Code: A-25 Subject: PHYSICAL ELECTRONICS AND SOLID STATE DEVICES
Time: 3 Hours June 2006 Max. Marks: 100

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks.**
- **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 State which of the statements are true and which are false. (2x10)

a. The most popular form of IC package is flatpack.

b. Input impedence of MOSFET is less than that of JFET.

c. GaAs cannot be used to construct Gunn diodes.

d. In a degenerate semiconductor (n type), electron concentration in conduction band exceeds the effective density of energy states.

e. An LED is a coherent light source.

f. A well-made Si cell can have about 10% efficiency for solar energy conversion.

g. The drift current is relatively insensitive to the height of the potential barrier.

h. The contact potential can be measured by placing a voltmeter across a diode.

i. Direct semiconductors limit photons during transitions.

j. Most silicon ingots are grown along the <100> direction.

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

Q.2 a. Discuss the concept of space charge neutrality in semiconductors. **(6)**

b. Differentiate between lattice scattering and impurity scattering. Explain the temperature dependence of mobility with both types of scattering mechanisms. **(10)**

Q.3 a. Derive an equation for the capacitance across a p-n junction. Explain how it can be used in tuned circuits. **(10)**

b. In a semiconductor, the Fermi-level is 0.33 eV above the intrinsic Fermi-level at a temperature of 300 K. If the intrinsic carrier concentration is $1.5\times10^{16}\,m^{-3}$, what are the electron and hole concentrations? **(6)**

Q.4 a. Show that for a n-type semiconductor under thermal equilibrium at $0^{\circ}K$, $E_F = \left(\frac{E_C + E_V}{2}\right)$, where the subscripts C, V and F stand for conduction, valence and Fermi levels. **(8)**

b. Explain carrier multiplication in Avalanche breakdown of a junction, and discuss how it affects the breakdown voltage. **(8)**

Q.5 a. Discuss Schottky effect arising in metal-semiconductor junctions using band diagrams. **(8)**

b. A Si solar cell has a short-circuit current of 100 mA and an open-circuit voltage of 0.8 V under full solar illumination. The fill factor is 0.7. What is the maximum power delivered to a load by this cell? **(8)**

Q.6 a. Draw the MOSFET equivalent capacitive model. Show graphically variation of various parasitic capacitances with applied gate voltage. **(8)**

b. Derive the current equation for a p-channel MOS transistor operating in the linear region. **(8)**

Q.7 a. What are LCDs? Give the principle of working, construction, merits, demerits and applications of LCDs. **(8)**

b. Explain why it is possible to obtain amplification by using a device which exhibits negative resistance. **(8)**

Q.8 a. Explain why heterojunction lasers are efficient at room temperature. **(8)**

b. Assuming equal electron and hole concentrations and band-to-band transitions, calculate the minimum carrier concentration n = p for population inversion in GaAs at 300 K. The intrinsic carrier concentration in GaAs is about $10^{6}\,cm^{-3}$. Assume bandgap for GaAs as 1.43 eV. **(8)**

Q.9 a. Explain the advantages and disadvantages of epitaxial growth. Describe vapour phase epitaxy. **(8)**

b. Explain photolithographic process used in monolithic IC production. **(8)**