Code: AE-25   **Subject: PHYSICAL ELECTRONICS AND SOLID STATE DEVICES**

JUNE 2007

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.**

Q.1   **Choose the correct or best alternative in the following:**   **(2x10)**

a. The unit of Boltzmann's constant is

    (A) ev/m.   **(B)** J/K.

    (C) m/s.   **(D)** m^2/s.

b. Fermi level relates to the probability of finding majority

    (A) charge carries in a semiconductor.
    (B) holes in an n-type semiconductor.
    (C) electrons in a p-type semiconductor.
    (D) None of these.

c. In a p-n junction, the total current is

    (A) only drift current.
    (B) only diffusion current.
    (C) sum of drift and diffusion currents.
    (D) difference between drift and diffusion currents.

d. Diode breakdown can be due to

    (A) Zener effect.   **(B)** Tunneling effect.
    (C) Avalanche effect.   **(D)** Any of these.

e. Schottky barrier is a

    (A) metal semiconductor junction.
    (B) p-n semiconductor junction.
    (C) semiconductor insulator junction.
    (D) metal insulator junction.

f. Breakdown in a P-N junction

(A) is always reversible.
(B) occurs for forward bias only.
(C) occurs for reverse bias only.
(D) occurs for forward as well as reverse biases.

g. Power-frequency limitation in BJT is due to

(A) collector current.   (B) emitter and collector areas.
(C) emitter current.   (D) emitter and collector doping.

h. FET is a

(A) current operated device.   (B) power operated device.
(C) voltage operated device.   (D) clock driven device.

i. FET operation is controlled by

(A) Gate.   (B) Source.
(C) Drain.   (D) Channel.

j. Gunn diodes are usually made of

(A) p-type silicon.   (B) n-type GaAs.
(C) n-type Germanium.   (D) n-type CdTe.

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

Q.2   a. Draw the energy band diagrams of a direct band gap semiconductor and an indirect band gap semiconductor. Give one example for each and one application of each type.   **(8)**

b.   A Si sample is doped with 10^{17} Arsenic atoms / cm^3. What is the equilibrium hole concentration at 300K? Where is E_F relative to E_i? Draw the resulting band diagram. **(8)**

Q.3   a. Describe Hall effect and define Hall voltage. How do you measure carrier concentration using Hall effect?   **(8)**

b. A sample of Si is doped with 10^{17} phosphorous atoms per cm^3. What is its resistivity, if the sample is $100\mu m$ thick, $I_x = 1mA$, $B_z = 10^{-5}\ wb/cm^2$, $\mu_n = 700\ cm^2/V-s$? **(8)**

Q.4   a.   Draw the energy band diagram showing the Fermi levels of p type and n-type materials of a forward biased p-n junction and explain the process of current conduction through the junction. **(8)**

     b.   Describe Zener Effect. How does it differ from avalanche break down? **(8)**

Q.5   a.   Define
       (i)   Schottky junction   (ii)   Rectifying junction
       (iii) Ohmic junction   (iv) Varactor junction   **(8)**

     b.   Draw and explain the I-V characteristics and transfer curves of a JFET.   **(8)**

Q.6   a.   Explain the following w.r.t. MOS devices:
       (i)   Short channel effects   (ii)   Subthreshold effects
       (iii) Latch up   (iv)   Leakage current.   **(12)**

     b.   Derive the relationship between α and β of a BJT.   **(4)**

Q.7   a.   Discuss the switching characteristics of a BJT and define Rise time and Fall time. **(8+2=10)**

     b.   Explain 'punch through' effect in a BJT.   **(6)**

Q.8   a.   Explain how negative resistance occurs in a IMPATT diode.   **(8)**

     b.   Compare the generation and recombination of charge carriers in LED and LASERS. **(4)**

     c.   How is a microwave transistor different from with BJT?   **(4)**

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

       (i)   Monolithic IC processes.
       (ii)   Solar cell.
       (iii) CCD.   **(8 × 2 = 16)**