E &ECE
EC 21007
Semiconductor Devices

Total marks : 50
Time duration : 2 hrs

1. Multiple type questions: 2x5

   i. In which direction maximum atomic density of Silicon crystal is found ?

      a) <111> b) <100> c) <110> d) none of these

   ii. Defect less pseudomorphic layer can be grown

      a) Upto critical thickness
      b) Beyond critical thickness
      c) None of these

   iii. Temperature versus mobility graph of pHEMT contains

      a) Impurity scattering
      b) Lattice scattering
      c) Both a & b

   iv. Solution of time independent equation can be expressed by

      a) $\Psi = A sin Kx$ b) $\Psi = A cos Kx$ c) $\Psi = (\frac{A}{2}) sin Kx$ d) none of these

   v. The layer is called pseudomorphic because

      a) Lattice mismatched to the substrate without strain
      b) Lattice mismatched to the substrate without stress
      c) Lattice matched to the substrate without strain

2. a) A sample of Si is doped with 5×10^{17} phosphorus atoms/ cm^3. What would you expect to measure for its resistivity? What Hall voltage would you expect in a sample 120 μm thick if $I_x = 1$ mA and $B_z = 10^{-5}$ Wb/cm^2. Value of electron mobility of Si is 700 $cm^2/V\text{-}s$.

   b) To calculate the intrinsic carrier concentration in GaAs at T=300K and at T=450K.
   The values of N_c and N_v at 300 for GaAs are 4.7×10^{17} cm^{-3} and 7.0×10^{18} cm^{-3} respectively. Both N_c and N_v vary at $T^{3/2}$. Assume the band gap of GaAs is 1.42 eV and does not vary with the temperature over the range. 5+5

3. a) How hole is captured in indirect trapping?

   b) A 0.20 μm thick sample of GaAs is illuminated with monochromatic light of hν=2 eV. The absorption coefficient α is 7×10^5 cm^{-1}. The power incident on the sample is 12 mW.

      i) Find the total energy absorbed by the sample per second (J/s)

ii) Find the rate of excess thermal energy given up by the electrons to the lattice before recombination (J/s)

iii) Find the number of photons per second given off from recombination events, assuming perfect quantum efficiency. 3+7

4. a) What is tunneling?

   b) Consider an electron in an infinite potential well of width 5 Å. Calculate three energy levels of an electron in that infinite potential well.

   c) Determine the position of Fermi level with respect to the valence band energy in p-type GaAs at T=300K. the doping concentrations are $N_a = 5x10^{16}$ cm^{-3} and $N_d = 4x10^{15}$ cm^{-3}. 2+4+4

5. a) Define polycrystalline solid and amphoteric impurity. Give examples.

   b) An abrupt Si p-n junction has N_a=10^{17} cm^{-3} on the p-side and N_d=10^{16} cm^{-3} on the n-side. Calculate the Fermi level, draw an equilibrium band diagram and contact potential from the diagram. 3+7