C/L/TX

Reg. No:

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BEVD202L - Electromagnetic Field Theory

Slot: D1+TD1

Class NBR(s): 4063

Max. Marks: 100

Time: Three Hours

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

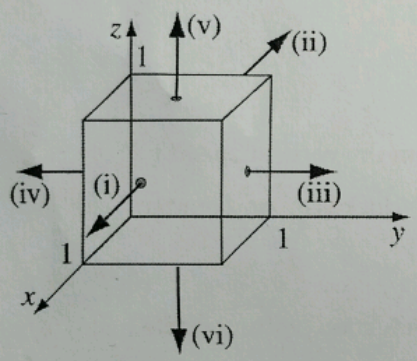
Answer ALL Questions

(10 X 10 = 100 Marks)

1. Check the divergence theorem using the function

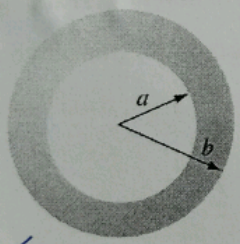
$$\mathbf{v} = y^2\,\hat{\mathbf{x}} + (2xy + z^2)\,\hat{\mathbf{y}} + (2yz)\,\hat{\mathbf{z}}$$

and a unit cube at the origin.



2. A thick spherical shell carries charge density

$$\rho = \frac{k}{r^2} \quad (a \le r \le b)$$

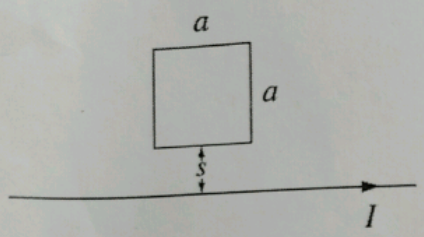


Find the electric field in the three regions: (i) $r < a$, (ii) $a < r < b$, (iii) $r > b$. Plot $|\mathbf{E}|$ as a function of r, for the case $b = 2a$.

3. A sphere of linear dielectric material has embedded in it a uniform free charge density ρ. Find the potential at the center of the sphere (relative to infinity), if its radius is R and the dielectric constant is ε_r. You may use Gauss's law in the presence of dielectric.

4. A current I flows down a long straight wire of radius a. If the wire is made of linear material (copper, say, or aluminum) with susceptibility χ_m, and the current is distributed uniformly, what is the magnetic field a distance s from the axis? Find all the bound currents. What is the net bound current flowing down the wire?

5. A square loop of wire (side a) lies on a table, a distance s from a very long straight wire, which carries a current I, as shown in Figure.

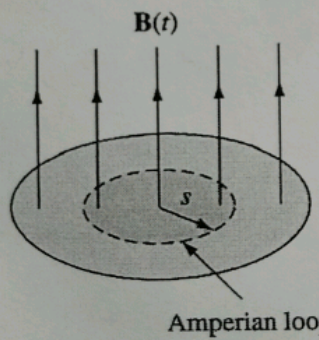


(a) Find the flux of **B** through the loop.

(b) If someone now pulls the loop directly away from the wire, at speed **v**, what emf is generated? In what direction (clockwise or counter clockwise) does the current flow?

6. (a) Describe Faraday's law of electromagnetic Induction with suitable diagrams. **[5]**

(b) A uniform magnetic field **B**(t), pointing straight up, fills the shaded circular region. If **B** is changing with time, what is the induced electric field? **[5]**



7. (a) What is Lenz's law? Illustrate with suitable diagrams. **[4]**

(b) Describe self-inductance and mutual inductance with appropriate diagrams and equations. **[6]**

8. (a) Write down the Maxwell's equations in vacuum. [4]

(b) From these equations, deduce the differential equations for electric field (**E**) and the magnetic field (**B**). [6]

9.(a) (i) What are transmission lines and their types? Briefly describe primary constants or transmission lines parameters with suitable diagrams. [5]

(ii) A transmission line with air as dielectric has the characteristic impedance of 60 Ω and phase constant of 4 rad/m at 500 MHz. Calculate the inductance per metre and the capacitance per metre of the line. [5]

OR

9.(b) (I) What is Smith chart and why we use it? Illustrate with suitable diagrams.

(II) In a lossless transmission line, the velocity of propagation is 2.5×10^8 m/s. Capacitance of the line is 30 pF/m, find: (i) inductance per metre of the line. (ii) phase constant at 100 MHz. (iii) characteristic impedance of the line.

10.(a) A distortionless line has $Z_0 = 60\ \Omega$, $\alpha = 20$ mNp/m, $v = 0.6c$ where c is the speed of light in a vacuum. Find R, L, G, C and λ at 100 MHz.

OR

10.(b) A transmission line of length 0.4λ has a characteristic impedance of 100 Ω and is terminated in a load impedance of (200 + j180) Ω. Find: (i) reflection coefficient, (ii) standing wave ratio, and (iii) input impedance of the line. Use Smith chart.

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