SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI DISEMBER 2016

EP603: MICROWAVE DEVICES

TARIKH : 10 APRIL 2017
MASA : 2.30 PM – 4.30 PM (2 JAM)

Kertas ini mengandungi **TUJUH (7)** 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)

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

SOALAN 1

By using a suitable illustration, explain the principle of electric and magnetic field in an electromagnetic wave.

Terangkan dengan bantuan gambarajah prinsip medan elektrik dan medan magnet dalam gelombang elektromagnetik.

[4 marks]
[4 markah]

CLO1
C1

QUESTION 2

SOALAN 2

Describe **TWO (2)** types of electromagnetic wave radiation hazard and its effects.

*Perihalkan **DUA (2)** jenis gejala radiasi gelombang elektromagnetik dan kesan-kesannya.*

[4 marks]
[4 markah]

CLO1
C2

QUESTION 3

SOALAN 3

An electromagnetic wave can propagate with various field configuration or patterns known as propagation mode. Explain **TWO (2)** types of propagation modes.

*Gelombang elektromagnet boleh merambat dalam pelbagai konfigurasi medan atau pola yang dikenali sebagai mod perambatan. Terangkan **DUA (2)** jenis mod perambatan.*

[4 marks]
[4 markah]

QUESTION 4

SOALAN 4

CLO1
C2

Explain **TWO (2)** boundary conditions that regulates propagation in the waveguide.
*Terangkan **DUA (2)** syarat sempadan yang mengatur perambatan di dalam pandu gelombang.*

[4 marks]
[4 markah]

CLO1
C3

QUESTION 5

SOALAN 5

Illustrate the shape of ridge waveguide and twist waveguide.
Ilustrasikan bentuk pandu gelombang 'ridge' dan pandu gelombang pulas.

[4 marks]
[4 markah]

CLO2
C3

QUESTION 6

SOALAN 6

Given admittance Y=1+j1. Illustrate the value of reflection coefficient (Γ) and impedance (Z) on Smith Chart.
Diberi nilai lepasan Y=1+j1. Ilustrasikan nilai pekali pantulan (Γ) dan galangan (Z) di atas Smith Chart.

[4 marks]
[4 markah]

CLO2
C3

QUESTION 7

SOALAN 7

A transmission line with $Z_L = 0.2 - j\ 0.2\ \Omega$ of load is connected to Zo = 1 Ω. By using Smith Chart, find the value of Z at l = 0.25 λ.
Satu talian penghantaran dengan galangan beban $Z_L = (0.2 - j\ 0.2)\ \Omega$ disambung kepada galangan ciri $Z_o = 1\ \Omega$. Dengan menggunakan Carta Smith, tentukan nilai Z pada l = 0.25 λ.

[4 marks]
[4 markah]

CLO1
C1

QUESTION 8

SOALAN 8

Microwave sources are divided into microwave tube and microwave semiconductor. List **TWO (2)** examples for each type.
*Sumber gelombang mikro terbahagi kepada gelombang mikro jenis tiub dan gelombang mikro jenis semikonduktor. Senaraikan **DUA (2)** contoh bagi setiap jenis tersebut.*

[4 marks]
[4 markah]

CLO1
C3

QUESTION 9

SOALAN 9

By using a suitable diagram, briefly explain the basic operation of transmitting and receiving antenna.
Dengan menggunakan gambarrajah yang sesuai, terangkan secara ringkas mengenai operasi asas penghantaran dan penerimaan antena.

[4 marks]
[4 markah]

CLO2
C3

QUESTION 10

SOALAN 10

A transmitter horn antenna with dimension 8 cm x 4 cm operates using frequency 6 GHz. If the aperture efficiency is 0.6, calculate the signal wavelength and antenna's gain.

Satu pemancar antena horn berukuran 8 cm x 4 cm beroperasi dengan menggunakan frekuensi 6 GHz. Sekiranya kecekapan bukaan adalah 0.6, kira panjang gelombang isyarat dan gandaan antena.

[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.*

QUESTION 1

SOALAN 1

CLO 2
C3

(a) A rectangular waveguide is filled by dielectric material of $\varepsilon_r = 9$ and has internal dimension of 7 cm x 3.5 cm is operated in dominant mode, TE_{10}. Calculate the cut off frequency, the phase velocity in the guide at frequency of 2 GHz and the guide wavelength at 2 GHz.

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

[10 marks]

[10 markah]

(b) An air-filled circular waveguide having an inner diameter of 4 cm is operated in a dominant mode of 10 GHz. Based on Table B1, calculate the cut off frequency, the guide wavelength and the characteristic wave impedance.

Sebuah pandu gelombang bulat berisi udara mempunyai diameter dalaman sebanyak 4 cm beroperasi dalam mod dominan pada frekuensi 10GHz. Berdasarkan Jadual B1, kira frekuensi potong, panjang gelombang bagi pandu gelombang, dan galangan ciri gelombang.

KR_{mn}	m=0	m=1	m=2	m=3
n=1	3.8318	1.8412	3.0542	4.2012
n=2	7.0156	5.3315	6.7062	8.0153
n=3	10.1735	8.5363	9.9695	11.3459

Table B1 / Jadual B1

[10 marks]

[10 markah]

QUESTION 2

SOALAN 2

CLO1
C2

(a) Describe Smith chart and label all the following items on Smith Chart: Normalize resistance r = 0.5, Normalize reactance = -j0.4, Short circuit position and Transmission line distance scale.

Perihalkan tentang Carta Smith dan labelkan semua perkara berikut pada Carta Smith: Bulatan rintangan ternormal r = 0.5, Lengkungan regangan ternormal = –j0.4, Kedudukan litar pintas dan Skala jarak di atas talian.

[6 marks]

[6 markah]

CLO2
C3

(b) A load of (45 - j90) Ω is connected to the lossless transmission line with 20cm length. The operating frequency is 0.15GHz and characteristic impedance is 75Ω. By using Smith Chart, find and initiate VSWR (dB), reflection coefficient, angle of reflection and input impedance.

Satu beban (45 - j90) Ω disambungkan kepada 20 cm talian penghantaran tanpa kehilangan. Frekuensi operasi adalah 0.15GHz dan galangan ciri 75Ω. Dengan menggunakan Carta Smith, cari dan tandakan VSWR (dB) , pekali pantulan, sudut pantulan dan input impedan.

[14 marks]

[14 markah]

CLO1
C1

QUESTION 3

SOALAN 3

(a) Magnetron is one of crossed-field tubes. Draw the schematic diagram of magnetron.

Magnetron adalah salah satu daripada beberapa tiub medan berpalang. Lukiskan gambarajah skematik bagi magnetron.

[4 marks]

[*4 markah*]

CLO2
C3

(b) For a 2 m radius parabolic reflector with 10 W of power radiated by the feed mechanism operating at 6 GHz with an efficiency of 55%. Calculate the beamwidth, the transmit power gain, the receive power gain and the Effective Isotropic Radiated Power (EIRP) in dBm.

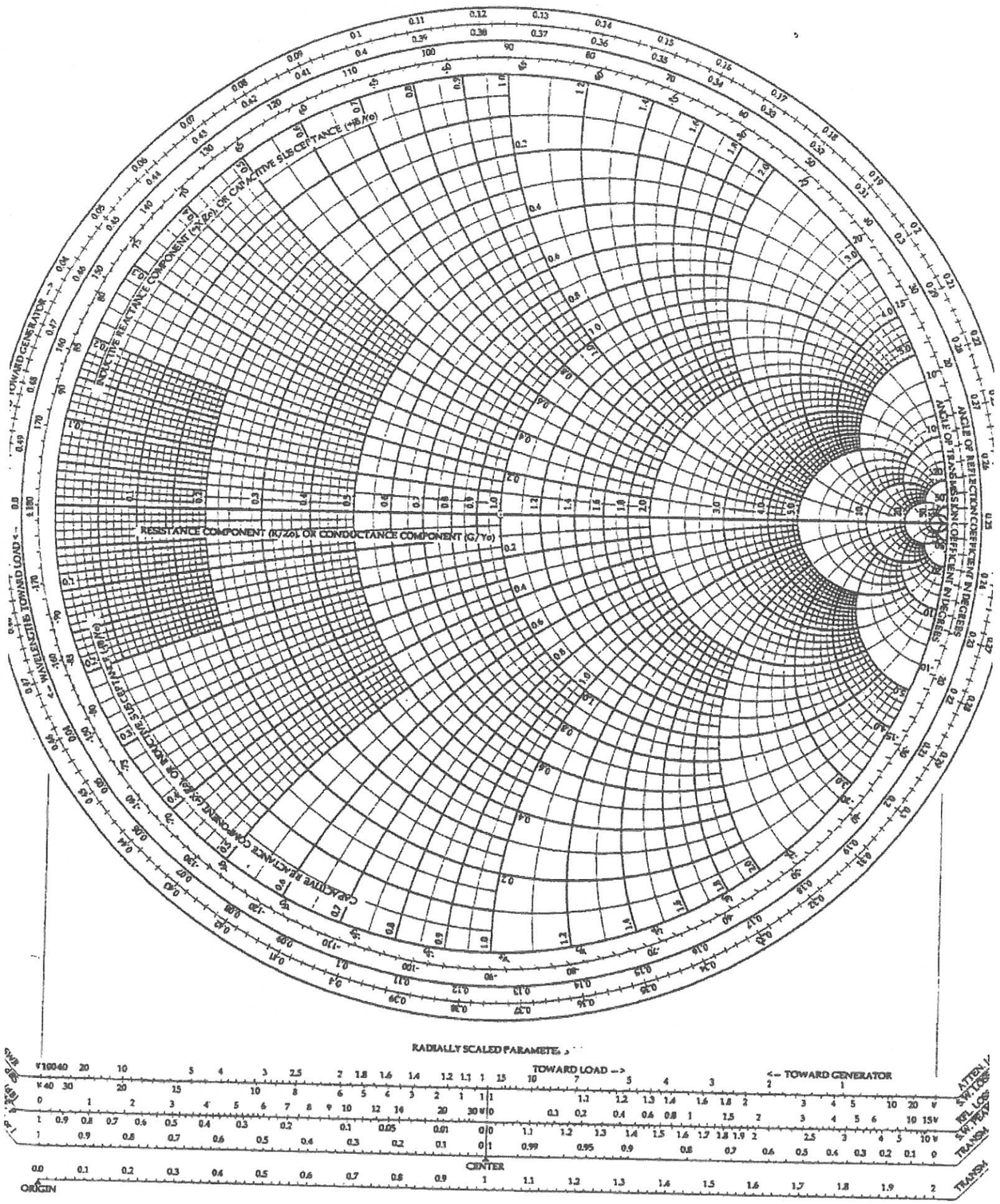
Untuk pemantul parabola berjejari 2 m dengan kuasa 10 W dipancarkan oleh mekanisma suapan yang beroperasi pada 6 GHz dengan kecekapan 55%. Kirakan nilai lebar alur, gandaan kuasa pemancar, gandaan kuasa penerima dan Kesan Isotropik Pancaran Kuasa (EIRP) dalam dBm.

[16 marks]

[16 *markah*]

SOALAN TAMAT

The Smith Chart



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

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

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

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

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

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

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

APPENDIX EP603

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