Code: AE25   **Subject: PHYSICAL ELECTRONICS AND**
Time: 3 Hours   **SOLID STATE DEVICES**

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. SIP, DIP, ZIP, PGA are the techniques of

       (A) IC packaging.
       (B) Logical expressions reduction.
       (C) Arrangement of logic gates on an IC chip.
       (D) IC fabrication.

    b. 'Latch up' effect is due to the presence of _____ device on the CMOS IC

       (A) FET.   **(B)** Thyristor.
       (C) BJT.   **(D)** PN diode.

    c. Varactor diode makes use of voltage variable capacitance of a

       (A) FB PN junction.
       (B) Unbiased PN junction.
       (C) RB PN junction.
       (D) Intrinsic semiconductor.

    d. Lasing action requires

       (A) Stimulated emission.   **(B)** Population inversion.
       (C) Both **(A)** & **(B)**.   **(D)** Only **(A)**.

    e. Fermi level indicates

       (A) Probability of finding electrons.
       (B) Probability of finding holes.
       (C) Energy level of conduction band.
       (D) Energy level of valence band.

f. Heterogeneous junctions are junctions between materials having different

    (A) Electron densities.
    (B) Energy band gaps.
    (C) Hole densities.
    (D) Fermi levels.

g. The Collector-Emitter voltage of a CE transistor is high in

    (A) Saturation state.   **(B)** Active state.
    (C) Cut-off state.   **(D)** Unbiased state.

h. 'Early effect' refers to

    (A) Collector narrowing.   **(B)** Emitter narrowing.
    (C) Gate narrowing.   **(D)** Base narrowing.

i. Which of these devices exhibit negative resistance in their V-I characteristics?

    (A) IMPATT Diode   **(B)** Tunnel diode
    (C) Gunn diode   **(D)** All of these

j. Which of these devices is used in TV cameras?

    (A) JFETs   **(B)** CCDs
    (C) MOSFETs   **(D)** BJTs

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

Q.2 a. List the advantages of Integration.   **(8)**

      b. Compare the Thin film and Thick film process of semiconductor device fabrication.   **(8)**

Q.3   Describe with neat diagrams the V-I characteristics of Tunnel diode and Gunn diode, give reasons for negative resistance in each of these devices.   **(16)**

Q.4 a. Describe with a neat diagram the equivalent circuit of a MOSFET.   **(10)**

      b. An n^+ poly silicon $SiO_2 - Si$ p-channel device has $N_d = 10^{16} \, cm^{-3}$ and $Q_i = 5 \times 10^{10} \, qC/cm^2$, $n_i = 1.5 \times 10^{10} \, cm^{-3}$, ε_r of $SiO_2 = 3.9$, thickness of $SiO_2 = 100A^\circ$, $\Phi_{ms} = -0.25V$, Calculate V_T for a gate oxide thickness of 0.01 μm and repeat for a field oxide thickness of 0.5 μm.   **(6)**

Q.5   a.   Draw the schematic band diagrams for

          (i)   intrinsic   (ii) n-type

          (iii) p-type

            semiconductor materials, showing density of states, Fermi levels and carrier concentrations at thermal equilibrium. **(9)**

       b.   A Si sample is doped with 10^{17} As atoms/cm^3. What is the equilibrium hole concentration P_0 at 300K? Where is E_F relative to E_i? Show the resulting band diagram. **(7)**

Q.6   a.   Describe Hall effect, with a neat diagram. Develop an expression for Hall Voltage. **(10)**

       b.   A Si sample is doped with 10^{17} Phosphorous atoms / cm^3, What is its resistivity? Find the hall voltage for a sample of thickness $100\,\mu m$, if $I_x = 1mA$ and $B_z = 10^{-5}\ Wb/cm^2$, $\mu_n = 700\,cm^2/V-s$. **(6)**

Q.7   a.   Explain Metal–Semiconductor junctions. How does it differ from Semiconductor-Semiconductor junctions? **(8)**

        b.   Describe the switching action of a Diode for a square wave input voltage. Draw the diode current waveform. **(8)**

Q.8   a.   Define the following parameters of a BJT : Emitter injection efficiency, collector efficiency, base transport factor, current gain. **(8)**

       b.   Explain various high frequency limitations of BJT. **(8)**

Q.9   Write short notes on:-

                 (i)   Heterojunctions.

                 (ii)   Thermal effects in BJTs.

                 (iii)   Short channel effects in MOSFETs.

                 (iv)   LASERS. **(16)**