National Institute of Technology Delhi

Mid Semester Examinations September 2017

Roll No:

Name of Specialization –B.Tech.(ECE)

Year- 2nd Semester - 3rd

Course Name-Electromagnetic theory

Maximum Marks – 25

Course Code:ECL-203

Total Time: 2:00 Hours

Instructions: All questions are compulsory. Assume if any data is missing. Symbols used in the questions are having their usual meaning.

Q-1: [a]: Define divergence theorem and stokes theorem. **(2)**

[b]: The common boundary surface of two dielectric regions is on the x-y plane. The relative permittivity of region 1 ($z < 0$) and that of region 2 ($z > 0$) are 1.1 and 6 respectively. The field intensity at the boundary in region 1 is $E_1 = 0.5u_x - 1.2u_y + 1.5u_z$ V/m. Calculate the magnitude of field intensities on two sides of the boundary and the angles which they make with normal to the interface. **(3)**

Q-2: [a]: Derive the expression for work and energy in electrostatics. **(3)**

[b]: Three charges are situated at the corner of square. How much work does it take to bring in another charge 'q' from far away and place it in the fourth corner? **(2)**

Q-3: [a]:A hollow spherical shell carries charge density $\rho = \frac{k}{r^2}$ in the region $a \leq r \leq b$. Find the electric field in the regions: **(i)**$r < a$, **(ii)**$a < r < b$, **(iii)**$r > b$. Plot $|E|$ as a function of 'r'. **(3)**

[b]:A dielectric cube of side 'L' and center at the origin has a radial polarization given by $P = ar$, where 'a' is a constant and $r = xa_x + ya_y + za_z$. Find all bound charge densities and show explicitly that the total bound charge vanishes. **(2)**

Q-4: [a]: Derive the expression for the boundary conditions at an interface separating **(i)** Dielectric (ε_{r1}) and dielectric (ε_{r2}), **(ii)** Conductor and dielectric, **(iii)** Conductor and free space. **(4)**

[b]: In a cylindrical conductor of radius 4mm, the current density is $J = 5e^{-10\rho}a_z$ A/m^2. Find the current through the conductor. **(1)**

Q-5:A metal bar of conductivity 'σ' is bent to form a flat 90°sector of inner radius 'a', outer radius 'b' and thickness 't'. Show that **(a)** the resistance of the bar between the vertical curved surface at '$\rho = a$' and '$\rho = b$' is

$$R = \frac{2ln\frac{b}{a}}{\sigma\pi t}$$

(b) the resistance between the two horizontal surface at $z = 0$ and $z = t$ is $R = \frac{4t}{\sigma\pi(b^2-a^2)}$ (5)