

**SULIT**



**BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENGAJIAN POLITEKNIK  
KEMENTERIAN PENDIDIKAN MALAYSIA**

**JABATAN KEJURUTERAAN ELEKTRIK**

**PEPERIKSAAN AKHIR  
SESI DISEMBER 2013**

**EP603: MICROWAVE DEVICES**

**TARIKH : 09 APRIL 2014  
TEMPOH : 2.30PM – 4.30PM (2 JAM)**

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.

Bahagian A: Struktur (10 soalan)

Bahagian B: Esei (3 soalan)

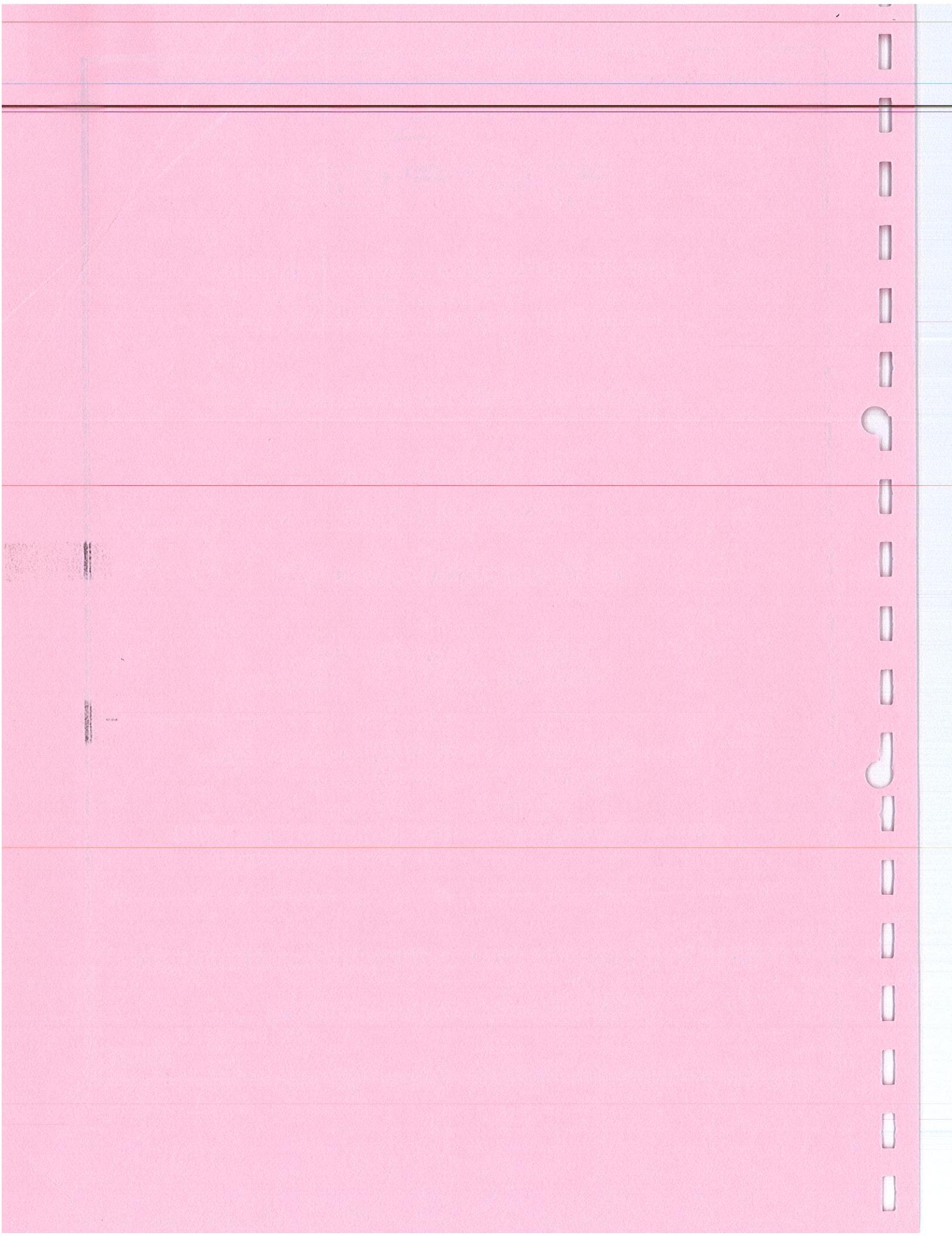
Dokumen sokongan yang disertakan :Lampiran 1(Carta Smith)

Lampiran 2 (Rumus)

**JANGAN BUKA KERTAS SOALANINI SEHINGGA DIARAHKAN**

(CLO yang tertera hanya sebagai rujukan)

**SULIT**



**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  
C1

**QUESTION 1**

State the definition of microwave.

**SOALAN 1**

Nyatakan takrifan gelombang mikro.

[4 marks]

[4 markah]

CLO1  
C2

**QUESTION 2**

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

**SOALAN 2**

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

[4 marks]

[4 markah]

CLO 1  
C2

**QUESTION 3**

State the definition of the propagation mode:

- a) TE Mode
- b) TM Mode

**SOALAN 3**

Nyatakan definisi mod perambatan:

- a) Mod TE
- b) Mod TM

[4 marks]

[4 markah]

CLO1  
C2**QUESTION 4**

By using a suitable diagram, explain the propagation of microwave when the operating frequency reaches the waveguide's cut-off frequency.

**SOALAN 4**

Dengan menggunakan rajah yang bersesuaian, terangkan perambatan gelombang mikro apabila frekuensi operasi mencecah frekuensi potong pandu gelombang.

$$a = 5 = 0.005 \text{ m}$$

[4 marks]

[4 markah]

CLO2  
C3**QUESTION 5**

A rectangular waveguide with a cross section of  $5\text{cm} \times 2\text{cm}$  is used to propagate  $\text{TM}_{11}$  mode. Calculate the cut-off wavelength.

**SOALAN 5**

Pandu gelombang segi empat tepat mempunyai keratan rentas  $5\text{cm} \times 2\text{cm}$  digunakan untuk merambat mod  $\text{TM}_{11}$ . Kirakan panjang gelombang potong.

[4 marks]

[4 markah]

CLO2  
C3**QUESTION 6**

By using Smith Chart, locate the following impedances if the characteristic impedance is  $50\Omega$ .

i.  $Z_1 = j200\Omega$

ii.  $Z_2 = 150\Omega$

**SOALAN 6**

Dengan menggunakan carta Smith, plotkan koordinat galangan – galangan yang berikut apabila galangan ciri talian adalah  $50\Omega$ .

i.  $Z_1 = j200\Omega$

ii.  $Z_2 = 150\Omega$

[4 marks]

[4 markah]

CLO2  
C3

### QUESTION 7

Given that the VSWR equal to 4 when the  $75\Omega$  transmission line is terminated with unknown load,  $Z_L$ . Use Smith chart to find the  $Z_L$  if the minimum distance of the standing wave from the load is  $0.15\lambda$ .

#### SOALAN 7

Diberi nilai VSWR bersamaan dengan 4 apabila suatu talian penghantaran bergalangan ciri,  $75\Omega$  ditamatkan dengan beban yang tidak diketahui,  $Z_L$ . Gunakan carta Smith bagi mencari nilai  $Z_L$  jika jarak minima glombang pegun dari beban adalah  $0.15\lambda$ .

[4 marks]

[4 markah]

CLO1  
C2

### QUESTION 8

List FOUR (4) main structures of a Travelling Wave Tube (TWT).

#### SOALAN 8

Senaraikan EMPAT (4) struktur utama dalam sebuah Tiub Kembara Gelombang (TWT).

[4 marks]

[4 markah]

CLO1  
C1

### QUESTION 9

Describe TWO (2) functions of microwave antenna.

#### SOALAN 9

Perihalkan DUA (2) kegunaan antenna gelombang mikro.

[4 marks]

[4 markah]

CLO2  
C3

**QUESTION 10**

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

- i) Wavelength of the signal
- ii) Antenna's Gain

**SOALAN 10**

Sebuah pemancar antena horn yang berdimensi 5cm x 3cm beroperasi pada frekuensi 12.75GHz. Sekiranya kecekapan bukaan adalah 0.597, kirakan:

- i) Panjang gelombang isyarat
- ii) 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 eseai. Jawab semua soalan.

CLO2  
C3

**QUESTION 1**  
**SOALAN 1**

A rectangular air filled copper waveguide with a dimension of 2.3cm x 1.01cm cross section and 30.48cm length is operated at 9.2GHz with a dominant mode.

*Sebuah pandu gelombang segiempat tembaga berisikan udara mempunyai keratan rentas berdimensi 2.3cm x 1.01cm dan panjangnya 30.48cm serta beroperasi pada 9.2GHz dengan mod dominan.*

- a) Prove that signal can be propagated inside the waveguide

*Buktikan isyarat tersebut boleh merambat di dalam pandu gelombang itu.*

[8 marks]

[8 markah]

- b) Calculate:

Kirakan:

- i. Wavelength of the waveguide

*Panjang gelombang bagi pandu gelombang*

- ii. Group velocity and phase velocity

*Halaju kumpulan dan halaju fasa*

- iii. Characteristic impedance

*Galangan ciri*

[12 marks]

[12 markah]

CLO2  
C3

**QUESTION 2**  
**SOALAN 2**

- a) The voltage standing wave caused by a mismatched load has a maximum value of 50V and a minimum value of 30V. Calculate:

*Voltan bagi gelombang pegun disebabkan oleh beban tak sepadan mempunyai nilai maksimum 50V dan nilai minimum 30V. Kirakan :*

- i. Standing Wave Ratio, SWR (dB)  
*Nisbah Gelombang Pegun, SWR (dB)*
- ii. Reflection Coefficient,  $\Gamma$   
*Pekali Pantulan,  $\Gamma$*

[8 marks]

[8 marks]

CLO2  
C3

- b) By using Smith chart, determine the input impedance of a transmission line at a point  $0.625\lambda$  from the load  $Z_L = 75 - j25\Omega$ . The characteristic impedance of the line is  $50\Omega$ .

*Menggunakan carta Smith, tentukan galangan masukan suatu talian penghantaran pada titik  $0.625\lambda$  dari beban  $Z_L = 75 - j25\Omega$ . Galangan ciri pada talian ialah  $50\Omega$*

[12 marks]

[12 marks]

CLO1  
C1

**QUESTION 3**  
**SOALAN 3**

- a) List FOUR (4) sources of microwave semiconductor.

*Senarai EMPAT (4) punca gelombang mikro jenis semikonduktor.*

[4 marks]

[4 markah]

CLO1  
C2

- b) Explain the operation of reflex klystron with the aid of its schematic diagram

*Terangkan kendalian reflex klystron dengan bantuan gambarajah skematik*

[10 marks]

[10 markah]

CLO1  
C2

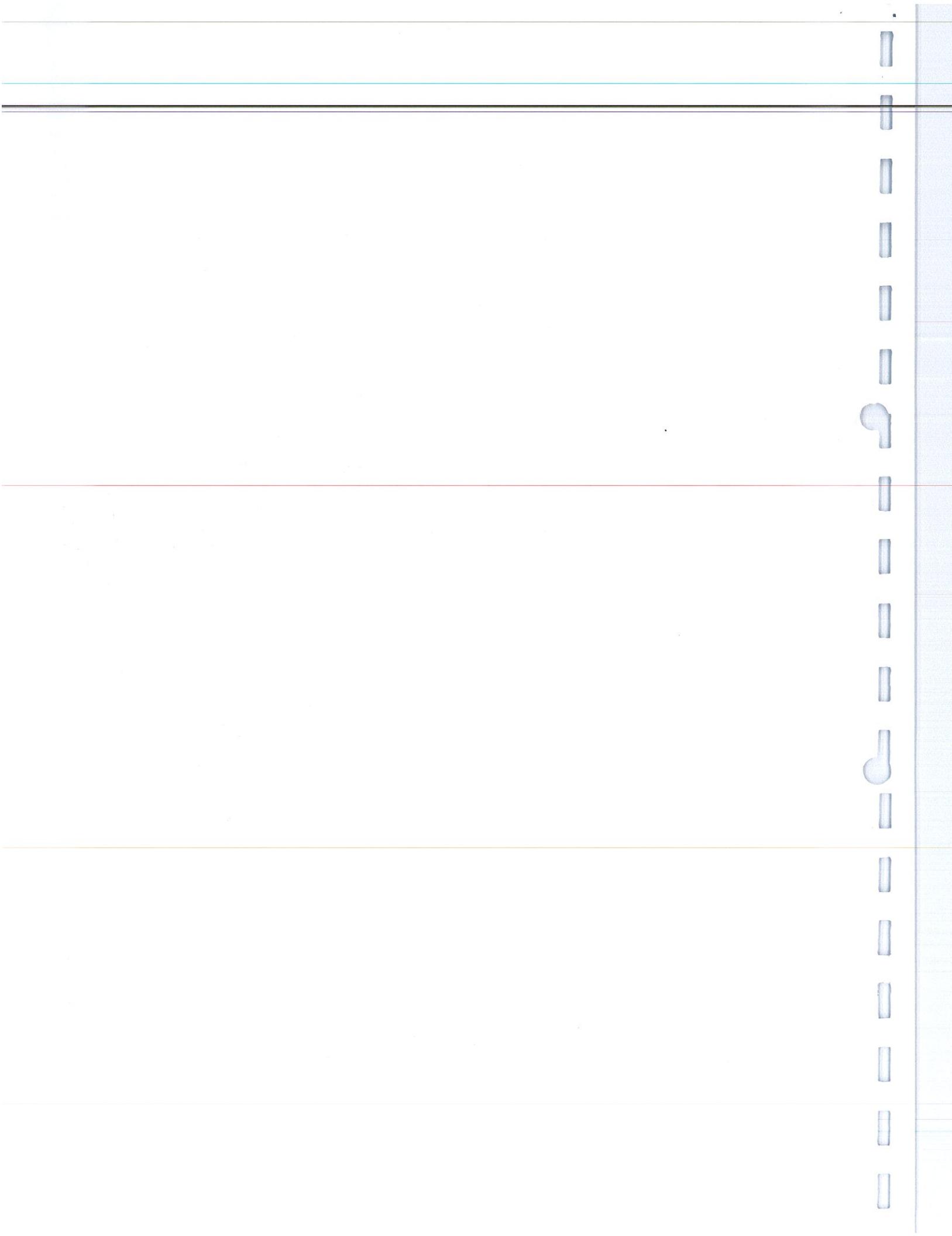
- c) With the aid of suitable diagram, explain briefly how Cassegrain feeder works with parabolic antenna.

*Dengan menggunakan gambarajah yang sesuai, terangkan secara ringkas bagaimana penyuap Cassegrain berkendali dengan antena parabola.*

[6 marks]

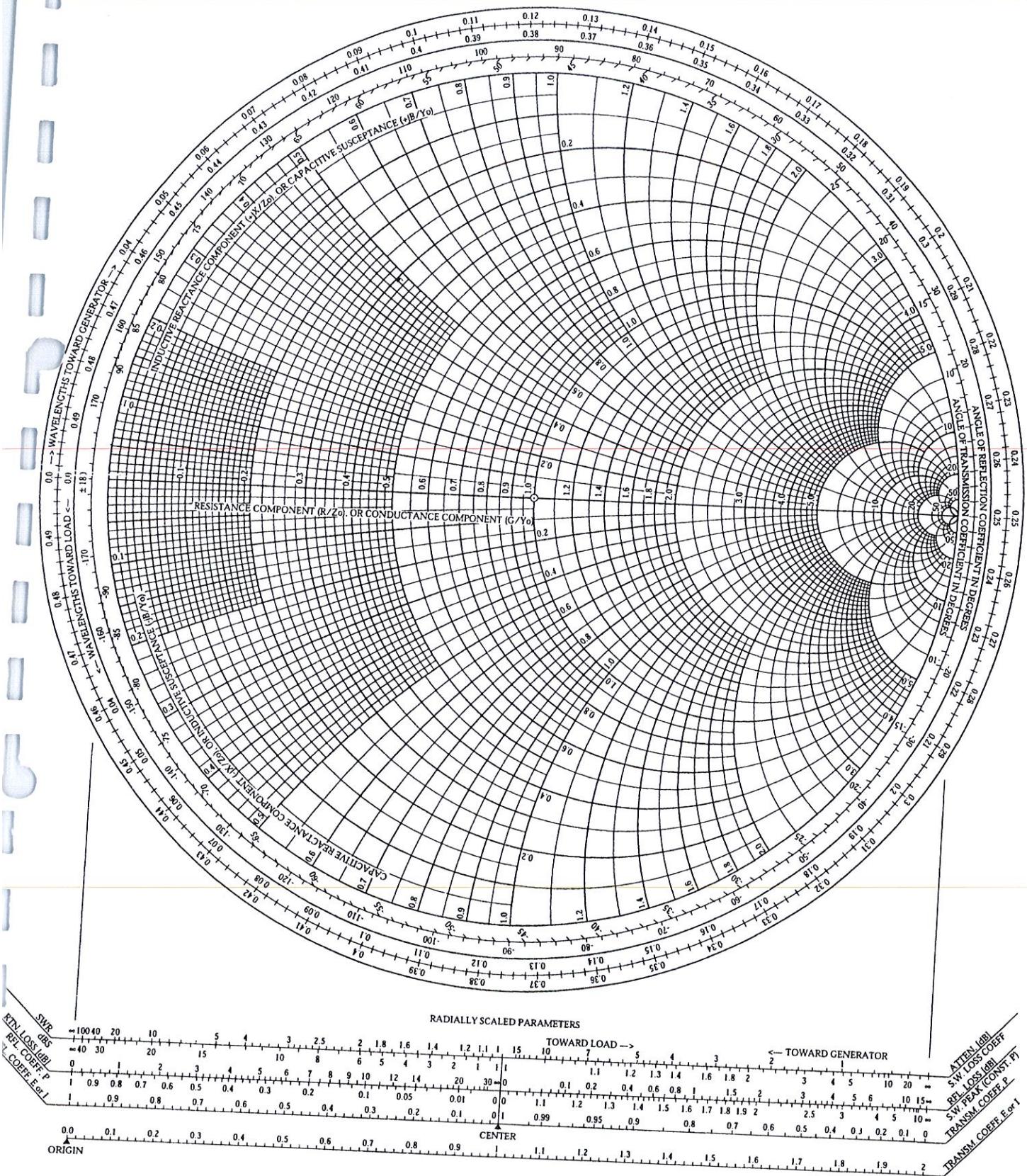
[6 markah]

**SOALAN TAMAT**



# The Complete Smith Chart

Black Magic Design



RECTANGULAR WAVEGUIDE (TE and TM Modes)		CIRCULAR WAVEGUIDE (TE AND TM Modes)
1. CUT-OFF FREQUENCY		1. CUT-OFF FREQUENCY
$f_c = \frac{c}{2} \sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$		$f_c = c \times \left( \frac{x_{np}}{2\pi a} \right)$
2. CUT-OFF WAVELENGTH		2. CUT-OFF WAVELENGTH
$\lambda_c = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}$		$\lambda_c = \frac{2\pi a}{x_{np}}$
3. GUIDE WAVELENGTH		3. GUIDE WAVELENGTH
$\lambda_g = \frac{\lambda}{\sqrt{1 - \left(\frac{\lambda}{\lambda_c}\right)^2}}$		$\lambda_g = \frac{\lambda}{\sqrt{1 - \left(\frac{\lambda}{\lambda_c}\right)^2}}$
4. OHMIC LOSS		4. OHMIC LOSS
$R_s = \sqrt{\pi f \mu / \sigma}$		$R_s = \sqrt{\pi f \mu / \sigma}$
5. ATTENUATION CONSTANT		5. ATTENUATION CONSTANT
$\alpha_c = \frac{R_s}{b \times \sqrt{\frac{\mu}{\epsilon}} \times \sqrt{1 - \left(\frac{f_c}{f}\right)^2}} \left[ 1 + \frac{2b}{a} + \left(\frac{f_c}{f}\right)^2 \right]$		$\alpha_{TE} = \frac{R_s}{aZ_0} \left( 1 - f_c^2 / f^2 \right)^{-1/2} \left( f_c^2 / f^2 + \frac{n^2}{x_{np}^2 - n^2} \right)$
		$\alpha_{TM} = \frac{R_s}{aZ_0} \left( 1 - f_c^2 / f^2 \right)^{-1/2}$
6. OTHER CONSTANTS:		
SPEED OF LIGHT, $c = 3 \times 10^8 \text{ m/s}$		
PERMEABILITY, $\mu_0 = 4\pi \times 10^{-7} \text{ Wb/m}$		
PERMITTIVITY, $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$		

TABLE 2

Values Of $X_{np}$ For TE Modes			Values Of $X_{np}$ For TM modes		
$n$	$X_{n1}$	$X_{n2}$	$n$	$X_{n1}$	$X_{n2}$
0	3.832	7.016	10.174	2.405	5.520
1	1.841	5.331	8.536	3.832	7.016
2	3.054	6.706	9.970	5.135	8.417
					8.654
					10.174
					11.620