on IC chip is 2.5 mm long and has a cross sectional area of 5×10^{-12} m^2. A current of 2 mA produces a voltage drop of 40 mV across the line. If mobility of electrons is 500 $cm^2/V\text{-}s$, find the electron concentration. **(8)**

Q.4 a. Describe "Punch Through" and "Early Effect" in practical BJT devices. **(8)**

b. Explain the following terms in context with BJT
   (i) Collector Efficiency
   (ii) Base Transport Factor **(8)**

Q.5 a. Discuss the various short channel effects present in small geometry MOS devices. **(8)**

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

Q.6 a. What is a varactor diode? How does it realize a voltage variable capacitance? Explain its working principle. **(8)**

b. Explain the suitability of solar cells as a global energy source. Discuss the V-I characteristics of an illuminated solar cell. **(8)**

Q.7 a. Differentiate between SSI, MSI, LSI, VLSI. Why do MOS ICs find wide applications in LSI and VLSI chips? **(8)**

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

Q.8 a. Discuss the formation and drift of a space charge domain in a Gunn diode. **(8)**

b. A bar of intrinsic Si measures 10 mm × 10 mm in cross–section. If a potential of 12 V is applied across the ends of bar, calculate the following:
   (i) Electron and hole drift velocities.
   (ii) Current in bar if its length is 1 cm
   (Given data μ_p=500 cm^2/V-s, μ_n=1300 cm^2/V-s, $n_i=1.5\times10^{10}$ /cm^3) **(8)**

Q.9 Write short notes on the following:

(i) Photodetectors
(ii) Breakdown mechanisms in p-n junction diodes
(iii) Frequency limitations of transistors
(iv) Substrate Bias effects in MOSFET **(4×4)**