SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI DISEMBER 2015

EP603: MICROWAVE DEVICES

TARIKH : 12 APRIL 2016
MASA : 8.30AM – 10.30AM

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.
Bahagian A: Struktur (10 soalan)
Bahagian B: Esei (3 soalan)
Dokumen sokongan yang disertakan : Carta Smith dan Lampiran Formula

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A : 40 MARKS

BAHAGIAN A : 40 MARKAH

INSTRUCTION:

This section consists of **TEN (10)** structured questions. Answer **ALL** questions

ARAHAN :

*Bahagian ini mengandungi **SEPULUH (10)** soalan berstruktur. Jawab **SEMUA** soalan.*

CLO1
C2

QUESTION 1

Explain with a proper diagram the Transverse Electromagnetic (TEM) that propagates in free space.

SOALAN 1

Terangkan dengan bantuan gambarajah gelombang *elektromagnetik melintang (TEM) yang merambat dalam ruang bebas.*

[4 marks]

[4 markah]

QUESTION 2

CLO1
C1

Identify **FOUR (4)** needs of microwave to communication system.

SOALAN 2

*Kenalpasti **EMPAT(4)** keperluan gelombang mikro kepada Sistem Komunikasi.*

[4 marks]

[4 markah]

CLO1
C1

QUESTION 3

Give a definition of waveguide and hence state **TWO (2)** types of it.

SOALAN 3

*Takrifkan pandu gelombang kemudian berikan **DUA (2)** contohnya.*

[4 marks]

[4 markah]

CLO1 C2

QUESTION 4

Differentiate between TEM and TE propagation modes by using vector diagram.

SOALAN 4

Bezakan antara mod perambatan TEM dan TE dengan menggunakan rajah vektor.

[4 marks]

[4 markah]

QUESTION 5

CLO2 C3

A rectangular waveguide with the dimension of 5cm x 2.4 cm is used to propagate at dominant mode. Calculate the cut-off frequency of the waveguide.

SOALAN 5

Satu pandu pelombang segi empat berdimensi 5cm x 2.4cm digunakan untuk merambat pada mod dominan. Kirakan frekuensi potong pandu gelombang tersebut.

[4 marks]

[4 markah]

QUESTION 6

CLO2 C3

A load of (100-j200) Ω is connected to 100 Ω transmission line. By using Smith Chart, illusrate the value of Γ (reflection coefficient) and the angle of reflection.

SOALAN 6

Sebuah beban (100-j200)Ω disambung kepada talian penghantaran bergalangan ciri 100 Ω. Dengan menggunakan Carta Smith, ilustrasikan nilai Γ (pekali pantulan) dan sudut pantulan beban tersebut.

[4 marks]

[4 markah]

QUESTION 7

CLO2 C3

A load of (100-j100) Ω is connected to 50 Ω transmission line. By using Smith Chart, show the value of Z_{max} and Z_{min}.

SOALAN 7

Sebuah beban (100-j100) Ω disambung kepada talian penghantaran bergalangan ciri 50 Ω. Dengan menggunakan Carta Smith, tunjukkan nilai Z_{max} dan Z_{min}.

[4 marks]

[4 markah]

CLO1 C2

QUESTION 8

a) Describe the function of attenuator in Travelling Wave Tube (TWT).

b) What is the function of output cavity in two-cavity klystron.

SOALAN 8

a) Perihalkan fungsi pelemah dalam 'Travelling Wave Tube' (TWT).

b) Berikan fungsi rongga keluaran dalam klystron dua rongga.

[4 marks]

[4 markah]

CLO1 C2

QUESTION 9

A parabolic antenna is an antenna that uses a parabolic reflector to direct the radio waves. Determine **FOUR (4)** common shapes of parabolic reflector.

SOALAN 9

*Antena parabola merupakan sejenis antenna yang menggunakan pemantul parabola untuk mengarahkan isyarat radio. Tentukan **EMPAT (4)** bentuk pemantul parabola yang biasa digunakan.*

[4 marks]

[4 markah]

QUESTION 10

CLO2 C3

A parabolic antenna with a dish diameter 4 m operates at frequency 6 GHz. Calculate the wavelength of the signal and antenna gain in dB.

SOALAN 10

Sebuah antena parabola dengan diameter 4 m beroperasi pada frekuensi 6 GHz. Kirakan panjang gelombang isyarat dan gandaan antena dalam dB.

[4 marks]

[4 markah]

SECTION B : 60 MARKS

BAHAGIAN B : 60 MARKAH

INSTRUCTION:

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

ARAHAN:

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

CLO2
C3

QUESTION 1

SOALAN 1

a) Calculate the frequency of the light if the light has a wavelength of 400m.

Kira nilai frekuensi bagi cahaya sekiranya sekiranya panjang gelombang bagi cahaya tersebut adalah 400m.

[4 marks]

[*4 markah*]

CLO2
C3

b) Based on the information in Table B1 below, calculate the value of cutoff frequency (f_c), waveguide wavelength (λ_g), group velocity in the waveguide (V_g), phase velocity (V_p) and characteristic impedance (Z_0) for mode TE_{10}.

Berpandukan maklumat dalam Jadual B1 di bawah, dapatkan nilai bagi frekuensi potong (f_c), panjang gelombang pandu (λ_g), halaju perambatan isyarat di dalam pandu gelombang (V_g), halaju fasa (V_p) dan galangan ciri (Z_0) bagi mod TE_{10}.

Waveguide *Pandu gelombang*	Rectangular *Segiempat*
External dimension *Dimensi luaran*	(2.94 x 1.27) cm
Wall Thickness *Ketebalan dinding*	0.2 cm
Operational frequency *Frekuensi operasi*	10 GHz
Mode *Mod*	Dominant *Dominan*

Table B1 / *Jadual B1*

[16 marks]

[*16 markah*]

CLO2
C3

QUESTION 2

SOALAN 2

a) A voltage standing wave caused by a mismatched load has a maximum value of 50V and a minimum value of 30V. Calculate Standing Wave Ratio, SWR (dB) and reflection coefficient, Γ.

Voltan bagi gelombang pegun disebabkan oleh beban tak sepadan mempunyai nilai maksimum 50V dan nilai minimum 30V. Kirakan Nisbah Gelombang Pegun, SWR (dB) dan pekali pantulan, Γ.

[8 marks]

[8 *markah*]

b) A load impedance of $(150 + j75)\Omega$ is connected to a line that has characteristic impedance equal to 75Ω. By using Smith Chart, locate the position of normalized load impedance, voltage standing wave ratio, angle coefficient and reflection coefficient. Then, locate the input impedance, Z_{in} when the length of the transmission line is 0.05λ.

Galangan beban (150 + j75)Ω disambungkan kepada talian yang mempunyai galangan ciri bernilai 75Ω. Gunakan carta Smith untuk menentukan kedudukan galangan beban ternormal, nisbah voltan gelombang pegun, sudut pantulan dan pekali pantulan. Seterusnya, cari galangan masukan, Z_{in} apabila jarak talian penghantaran adalah 0.05λ.

[12 marks]
[12 *markah*]

QUESTION 3
SOALAN 3

CLO1 C2

a) Explain the operation of the microwave source shown in Figure B 3(a) below.

Terangkan operasi sumber gelombang mikro yang ditunjukkan dalam Rajah B 3(a) di bawah.

[7 marks]
[7 *markah*]

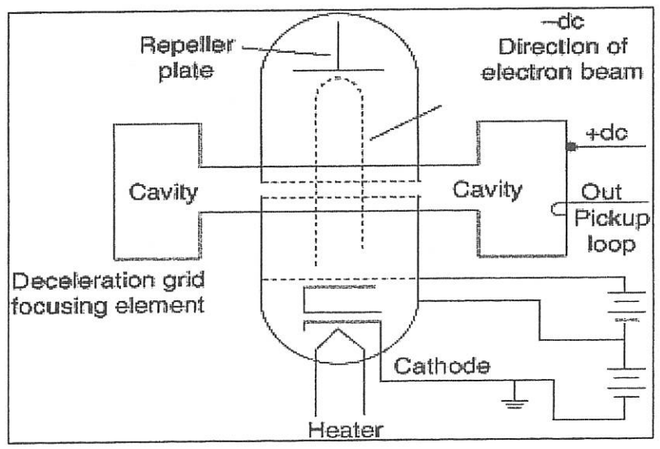

Figure B 3(a) / *Rajah B 3(a)*

CLO2 C2

b) A 2.5m diameter parabolic reflector emits a power of 5W using the feeder mechanism at a frequency of 5 GHz with antenna aperture efficiency as high as 60%. Determine the wavelength of the signal (λ), beam width of the antenna (Θ), effective aperture area (A_e), antenna gain (G (dB)) and power transmission (P_T (dB)).

Sebuah pemantul parabola berdiameter 2.5m memancarkan kuasa sebanyak 5W menggunakan mekanisma penyuap pada frekuensi 5 GHz dengan kecekapan bukaan antena setinggi 60%. Tentukan nilai panjang gelombang isyarat (λ), sudut lebar alur antena (Θ), luas bukaan berkesan (A_e), gandaan antena (G(dB)), dan kuasa penghantaran antena (P_T(dB)).

[13 marks]
[13 *markah*]

SOALAN TAMAT

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$$c = \lambda f = (3\times10^{8})ms^{-1}$$

Rectangular Waveguide	Circular Waveguide
Wavelength $\lambda_c = \dfrac{2}{\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}}$	Wavelength $\lambda_c = \dfrac{\pi d}{Smn}$
Frequency, $f_c = \dfrac{c}{2}\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}$ $f_c = \dfrac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}$ $\mu_0 = 4\pi \times 10^{-7}$ H/m $\varepsilon_0 = 8.854\times 10^{-12}$ F/m	Frequency, $f_c = \dfrac{cSmn}{\pi d}$ Bessel Equation's Table for Circular Waveguide:

Mode	Smn	Mode	Smn
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

$$\lambda_{guide} = \lambda_{pandu} = \frac{\lambda_o}{\sqrt{\left[1-\left(\frac{\lambda_o}{\lambda_c}\right)^2\right]}} \text{ meter or } \lambda_{guide} = \lambda_{pandu} = \frac{\lambda_o}{\sqrt{\left[1-\left(\frac{f_c}{f_0}\right)^2\right]}} \text{ meter}$$

$$v_{group} = v_{kumpulan} = c\sqrt{\left[1-\left(\frac{\lambda_o}{\lambda_c}\right)^2\right]}ms^{-1} \text{ or } v_{group} = v_{kumpulan} = c\sqrt{\left[1-\left(\frac{f_c}{f_o}\right)^2\right]}ms^{-1}$$

$$v_{phase} = v_{fasa} = \frac{c}{\sqrt{\left[1-\left(\frac{\lambda_o}{\lambda_c}\right)^2\right]}}ms^{-1} \text{ or } v_p = \frac{c}{\sqrt{\left[1-\left(\frac{f_c}{f_0}\right)^2\right]}}ms^{-1}$$

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

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

$Z_{IN} = j\, Z_{TEmn} \tan(\beta l)$; $Z_{IN} = j\, Z_{TMmn} \tan(\beta l)$; $\beta = \dfrac{2\pi f_o}{c}\sqrt{\left(1-\left(\frac{f_c}{f_o}\right)^2\right)}$

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$front\ to\ back\ ratio = \dfrac{front\ lobe\ power}{back\ lobe\ power}$	$front\ to\ side\ ratio = \dfrac{front\ lobe\ power}{side\ lobe\ power}$
$Reflection\ Coefficient, \Gamma = \left(\dfrac{Z_O - Z_L}{Z_L + Z_L}\right)$	VSWR= $\left(\dfrac{1+\lvert\Gamma\rvert}{1-\lvert\Gamma\rvert}\right)$
(Parabolic Antenna) $Beam\ Width, \alpha = \frac{70\lambda}{D}$	Horn Antenna, $Beam\ Width, \alpha = \frac{80\lambda}{W}$
$P_T = \eta\left(\dfrac{\pi D}{\lambda}\right)^2$	$P_T = (P_R G)$
$G(dB) = 10\ log\dfrac{4\pi kA}{\lambda^2}$	$Attenuation\ (dB) = \dfrac{54z}{\lambda c}$

The Smith Chart