SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI DISEMBER 2017

DEP5303 : MICROWAVE DEVICES

TARIKH : 09 APRIL 2018
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.

Bahagian A: Struktur (4 soalan)
Bahagian B: Esei (2 soalan)

Dokumen sokongan yang disertakan : Formula dan 3 Helai Smith Chart

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SECTION A: 60 MARKS

BAHAGIAN A: 60 MARKAH

INSTRUCTION:

This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan berstruktur. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1
C1

(a) State the types of electromagnetic radiation hazard.

Nyatakan jenis-jenis bahaya radiasi elektromagnetik.

[3 marks]

[*3 markah*]

CLO1
C2

(b) Explain an electromagnetic wave by using the image of electromagnetic waves, locate the place of electric field, magnetic field and wavelength.

Terangkan gelombang elektromagnetik dengan menggunakan imej gelombang elektromagnetik, letakkan kedudukan medan elektrik, medan magnet dan panjang gelombang.

[6 marks]

[*6 markah*]

CLO1
C2

(c) Radiation exposure hazard is very dangerous especially to the general public. Explain **THREE (3)** basic ways of controlling exposure to harmful radiation.

*Radiasi sangat berbahaya terutamanya kepada orang awam. Terangkan **TIGA (3)** cara asas untuk mengawal dari terdedah kepada bahaya radiasi.*

[6 marks]

[*6 markah*]

QUESTION 2

SOALAN 2

CLO1 C2

(a) Explain the types of propagation mode below :

Terangkan jenis mod perambatan di bawah:

i. TEM Wave

Gelombang TEM

ii. TM Wave

Gelombang TM

[3 marks]

[*3 markah*]

CLO1 C3

(b) A waveguide, with dimension a = 10 mm and b = 7 mm, is to be used at 20 GHz for the dominant mode. If the guide is empty, calculate:

Sebuah pandu gelombang dengan dimensi a = 10 mm dan b = 7 mm, digunakan pada 20GHz pada mod dominan. Jika pandu gelombang tersebut tidak berisi, kirakan:

i. Free space wavelength, λ_0

Panjang gelombang bagi ruang bebas, λ_0

ii. Cut-off wavelength, λ_c

Panjang gelombang potong, λ_c

iii. Cut-off frequency, f_c

Frekuensi potong, f_c

[6 marks]

[*6 markah*]

(c) A TE_{11} wave is propagating through a circular waveguide. The diameter of the guide is 9.5 cm and the guide is air-filled. Calculate :

CLO1 C3 *Gelombang TE_{11} ini terambat melalui pandu gelombang bulat. Diameter pandu gelombang adalah 9.5 cm dan berisi udara. Kirakan:*

i. Cut-off frequency, f_c
Frekuensi potong, f_c

ii. Wavelength in the guide for frequency of 5 GHz, λ_g
Panjang gelombang pandu pada frekuensi 5GHz, λ_g

iii. Characteristic impedance, Z_o(TE)
Galangan ciri, Z_o(TE)

[6 marks]
[*6 markah*]

QUESTION 3

SOALAN 3

CLO2
C2

(a) Based on **Figure A3(a),** identify the normalized values plotted as Z_1, Z_2 and Z_3

Merujuk kepada ***Rajah*** **A3(a),** *tentukan nilai-nilai ternormal yang terplot,* Z_1, Z_2 *dan* Z_3.

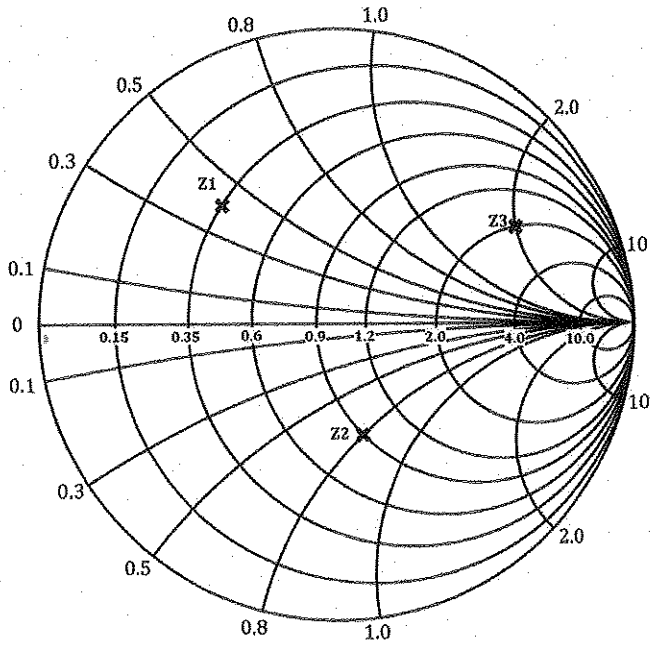

Figure A3(a) / ***Rajah*** **A3(a)**

[3 marks]

[*3 markah*]

CLO2
C3

(b) Based on **Figure A3(b),** calculate the value of :

Merujuk kepada ***Rajah A3 (b),*** *kirakan nilai bagi:*

i. Load Impedence Z_L, if Zo = 100Ω

Galangan Beban Z_L , *jika* Zo = 100Ω

ii. Voltage Standing Wave Ratio, VSWR (dB)

Nisbah Gelombang Voltan Pegun, VSWR (dB)

iii. Reflection Coefficient, Γ

Pekali Pantulan , Γ

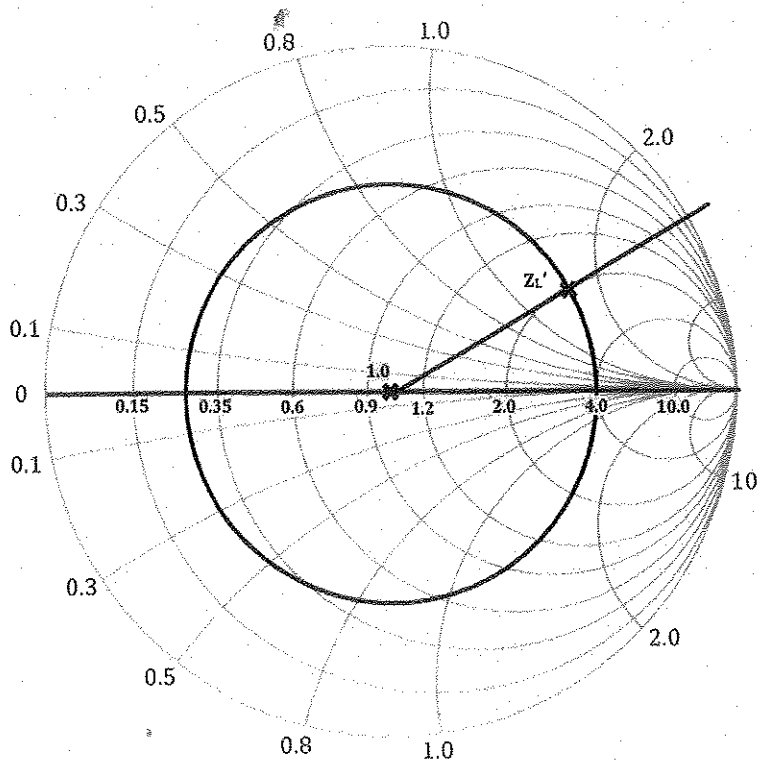

Figure A3(b) / *Rajah* A3(b)

[6 marks]

[*6 markah*]

CLO2
C3

(c) Illustrate and completely label the diagram of microwave measurement system.
Lukiskan dan labelkan dengan lengkap gambarajah blok sistem pengukuran gelombang mikro.

[6 marks]

[*6 markah*]

QUESTION 4

SOALAN 4

CLO1 C1 (a) List **THREE (3)** microwave sources for semiconductor type.
*Senaraikan **TIGA (3)** sumber gelombang mikro dari jenis semikonduktor.*

[3 marks]
[*3 markah*]

CLO1 C2 (b) Microwave sources are divided into two types. Identify the types of microwave source and determine **TWO (2)** examples for each type.
*Sumber gelombang mikro dibahagikan kepada dua jenis. Kenalpasti jenis sumber gelombang mikro tersebut dan tentukan **DUA (2)** contoh bagi setiap jenis.*

[5 marks]
[*5 markah*]

CLO1 C3 (c) A parabolic reflector with diameter of 2.5 m is used to transmit power of 15 W using a feeder operating at 7.5 GHz and an antenna aperture efficiency of 65%. Calculate:
Sebuah pemantul parabola berdiameter 2.5 m digunakan untuk memancar kuasa sebanyak 15 W dengan menggunakan penyuap yang beroperasi pada 7.5 GHz dan mempunyai kecekapan apertue antena sebanyak 65%. Kirakan;

i. Wavelength of the signal, λ
Panjang gelombang isyarat, λ

ii. Beamwidth of the antenna, θ
Lebar pemancar antena, θ

iii. Effective aperture area, A_e.
Kawasan aperture berkesan, A_e

iv. Antenna gain, G
Peningkatan antena, G

[7 marks]
[*7 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

CLO2
C3

A rectangular waveguide with dimension of 6.04 cm x 4.04 cm and an inner thickness of 0.02cm is used to propagate a 3GHz signal in dominant mode. Calculate the cut off frequency (f_c), guide wavelength (λ_g), velocity inside waveguide (V_g), phase velocity (V_p) and characteristic impedance ($Z_{0\,(TE)}$).
Sebuah pandu gelombang segi empat dengan dimensi dalaman 6.04 cm x 4.04 cm dan ketebalan dalaman 0.02cm digunakan untuk merambat isyarat pada 3GHz di dalam mod dominan. Kirakan frekuensi potong (f_c), panjang gelombang pandu (λ_g), halaju dalam pandu gelombang (V_g), halaju fasa (V_p) dan galangan ciri ($Z_{0\,(TE)}$).

[20 marks]
[20 markah]

QUESTION 2
SOALAN 2

CLO2
C4

A load impedance Z_L=30 + j75Ω is connected to a line that has a characteristic impedance, Z_0 = 75Ω. By using Smith Chart, relate the position of normalized load impedance, VSWR(S), angle of reflection (θ), reflection coefficient (Γ), admittance load (Y_L) and input impedance (Z_{IN}) when the transmission line is 0.07λ from load.
Galangan beban Z_L=30 + j75Ω disambung kepada talian yang mempunyai galangan ciri Z_0 = 75Ω. Dengan menggunakan Carta Smith, kaitkan kedudukan galangan beban ternormal, VSWR(S), sudut pantulan (θ), pekali pantulan (Γ), *nilai lepasan (Y_L) dan galangan masukan (Z_{IN}) apabila talian penghantaran adalah 0.07λ dari beban.*

[20 marks]
[20 markah]

SOALAN TAMAT

FORMULA FOR DEP5303 MICROWAVE DEVICES

$$c = \lambda f = 3\,x10^{8}\,ms^{-1}$$

$$\varepsilon_o = 8.854\times10^{-12}\,F/m$$

$$\mu_o = 4\pi\times10^{-7}\,H/m$$

$$v_c = \frac{1}{\sqrt{\varepsilon_o\varepsilon_r\mu_o\mu_r}}$$

$$Z = 377\sqrt{\frac{\mu_r}{\varepsilon_r}}(\Omega)$$

$$\lambda_c = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}}$$

$$\lambda_c = \frac{\pi d}{S_{mn}}$$

$$f_c = \frac{c}{2}\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}$$

$$f_c = \frac{cS_{mn}}{\pi d}$$

$$\lambda_g = \frac{\lambda_o}{\sqrt{1-\left(\frac{\lambda_o}{\lambda_c}\right)^2}} = \frac{\lambda_o}{\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}}$$

$$v_p = \frac{c}{\sqrt{1-\left(\frac{\lambda_o}{\lambda_c}\right)^2}} = \frac{c}{\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}}$$

$$v_g = c\sqrt{1-\left(\frac{\lambda_o}{\lambda_c}\right)^2} = c\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}$$

$$Z_{o(TE)} = \frac{377}{\sqrt{1-\left(\frac{\lambda_o}{\lambda_c}\right)^2}} = \frac{377}{\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}}$$

$$Z_{o(TM)} = 377\sqrt{1-\left(\frac{\lambda_o}{\lambda_c}\right)^2} = 377\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}$$

$$|\Gamma| = \frac{Z_L - Z_o}{Z_L + Z_o}$$

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

$$A(watt) = e^{\propto z} \quad where \propto = \frac{2\pi}{\lambda_c}$$

$$A(dB) = \frac{54.5z}{\lambda_c}$$

$$front\ to\ back\ ratio = \frac{front\ lobe\ power}{back\ lobe\ power}$$

$$front\ to\ side\ ratio = \frac{front\ lobe\ power}{side\ lobe\ power}$$

$$Beam\ width\ (parabolic) = \frac{70\lambda}{d}$$

$$Beam\ width\ (horn) = \frac{80\lambda}{W}$$

$$G_R(dB) = 10log\frac{4\pi kA}{\lambda^2}$$

$$G_T(dB) = 10log\frac{4\pi\eta A}{\lambda^2}$$

$P_T = P_R\,G$

Bassel Equation's Schedule for Circular Waveguide:

Mode	S_{mn}	Mode	S'_{mn}
TE_{01}	3.832	TM_{01}	2.405
TE_{11}	1.841	TM_{11}	3.832
TE_{21}	3.050	TM_{21}	5.136
TE_{02}	7.016	TM_{02}	5.520
TE_{12}	5.330	TM_{12}	7.016
TE_{22}	6.710	TM_{22}	8.420