بسم الله الرحمن الرحيم *** لا إله إلا الله محمد رسول الله)

جامعة المنوفية كلية الهندسة بشبين الكوم قسم الهندسة الكهربية الدراسات: العليا/ ماجستير

أمتحان: الفصل الدراسي الثاني٢٠١٩/٢٠٢٠م الاثنين ١٠/٨/٢٠٢٠م الزمن:١٨٠دقيقة

مادة: ~~تحليل التوافقيات لمحركات الجر الكهربي~~ ELE719 الدرجة: ١٠٠

ELE601

Answer all the following questions

Question1(10D): Write the Maxwell's Equations of electromagnetic fields. Then drive the general form of Laplace's Equations in terms of :

1- The electric voltage potential. 2- The magnetic scalar potential.

Question2 (10D): Drive the equation of stored magnetic energy for three identical coils wounded symmetrically on a magnetic circuit. Put the result in matrix form.

Question3(10D): A capacitor sphere has 100, 110 mm radii and insulator material between them has ε_r =3, calculate; 1- the capacitance, 2-the charge of each sphere if the potential deference between the spheres is 600 v, 3- the stored energy in all rejoins.

Question4 (30D): Figure 1 shows a cross section, el-vision view, of an electrostatic cell. The area of two parallel plates are equal and has square-shape. If V_H = 400 Kv, V_L =0 v and $\varepsilon_{r1} = 2\ \varepsilon_{r2} = 5$, using 2DFEM as a numerical method, calculate:

1- the electric flux density in each finite element.

2- the electric stored energy in each element.

3- the cell capacitance.

Question5 (20D): Figure 2 shows a cross section, el-vision view, of an magneto static cells, Both have the same dimensions and air gap and used to produce 0.75 T, flux density in the air gap. Fig 2-(a) shows a soft iron core (μ_r =10000) with dc exciting coil has 10000 turns, while Fig 2-(b) shows a permanent magnet cell. Fig 2-(c) shows the B-H curve of the permanent magnet, Calculate: 1- the excitation current for (a).

2- the length and volume of the permanent magnet for (b).

Question6 (20D): If a composite sheet is put into the air gap of any cell, as shown in Fig.2-(d), 2: air , 3: μ_r =2, 4: μ_r =1000, using 2DFEM to calculate the magnetic flux density in each elements.

Good Luke

الحمد لله رب العالمين

DIVERGENCE

CARTESIAN $\nabla \cdot \mathbf{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$

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

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

GRADIENT

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

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

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

CURL

CARTESIAN $\nabla \times \mathbf{H} = \left(\frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z}\right)\mathbf{a}_x + \left(\frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x}\right)\mathbf{a}_y + \left(\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y}\right)$

CYLINDRICAL $\nabla \times \mathbf{H} = \left(\frac{1}{\rho}\frac{\partial H_z}{\partial \phi} - \frac{\partial H_\phi}{\partial z}\right)\mathbf{a}_\rho + \left(\frac{\partial H_\rho}{\partial z} - \frac{\partial H_z}{\partial \rho}\right)\mathbf{a}_\phi$

$$+ \frac{1}{\rho}\left[\frac{\partial(\rho H_\phi)}{\partial \rho} - \frac{\partial H_\rho}{\partial \phi}\right]\mathbf{a}_z$$

SPHERICAL $\nabla \times \mathbf{H} = \frac{1}{r\sin\theta}\left[\frac{\partial(H_\phi \sin\theta)}{\partial\theta} - \frac{\partial H_\theta}{\partial\phi}\right]\mathbf{a}_r + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial H_r}{\partial\phi} - \frac{\partial(rH_\phi)}{\partial r}\right]$

$$+ \frac{1}{r}\left[\frac{\partial(rH_\theta)}{\partial r} - \frac{\partial H_r}{\partial\theta}\right]\mathbf{a}_\phi$$

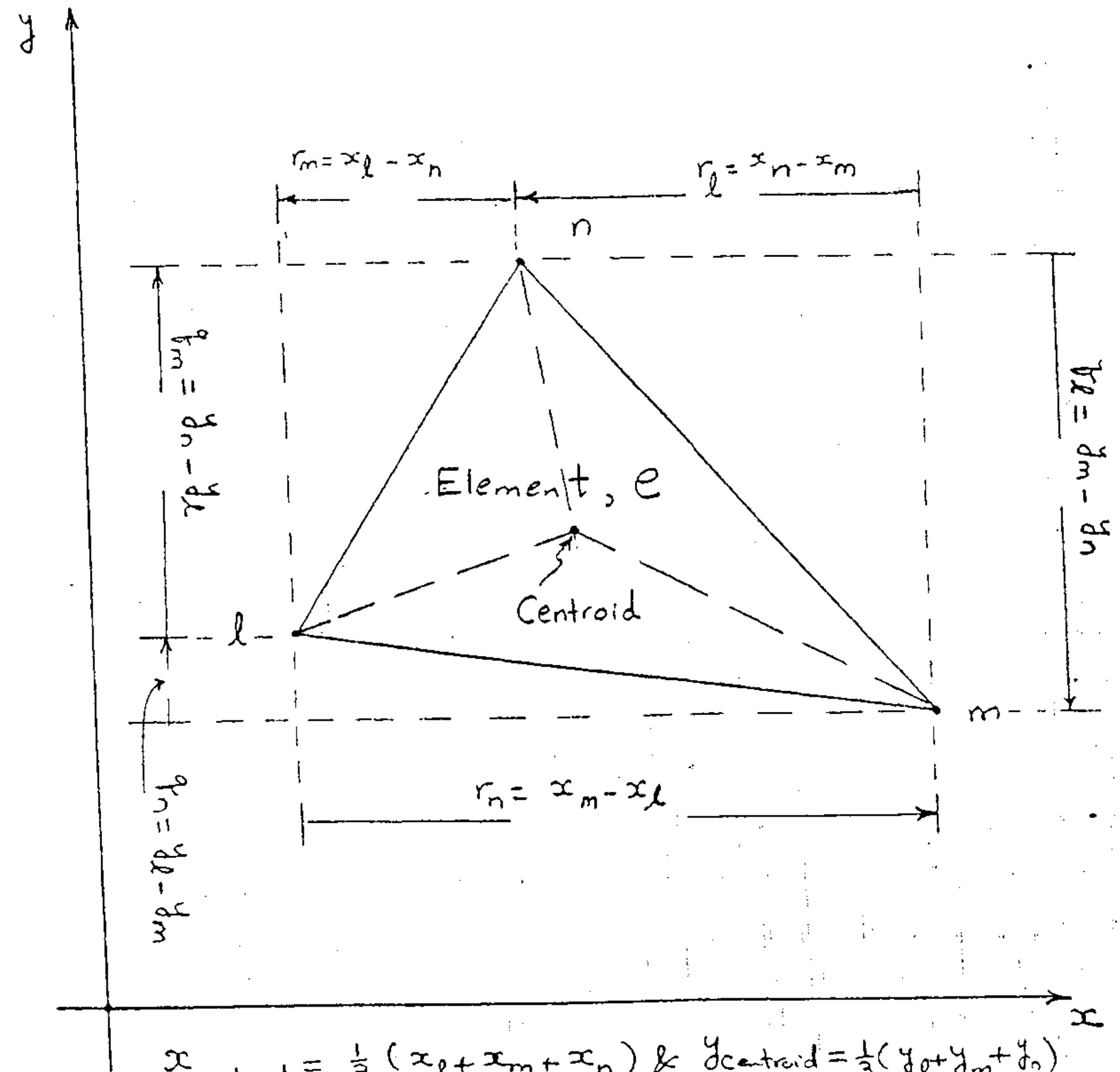
LAPLACIAN

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

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

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

Linear Triangle Element
For Finite Element Method



$x_{centroid} = \frac{1}{3}(x_l + x_m + x_n)$ & $y_{centroid} = \frac{1}{3}(y_l + y_m + y_n)$

Figure (5-3) Element Coefficients

Area of Element $\Delta = \frac{1}{2}(P_l + P_m + P_n)$

where:

$P_l = x_m y_n - x_n y_m$

$P_m = x_n y_l - x_l y_n$

$P_n = x_l y_m - x_m y_l$

Notice At All Times

$r_l + r_m + r_n \equiv 0$

$q_l + q_m + q_n \equiv 0$

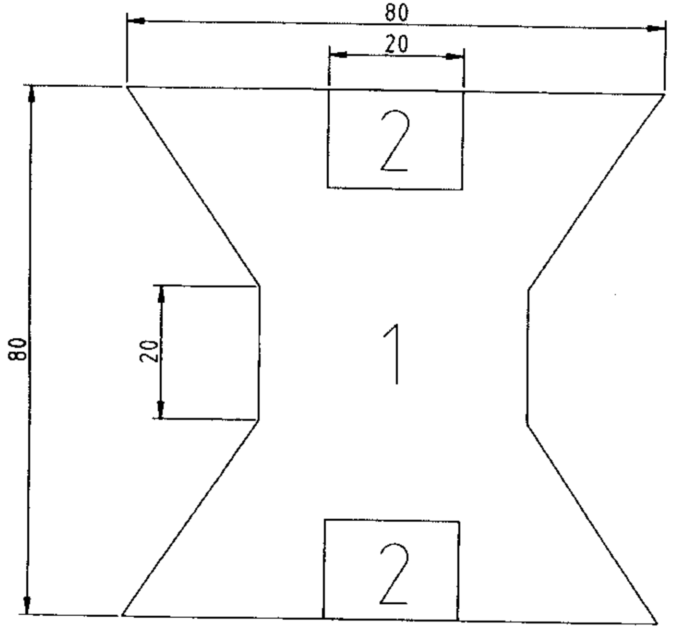

80
20
80
20
2
1
2

Fig. 1

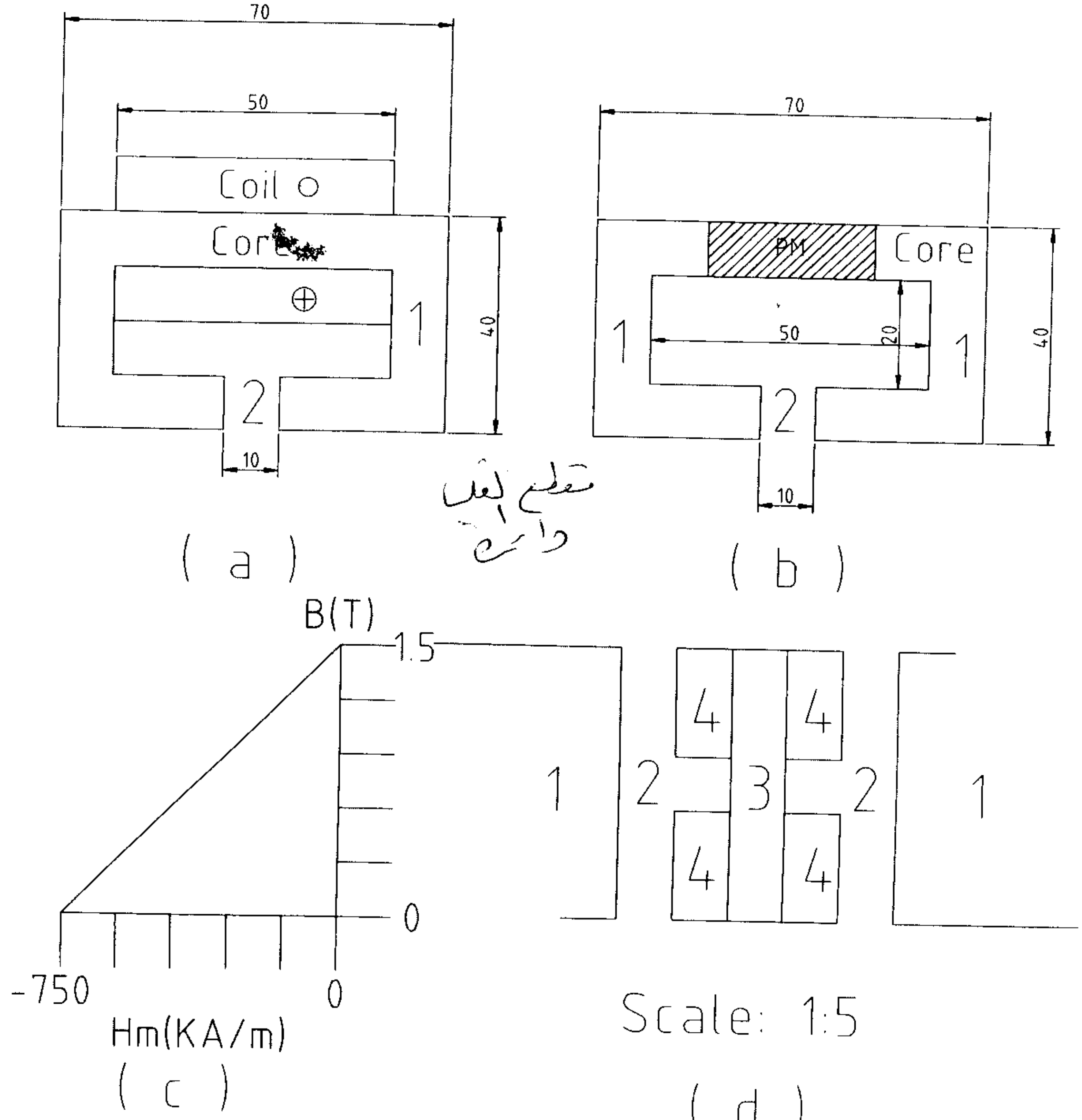

70
50
Coil ○
Core
⊕
1
2
40
10
(a)
70
PM
Core
1
50
20
1
2
40
10
(b)
B(T)
1.5
0
-750
0
Hm(KA/m)
(c)
1
2
4
4
3
4
4
2
1
Scale: 1:5
(d)

Fig. 2