(بسم الله الرحمن الرحيم***لا اله الا الله محمد رسول الله)

جامعة المنوفية

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قسم الهندسة الكهربية

دوريونيو ٢٠١٨ م

النهاية العظمى:١٠٠درجة

Answer all the following questions

1)General:-

Q1(6D): a- Write the Maxwell's Equations of electromagnetic fields.

b-If **E** = 2 sin 314t V/m in the core of a capacitor has ϵ_r=5, find:

1- the electric flux in the core/m^2. 2- the displesmint current.

Q2(14D):a- What is meant by: 1- the self & mutual inductances.

2- The energy density, J/m^3 in electro-static and magneto-static fields.

b- Compare between the electric and the magnetic circuits.

c- Draw a cross section in 2-windings, core type transformer. Discus how can be calculate the magnetizing current to produce certain value of B_{core} in the transformer core.

2) Electro-static fields:-

Q3(20D): a) Drive the capacitance equation of cylindrical capacitor with two conducting cylinders.

b) If the radii of the two conducting cylinders are 1500 mm, 1700 mm respectively and the insulator material has ϵ_r =4, calculate:

1- the capacitance.

2- the charge of each cylinder if the potential difference between the conducting surfaces is 10000v.

3- the capacitor stored energy.

Q4(20D): Figure1 shows a cross section, el-vision view, of an electrostatic cell. The area of two parallel plates are equal and each has 400 cm^2, a =40 mm. If V_H=1000Kv, V_L=0.0v and ϵ_1 = 2ϵ_2 =5.8, using 2DFEM as a numerical method, Discus the steps and the main equations, to calculate:

1- the electric flux density in each element between the two plats.

2- the electric stored energy in each material.

3) Magneto-static fields:-

Q5(20D): Figure2 shows a cross section, el-vision view, of two magneto-static cells, a=10mm. Both have the same dimensions, square section of the core and air gap and used to produce 1.6 T, flux density in the air gap. Fig.2-(a) shows a soft iron core with dc exciting coil has 1000 turns, while Fig.2-(b) shows a permanent magnet cell. Calculate: 1- the exciting current for (a).

2- the permanent magnet length for (b), the (B_m-H_m) curve is shown in Fig.2c.

Q6(20D): If a composite sheet is put into the air gap of cell (a), as shown in Fig.2-(d). Using 2DFEM, Discus the steps and the main equations, to <u>calculate</u>:

1- the magnetic flux density in each element.

2- the total magnetic energy in the gap.

3- the self inductance of the cell in Fig.2-(a).

(الحمد لله رب العالمين)

Divergence, Curl, Gradient, and Laplacian

Cartesian Coordinates.

$$\nabla \cdot \mathbf{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$$

$$\nabla \times \mathbf{A} = \left(\frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z}\right)\mathbf{a}_x + \left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x}\right)\mathbf{a}_y + \left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y}\right)\mathbf{a}_z$$

$$\nabla V = \frac{\partial V}{\partial x}\mathbf{a}_x + \frac{\partial V}{\partial y}\mathbf{a}_y + \frac{\partial V}{\partial z}\mathbf{a}_z$$

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$$

Cylindrical Coordinates

$$\nabla \cdot \mathbf{A} = \frac{1}{r}\frac{\partial}{\partial r}(rA_r) + \frac{1}{r}\frac{\partial A_\phi}{\partial \phi} + \frac{\partial A_z}{\partial z}$$

$$\nabla \times \mathbf{A} = \left(\frac{1}{r}\frac{\partial A_z}{\partial \phi} - \frac{\partial A_\phi}{\partial z}\right)\mathbf{a}_r + \left(\frac{\partial A_r}{\partial z} - \frac{\partial A_z}{\partial r}\right)\mathbf{a}_\phi + \frac{1}{r}\left[\frac{\partial}{\partial r}(rA_\phi) - \frac{\partial A_r}{\partial \phi}\right]\mathbf{a}_z$$

$$\nabla V = \frac{\partial V}{\partial r}\mathbf{a}_r + \frac{1}{r}\frac{\partial V}{\partial \phi}\mathbf{a}_\phi + \frac{\partial V}{\partial z}\mathbf{a}_z$$

$$\nabla^2 V = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial V}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2}$$

Spherical Coordinates

$$\nabla \cdot \mathbf{A} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 A_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(A_\theta \sin\theta) + \frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial \phi}$$

$$\nabla \times \mathbf{A} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial \theta}(A_\phi \sin\theta) - \frac{\partial A_\theta}{\partial \phi}\right]\mathbf{a}_r + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial A_r}{\partial \phi} - \frac{\partial}{\partial r}(rA_\phi)\right]\mathbf{a}_\theta + \frac{1}{r}\left[\frac{\partial}{\partial r}(rA_\theta) - \frac{\partial A_r}{\partial \theta}\right]\mathbf{a}_\phi$$

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

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