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National Institute of Technology Goa

Programme Name: B.Tech.

End Semester Examinations, December 2021

Course Name: **Electromagnetic Theory**

Course Code: **EE200 and EC204**

Date: 09/12/2021

Time: 9.30 AM - 12.30 PM

Duration:3 Hour

Max. Marks: 100

ANSWER ALL QUESTIONS

NOTE: Assume suitable values if data is insufficient

1. A perfectly conducting filament containing a small resistor 300 Ω is formed into a square as shown in Fig. 1 Find $I(t)$ if (a) $B = 0.3\cos(120\pi t - 30\deg)a_z + 0.4\sin(\pi(ct-y))a_z\ \mu$ T. Consider $c = 3\times10^8$ m/s. [8M]

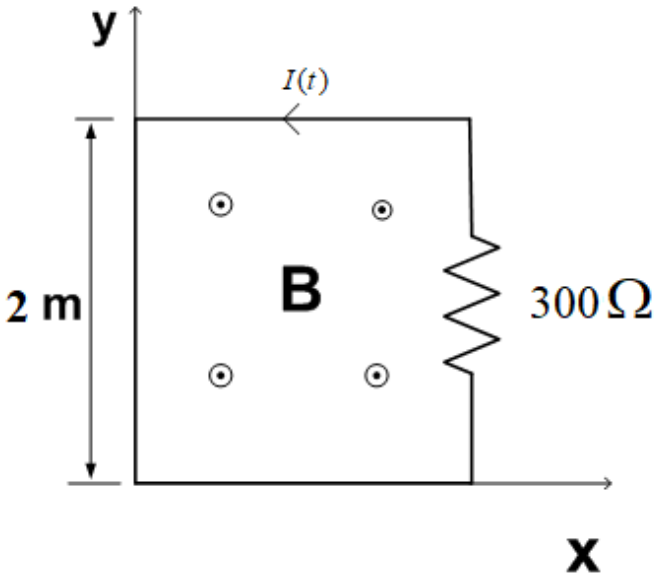

Figure 1:

2. What are Maxwells equations? Derive from Amperes and Faradays Laws? If the Electric field is $\bar{E} = (4x-2y)\hat{a}_x - (2x+4y)\hat{a}_y$. Find magnetic field ($\bar{B}$) at point $(1,-3,4)$. [10M]

3. A cube is defined by $x<1$, $y<1$, $z<2$. If $\bar{D} = 2x^2y\hat{a}_x + 3x^2y^2\hat{a}_y$. (a) Apply the Guass's law to find total flux leaving the closed surface. (b) Apply the Divergence theorem to find the total flux and verify the part (a). [10M]

4. A metalic sphere of radius $a = 0.1$ m has surface charge of 2nC/m^2 and its center is located at (0, 0, -3). A sheet of charge having density -2nC/m^2 is located at $x = 4$. Find the electric field at point $P(1,1,-1)$. [10M]

5. Consdier a parallel plate capacitor of Area A =1 cm^2 and seperated by distance of $d = 0.1$ cm. If the space between the plates is filled by a medium of $\epsilon_r = 3$. Calculate capacitance from Poisson's equation. [8M]

6. Derive the expression for electric field from the potential function. [8M]

7. What is Biot-Savart Law. Derive Magnetic field intensity from a loop of circuilar element carrying current I. Consider the radius of the loop is a [8M]

8. the surfaces $r = 1$ and $r = 2.5$, $\theta = 30^0$ and $\theta = 90^0$, $\phi = 10^0$ and $\phi = 60^0$, identify a closed surface. (b) Find the total area of the closed surface; (c) Find the total lenth of the twelve edges of the surface; (d) Find the length of the longest straight line that lies entirely within the surface [8M]

9. What are the magnetif field boundary conditions?. Two perfect dielectrics have a relative permittivities $\epsilon_{r1} = 2$ and $\epsilon_{r2} = 8$. The planar interface between them is the surface $x - y + 2z = 5$. The origin lies in region 1. If $E_1 = 100a_x + 200a_y - 50a_z$ V/m. Find E_2. [12M]

10. Consider a 100 cm coaxial cable having inner radius of ($\rho = a$) 1 mm and outer radius of ($\rho = b$) 4 mm and ($\rho = c$) 5 mm. See Fig. 2. The space between the conductors is assumed to be filled with air. The current flowing is 1 A. Calculate magnetic field ($\bar{H}$) in the regions of $\rho < a$, $a < \rho < b$, $b < \rho < c$, and $c < \rho$. [18M]

    In the above problem, instead of current, if charge density on inner conductor is 10 μC/m^2.

    (a) Calculate total charge on inner coductor.
    (b) What is the induced charge on outer conudctor. Calculate charge density.
    (c) Find the flux density and electric field intesity in the regions $\rho < a$, $a < \rho < b$, $c > \rho > b$?
    (d) What is the capacitance of the coaxial cable.

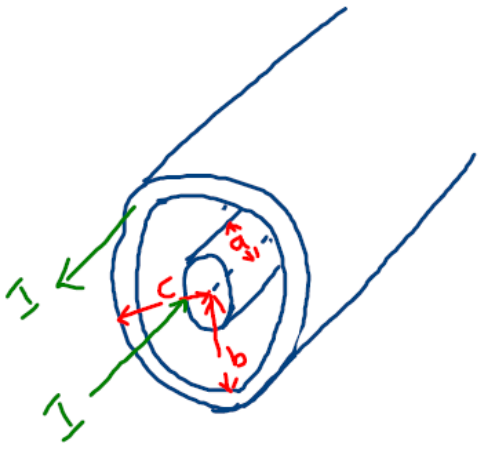

Figure 2:

$***$ALL THE BEST $***$