SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI JUN 2015

EP603: MICROWAVE DEVICES

TARIKH : 4 NOVEMBER 2015
MASA : 11.15 AM – 1.15 PM (2 JAM)

Kertas ini mengandungi **DUA BELAS (12)** halaman bercetak.
Bahagian A: Struktur (10 soalan)
Bahagian B: Esei (3 soalan)
Dokumen sokongan yang disertakan : Formula dan 2 Carta Smith.

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

Explain **TWO (2)** methods used to control radiation of microwave signal.

SOALAN 1

*Terangkan **DUA (2)** kaedah yang digunakan untuk mengawal radiasi isyarat gelombang mikro.*

[4 marks]

[4 markah]

CLO1
C2

QUESTION 2

Identify **TWO (2)** reasons why microwave is very important in communication technology.

SOALAN 2

*Kenalpasti **DUA (2)** sebab mengapa gelombang mikro sangat penting dalam teknologi komunikasi.*

[4 marks]

[4 markah]

CLO1 C2

QUESTION 3

According to waveguide theory, there are three different types of electromagnetic wave that can propagate within the waveguide. Name and explain **TWO (2)** of these waves.

SOALAN 3

*Berdasarkan kepada teori pandu gelombang, terdapat tiga jenis gelombang elektromagnetik yang boleh merambat di dalam pandu gelombang. Namakan dan terangkan **DUA(2)** daripada gelombang ini .*

[4 marks]

[4 markah]

QUESTION 4

CLO1 C2

Explain cut-off frequency for rectangular and circular waveguide in microwave communication system.

SOALAN 4

Terangkan frekuensi potong bagi pandu gelombang empat segi dan bulat dalam sistem komunikasi gelombang mikro.

[4 marks]

[*4 markah*]

CLO2 C3

QUESTION 5

A standard WR90 waveguide dimensions are 2.286 cm x 1.143 cm. Calculate the TE_{10} mode impedance, Z_{TE} if only this mode is permitted to pass through the waveguide at operational frequency of 10 GHz.

SOALAN 5

Suatu pandu gelombang piawai WR90 mempunyai ukuran 2.286 cm x 1.143 cm. Kirakan nilai galangan, Z_{TE} bagi mod TE_{10} jika hanya mod itu yang dibenarkan melalui pandu gelombang tersebut pada frekuensi operasi 10 GHz.

[4 marks]

[4 markah]

CLO2 C3

QUESTION 6

Calculate the Voltage Standing Wave Ratio (VSWR) given that $Z_L = (50 + j\ 50)\ \Omega$ if $Z_o = 50\ \Omega$.

SOALAN 6

Kirakan nilai Nisbah Voltan Gelombang Pegun (VSWR) sekiranya $Z_L = (50 + j\ 50)\ \Omega$ jika $Z_o = 50\ \Omega$.

[4 marks]

[4 markah]

CLO2 C3

QUESTION 7

Determine normalized admittance Y_L' for $Z_L = (50 + j\ 100)\ \Omega$ when $Z_o = 50\ \Omega$ using Smith Chart.

SOALAN 7

Tentukan nilai lepasan ternormal Y_L' bagi $Z_L = (50 + j\ 100)\ \Omega$ apabila $Z_o = 50\ \Omega$ dengan menggunakan Carta Smith.

[4 marks]

[4 markah]

CLO1 C1

QUESTION 8

Linear beam tubes and crossed field tubes are types of microwave tubes used as microwave frequency sources. State the definition of each type respectively.

SOALAN 8

Tiub sinar lelurus dan tiub medan bersilang adalah jenis tiub gelombang mikro yang digunakan sebagai sumber frekuensi gelombang mikro. Nyatakan definisi setiap jenis tiub tersebut.

[4 marks]

[4 markah]

CLO1
C2

QUESTION 9

With the aid of a suitable diagram, describe the operation of horn antenna.

SOALAN 9

Dengan menggunakan gambar rajah yang sesuai, terangkan operasi antena hon.

[4 marks]

[4 markah]

CLO2
C3

QUESTION 10

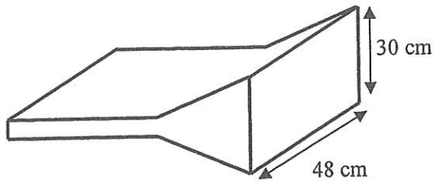


Figure A10 / *Rajah A10*

A group of students conducted an experiment using an antenna horn as in Figure A10.

The experiment has been set with the following information:-

- Transmitted power 15dB, Received power 2W
- Electromagnetic field amplitude across the aperture is 0.5

From this experiment calculate:

i. frequency, f

ii. beam width, α

SOALAN 10

Sekumpulan pelajar menjalankan eksperimen menggunakan antena hon seperti di Rajah A10. Eksperimen telah ditetapkan dengan maklumat berikut:

- *Kuasa penghantaran 15dB, Kuasa penerimaan 2W*
- *Amplitud medan elektromagnetik pada bukaan adalah 0.5*

Dari eksperimen ini kirakan:

i. frekuensi, f

ii. lebar alur, α

[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.*

CLO 2
C1

QUESTION 1

(a) List **FOUR (4)** applications of microwave system.

*Senaraikan **EMPAT (4)** aplikasi sistem gelombang mikro.*

[4 marks]

[4 markah]

CLO 2
C3

(b) An air-filled rectangular waveguide with a dimension (7 x 3.5) cm operates in the dominant TE_{10} mode with frequency 3.5GHz as shown in Figure B1.

Satu pandu gelombang segiempat berisi udara berdimensi (7 x 3.5) cm beroperasi dalam mod dominan TE_{10} dengan frekuensi 3.5GHz seperti yang ditunjukkan dalam Rajah B1.

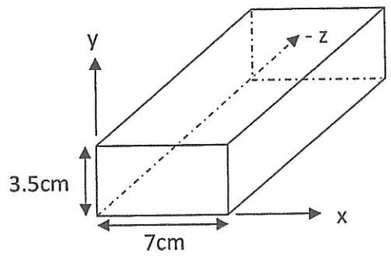


Figure B1 / *Rajah B1*

From Figure B1, determine:

Dari Rajah B1, tentukan:

i) Cut-off frequency [4 marks]

Frekuensi potong. *[4 markah]*

ii) Phase velocity in the waveguide [4 marks]
Halaju fasa dalam pandu gelombang *[4 markah]*

iii) Guide wavelength [4 marks]
Panjang gelombang pandu *[4 markah]*

iv) Characteristic impedance [4 marks]
Galangan ciri *[4 markah]*

CLO1
C2

CLO2
C3

QUESTION 2

SOALAN 2

(a) Given that the VSWR equals to 4.2 when the 75 Ω transmission line is terminated with an unknown load, Z_L. Use a Smith Chart to calculate the value of:

i. Z_L if the minimum distance of the standing wave from the load is 0.15λ;

ii. Reflection coefficient, Γ ;

iii. Load admittance, Y_L;

iv. Z_{in} at 0.3λ from the load.

Diberi bahawa VSWR adalah 4.2 apabila talian penghantaran 75 Ω ditamatkan dengan beban yang tidak diketahui, Z_L. Gunakan Carta Smith untuk mengira nilai:

i. Z_L jika jarak minimum gelombang pegun dari beban adalah 0.15λ;

ii. Pekali pantulan, Γ ;

iii. Lepasan beban, Y_L;

iv. Z_{in} pada 0.3λ dari beban.

[15 marks]
[15 markah]

(b) Draw and identify completely the block diagram of VSWR measurement using slotted line technique.
Lukiskan dan tentukan dengan lengkap rajah blok pengukuran VSWR menggunakan teknik talian slot.

[5 marks]
[5 markah]

QUESTION 3
SOALAN 3

CLO1 C2 (a) Travelling Wave Tube (TWT) is one of the microwave sources of tubes type. With the aid of a suitable diagram explain the characteristics of TWT.
Tiub Gelombang Bergerak (TWT) adalah salah satu dari jenis sumber gelombang mikro jenis tiub. Terangkan ciri-ciri bagi TWT ini dengan bantuan gambarajah yang sesuai.

[12 marks]
[12 markah]

CLO1 C1 (b) Antenna is defined as a transducer between guided wave propagating in a transmission line and an electromagnetic wave propagating in unbounded media (free space) and vice versa.

i. State **TWO (2)** functions of microwave antenna

CLO2 C3 ii. Calculate the gain (dB) of the half-wave antenna (λ / 2) for a parabolic antenna that operates at a frequency of 2.5 GHz if the diameter of the dish is 3.5m

Antena bermaksud sebuah peralatan perantara di antara perambatan gelombang dalam talian penghantaran dengan perambatan gelombang elektromagnetik dalam media tanpa batas (ruang bebas) dan sebaliknya.

i. *Nyatakan **DUA (2)** fungsi antena gelombang mikro.*

ii. *Kira gandaan (dB) antena bagi separuh panjang gelombang (λ / 2) bagi antena parabolik yang beroperasi pada frekuensi 2.5 GHz di mana diameter piring antena adalah berukuran 3.5m.*

[8 marks]
[8 markah]

SOALAN TAMAT

APPENDIX EP603

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

Rectangular waveguide	Circular waveguide
Wavelength, $\lambda_c = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}$	Wavelength, $\lambda_c = \frac{\pi d}{Smn}$
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	Frequency $f_c = \frac{CSmn}{\pi d}$ 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

$\lambda_g = \frac{\lambda_0}{\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}}$ @ $\lambda_g = \frac{\lambda_0}{\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}}$

$v_p = \frac{c}{\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}}$ @ $v_p = \frac{c}{\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}}$

$v_g = c\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}$ @ $v_g = c\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}$

$Z_{TE} = \frac{377}{\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}}$ @ $Z_{TE} = \frac{377}{\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}}$

$Z_{TM} = 377\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}$ @ $Z_{TM} = 377\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}$

$Z_{IN} = jZ_{mn}^{TE}\tan(\beta l)$

$Z_{IN} = jZ_{mn}^{TM}\tan(\beta l)$

$\beta = \frac{2\pi f_o}{c}\sqrt{1-\left(\frac{f_c}{f_o}\right)^2}$

Reflection coefficient, $\Gamma = \frac{Z_L - Z_o}{Z_L + Z_o}$

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

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

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

$(Parabolic\ antenna) Beam\ Width, \alpha = \frac{70\lambda}{D}$

$(Horn\ Antenna) Beam\ Width, \alpha = \frac{80\lambda}{W}$

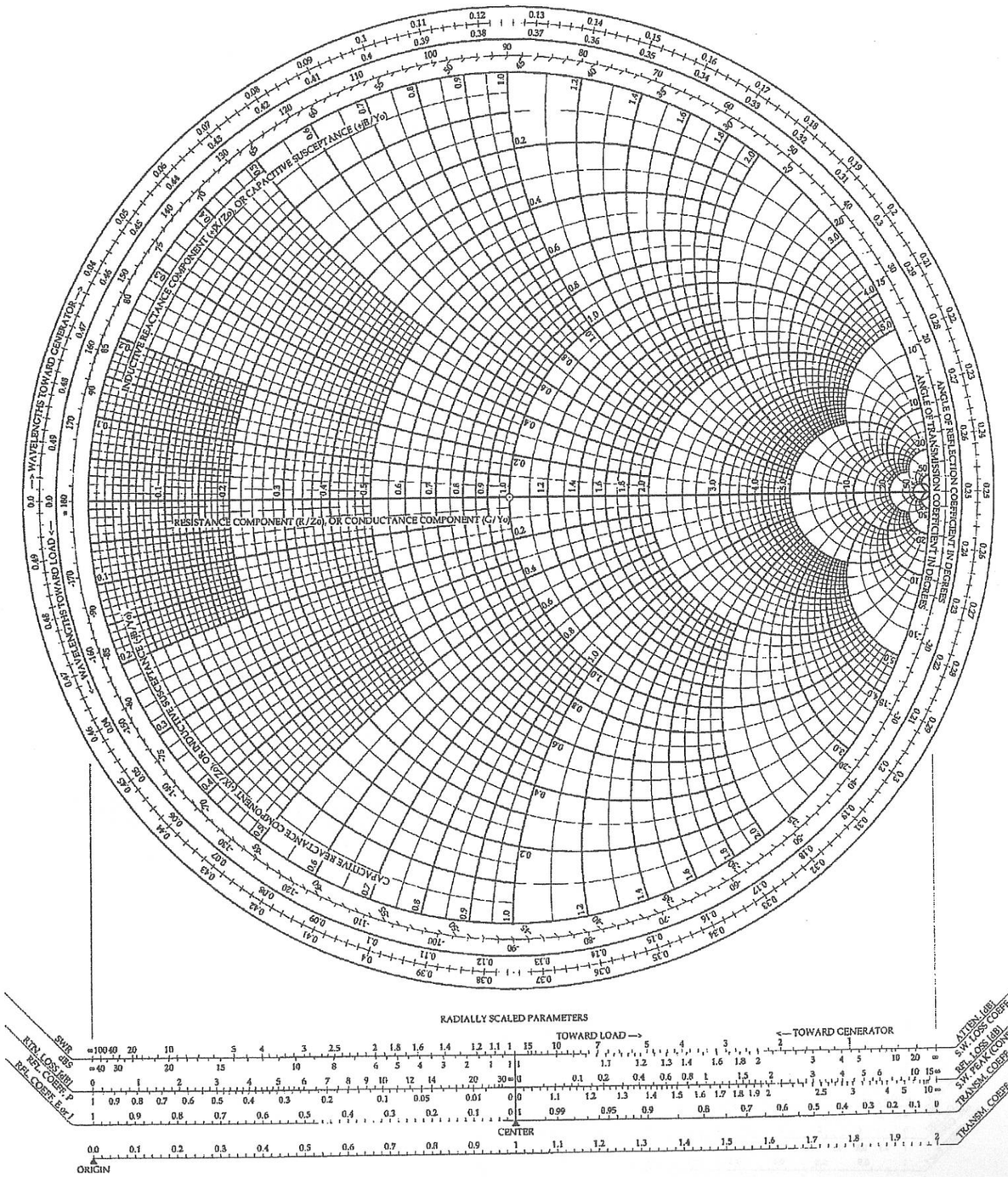
$P_T = P_R G$

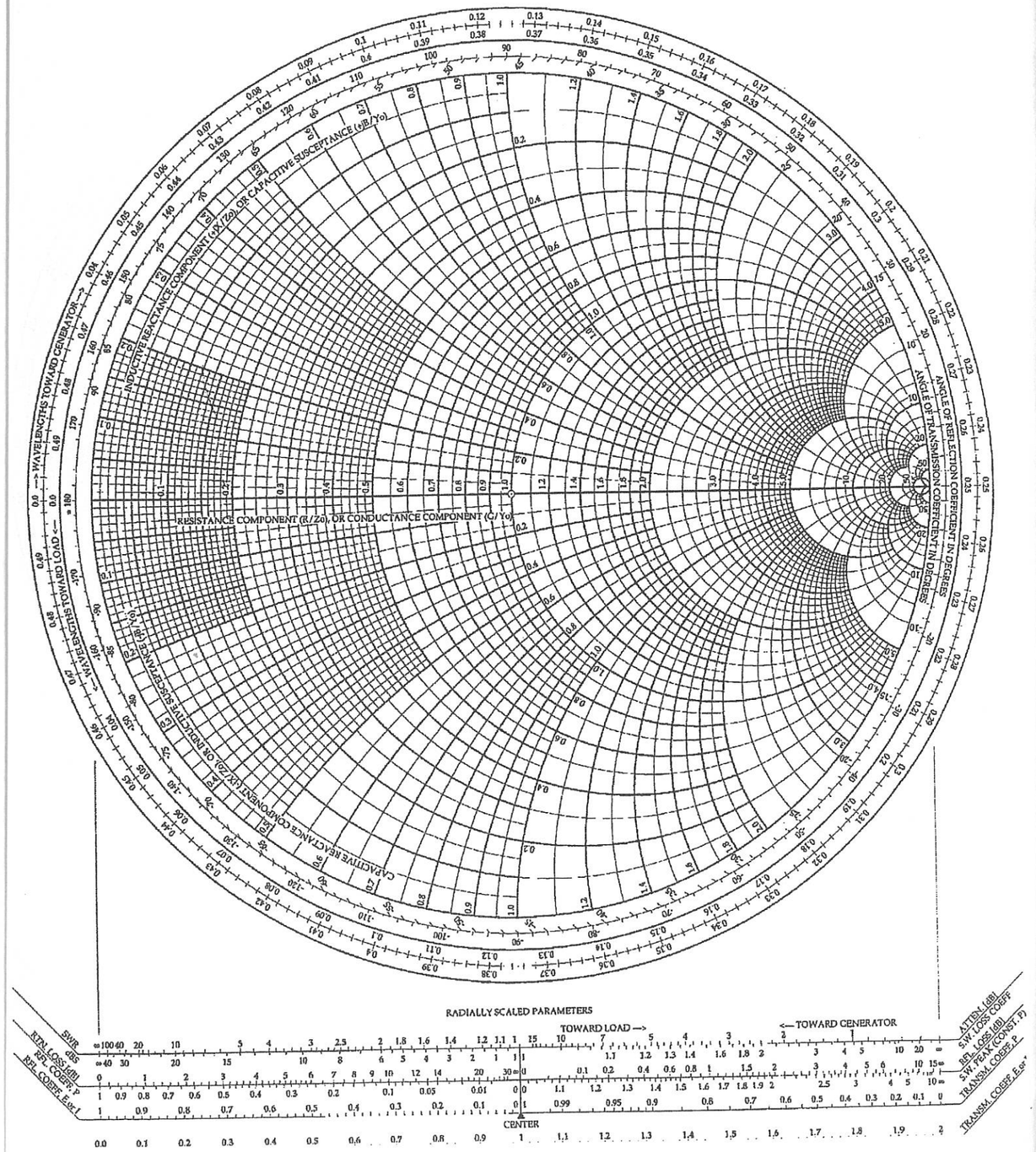
$P_T = \eta \left(\frac{\pi D}{\lambda}\right)^2$

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

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

CARTA SMITH




WAVELENGTHS TOWARD GENERATOR →
WAVELENGTHS TOWARD LOAD →
INDUCTIVE REACTANCE COMPONENT (+jX/Z0) OR CAPACITIVE SUSCEPTANCE (-jB/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Z0) OR INDUCTIVE SUSCEPTANCE (+jB/Yo)
RESISTANCE COMPONENT (R/Z0), OR CONDUCTANCE COMPONENT (G/Yo)
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES
RADIALLY SCALED PARAMETERS
TOWARD LOAD →
← TOWARD GENERATOR
SWR
RTN. LOSS (dB)
REFL. COEFF. |ρ|
REFL. COEFF. E or I
ATTEN. (dB)
S.W. LOSS COEFF
REFL. LOSS (dB)
S.W. PEAK (CONST. F)
TRANSM. COEFF. |τ|
TRANSM. COEFF. E or I
CENTER