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 : 2024/2025

BEU50153: ELECTROMAGNETIC FIELD THEORY

TARIKH : 20 JUN 2025
MASA : 9.00 PG – 12.00 TGH (3 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.
Bahagian A: Struktur (3 soalan)
Bahagian B: Esei (2 soalan)
Dokumen sokongan yang disertakan : Kertas Grid

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)** structure questions. Answer **ALL** questions.

ARAHAN :

*Bahagian ini mengandungi **TIGA (3)** soalan struktur. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1 (a) Figure A1(a) shows a conductor carrying current, I. Based on Figure A1(a), explain the principle of a law related to magnetic flux density, ***B*** and current flows in a conductor, ***I*** at point vector *P*.

Rajah A1(a) menunjukkan suatu pengalir mengalirkan arus elektrik, I. Berdasarkan Rajah A1(a), jelaskan prinsip bagi suatu hukum yang berkaitan dengan ketumpatan flux magnet, ***B*** *dan arus yang mengalir melalui pengalir,* ***I*** *pada titik vektor* ***P****.*

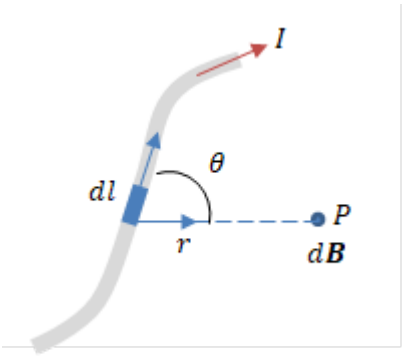


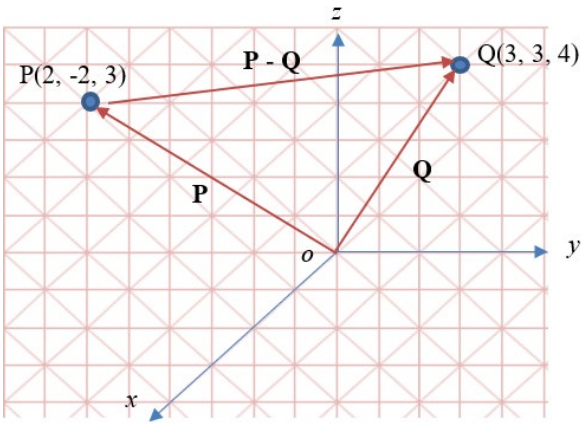
Figure A1(a) / *Rajah A1(a)*

[4 marks]

[4 *markah*]

CLO1 (b) Based on Figure A1(b), calculate the unit vector normal to the planes $\boldsymbol{P}$ and **Q.**

Berdasarkan Rajah A1(b), hitungkan vektor unit normal terhadap satah $\boldsymbol{P}$ dan Q.



A1(b) / *Rajah A1(b)*

[6 marks]

[6 *markah*]

CLO1 (c)

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

Based on the mathematical representation given, determine the law related to differential magnetic field intensity, $\boldsymbol{dH}$ produced when a straight conductor is carrying current, $\boldsymbol{I}$.

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

[10 marks]

[10 *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 Maxwel dalam bentuk integrasi yang digunakan untuk memperjelaskan fenomena teori medan elektromagnetik.*

[4 marks]

[4 *markah*]

CLO1 (b) The electromagnetic field consists of an electric field $\boldsymbol{E}$ and a magnetic field, $\boldsymbol{B}$. With the aid of a suitable diagram, write the Lorentz force equation experienced by a moving charge Q with velocity $\boldsymbol{v}$ in an electromagnetic field.

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

[6 marks]

[*6 markah*]

CLO1 (c)

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

The equation shows a mathematical representation of a law for magnetism based on Four Maxwell's equation. Analyse the statement related to the law and two-point vectors of P(x,-3,6) which are located in the magnetic field, $\boldsymbol{B} = x^2yz - 2x^2y^2 + 2z^2$.

Persamaan ini mewakili ungkapan matematik bagi satu hukum magnetisme berdasarkan empat persamaan Maxwell. Analisis pernyataan yang berkaitan dengan hukum ini dan dua vektor titik bagi P(x, -3, 6), yang terletak dalam medan magnet $\boldsymbol{B} = x^2yz - 2x^2y^2 + 2z^2$.

[10 marks]

[*10 markah*]

QUESTION 3

SOALAN 3

CLO1 (a) Magnetic wave is represented by $\boldsymbol{H}(z,t) = 2\pi\cos(0.5 \times 10^8 t - \beta z)\,\boldsymbol{a}_x$ A/m with a phase shift constant of β rad/m. Visualize the propagating electromagnetic wave.

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

[4 marks]

[4 *markah*]

CLO1

(b) Based on Figure A3(b), calculate the minimum angle between vectors ***L*** and ***M***.

Berdasarkan Rajah A3(b), hitungkan sudut minimum di antara vektor ***L*** *dan* ***M.***

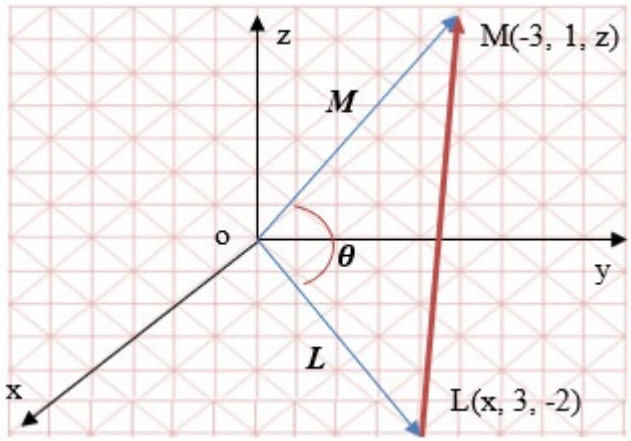


Figure A3(b)/ Rajah A3(b)

[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 $1\ kHz$. Illustrate the transmission line model circuit with the given distribution coefficients and the characteristic impedance, Z_o of the transmission line.

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* $1\ kHz$. *Gambarkan litar model talian penghantaran dengan pekali taburan yang diberi dan galangan ciri,* Z_o *bagi talian penghantaran tersebut.*

[10 marks]

[10 *markah*]

SECTION B : 20 MARKS

BAHAGIAN B :20 MARKAH

INSTRUCTION:

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

ARAHAN:

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

CLO1

QUESTION 1

SOALAN 1

In free space region, a charge distribution system consists of two-point charges, $Q_a = +35\ nC$, and $Q_b = +30\ nC$, which are located at point S(3,2,-1) m and T(-3,3,4) m, respectively. Based on a mathematical expression, determine law related to the effect of distance between two charges that can influence the electrostatic force experienced by each charge. The mathematical expression must be explained in terms of ; electrostatic force, F experienced by charge Q_b due to charge Q_b and electric field intensity; E at point charges Q_b due to Q_b; 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, $Q_a = +35\ nC$, and $Q_b = +30\ nC$,, yang masing-masing terletak pada kedudukan koordinat A(3,2,-1) m dan T(-3,3,4) m. Berdasarkan ungkapan matematik, tentukan hukum yang berkaitan dengan kesan jarak antara dua cas yang boleh mempengaruhi daya elektrostatik yang dialami oleh setiap cas. Ungkapan matematik mesti dijelaskan dari segi ; daya elektrostatik, F dialami oleh cas Q_b disebabkan oleh cas Q_b dan keamatan medan elektrik; E pada titik caj Q_b disebabkan Q_a; gambarajah vektor menentukan potensi vektor pada titik asalan dan jumlah tenaga yang disimpan bagi sistem pengagihan cas.

[20 marks]

[20 *markah*]

CLO1

QUESTION 2

SOALAN 2

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

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

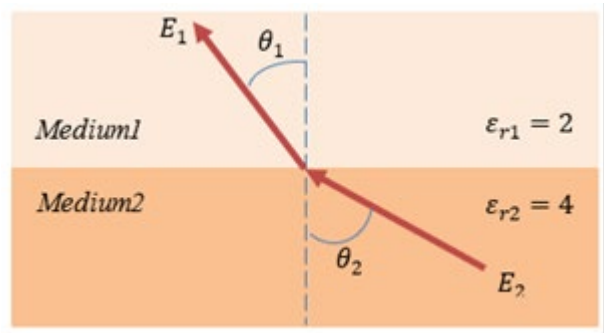


Figure B1/*Rajah B1*

[20 marks]

[20 *markah*]

SOALAN TAMAT