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بطوف الكامل د. ناجي

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Faculty	: Electronic Engineering		Time	:	3 Hours
Department	: Electronics and Electrical Comm.		No. of pages	:	2
Academic level	: 2^{nd} Year	جـامعة المنوفيـة	Full Mark	:	70 Marks
Course Name	: Static Field Theory		Exam	:	Final Exam.
Course Code	: ECE 214		Examiner	:	Dr: Ahmed I. Bahnacy

برجاء إجابة الجزء الاول من الناحية اليمنى والجزء الثاني من الناحية اليسرى في كراسة الإجابة

Part 2

Answer all the following questions :

Question No 1(10 Marks) :

1- a- Consider a filamentary current along Z-axis extending from $z=z_1$ to $z=z_2$ and carries a dc current I A. Using Biot-Savart law derive an expression for the steady magnetic field intensity **H** at a radial distance ρ from the filamentary line current in the plane z=0.
Determine **H** when I=0.5 A, z_1=-0.4m, z_2=0.4m and ρ=0.3m. (6 Marks)

1-b- A filament is formed into a circle of radius a, centered at the origin in the plane z = 0. It carries a current I in the $\mathbf{a}_\phi$ direction. Find **H** at the origin. (4 Marks)

Question No 2 (10 Marks):

2-a- A long coaxial cable has an inner conductor of radius a, carrying a uniformly distributed dc Current I A, and an outer conductor of inner radius b carrying current - I . Find the steady magnetic field intensity **H**, the magnetic flux density **B** between the conductors and the magnetic flux Φ contained between conductors in a length d of the cable . (5 Marks)

2-b- Assume that $\mathbf{A} = 50\rho^2 \mathbf{a}_z$ Wb/m in a certain region of free space.
i) Find **H** and **B** ii) Find **J** iii) Use **J** to find the total current crossing the surface
$0 \le \rho \le 1,\ 0 \le \varphi < 2\pi,\ z = 0$ (5 Marks)

Question No 3 (10 Marks):

3-a- Write Maxwell's equations in differential and integral forms for time varying fields. (4 Marks)
3-b- State the electric and magnetic boundary conditions at the interface between:
i- Two dielectric media. ii-Perfect conductor and free space. (4 Marks)

3-c- Find the displacement current inside a typical metallic conductor where f = 1kHz, $\sigma = 5\times10^7\,\Omega/m$, $\epsilon_R = 1$; and the conduction current density is
$\mathbf{J} = 10^7 \sin(6283t - 444z)\ \mathbf{a}_x A/m^2$. (2 Marks)

(See Data Sheet)

مع أطيب الأمنيات بالنجاح والتفوق

DATA SHEET:

Divergence of a vector flux Density **D**:

$$\nabla\cdot\mathbf{D}=\frac{1}{\rho}\frac{\partial}{\partial\rho}(\rho D_\rho)+\frac{1}{\rho}\frac{\partial D_\phi}{\partial\phi}+\frac{\partial D_z}{\partial z}$$ Cylindrical

$$\nabla\cdot\mathbf{D}=\frac{1}{r^2}\frac{\partial}{\partial r}(r^2D_r)+\frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\sin\theta\,D_\theta)+\frac{1}{r\sin\theta}\frac{\partial D_\phi}{\partial\phi}$$ Spherical

Gradient of a Scalar Potential V:

$$\nabla V=\frac{\partial V}{\partial\rho}\mathbf{a}_\rho+\frac{1}{\rho}\frac{\partial V}{\partial\varphi}\mathbf{a}_\varphi+\frac{\partial V}{\partial z}\mathbf{a}_z$$ Cylindrical

$$\nabla V=\frac{\partial V}{\partial r}\mathbf{a}_r+\frac{1}{r}\frac{\partial V}{\partial\theta}\mathbf{a}_\theta+\frac{1}{r sin\theta}\frac{\partial V}{\partial\varphi}\mathbf{a}_\varphi$$ Spherical

Laplacian of a scalar potential V

$$\nabla^2V=\frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial V}{\partial\rho}\right)+\frac{1}{\rho^2}\left(\frac{\partial^2V}{\partial\varphi^2}\right)+\frac{\partial^2V}{\partial z^2}$$ Cylindrical

$$\nabla^2V=\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right)+\frac{1}{r^2 sin\theta}\frac{\partial}{\partial\theta}(sin\theta\frac{\partial V}{\partial\theta})+\frac{1}{r^2 sin^2\theta}\frac{\partial^2V}{\partial\varphi^2}$$ Spherical

CURL of a vector **H**:

$$\nabla\text{x}H=\frac{1}{\rho}\begin{vmatrix}a_\rho & \rho a_\phi & a_z\\ \frac{\partial}{\partial\rho} & \frac{\partial}{\partial\phi} & \frac{\partial}{\partial z}\\ H\rho & \rho H\phi & Hz\end{vmatrix}$$ Cylindrical

$$\nabla\text{x}H=\frac{1}{r^2\,sin\Theta}\begin{vmatrix}a_r & ra_\Theta & rsin\Theta a_\phi\\ \frac{\partial}{\partial r} & \frac{\partial}{\partial\Theta} & \frac{\partial}{\partial\phi}\\ H_r & rH_\Theta & rsin\Theta H_\phi\end{vmatrix}$$ Spherical

Standard Integrals:

$$\int_{x_1}^{x_2}\frac{dx}{(a^2+x^2)^{3/2}}=\frac{1}{a^2}\frac{x}{\sqrt{a^2+x^2}}\Bigg|_{x_1}^{x_2}$$

$$\int_{x_1}^{x_2}\frac{dx}{a^2+x^2}=\frac{1}{a}tan^{-1}\frac{x}{a}\Bigg|_{x_1}^{x_2}$$

Constants:

$\varepsilon_o=\frac{1}{36\pi\times10^9}\cong 8.854\times10^{-12}$ F/m

$\mu_o=4\pi\times10^{-7}$ H/m