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SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI JUN 2017

DEP5303 : MICROWAVE DEVICES

TARIKH : 23 OKTOBER 2017
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, Smith Chart

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) Define spherical wave in microwave system.

Takrifkan gelombang sfera dalam sistem microwave.

[3 marks]

[*3 markah*]

CLO1
C2

(b) Describe **TWO (2)** characteristics of microwave.

*Huraikan **DUA(2)** ciri-ciri gelombang mikro.*

[6 marks]

[*6 markah*]

CLO1
C2

(c) Explain clearly **TWO (2)** methods of controlling electromagnetic radiation hazard.

*Terangkan dengan jelas **DUA (2)** kaedah untuk mengawal hazard radiasi Elektromagnetik.*

[6 marks]

[*6 markah*]

QUESTION 2

SOALAN 2

CLO1 C2

(a) Explain the propagation of microwave when the operating frequency reaches the waveguide's cut off frequency.

Terangkan perambatan gelombang mikro apabila frekuensi operasi mencecah frekuensi potong pandu gelombang.

[3 marks]

[*3 markah*]

CLO1 C3

(b) Draw the rectangular and circular waveguide and then relate both of these in terms of structure and application.

Lukiskan pandu gelombang segiempat dan pandu gelombang bulat kemudian hubungkaitkan keduanya dari segi struktur dan kegunaannya.

[6 marks]

[*6 markah*]

CLO1 C3

(c) An air filled circular waveguide is operated at frequency of 10GHz while the critical frequency is fo = 0.75F. Calculate the diameter of the waveguide if X*mn* =1.841.

Satu pandu gelombang bulat berisi udara beroperasi pada frekuensi 10GHz manakala frekuensi kritikal adalah fo=0.75F. Kirakan diameter bagipandu gelombang tersebut jika Xmn=1.841.

[6 marks]

[*6 markah*]

QUESTION 3

SOALAN 3

CLO1
C2

(a) Determine the actual impedance for the following normalized impedance, with character impedance at 50Ω:

i) $Z_x' = 1 - j\,0.5\ \Omega$

ii) $Z_y' = 2.5 + j\,0.8\ \Omega$

Tentukan galangan sebenar bagi galangan ternormal berikut, dengan galangan ciri sebanyak 50Ω:

i) $Z_x' = 1 - j\,0.5\ \Omega$

ii) $Z_y' = 2.5 + j\,0.8\ \Omega$

[3 marks]

[*3 markah*]

CLO1
C3

(b) In a transmission line, standing wave is generated when the reflected wave is added to the incident wave, interpret and relate the relationship between reflection coefficient (Γ) and Voltage Standing Wave Ratio (VSWR). By using a suitable formula, calculate the voltage standing wave ratio (VSWR) in decibel (dB) if the maximum voltage is 45V and the minimum voltage is 15V.

Di dalam talian penghantaran, gelombang pegun terbentuk apabila gelombang pantulan bercampur dengan gelombang tuju, tafsir dan hubungkaitkan antara pekali pantulan (Γ) *dengan nisbah voltan gelombang pegun(VSWR). Dengan menggunakan formula yang bersesuaian, kira nisbah voltan gelombang pegun (VSWR) dalam desibel(dB) jika nilai voltan maksima ialah 45V dan voltan minimum ialah 15V.*

[6 marks]

[*6 markah*]

CLO1 C3 (c) Illustrate the block diagram of the instrument for microwave testing. Based on the diagram drawn, list the function of microwave source and power meter.
Gambarkan rajah blok yang menunjukkan peralatan untuk pengujian gelombang mikro. Berdasarkan gambarajah tersebut, senaraikan fungsi punca gelombang mikro dan meter kuasa.

[6 marks]
[*6 markah*]

QUESTION 4
SOALAN 4

CLO1 C1 (a) Write down the function of an isolator in a waveguide system.
Tuliskan fungsi isolator dalam sistem pandu gelombang.

[3 marks]
[*3 markah*]

CLO1 C2 (b)

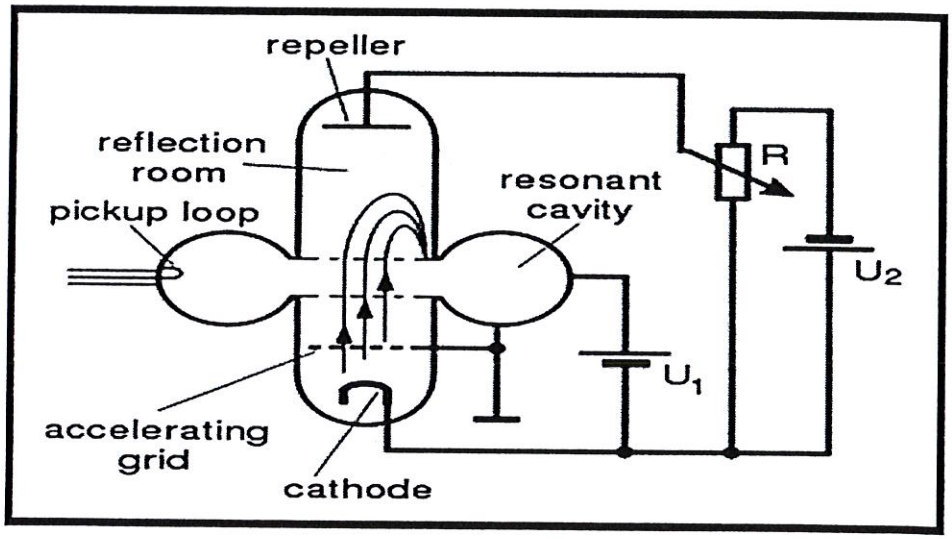


Figure A4(b) / Rajah A4(b)

Figure A4(b) above shows the microwave tube source called Reflex Klystron. Based on the figure, describe clearly the function of "Cathode", "Repeller" and the "Resonant Cavity".

Rajah A4(b) di atas menunjukkan punca gelombang mikro tiub yang dipanggil Reflex Klystron. Huraikan dengan jelas fungsi bagi "Katod", "Repeller" dan "Rongga Salunan".

[5 marks]

[*5 markah*]

CLO1
C3

(c) A horn antenna with a dimension of 0.6m x 0.4m is used to transmit signal at a frequency of 10GHz. If the aperture efficiency is 0.582, calculate the gain of the antenna.

Sebuah antenna hon berdimensi 0.6m x 0.4m digunakan untuk penghantaran isyarat pada frekuensi 10GHz. Jika kecekapan bukaannya adalah 0.582, kirakan gandaan bagi antenna tersebut.

[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 **TWO (2)** soalan esei. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1 C3 (a) A rectangular waveguide with an inner dimension of (4.0 x 2.0) cm is used for propagating a microwave signal at mode TE_{11}. If the microwave frequency given is 12 GHz, calculate the cut-off frequency, cut-off wavelength, guide wavelength and velocity of the waveguide.

Sebuah pandu gelombang empat segi mempunyai dimensi dalaman (4.0 x 2.0) cm digunakan untuk merambat satu isyarat gelombang mikro pada mod TE_{11}. Jika diberi frekuensi gelombang mikro adalah 12 GHz, kirakan frekuensi potong, panjang gelombang pandu, panjang gelombang potong dan halaju dalam pandu gelombang.

[10 marks]

[*10 markah*]

CLO1 C3 (b) An air-filled circular waveguide having an inner diameter of 9 cm is operated in a dominant mode with frequency 12 GHz. Calculate the cut-off frequency, guide wavelength and wave characteristic impedance.

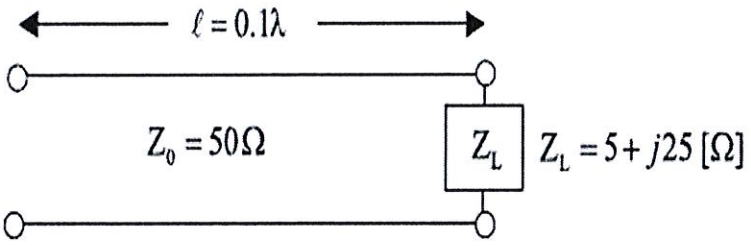
Sebuah pandu gelombang bulat berisi udara mempunyai garis pusat dalaman 9 cm beroperasi dalam mod dominan pada frekuensi 12 GHz. Kira frekuensi potong, panjang gelombang pandu dan galangan ciri gelombang.

[10 marks]

[*10 markah*]

QUESTION 2

SOALAN 2



CLO2
C4

The 0.1 λ length line above has a characteristic impedance of 50 Ω and it is terminated with a load impedance of Z_L = 5 + j25 Ω. Locate the normalized load impedance on the Smith Chart. Determine the value of Voltage standing wave Ratio (VSWR), reflection coefficient, angle of reflection coefficient and input impedance (Zin) at l = 0.1 λ.

Panjang talian 0.1 λ seperti rajah di atas mempunyai galangan ciri 50 Ω dan ditamatkan dengan galangan beban Z_L = 5 + j25 Ω . Tandakan lokasi galangan beban ternormal pada Carta Smith. Tentukan nilai bagi nisbah gelombang pegun (VSWR), pekali pantulan, sudut pekali pantulan dan galangan masukan (Z_{in}) pada talian l = 0.1 λ.

[20 marks]

[*20 markah*]

SOALAN TAMAT

FORMULA

$$c = \lambda f = (3 \times 10^8) ms^{-1}$$

Rectangular waveguide	Circular waveguide
Cut-off wavelength $\lambda_c = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}$	Cut-off wavelength (TE_{mn}) $\lambda_c = \frac{2\pi r}{\chi_{mn}}$ Cut-off wavelength (TM_{mn}) $\lambda_c = \frac{2\pi r}{\chi_{mn}}$
Cut-off frequency $f_c = \frac{c}{2}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$ $f_c = \frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$ $\mu_0 = 4\pi \times 10^{-7}$ H/m $\varepsilon_0 = 8.854 \times 10^{-12}$ F/m	Cut-off frequency (TE_{mn}) $f_c = \frac{c\chi}{2\pi r}$ Cut-off frequency (TM_{mn}) $f_c = \frac{c\chi}{2\pi r}$

Value of χ_{mn}

	$m=0$	$m=1$	$m=2$	$M=3$	$m=4$	$m=5$	$m=6$
$n=1$	3.8318	1.8412	3.0542	4.2012	5.3175	6.4155	7.5013
$n=2$	7.0156	5.3315	6.7062	8.0153	9.2824	10.5199	11.7349
$n=3$	10.1735	8.5363	9.9695	11.3459	12.6819	13.9872	15.2682
$n=4$	13.3237	11.7060	13.1704	14.5859	15.9641	17.3129	18.6375
$n=5$	16.4706	14.8636	16.3475	17.7888	19.1960	20.5755	21.9317

Value of X_{mn}

	$m=0$	$m=1$	$m=2$	$M=3$	$m=4$	$m=5$	$m=6$
$n=1$	2.4049	3.8318	5.1357	6.3802	7.5884	8.7715	9.9361
$n=2$	5.5201	7.1056	8.4173	9.7610	11.0647	12.3386	13.5893
$n=3$	8.6537	10.1735	11.6199	13.0152	14.3726	15.7002	17.0038
$n=4$	11.7915	13.3237	14.7960	16.2235	17.6160	18.9801	20.3208
$n=5$	14.9309	16.4706	17.9598	19.4094	20.8269	22.2178	23.5861

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

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

$Z_{o(TE)} = \frac{377}{\sqrt{\left(1-\left(\frac{\lambda_o}{\lambda_c}\right)^2\right)}}$ or $Z_{o(TE)} = \frac{377}{\sqrt{\left(1-\left(\frac{f_c}{f_o}\right)^2\right)}}$	
$Z_{o(TM)} = 377 \times \sqrt{\left(1-\left(\frac{\lambda_o}{\lambda_c}\right)^2\right)}$ or $Z_{o(TM)} = 377 \times \sqrt{\left(1-\left(\frac{f_c}{f_o}\right)^2\right)}$	
$Z_{IN} = j\, Z_{TEmn} \tan(\beta l)$; $Z_{IN} = j\, Z_{TMmn} \tan(\beta l)$; $\beta = \frac{2\pi f_o}{c}\sqrt{\left(1-\left(\frac{f_c}{f_o}\right)^2\right)}$	
Transmission Lines Equation	
$Reflection\ Coefficient, \Gamma = \left(\frac{Z_O - Z_L}{Z_L + Z_L}\right)$	VSWR= $\left(\frac{1+\lvert\Gamma\rvert}{1-\lvert\Gamma\rvert}\right)$
Antenna	
$front\ to\ back\ ratio = \frac{front\ lobe\ power}{back\ lobe\ power}$	$front\ to\ side\ ratio = \frac{front\ lobe\ power}{side\ lobe\ power}$
(Parabolic Antenna) $Beam\ Width, \alpha = \frac{70\lambda}{D}$	Horn Antenna, $Beam\ Width, \alpha = \frac{80\lambda}{W}$
$P_T = \eta\left(\frac{\pi D}{\lambda}\right)^2$	$P_T = (P_R G)$
$G(dB) = 10\ log\frac{4\pi kA}{\lambda^2}$	$Attenuation\ (dB) = \frac{54z}{\lambda c}$

The Complete Smith Chart

Black Magic Design