R09

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD
B.Tech II Year I Semester Examinations, May/June-2013
Electromagnetic Fields
(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any five questions
All questions carry equal marks
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1.a) State and prove Gauss's law.
b) Using the Gauss's law in differential form, obtain the 'E' and 'D' at different points due to the following charge distribution in spherical coordinates.

$\rho(r, \theta, \varphi) = \rho_0 (r/a)$ $0 < r < a$
$= 0$ $a < r < \infty$ [15]

2.a) Find the electric field intensity 'E' at a point due to an electric dipole.
b) Find the general equation of flux lines which represent the field $\mathbf{E= (P/4\pi\varepsilon_0 r^3) (2\cos\theta\ 1_r + \sin\theta\ 1_\theta)}$ in the spherical coordinate system, when **'P'** is a dipole moment. [15]

3.a) Define flux density 'D' and explain how electric charge and electric flux is calculated from 'D'.
b) Calculate the 'D' at a point A (6, 4, -5) caused by (i) a point charge of 20mC at the origin. (ii) a uniform line charge density ρ_l = 20μC/m on the z-axis. (iii) A uniform charge density $\rho_s = 60\mu C/m^2$ at a plane x = 4. [15]

4.a) A Potential field in free space is given by $\mathbf{V=60Sin\theta/r^2}$. Find the electric flux density 'D' and volume charge density at the point $\mathbf{(r=3m,\ \theta=60^0,\ \varphi=25^0)}$ in spherical coordinates.
b) Calculate the capacitance between two concentric metal spheres of radius '$\mathbf{r_1}$' and '$\mathbf{r_2}$' with charge 'Q' placed on the outer surface of inner shell. [15]

5.a) A boundary exists at z=0 between two dielectrics $\mathbf{\varepsilon r_1=2.5}$ region z<0 and the $\mathbf{\varepsilon r_2=4}$ region z>0. The Electric filed intensity in region Z<0 is $\mathbf{E= -30 1_x+50 1_y+70 1_z\ V/m}$. Find (i) En_1 (ii) Et_1 (iii) Dn_2 (iv) Dt_2 (v) D_2 (vi) The angle 'α_1'between E_1 and normal to the Surface (vii) Polarization in Z>0 region (viii) The angle 'α_2' between D_2 and normal to the surface.
b) A dielectric slab of thickness'd' with a Non-uniform susceptibility given by $\mathbf{\lambda e\ (z) = z/(4-z)}$ occupies region **1<z<2**. A uniform field $\mathbf{E_a=E_0\ 1_z}$ is applied. Calculate the surface charge densities and volume charge density due to polarization. [15]

6.a) A circular loop of wire of radius 'a', lying in the "x-y" plane with its centre at the origin carries current 'I' in the + **φ** direction. Using Biot-Savart's law, find **H (0, 0, z)** and **H (0, 0, 0)**.
b) Find the current distribution which produces the field, using Ampere's circuital law in differential form in cylindrical coordinates for the given value of 'H'

$H = J_0 r^2\ 1\varphi$ $0<r<a$
$= J_0 (a^3/r)\ 1\varphi$ $a<r<b$
$= 0$ $b<r<\infty$ [15]

7.a) A variable loop consisting of two stationery parallel conductors connected at one end to a voltmeter, and a moving bar at the other end, moving with a uniform velocity **'v'** m/s. The loop is situated in a uniform flux density **'B'1_z** Tesla. Derive an expression for the EMF induced in the loop for L=10cm, B=0.21_z Tesla and V=20$\sqrt{y}$ 1_y m/s and if y=2cm at t=0, find for t=0.006s (i) The 'V' of the moving bar (ii) 'y' of the moving bar (iii) The EMF induced in the loop and its polarity.

b) Verify that the displacement current in the capacitor is same as that of the conduction current in wires. [15]

8.a) Derive the Boundary relations in magnetic fields.

b) A flux density **B=0.05x 1_y tesla** exists in a material having magnetic susceptibility λ_m **=2.5**. Find (i) Magnetic field intensity 'H' (ii) Magnetization 'M' (iii) Current Density 'J' (iv) Volume current density due to Magnetization. [15]

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