

# B.E. (EE) 3<sup>rd</sup> Semester Final Examination, 2011

## ELECTRICAL ENGINEERING MATERIALS (PH - 302)

Full Marks: 35

Time: 2 hrs.

*All the questions are mandatory:*

1. a) Calculate the value of energy and angular momentum of an electron in an H-atom in the 3p state.  
b) Deduce the expression of Madelung constant for the lattice of ionic crystal.  
c) Assuming an overlap interaction between nearest neighbors of the type  $\phi(r) = B \exp(-r/\rho)$ , where  $B$  and  $\rho$  are constants, calculate the equilibrium spacing in terms of  $B$  and  $\rho$ .  
[3+3+3]
2. a) What is population inversion? Explain.  
b) How higher probability of stimulated emission compared to that of spontaneous emission is achieved in a laser?  
c) A relative population of two energy state at room temperature  $T=300K$  is  $1/e$ . Determine the wavelength of radiation emitted due to transition between the states.  
[2+3+3]
3. a) Give sketches of the energy-momentum dispersion relation for a non-relativistic and a relativistic free particle moving in one dimension.  
b) Explain the concept of hole in energy band structure to study the electrical conductivity property of solids.  
c) Show that the electrical conductivity is maximum if the energy band is nearly half-filled.  
[2+3+3]
4. a) Write down the Fermi-Dirac distribution function for free electrons. Give a plot of the distribution function. What is Fermi level?  
b) Obtain the density of holes in valence band at a temperature  $T$  and interpret this result.  
c) Use these distribution functions to find the electron density in conduction band and hole density in valence band in an intrinsic semiconductor with band gap  $E_g$ . How Fermi level energy is related to band gap energy?  
[2+2+5]

*Overall performance: 1*