Answer all questions

Time One Hour

Maximum Marks 20

1. State the following statements as True or False with justification (in the absence of justification no marks will be given).

   (a) Capacitance of a p-n junction increases with the increae of forward bias.

   (b) In a metal-semiconductor (n-type) junction with $\Phi_M < \chi_s$, cooling effect takes place when current flows from metal to semiconductor.

   (c) For some metals Seebeck Coefficient is positive and for some metal Seebeck Coefficient is negative.

   (d) For phonons the group velocity is maximum at $k = \pi/a$.

   (e) Light absorption by an indirect band gap semiconductor involves photon and phonon.

   [1 x 5]

2. (a) A metal plate is heated at one end. The temperature of hot and cold end of the metal plate is 100°C and 10°C. What is the voltage developed across the metal plate (Seeback coefficient, $S = 1.7T$ μV, here T is temperature in the unit K).   [2]

   (b) Dispersion relation for phonon is given as $\omega = vk$, where v is sound velocity. Obtain volume (in k space) of one state and density of states [$D(\omega)$] for phonons.   [3]

3. Draw the following (Drawing should be properly labelled)

   (a) Energy level diagram of metal-n-semiconductor with ($\Phi_M < \chi_s$).

   (b) I-V characteristics of a p-n junction of a semiconductor (band gap ~ 3eV) in dark and under illumination. (source wave length $\lambda = 700$nm)

   (c) I-V characteristics (in the reverse bias region) of a Zener Diode and a tunnel diode).

   (d) Energy level diagram of tunnel diode when it is biased at the negative resistance region.

   (e) Eergy level diagram of Zener Diode when it is forward bias.   [1 x 5]

4. n-and p-type of Silicon (bandgap ~1.1eV) are fabricated by doping Arsenic ($N_D = 10^{16}$/cm^3) and Boron ($N_A = 10^{17}$/cm^3). A p-n junction is fabricated from these n-and p-type semiconductor. Obtain

   (a) Postions of Fermi levels for n-and p-semoconductor with reference to Fermi levels of intrinsic semiconductor before the junction is fabricated.

   (b) After the p-n junction is fabricated, draw the energy level diagram and obtain the built in voltage at the interface.

   (c) Difference between E_{Fn} and E_{Fp} when 0.2V forward bias is applied at p-n junction.
   [$n_i = 10^{10}$cm^{-3}, T= 300K, $k_B = 8.6 \times 10^{-5}$eV K^{-1}]   [2+2+1]