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) In Communication System, microwave is needed to carry an information signal from sender to receiver. Define microwave.

Dalam Sistem Komunikasi, gelombang mikro amat diperlukan dalam membawa isyarat maklumat daripada sistem penghantar ke sistem penerima.

Definisikan gelombang mikro.

[3 marks]
[3 *markah*]

CLO1
C2

(b) Explain the Hazard of Electromagnetic Radiation to Personnel and the possible effects due to electromagnetic radiation.

Terangkan Bahaya Radiasi Elektromagnetik terhadap Individu dan kesan yang mungkin disebabkan oleh radiasi elektromagnetik tersebut.

[6 marks]
[6 *markah*]

CLO1
C2

(c) Explain **THREE (3)** advantages of using very high frequency in microwave application.

*Terangkan **TIGA (3)** kelebihan menggunakan frekuensi yang sangat tinggi dalam aplikasi gelombang mikro.*

[6 marks]
[*6 markah*]

QUESTION 2

SOALAN 2

Answer all the questions based on the given statement below:

Jawab semua soalan berdasarkan pernyataan dibawah:

"A technician installs microwave transmission medium which propagates at 6 GHz. It is an air-filled waveguide operates at dominant mode."

"Seorang juruteknik memasang media penghantaran gelombang mikro yang dirambat pada 6 GHz. Media tersebut merupakan pandu gelombang berisi-udara yang beroperasi pada mod dominan."

CLO1
C2

(a) Assume that the above statement refers to a rectangular waveguide. Explain the rectangular waveguide with a diagram.

Andaikan penyataan di atas merujuk kepada pandu gelombang segi empat tepat. Terangkan pandu gelombang segi empat tepat dengan gambarajah

[3 marks]

[*3 markah*]

CLO2
C3

(b) Based on the above statement, if a technician installs WG13 type of waveguide with inner dimension 40 x 20 mm. Calculate;

i). Operating wavelength

ii). Cut-off frequency

iii). Cut-off wavelength

Berdasarkan kepada penyataan di atas, jika seorang juruteknik memasang pandu gelombang jenis WG13 yang berdimensi dalaman 40 x 20 mm. Kirakan;

i). Panjang gelombang operasi

ii). Frekuensi potong

iii). Panjang gelombang potong

[6 marks]

[*6 markah*]

CLO2
C3

(c) Refer to the above statement again, if the technician installs UG36U circular type of waveguide with inner area size 100π mm^2. (Given Table A1 for reference)
Calculate:

i). Radius of circular waveguide

ii). Cut-off frequency

iii). Cut-off wavelength

Merujuk kepada penyataan di atas sekali lagi, jika juruteknik tersebut memasang pandu gelombang bulat jenis UG36U yang keluasan dalaman 100π mm^2. (Diberi Jadual A1 untuk rujukan)

Kirakan;

i). Jejari bagi pandu gelombang bulat

ii). Frekuensi potong

iii). Panjang gelombang potong

[6 marks]
[*6 markah*]

	$\mathbf{m_1}$	$\mathbf{m_2}$	$\mathbf{m_3}$
n_0	3.832	7.016	10.174
n_1	1.842	5.331	8.536
n_2	3.054	6.706	9.970

Table A1 / Jadual A1

QUESTION 3

SOALAN 3

CLO2 C2

(a) A microwave transmission line terminated with load impedance. Assume that the characteristic of line impedance is same as the load impedance. Explain the reflection coefficient equation with appropriate diagram for this case.

Talian penghantaran gelombang mikro ditamatkan dengan beban galangan. Andaikan ciri galangan talian sama seperti beban galangan. Terangkan persamaan pekali pantulan dengan gambarajah yang sesuai bagi kes ini

[3 marks]

[*3* markah]

CLO2 C3

(b) A 50Ω lossless line is connected to a matched signal of 100kHz with load of (100 + j50) Ω. Calculate the reflection coefficient and Voltage Standing Wave Ratio(VSWR) of the load.

Talian tanpa-kehilangan 50Ω disambungkan serta dipadankan isyarat 100kHz untuk beban (100 + j50)Ω. Kirakan pekali pantulan dan Nisbah Voltan Gelombang Pegun (VSWR) bagi beban tersebut.

[6 marks]

[*6 markah*]

CLO2 C3

(c) A line impedance of 50Ω has a load impedance (150-j50) Ω. By using Smith Chart, show the following elements:

i) Normalized impedance value

ii) Voltage Standing Wave Ratio (VSWR)

iii) Reflection coefficient and angle of reflection coefficient

Talian bergalangan 50Ω mempunyai beban galangan (150-j50)Ω . Dengan menggunakan Carta Smith, tunjukkan elemen-elemen berikut;

i). Nilai galangan ternormal

ii). Nisbah Voltan Gelombang Pegun (VSWR)

iii). Pekali pantulan dan sudut pekali pantulan

[6 marks]

[*6 markah*]

QUESTION 4

SOALAN 4

CLO1
C1

(a) List **THREE (3)** types of waveguide components in a microwave.
*Senaraikan **TIGA (3)** jenis komponen pandu gelombang dalam gelombang mikro.*

[3 marks]
[*3 markah*]

CLO1
C2

(b) A group of students who conducted an experiment in the laboratory used Gunn diode at 5 GHz. The result of experiment was tabulated as in Diagram A2. Explain the operation based on Diagram A2 with equivalent circuit.
Sekumpulan pelajar mengendalikan eksperimen di dalam makmal menggunakan Gunn diod pada 5GHz. Hasil eksperimen telah dijadualkan seperti dalam Rajah A2. Terangkan operasi berdasarkan Rajah A2 bersama litar setara.

[5 marks]
[*5 markah*]

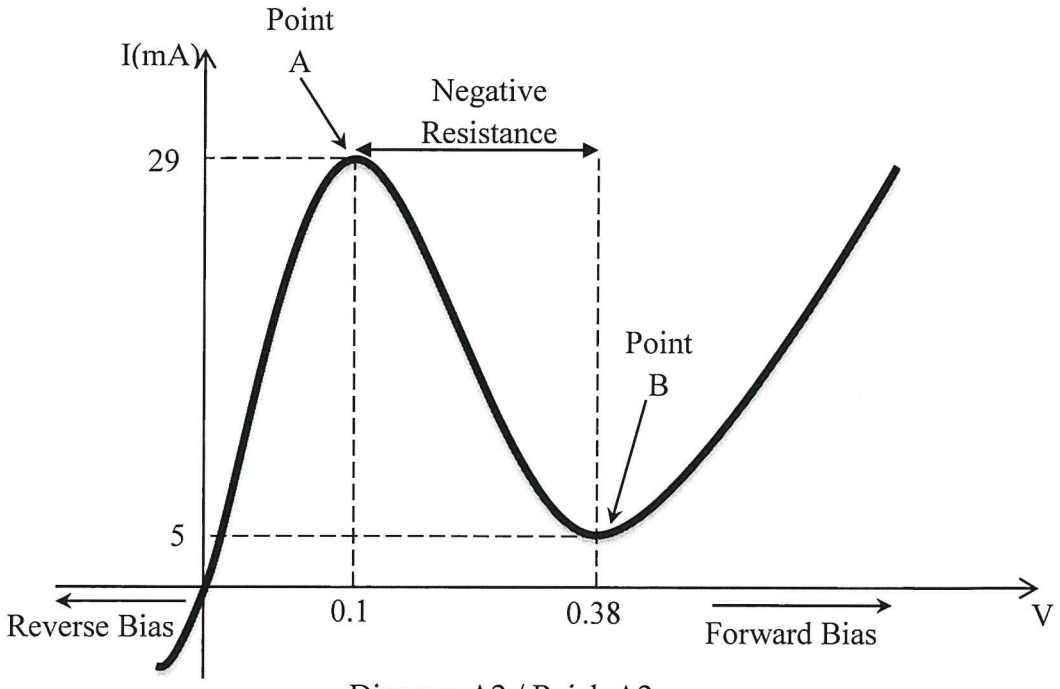


Diagram A2 / Rajah A2

CLO1
C3

(c) i. A horn antenna 12cm x 22cm is used to propagate 5 GHz frequency. The halfwave antenna angle beam is 13^0 and the aperture constant value is 0.59. Calculate the value gained in dB.

Antena horn 12cm x 12cm digunakan untuk merambat frekuensi 5 GHz. Pancaran sudut alur separuh gelombang adalah 13^0 dan nilai bukaan tetap 0.59. Kirakan nilai gandaan dalam dB.

ii. A reflective dish antenna is aligned at site to receive signal from transmitter. The diameter of receiver antenna is 180cm and operates at 9 GHz. Calculate the 3dB beamwidth and gain in dB for the receiver antenna.

Antena dish pantulan dilaras di tapak sejajar dengan penghantar untuk menerima isyarat. Diameter antena penerima adalah 180cm dan beroperasi pada 9 GHz. Kirakan lebar-alur 3dB dan gandaan dalam dB bagi antena penerima.

[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

An air filled rectangular waveguide is installed from RF amplifier to horn antenna as a transmission medium. It operates at frequency of 6 GHz in TE_{11} mode and the width is twice larger than the height of waveguide. The waveguide is matched with characteristic impedance 400 Ω. Calculate the cut-off frequency, wavelength guide, width and length of waveguide, and cutoff wavelength.

Pandu gelombang segiempat tepat berisi udara dipasang dari penguat RF ke horn antena sebagai medium penghantaran. Ia beroperasi pada frekuensi 6 GHz dalam mod TE_{11} dan lebarnya adalah dua kali ganda lebih besar daripada ketinggian pandu gelombang. Pandu gelombang dipadankan dengan galangan ciri 400 Ω . Kirakan frekuensi potong, panjang gelombang dalam pandu gelombang, lebar dan panjang pandu gelombang, dan panjang gelombang potong.

[20 marks]
[*20 markah*]

QUESTION 2
SOALAN 2

CLO2
C4

A load impedance $Z_L = (45 - j60)\Omega$ is connected to a line that has a characteristic impedance 75Ω. By using Smith Chart, determine the values for normalized load impedance (Z_L'), VSWR, reflection coefficient and angle of reflection coefficient ($\rho\angle\theta$), load admittance (Y_L) and input impedance (Z_{in}) when the length of transmission line is 0.06λ.

Suatu galangan beban $Z_L = (45 - j60)\Omega$ dihubungkan dengan talian yang mempunyai galangan ciri 75Ω. Dengan menggunakan Carta Smith , tentukan nilai untuk galangan beban ternormal(Z_L'), VSWR, pekali pantulan dan sudut pekali pantulan($\rho\angle\theta$), lepasan beban (Y_L) dan galangan masukan (Z_{in}) apabila panjang talian penghantaran adalah 0.06λ.

[20 marks]

[*20 markah*]

SOALAN TAMAT

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Effective Aperture Area, $A_e = \eta A$

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

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

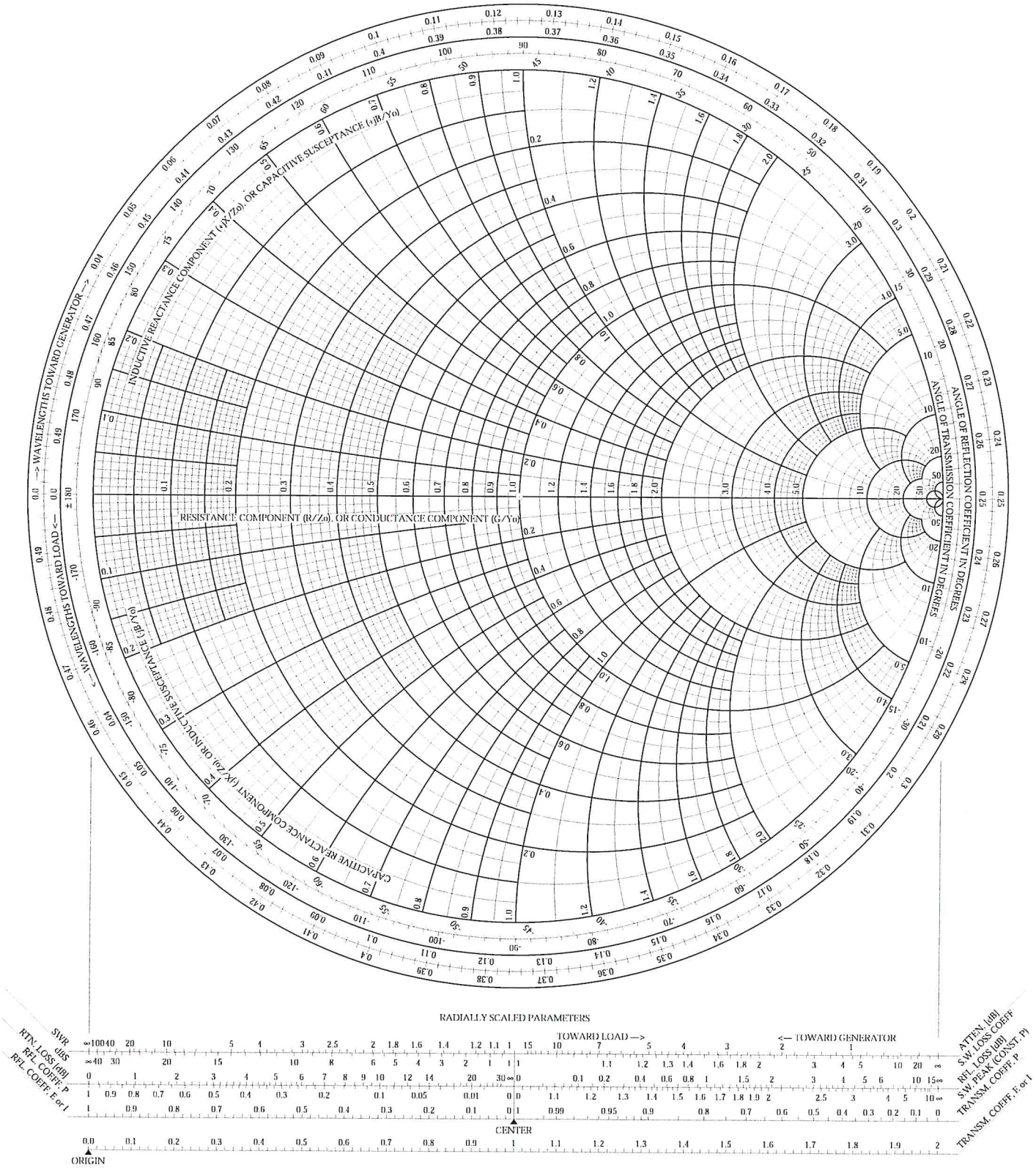
$P_T = P_R\,G$

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

The Complete Smith Chart

Black Magic Design



The Complete Smith Chart

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