UNIVERSITI SAINS MALAYSIA

Peperiksaan Kursus Semasa Cuti Panjang
Sidang Akademik 2004/2005

Mei 2005

EEE 223 – TEORI MEDAN ELEKTROMAGNET

Masa : 3 jam

ARAHAN KEPADA CALON:

Sila pastikan bahawa kertas peperiksaan ini mengandungi **LAPAN (8)** muka surat bercetak dan **ENAM (6)** soalan sebelum anda memulakan peperiksaan ini.

Jawab **LIMA (5)** soalan.

Agihan markah bagi soalan diberikan disudut sebelah kanan soalan berkenaan.

Semua soalan hendaklah dijawab di dalam Bahasa Malaysia. Jika pelajar memilih menjawab di dalam Bahasa Inggeris sekurang-kurangnya satu soalan mesti dijawab di dalam Bahasa Malaysia.

Simbol mempunyai makna yang biasa.
Vektor diwakili oleh huruf `Bold Face'.
Guna sistem unit SI.
Guna $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m, $\mu_0 = 4 \times 10^{-7}$ H/m.
Anggap data bersesuaian jika tidak diberi.

...2/-

1. (a) Keamataan medan magnet **H** dalam kawasan tertentu diberi oleh $\mathbf{H} = \frac{I}{2\pi}\left(\frac{-y\mathbf{a}_x + x\mathbf{a}_y}{x^2+y^2}\right)$. Tentukan ikal bagi **H**. Perhatikan bahawa ikal bagi rektor **A** dalam koordinat Cartesian diberikan oleh.

*The magnetic field intensity **H** in a certain region is given by* $\mathbf{H} = \frac{I}{2\pi}\left(\frac{-y\mathbf{a}_x + x\mathbf{a}_y}{x^2+y^2}\right)$. *Determine the curl of **H**. Note that the curl of a vector **A** in Cartesian coordinates, is given by.*

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

Simbol-simbol di atas membawa makna yang biasa.
The symbols have their usual meaning.

(10%)

(b) Suatu filament arus tak terhingga membawa arus 3 Amps dan berada sepanjang paksi x menggunakan Hukum Biot-Savart, cari keamatan medan magnet **H** dalam koordinat Cartesian pada titik P(-1,3,2).

*An infinite current filament carries a current of 3 Amps and lies along the x-axis. Using Biot-Savart Law find the magnetic field intensity **H** in Cartesian coordinates at a point P(-1,3,2).*

Perhatikan bahawa mengikut Hukum Biot-Savart.
Note that according to Biot-Savart Law

$$\mathbf{H} = \oint \mathbf{I}\mathbf{dL} \times \mathbf{a}_R / 4\pi R^2$$

Simbol-simbol di atas membawa makna yang biasa.
The symbols have their usual meaning.

(10%)

2.. Dua ciri bagi talian penghantaraan tiada kehilangan adalah Z_0 = 50 Ω dan γ = 0+j0.2 m^{-1} pada f = 60 MHz.

Two characteristics of a certain lossless transmission line are Z_0 = 50 Ω and γ = 0+j0.2 m^{-1} at f = 60 MHz.

(a) Cari L dan C bagi talian tersebut.
Find L and C for the line.

(b) Suatu beban Z_L = 60 +j80 Ω terletak pada z = 0. Menggunakan Smiths Chart, tentukan jarak terdekat antara beban kepada satu titik di mana $Z_{in} = R_{in} + j\,0$.

A load Z_L = 60 +j80 Ω is located at z = 0. Using Smiths Chart determine the shortest distance from the load to a point at which $Z_{in} = R_{in} + j\,0$.

(20%)

3. Diberi medan upaya $\mathbf{V} = 2x^2y-5z$, tentukan
Given the potential field $\boldsymbol{V} = 2x^2y-5z$, *determine*

(i) Keamatan medan elektrik **E**
The electric field intensity ***E***

(ii) Arah **E**
The direction of ***E***

(iii) Ketumpatan flux elektrik **D**
The electric flux density ***D***

(iv) Ketumpatan isipadu cas ρ_v pada titik P(-4,3,6)
The volume charge density ρ_v *at point P(-4,3,6)*

Diberi bahawa kecapahan medan vektor dalam Koordinat Cartesian diberi oleh
Note that the divergence of a vector field in Cartesian coordinates is given by

$$\nabla.\mathbf{A} = \left[\frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}\right]$$

Simbol-simbol di atas membawa makna yang biasa.
The symbols have their usual meanings.

(20%)

4. (a) Diberi titik A (5,70,-3) dan B(2,-30,1) dalam koordinat sistem silinder (r,ϕ,z), cari.

Given points A (5,70,-3) and B(2,-30,1) in cylindrical (r,ϕ,z) coordinates system, find:

(i) Vektor unit dalam Koordinat Cartesian pada A kea rah B.
Unit vector in Cartesian coordinates at A directed towards B.

(ii) Vektor unit dalam koordinat silinder pada A ke arah B.
Unit vector in cylindrical coordinates at A directed towards B.

(10%)

(b) Wayar Antena TV panjang l = 10cm mempunyai ciri-ciri galangan 300 Ω. Wayar tersebut dipintas pada satu hujungnya. Cari galangan masukan bagi talian ini untuk digunakan pada 300 MHz. Galangan masukan bagi talian yang dilitar pintas diberi oleh $Z_{sc} = j\, z_0 \tan(\beta l)\ \Omega$. Simbol-simbol di atas membawa makna yang biasa.

A television antenna wire of length l = 10cm has a characteristic impedance of 300 Ω. The wire is shorted at one end. Find the input impedance of this line if it is to be used at 300 MHz. The input impedance of a shorted line is given by $Z_{sc} = j\, z_0 \tan(\beta l)\ \Omega$. The symbols have their usual meanings.

(10%)

5. (a) Dua titik cas Q_1 = 0.35 C dan Q_2 = -0.55 C terletak pada (0,4,0) meter dan (3,0,0) meter, masing-masing dalam system koordinat Cartesian. Kirakan keamatan medan elektrik E pada (0,0,5) meter. Keamatan medan elektrik diberi oleh $\mathbf{E} = (Q/4\pi\varepsilon_0 R^2)\mathbf{a}_R$. Simbol-simbol di atas membawa makna yang biasa.

Two point charges Q_1 = 0.35 C and Q_2 = -0.55 C are located at (0,4,0) meters and (3,0,0) meters, respectively, in Cartesian coordinate system. Calculate the electric field intensity E at (0,0,5) meters. The Electric field intensity is given by $\mathbf{E} = (Q/4\pi\varepsilon_0 R^2)\mathbf{a}_R$. The symbols have their usual meanings.

(10%)

(b) Koordinat silinder bagi ketumpatan fluk $\mathbf{D} = (10r^3/4)\mathbf{a}_r$ di dalam kawasan $0 < r \leq 3$ m dan $\mathbf{D} = (810/4r)\mathbf{a}_r$ di kawasan lain. Cari ketumpatan cas ρ. Kecapahan bagi medan vector **A** dalam koordinat silinder

*In cylindrical coordinates the flux density $\mathbf{D} = (10r^3/4)\mathbf{a}_r$ in the region $0 < r \leq 3$ m and $\mathbf{D} = (810/4r)\mathbf{a}_r$ elsewhere. Find the charge density ρ. The divergence of a vector field **A** in cylindrical coordinates (r,ϕ,z) is given by*

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

Simbol-simbol di atas membawa makna yang biasa.
The symbols have their usual meanings.

(10%)

6. (a) Empat 10 nC cas positif terletak pada satah z = 0 pada bucu segiempat sama dengan sisi 8 cm. Cas kelima terletak pada titik sejauh 8 cm daripada cas yang lain. Kirakan magnitude bagi jumlah daya pada cas kelima dalam ruang bebas. Menurut Hukum Coulombs, daya akibat dua titik cas Q_1 dan Q_2 yang terpisah pada jarak R meter diberi oleh $\mathbf{F} = (Q_1Q_2 / 4\pi\varepsilon_0\mathbf{R}^2)$ Newton.

Four 10 nC positive charges are located in the z = 0 plane at the corners of a square with sides 8 cm. A fifth charge is located at a point 8 cm distant from the other charges. Calculate the magnitude of the total force on the fifth charge in free space. According to the Coulombs law, force due to two point charges Q_1 and Q_2 coulombs separated by a distance R meters is given by $\mathbf{F} = (Q_1Q_2 / 4\pi\varepsilon_0\mathbf{R}^2)$ Newtons.

(10%)

(b) Filemen arus pada paksi z membawa arus sebanyak 7 mA dalam arah $\mathbf{a}_z$ dan helaian arus 0.5 $\mathbf{a}_z$ A/m dan -0.2 $\mathbf{a}_z$ A/m terletak pada ρ = 1 cm dan ρ = 0.5 cm dalam sistem koordinat silinder masing-masing menggunakan Hukum Ampere, nyatakan kamiran garis bagi keamatan medan magnet **H** dalam suatu laluan tertutup adalah bersamaan dengan arus terus melingkupi laluan tersebut secara matematik.

*A current filament on the z-axis carries a current of 7 mA in the $\mathbf{a}_z$ direction, and current sheets of 0.5 $\mathbf{a}_z$ A/m and -0.2 $\mathbf{a}_z$ A/m are located at ρ = 1 cm and ρ = 0.5 cm in cylindrical coordinate system, respectively. Using Ampere's law calculate the magnetic field intensity at ρ = 0.5 cm and ρ = 2.0 cm. The Ampere's law states that the line integral of the magnetic field intensity **H** about any closed path is exactly equal to the direct current enclosed by the path. Mathematically*

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