

**SULIT**



**KEMENTERIAN PENDIDIKAN TINGGI  
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI**

**BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI  
KEMENTERIAN PENDIDIKAN TINGGI**

**JABATAN KEJURUTERAAN ELEKTRIK**

**PEPERIKSAAN AKHIR**

**SESI II : 2022/2023**

**BEU50153: ELECTROMAGNETIC FIELD THEORY**

**TARIKH : 12 JUN 2023**

**MASA : 8.30 AM – 11.30 AM (3 JAM)**

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Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.

Bahagian A: Subjektif (3 soalan)

Bahagian B: Esei (2 soalan)

Dokumen sokongan yang disertakan : Kertas Grid

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**JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN**

(CLO yang tertera hanya sebagai rujukan)

**SULIT**

**SECTION A : 60 MARKS****BAHAGIAN A : 60 MARKAH****INSTRUCTION:**

This section consists of **THREE (3)** subjective questions. Answer **ALL** questions.

**ARAHAN:**

Bahagian ini mengandungi **TIGA (3)** soalan subjektif. Jawab semua soalan.

**QUESTION 1****SOALAN 1**

CLO1

- (a) Diagram A1(a) shows a conductor carrying current,  $I$ .

*Rajah A1(a) menunjukkan suatu pengalir mengalirkan arus elektrik,  $I$ .*

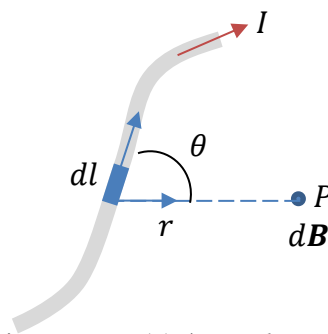


Diagram A1(a) / *Rajah A1(a)*

Based on Diagram A1(a), explain the principle of law related to magnetic flux density,  $\mathbf{B}$  and current flows in a conductor,  $I$  at point vector  $P$ .

*Berdasarkan Rajah A1(a), jelaskan prinsip bagi suatu hukum yang berkaitan dengan ketumpatan flux magnet,  $\mathbf{B}$  dan arus yang mengalir melalui pengalir,  $I$  pada titik vektor  $P$ .*

[4 marks]

[4 markah]

CLO1

- (b) Based on vector diagram shown in Diagram A2(b), calculate unit vector normal to plane  $P$  and  $Q$ .

*Berdasarkan gambar rajah vektor yang ditunjukkan pada Rajah A2(b), hitungkan vektor unit normal terhadap satah  $P$  dan  $Q$ .*

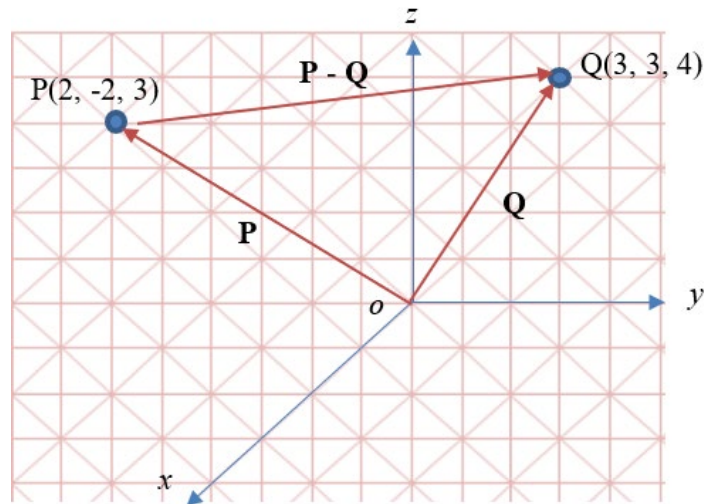


Diagram A2(b) / Rajah A2(b)

[6 marks]

[6 markah]

CLO1

- (c)

$$H = \int \mu_o I dl$$

- i. Based on the mathematical representation given, figure out a law related to the differential magnetic field intensity,  $dH$  produced when a straight conductor is carrying current,  $I$ .

*Berdasarkan perwakilan matematik yang diberikan, perelaskan suatu hukum yang berkaitan tentang keamatan medan magnet,  $dH$  yang terhasil apabila suatu pengalir lurus mengalirkan arus elektrik.  $I$ .*

[4 marks]

[4 markah]

- ii. Based on the principle of Ampere's law, illustrate the pattern of magnetic flux around **TWO (2)** separate conductors carrying current in the same direction.

*Berdasarkan prinsip hukum Ampere, gambarkan bentuk fluks magnet disekeliling **DUA (2)** pengalir yang terpisah yang mengalirkan arus elektrik,  $I$  yang sama arah.*

[6 marks]

[6 markah]

## QUESTION 2

### SOALAN 2

CLO1

- (a) Express **FOUR (4)** Maxwell's equations in integral form that are used to explain the phenomena of electromagnetic field theory.

*Nyatakan **EMPAT (4)** persamaan Maxwell dalam bentuk integrasi yang digunakan untuk memperjelaskan fenomena teori medan elektromagnetik.*

[4 marks]

[4 markah]

CLO1

- (b) Electromagnetic field consists of electric field,  $\mathbf{E}$  and magnetic field,  $\mathbf{B}$ . With the aid of a suitable diagram, write Lorentz force equation experienced by a moving charge  $Q$  with velocity  $\mathbf{v}$  in an electromagnetic field.

*Medan elektromagnet terdiri daripada medan elektrik,  $\mathbf{E}$  dan medan magnet,  $\mathbf{B}$ . Dengan bantuan gambarajah yang sesuai, tuliskan persamaan daya Lorentz yang dialami oleh cas  $Q$  yang bergerak dengan halaju  $\mathbf{v}$  dalam suatu medan elektromagnet.*

[6 marks]

[6 markah]

CLO1

- (c) The equation shows mathematical representation of a law for magnetism based on four Maxwell's equation.

$$\nabla \cdot \mathbf{B} = 0$$

*Persamaan menunjukkan perwakilan matematik bagi suatu hukum bagi kemagnetan berdasarkan empat persamaan Maxwell.*

- i. Figure-out the statement related to the law.

*Kenalpasti pernyataan berkaitan hukum tersebut.*

[4 marks]

[4 markah]

- ii. Determine two point vectors of  $P(x, -2, 5)$  which are located in magnetic field,  $\mathbf{B} = x^2yz\mathbf{a}_x - 2x^2y^2\mathbf{a}_y + 2z^2\mathbf{a}_z$ .

*Tentukan dua titik vector bagi  $P(x, -2, 5)$  yang terletak dalam medan magnet,  $\mathbf{B} = x^2yz\mathbf{a}_x - 2x^2y^2\mathbf{a}_y + 2z^2\mathbf{a}_z$ .*

[6 marks]

[6 markah]

**QUESTION 3****SOALAN 3**

CLO1

- (a) Magnetic wave is represented by  $\mathbf{H}(z, t) = 2\pi \cos(0.5 \times 10^8 t - \beta z) \mathbf{a}_x$  A/m with phase shift constant of  $\beta$  rad/m. Visualize the propagating electromagnetic wave.

*Gelombang magnet diwakili oleh  $\mathbf{H}(z, t) = 2\pi \cos(0.5 \times 10^8 t - \beta z) \mathbf{a}_x$  A/m dengan pemalar anjakan fasa  $\beta$  rad/m. Gambarkan perambatan gelombang electromagnet tersebut.*

[4 marks]

[4 markah]

CLO1

- (b) Based on Diagram A3(b)/, calculate the minimum angle between vector  $\mathbf{L}$  and  $\mathbf{M}$ .

*Berdasarkan Rajah A3(b)/, hitungkan sudut minimum di antara vektor  $\mathbf{L}$  dan  $\mathbf{M}$ .*

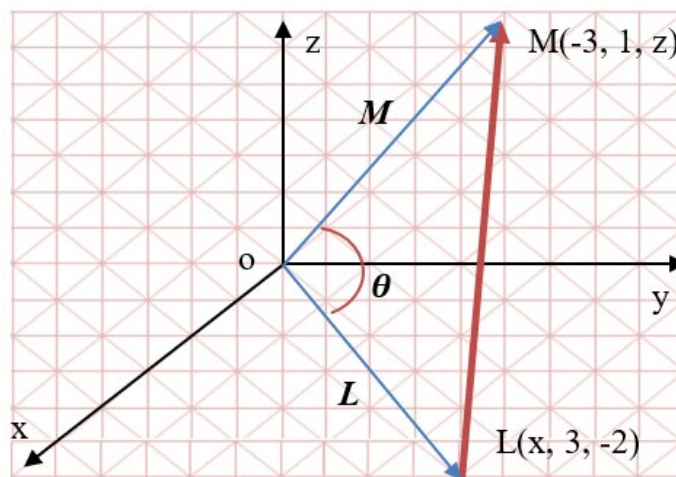


Diagram A3(b)/Rajah A3(b)

[6 marks]

[6 markah]

CLO1

- (c) A transmission line has distributed circuit coefficients of  $R = 4.19 \Omega/km$ ,  $G = 0.18 \mu S/km$ ,  $L = 2.19 mH/km$  and  $C = 5.41 nF/km$  at frequency of  $1 kHz$ .

*Suatu talian penghantaran mempunyai taburan pekali litar iaitu  $R = 4.19 \Omega/km$ ,  $G = 0.18 \mu S/km$ ,  $L = 2.19 mH/km$  and  $C = 5.41 nF/km$  pada frekuensi  $1 kHz$ .*

- i. Illustrate transmission line model circuit with the given distribution coefficients.

*Gambarkan litar model talian penghantaran dengan pekali taburan yang diberi.*

[4 marks]

[4 markah]

- ii. Determine characteristic impedance,  $Z_o$  of the transmission line.

*Tentukan galangan ciri,  $Z_o$  bagi talian penghantaran tersebut.*

[6 marks]

[6 markah]

**SECTION B: 40 MARKS****BAHAGIAN B: 40 MARKAH****INSTRUCTION:**

This section consists of **TWO (2)** essay questions. Answer **ALL** questions.

**ARAHAN:**

*Bahagian ini mengandungi DUA (2) soalan esei. Jawab SEMUA soalan.*

**QUESTION 1****SOALAN 1**

CLO1

In free space region, a charge distribution system consists of two-point charges,  $Q_a = +25 \text{ nC}$ , and  $Q_b = +20 \text{ nC}$ , which are located at point  $S(4, 3, -1) \text{ m}$  and  $T(-2, 2, 3) \text{ m}$ , respectively. Based on a mathematical expression, correlate a law that explain the effect of the distance between the two charges influence the electrostatic force experienced by each charge. Determine the electrostatic force,  $F$  experienced by charge  $Q_b$  due to charge  $Q_a$  and electric field intensity,  $E$  at point charges  $Q_b$  due to  $Q_a$ . Based on the vector diagram determine the vector potential at the origin point and total energy stored of the charge distribution system.

*Dalam kawasan ruang bebas, system taburan cas terdiri daripada dua cas,  $Q_a = +25 \text{ nC}$ , dan  $Q_b = +20 \text{ nC}$ , yang masing-masing terletak pada kedudukan koordinat  $S(4, 3, -1) \text{ m}$  dan  $T(-2, 2, 3) \text{ m}$ . Berdasarkan pernyataan matematik, hubungkan suatu hukum yang menerangkan kesan jarak antara kedua-dua cas mempengaruhi daya elektrostatis yang dialami oleh setiap cas tersebut. Tentukan daya elektrostatis,  $F$  yang dialami cas  $Q_b$  disebabkan oleh cas  $Q_a$  dan keamatan medan elektrik,  $E$  pada cas titik  $Q_b$  yang disebabkan oleh  $Q_a$ . Berdasarkan gambar rajah vektor tentukan keupayaan voltan pada titik asalan dan jumlah tenaga tersimpan bagi sistem taburan cas tersebut.*

[20 marks]

[20 markah]



**QUESTION 2**  
**SOALAN 2**

CLO1

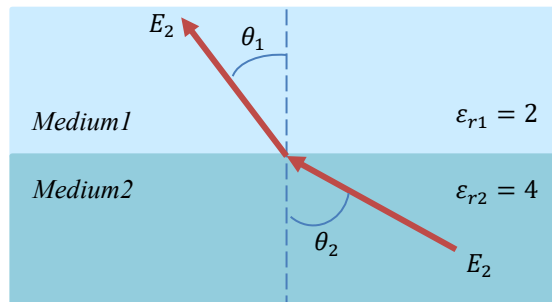


Diagram B1/Rajah B1

Given electric field intensity,  $\mathbf{E}_1 = 3\mathbf{a}_x - 2\mathbf{a}_y + 4\mathbf{a}_z$  V/m at the free-charge dielectric interface as shown in Diagram B1. Based on **TWO (2)** boundary conditions, evaluate the relationship between electric field intensity,  $\mathbf{E}$  and electric flux density,  $\mathbf{D}$  at a boundary between two dielectric materials as shown in Diagram B1. Measure the electric field intensity of medium 2, angle and flux density at each medium respectively.

*Diberi keamatan medan elektrik,  $\mathbf{E}_1 = 3\mathbf{a}_x - 2\mathbf{a}_y + 4\mathbf{a}_z$  pada antaramuka dielektrik cas bebas seperti ditunjukkan pada Rajah B1. Berdasarkan keadaan **DUA (2)** sempadan, tentukan hubungkait antara keamatan medan elektrik,  $\mathbf{E}$  dan ketumpatan fluks elektrik,  $\mathbf{D}$  pada sempadan di antara dua bahan dielektrik tersebut seperti ditunjukkan pada Rajah B1. Ukurkan keamatan medan elektrik media 2, sudut dan ketumpatan fluks bagi setiap media masing-masing.*

[20 marks]

[20 markah]

**SOALAN TAMAT**

Answer Book No: \_\_\_\_\_

Question No.: \_\_\_\_\_

