SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENGAJIAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI II : 2021 / 2022

DEP50043: MICROWAVE DEVICES

TARIKH : 02 JULAI 2022
MASA : 8.30 PAGI – 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.
Bahagian A: Struktur (2 soalan)
Bahagian B: Esei (2 soalan)
Dokumen sokongan yang disertakan : **FORMULA dan 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 **TWO (2)** structure questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan subjektif. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1
C3

(a) A technician installs a microwave transmission medium, which propagates at 6GHz. It is an air-filled waveguide that operates at dominant mode. If the technician installs WG13 type of waveguide with inner dimension 40 mm x 20 mm, calculate:

Seorang juruteknik memasang media penghantaran gelombang mikro yang dirambat pada 6 GHz. Media tersebut merupakan pandu gelombang berisi udara yang beroperasi pada mod dominan. Jika juruteknik tersebut memasang pandu gelombang jenis WG13 yang berdimensi dalaman 40 mm x 20 mm, kirakan:

i. Operating wavelength.
Panjang gelombang operasi.

ii. Cut-off wavelength.
Panjang gelombang potong.

iii. Cut-off frequency.
Frekuensi potong.

iv. Guide wavelength.
Panjang gelombang pandu

[10 marks]
[*10 markah*]

CLO1 C3

(b) A rectangular waveguide with a dimension of 2 cm x 1 cm filled with deionized water that has $\mu_r = 1$ and $\varepsilon_r = 81$ operates at 3 GHz in a TE_{11} mode. Calculate:

Satu pandu gelombang dengan dimensi 2 cm x 1 cm diisi dengan air ternyahion yang mempunyai $\mu_r = 1$ dan $\varepsilon_r = 81$ beroperasi pada 3 GHz dalam mod TE_{11}. Kirakan:

i. Cut-off wavelength.
Panjang gelombang potong.

ii. Cut-off frequency.
Frekuensi potong.

iii. Phase velocity.
Halaju fasa.

iv. Characteristic impedance of the guide.
Galangan ciri bagi pandu gelombang.

[10 marks]
[*10 markah*]

CLO1
C3

(c) A certain transmission line has a characteristic impedance of 75 + j0.01 Ω and is terminated in a load impedance of 70 + j50 Ω. Calculate:

Satu kabel penghantaran tertentu mempunyai galangan ciri (75 + j0.01) Ω *dan ditamatkan dengan galangan beban (70 + j50)* Ω*. Kirakan:*

i. Reflection coefficient.
Pekali pantulan.

ii. Voltage standing wave ratio.
Nisbah voltan gelombang pegun.

iii. Voltage standing-wave ratio in decibel.
Nisbah voltan gelombang pegun dalam desibel.

[10 marks]
[*10 markah*]

QUESTION 2

SOALAN 2

CLO1
C3

(a) A load of (120 - j150) Ω is connected to a 50 Ω transmission line. By using a Smith Chart, calculate the following elements:

Satu beban (120 – j150) disambungkan kepada talian penghantaran 50 Ω*. Dengan menggunakan Carta Smith, kirakan elemen-elemen berikut:*

i. Normalised load impedance value.
Nilai galangan beban ternormal.

ii. Voltage standing wave ratio.
Nisbah voltan gelombang pegun.

iii. Reflection coefficient and angle of reflection coefficient.
Pekali pantulan dan sudut pekali pantulan.

[10 marks]
[*10 markah*]

CLO1
C3

(b) A transmitter antenna with dimension 5 cm x 3 cm operates using frequency 12.75 GHz. If the aperture efficiency is 0.597, calculate:

Sebuah antena pemancar dengan dimensi 5 cm x 3 cm beroperasi menggunakan frekuensi 12.75 GHz. Jika kecekapan apetur ialah 0.597, kirakan:

i. Wavelength of the signal.
Panjang gelombang isyarat.

ii. Beamwidth angle.
Sudut lebar pancaran.

iii. Antenna's gain.
Gandaan antena.

iv. Antenna gain in decibel.
Gandaan antena dalam desibel.

[10 marks]
[*10 markah*]

CLO1
C3

(c) For a transit antenna with radiation resistance Rr = 72 Ω, and effective antenna resistance, Re = 8 Ω, directive gain, D = 20 and the input power, Pin = 100 W. Calculate:

Satu antenna dengan galangan sinaran Rr = 72 Ω, kerintangan berkesan bagi antenna Re = 8 Ω, gandaan D = 20 dan kuasa masukan Pin = 100 W. kirakan:

i. Antenna efficiency.
Kecekapan antenna.

ii. Antenna gain in dB.
Gandaan bagi antenna dalam dB.

iii. Radiated power in watt.
Pancaran kuasa dalam watt.

iv. EIRP in watts.
EIRP dalam watts.

[10 marks]
[*10 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

CLO1
C4

A 1.5 meter long aluminum waveguide (a = 4.22 cm, b = 1.5 cm, $\sigma_c = 3.5 \times 10^7$ mhos/m) filled with teflon ($\mu_r = 1$, $\varepsilon_r = 2.6$, $\sigma_d = 1 \times 10^{-15}$ mhos /m) operates at 4 GHz in TE_{10} mode. Show whether there is attenuation occurred in the waveguide or not based on the condition of $f_0 > f_c$. Determine conductor loss, dielectric loss, waveguide loss and waveguide loss in decibel over the distance.

Pandu gelombang aluminium sepanjang 1.5 meter (a = 4.22 cm, b = 1.5 cm, $\sigma c = 3.5 \times 10^7$ mhos/m) yang diisi dengan teflon ($\mu r = 1$, $\varepsilon r = 2.6$, $\sigma d = 1 \times 10^{-15}$ mhos /m) beroperasi pada 4 GHz dalam mod TE_{10}. Tunjukkan sama ada terdapat pengecilan berlaku dalam pandu gelombang atau tidak berdasarkan kepada syarat $f_0 > f_c$. Tentukan kehilangan konduktor, kehilangan dielektrik, kehilangan pandu gelombang dan kehilangan pandu gelombang dalam decibel di sepanjang jarak tersebut.

[20 marks]

[*20 markah*]

QUESTION 2
SOALAN 2

CLO1
C4

The voltage standing wave caused by a mismatched load has a maximum value of 80V and minimum value of 19V when the 75 Ω transmission line is terminated with an unknown load. Use Smith Chart to determine the standing wave ratio, load impedance if the minimum distance of the standing wave from the load is 0.15λ, reflection coefficient, load admittance and input impedance at 0.3λ from the load.

Voltan gelombang pegun yang disebabkan oleh beban yang tidak sepadan mempunyai nilai maksimum 80V dan nilai minimum 19V apabila talian penghantaran 75 Ω ditamatkan dengan beban yang tidak diketahui. Gunakan Carta Smith untuk menentukan nisbah gelombang pegun, galangan beban jika jarak minimum gelombang pegun dari beban ialah 0.15λ, pekali pantulan, kemasukan beban dan galangan masukan pada 0.3λ dari beban.

[20 marks]
[*20 markah*]

SOALAN TAMAT

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

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

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

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

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

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

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

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

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

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

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

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

W/d > 1

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(1+\frac{12d}{W}\right)^{-1/2}$$

$$Z_o = \frac{376.7}{\sqrt{\varepsilon_{eff}}\left[\frac{W}{d}+1.4+0.667\ln\left(\frac{W}{d}+1.444\right)\right]}$$

$$v_p = \frac{c}{\sqrt{\varepsilon_{eff}}}$$

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

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

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

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

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

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

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

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

$$Effective\ Aperture\ Area,\ A_e = \eta A$$

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

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

$P_T = P_R\,G$

The Complete Smith Chart

Black Magic Design