SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI JUN 2016

EP603: MICROWAVE DEVICES

TARIKH : 23 OKTOBER 2016 (AHAD)
MASA : 2.30 PM – 4.30 PM (2 JAM)

Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.
Bahagian A: Struktur (10 soalan)
Bahagian B: Esei (3 soalan)
Dokumen sokongan yang disertakan : Lampiran Formula & Carta Smith

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JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

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 **TWO (2)** requirements for microwave in communication system.

SOALAN 1

*Terangkan **DUA (2)** keperluan untuk gelombang mikro dalam sistem komunikasi.*

[4 marks]
[*4 markah*]

CLO1
C2

QUESTION 2

Explain briefly **TWO (2)** types of electromagnetic radiation hazards.

SOALAN 2

*Terangkan secara ringkas **DUA (2)** jenis bahaya radiasi gelombang elektromagnetik.*

[4 marks]
[*4 markah*]

CLO1
C1

QUESTION 3

Define waveguide and list **TWO (2)** types of waveguide.

SOALAN 3

*Takrifkan pandu glombang dan senaraikan **DUA (2)** jenis pandu gelombang.*

[4 marks]
[*4 markah*]

CLO1
C2

QUESTION 4

Differentiate between rectangular waveguide and circular waveguide.

SOALAN 4

Berikan perbezaan di antara pandu gelombang segi empat tepat dan pandu gelombang bulat.

[4 marks]

[*4 markah*]

CLO2
C3

QUESTION 5

A rectangular waveguide WR-90 with an inner dimension of 22.86 mm × 10.16 mm is used to propagate a microwave signal at mode TE_{10}. If the characteristic wave impedance is 510 Ω, calculate the microwave frequency.

SOALAN 5

Satu pandu gelombang berbentuk segiempat WR-90 mempunyai dimensi 22.86 mm × 10.16 mm digunakan untuk merambat isyarat gelombang mikro pada mod TE_{10}. Jika galangan ciri gelombang ialah 510 Ω, kirakan frekuensi gelombang mikro tersebut.

[4 marks]

[*4 markah*]

CLO2
C2

QUESTION 6

Given characteristic impedance, $Z_0 = 50\ \Omega$. Find the Normalized Impedance, Z_L' below:

i) $Z_L = 200 + j\ 150\ \Omega$

ii) $Z_L = 75 - j\ 100\ \Omega$

iii) $Z_L = j\ 200\ \Omega$

iv) $Z_L = 150\ \Omega$

SOALAN 6

Diberi galangan ciri, Z_0 bagi satu talian penghantaran adalah 50 Ω. *Dapatkan Galangan Ternormal,* Z_L' *berikut :*

i) $Z_L = 200 + j\ 150\ \Omega$

ii) $Z_L = 75 - j\ 100\ \Omega$

iii) $Z_L = j\ 200\ \Omega$

iv) $Z_L = 150\ \Omega$

[4 marks]

[*4 markah*]

CLO2
C3

QUESTION 7

Plot the coordinate of impedance below on Smith Chart if the Characteristic Impedance is 50 Ω.

i. $Z_a = -j60\ \Omega$

ii. $Z_b = 100+j20\ \Omega$

SOALAN 7

Plotkan koordinat galangan-galangan di bawah pada Carta Smith jika galangan ciri talian adalah 50 Ω.

i. $Z_a = -j60\ \Omega$

ii. $Z_b = 100+j20\ \Omega$

[4 marks]

[*4 markah*]

CLO1
C1

QUESTION 8

List **FOUR (4)** types of microwave diode semiconductor sources.

SOALAN 8

*Berikan **EMPAT (4)** jenis-jenis sumber gelombang mikro diod separa pengalir.*

[4 marks]

[*4 markah*]

CLO1
C2

QUESTION 9

Discuss **TWO (2)** functions of microwave antenna.

SOALAN 9

*Bincangkan **DUA (2)** fungsi antena gelombang mikro.*

[4 marks]

[*4 markah*]

CLO2
C3

QUESTION 10

A horn antenna with a dimension of 6cm x 4cm is used to transmit at frequency of 13GHz. If the aperture efficiency is 0.582, find the beamwidth of the antenna.

SOALAN 10

Sebuah antena hon berdimensi 6cm x 4cm digunakan untuk penghantaran isyarat pada frekuensi 13GHz. Jika kecekapan bukaannya adalah 0.582, dapatkan lebar alur antenna tersebut.

[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) A rectangular waveguide filled with dielectric material of $\varepsilon_r = 9$ and has internal dimension of 7 cm x 3.5 cm is operating in dominant mode. Determine the phase velocity and guide wavelength if the operational frequency is 2GHz.

Sebuah pandu gelombang segiempat diisi dengan bahan dielektrik $\varepsilon_r = 9$ dan mempunyai dimensi dalaman 7cm x 3.5 cm beroperasi di dalam mod dominan. Tentukan halaju fasa dan panjang gelombang pandu jika frekuensi operasi pada 2GHz.

[10 marks]

[10 markah]

CLO2
C3

(b) An air-filled circular waveguide having an inner diameter of 4 cm operates in a dominant mode of 10 GHz. Calculate the guide wavelength and characteristic wave impedance.

Satu pandu gelombang bulat berisi udara mempunyai diameter dalaman 4 cm beroperasi dalam mod dominan pada frekuensi 10GHz. Kira panjang gelombang bagi pandu gelombang dan galangan ciri gelombang.

[10 marks]

[10 markah]

QUESTION 2
SOALAN 2

CLO2 C3

a) In a transmission line, standing wave is generated when the reflected wave is added to the incident wave. By using a suitable formula, calculate the voltage standing wave ratio (VSWR) in decibel (dB), if the maximum voltage is 30V and the minimum voltage is 12V.

Di dalam talian penghantaran, gelombang pegun terbentuk apabila gelombang pantulan bercampur dengan gelombang tuju. Dengan menggunakan formula yang bersesuaian, kira nisbah voltan gelombang pegun (VSWR) dalam decibel (dB) jika nilai voltan maksima adalah 30V dan voltan minimum adalah 12V.

[5 marks]
[5 markah]

CLO2 C3

b) A load of $(75 + j150)\Omega$ is connected to 75Ω transmission line. By using a Smith Chart, find the value of reflection coefficient (Γ), standing wave ratio (S) and the load admittance, (Y_L). Then, find the value Z_{in} at 0.4λ from the load.

Sebuah beban $(75 + j150)\Omega$ disambungkan kepada talian penghantaran bergalangan ciri 75Ω. Gunakan Carta Smith untuk mendapatkan nilai pekali pantulan (Γ), nisbah gelombang pegun (S) dan lesapan beban, (Y_L). Kemudian, cari nilai Z_{in} pada 0.4λ daripada beban penamat.

[15 marks]
[15 markah]

QUESTION 3
SOALAN 3

CLO1 C3

(a) The Traveling Wave Tube is a valve that is still used for high power microwave amplifier designs. Its application includes broadcasting, radar and in satellite transponders. The construction of the tube can be split into a number of separate major elements:

- Electron gun
- Magnet and focusing structure
- RF input and RF output
- Helix
- Collector

Generalize the operation of the tube according to the elements listed above.

Tiub gelombang bergerak merupakan sebuah injab atau tiub yang masih digunakan di dalam rekaan penguat gelombang mikro berkuasa tinggi. Penggunaannya termasuk untuk penyiaran, radar dan transponder satelit. Manakala pembinaannya boleh dibahagikan kepada beberapa elemen utama iaitu:

- *Senapang elektron*
- *Magnet dan struktur pemfokus*
- *Masukan dan keluaran RF*
- *Heliks*
- *Pemungut.*

Beri penerangan mengenai operasi tiub ini mengikut elemen-elemen yang tersenarai di atas.

[10 marks]
[10 markah]

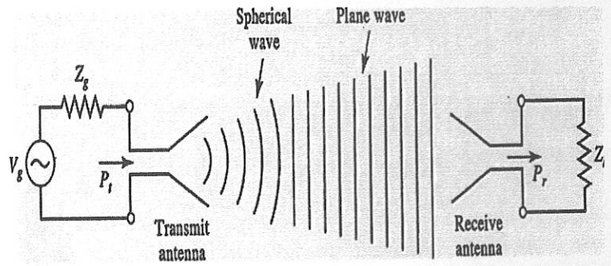

Figure B3b / *Rajah B3b*

CLO2 C3

b) Referring to Figure B3b above. Explain the basic operation of transmitting and receiving antenna. If given the aperture of a parabolic antenna is 4.2 m^2 and the input frequency of 6 GHz, calculate the gain of the antenna. The efficiency is measured to be 70 %.

Rujuk Rajah B3b di atas. Terangkan operasi asas sebuah antena pemancar dan penerima . Jika diberi bahawa saiz bukaan sebuah antena parabola ialah 4.2 m^2 dan masukan frekuensi 6GHz, kirakan gandaan antena tersebut. Nilai kecekapan antena diukur adalah 70%.

[10 marks]

[10 markah]

SOALAN TAMAT

APPENDIX EP603

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

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

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

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

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

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

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

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

APPENDIX EP603

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