UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 1996/97

April 1997

EEE 234 - Teori Elektromagnet

Masa : [3 jam]

ARAHAN KEPADA CALON :

Sila pastikan bahawa kertas peperiksaan ini mengandungi **TUJUH** (7) muka surat berserta **DUA** (2) Lampiran bercetak dan **ENAM** (6) soalan sebelum anda memulakan peperiksaan ini.

Jawab **LIMA** (5) soalan.

Agihan markah bagi soalan diberikan di sut sebelah kanan soalan berkenaan.

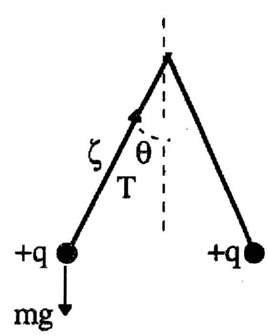
Jawab semua soalan di dalam Bahasa Malaysia.

Nota: $\varepsilon_o = 8.855 \times 10^{-12}$ F/m $\mu_o = 4\pi \times 10^{-7}$ H/m

1. (a) Rajah 1 menunjukkan dua cas serupa (q) berjisim m gram, masing-masing digantung dengan benang panjangnya ζ meter. Oleh kerana ujud daya menolak antara cas tersebut, maka benang tersebut membuat sudut θ dengan garis tegaklurus. Dapatkan kaitan θ dalam sebutan m, q dan ζ.

Two identical charges(q) of masses m gram are suspended by two strings of length ζ meter as shown in Figure 1. Due to repelling force exerted by the two charges, the string make an angle θ with the perpendicular line. Obtain a formula to relate θ, m ,q and ζ.

(40%)



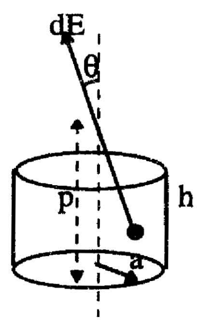
Rajah 1 *(Figure 1)*

(b) Dapatkan medan E dalam arah paksi z yang dihasilkan oleh cas silinder pada jarak p daripada tapak silinder seperti ditunjukkan dalam Rajah 2. Jejari silinder ialah a dan tinggi silinder ialah h .Anggap taburan cas adalah seragam iaitu ρ per unit isipadu.

...3/-

Obtain the electric field E along z axis that is produced by a cylinder charges at distance p from the base of the cylinder as shown in Figure 2. Radius of the cylinder is a and the heigth is h. Assume that the charge distribution is uniform, i.e ρ per unit volume.

(60%)



Rajah 2 *(Figure 2)*

2. (a) Tentukan galangan kecirian Z_o bagi kabel sepaksi menggunakan kaitan $Z_0 = \sqrt{L/C}$. L ialah induktans/m dan C ialah kapasitans/m yang perlu diterbitkan dahulu.

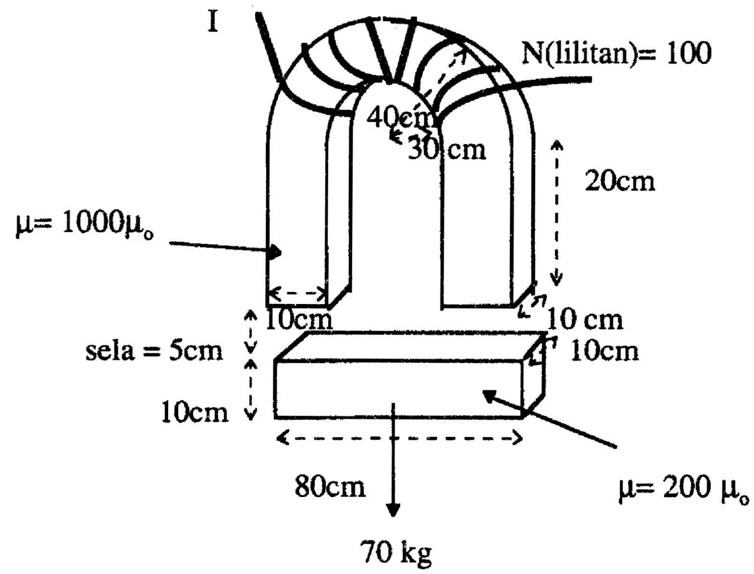
Determine the characteristic impedance Z_o of a coaxial cable using the relation $Z_0 = \sqrt{L/C}$. L is the inductance /m and C is the capacitance/m which have to be derived first.

(70%)

(b) Jika pengalir dalam mempunyai garispusat 1 mm dan pemalar dielektrik bagi bahan yang memisah antara pengalir dalam dan pengalir luar mempunyai nilai $\varepsilon = 2.5\ \varepsilon_o$. tentukan garispusat pengalir luar bagi kabel tersebut yang mempunyai galangan kecirian 100 ohm. Anggap ketelapan bahan pemisah antara dua pengalir tersebut ialah $\mu = \mu_o$.

If the diameter of the inner conductor is 1 mm and the dielectric constant of a seperation material between the two conductors is $\varepsilon = 2.5\ \varepsilon_o$, then determine the diameter of the outer conductor of a 100 ohm cable.Assume that the permeability of the seperation material is $\mu = \mu_o$.

(30%)



Rajah 3 *(Figure 3)*

3. (a) Rajah 3 menunjukkan satu batang U yang dimagnetkan untuk mengangkat satu ketul besi seberat 70 kg. Menggunakan dimensi dan parameter yang diberi, hitung nilai arus yang boleh melakukan tugas tersebut. (Ambil graviti = 9.8 m/s^2).

Figure 3 shows a U bar, magnetised by N turns of current loops. This bar is used to elevate the 70 Kg iron bar. Using the dimensions and parameters given, calculate the current that would be able to do this task. (Take gravity = 9.8 m/s^2)

(70%)

...5/-

(b) Hitung nilai ketumpatan medan magnet B dalam setiap batang besi dan sela udara bagi arus yang telah didapati dalam 3(a).

Calculate the magnet density B in every iron bar and air gap for the calculated current as in 3(a) above.

(30%)

4. (a) Satu toroid mempunyai dimensi seperti Rajah 4. Jejari dalam ialah 40cm , jejari luar ialah 50 cm, dan tebal toroid ialah 10 cm. Ketelapan bahan teras ialah 10 μ_o . Hitung

(i) Purata ketumpatan medan magnet (B)

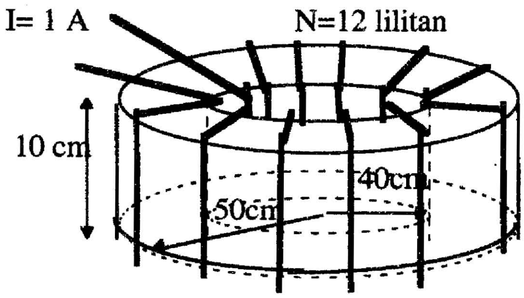
(ii) Induktans toroid tersebut

A toroid has a dimension as shown in Figure 4. Inner radius of the toroid is 40 cm , outer radius is 50 cm, and the thickness is 10 cm. Permeability of core is 10 μ_o. Calculate

(i) Average magnetic density (B)

(ii) Inductance of the toroid.

(70%)



Rajah 4 *(Figure 4)*

(b) Satu gelung dawai pengalir mempunyai N lilitan terletak dalam satah x-y dengan titik tengah di titik asal(origin) medan magnet yang di beri kaitan sebagai $B = B_o \cos\left(\pi r / 2b\right) \sin \omega t \, \hat{x}$, dengan b ialah jejari gelung dan ω ialah frekuensi sudut. Dapatkan emf (daya elektromotif) yang teraruh dalam gelung tersebut.

A circular loop of N turns of conducting wire lies in the xy-plane with its center at the origin of a magnetic-field specified by $B = B_o \cos\left(\pi r / 2b\right) \sin \omega t \, \hat{x}$, *where b is the radius of the loop and ω is the angular frequency. Find the emf (electromagnetic force) induced in the loop.*

(30%)

5. (a) Satu talian voltan tinggi berjejari b = 2 cm dan jarak dari bumi h = 4 m membawa voltan V_o = 1000 V. Ini boleh dimodelkan seperti Rajah 5. Jika seorang yang tingginya 2 m berdiri dibawah talian tersebut, berapakah nilai medan elektrik E yang dialami dikepalanya. Kaitan-kaitan penting diberikan dibawah ini.

A high tension cable of radius b = 2 cm and distance from earth h = 4 m carries a voltage of 1000 V. This is modelled as in Figure 5. If a person of height 2 m stands just underneath the cable, calculate the electric field at his head that he had experienced. The following relationship can be used for the calculation.

$$V = \frac{q_\ell}{4\pi\varepsilon} \ln\left[\frac{(x+a)^2 + y^2}{(x-a)^2 + y^2}\right] \qquad a = \sqrt{h^2 - b^2}\ , \ \sqrt{K} = \frac{h + \sqrt{h^2 - b^2}}{b}$$

dan

and $q_\ell = \dfrac{4\pi\varepsilon V_o}{\ln K}$

(70%)

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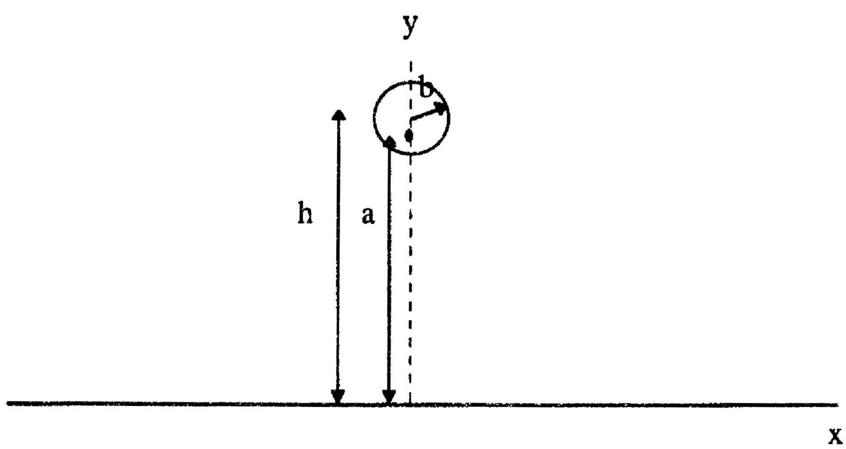

Rajah 5 *(Figure 5)*

(b) Hitung kapasitans antara talian dengan bumi.

Calculate the capacitance between the cable and the earth. (30%)

6. Suatu talian 50 ohm ditamatkan dengan beban 100 - j 50 . Menggunakan carta Smith atau kiraan, hitung SWR dan pekali pantulan. Jika beban hendak dipadankan dengan talian, rekabentuk satu pemadan.

A 50 ohm transmission line is terminated with a load of 100 - j 50. Using Smith chart or calculation, calculate the SWR and reflection coefficient. If the load is to be matched with the 50 ohm line , design the matching section.

(a) Menggunakan transformer suku-gelombang.
Using a quarter-wave transformer.

(70%)

(b) Menggunakan kaedah puntung-tunggal (stub).

Using a single stub technique.

(30%)

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LAMPIRAN I

SI Unit Prefixes

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^{18}	exa	E	$(10^{-1}$	deci	d)
10^{15}	peta	P	$(10^{-2}$	centi	c)
10^{12}	tera	T	10^{-3}	milli	m
10^{9}	giga	G	10^{-6}	micro	μ
10^{6}	mega	M	10^{-9}	nano	n
10^{3}	kilo	k	10^{-12}	pico	p
$(10^{2}$	hecto	h)	10^{-15}	femto	f
(10	deka	da)	10^{-18}	atto	a

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

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

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

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

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

LAMPIRAN II

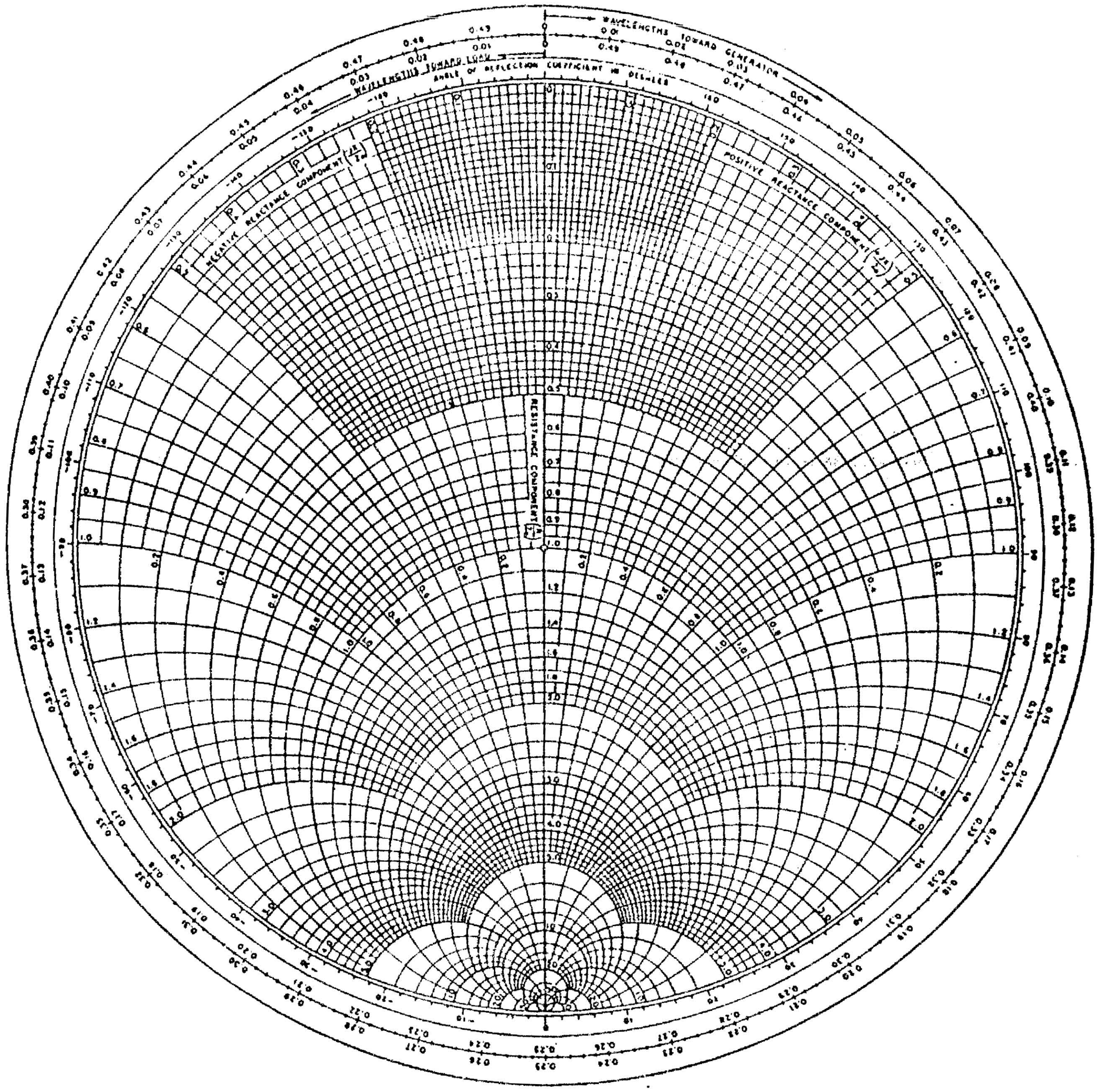

Fig. 1.206