ROLL NO. _____

Code: AE25 Subject: PHYSICAL ELECTRONICS AND SOLID STATE DEVICES

AMIETE – ET (OLD SCHEME)

Time: 3 Hours **OCTOBER 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. MOSFET can be used as a

(A) current controlled capacitor **(B)** voltage controlled capacitor
(C) current controlled inductor **(D)** voltage controlled inductors

b. The early effect in a bipolar junction transistor is caused by

(A) fast turn-on **(B)** fast turn-off
(C) large collector-base reverse bias **(D)** large emitter-base forward bias

c. Which of the following is not associated with a p-n junction?

(A) channel length modulation **(B)** charge storage capacitance
(C) depletion capacitance **(D)** junction capacitance

d. The MOSFET switch in its on-state may be considered equivalent to

(A) resistor **(B)** inductor
(C) capacitor **(D)** battery

e. Fermi level for extrinsic semiconductor depends on

(A) Donor element **(B)** Impurity concentration
(C) Temperature **(D)** All

f. Which of the following materials is not a semiconductor?

(A) Silicone. **(B)** Germanium.
(C) Gallium arsenide. **(D)** Gallium nitride.

g. Energy band gap size for Si semiconductors is in the range _____ eV.

(A) 1-2 **(B)** 2-3
(C) 3-4 **(D)** > 4

h. Which type of special-purpose diode has the characteristics of a voltage-controlled capacitor?

(A) varactor diode. **(B)** tunnel diode.
(C) zener diode. **(D)** Schottky diode.

i. Flow of electrons is affected by the following

(A) Thermal vibrations **(B)** Impurity atoms
(C) Crystal defects **(D)** all

j. A Zener diode is based on the principle of:

(A) Thermionic emission
(B) Tunneling of charge carriers across the junction
(C) Diffusion of charge carriers across the junction
(D) None of the above

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

Q.2 a. Describe the impact ionization process where a high energy conduction-band electron scatters from a valence-band electron, producing two conduction-band electrons and a hole. **(8)**

b. A sample of Si is doped with 10^{17} phosphorus atoms$/cm^3$. What would you expect to measure for its resistivity? What Hall voltage would you expect in a sample $100\mu m$ thick if $I_x = 1mA$ and $B_z = 1KG = 10^{-5}$ wb$/cm^2$ **(8)**

Q.3 a. When a heavily doped junction is reverse biased, the energy bands become crossed at relatively low voltages, explain it by characteristics curves. **(8)**

b. Describe and design an ohmic contact for n-type GaAs using InAs, with an intervening graded InGaAs region. **(8)**

Q.4 a. Explain briefly the switching operation of a transistor. **(8)**

b. List and explain BJT static performance parameters. **(8)**

Q.5 a. Discuss the output characteristics of the MOS field effect transistor. **(8)**

b. Consider an aluminium-$SiO_2 - Si$ MOS device. The work function of Al is 4.1eV, the electron affinity for SiO_2 is 0.9eV, and that of Si is 4.15 eV. Calculate the potential V_{fb} if the Si doping is $N_a = 10^{14} cm^{-3}$. **(8)**

Q.6 a. Briefly explain the principle and applications of semiconductor lasers. **(8)**

b. Write a brief about the characteristics of microwave transistor. **(8)**

Q.7 Write a brief note on the evolution of IC technology and the role of testing, bonding and packaging into IC fabrication. **(16)**

Q.8 a. The production of a voltage difference across an electrical conductor, transverse to an electric current in the conductor and a magnetic field perpendicular to the current. Derive the effect with diagram. **(8)**

b. State and derive Einstein's relation in the carrier dynamics of semi conductors. **(8)**

Q.9 Write short notes on any **TWO**:

(i) Schottky barriers
(ii) Kirk effect
(iii) Charge transfer device
(iv) Solar cells **(2×8)**