UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2007/2008

April 2008

EEE 322 – KEJURUTERAAN GELOMBANG MIKRO DAN RF

Masa: 2 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi TUJUH muka surat dan TUJUH muka surat LAMPIRAN yang bercetak sebelum anda memulakan peperiksaan ini.

Kertas soalan ini mengandungi ENAM soalan.

Jawab EMPAT soalan.

Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.

Agihan markah bagi setiap soalan diberikan di sudut sebelah kanan soalan berkenaan.

Jawab semua soalan dalam bahasa Malaysia atau bahasa Inggeris atau kombinasi kedua-duanya.

1. (a) Sebuah rangkaian dua-liang di mana pada kedua-dua rangkaian adalah liang voltan dan liang arus mempunyai nilai-nilai yang berikut ($Z_0 = 50\Omega$).

A two-port network is driven at both ports such that the port voltages and currents have the following values ($Z_0 = 50\Omega$).

$$V_1 = 20\angle 0^0$$
$$V_2 = 4\angle -90^0$$
$$I_1 = 0.4\angle 90^0$$
$$I_2 = 0.08\angle 0^0$$

Nyatakan masukan galangan yang dilihat pada setiap liang dan carikan nilai voltan tuju dan voltan balikan pada setiap liang.

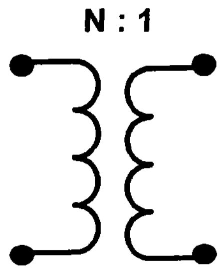
Determine the input impedance seen at each port, and find the incident and reflected voltages at each port.

(50%)

(b) Carikan parameter-parameter ABCD bagi Rajah 1 berikut.

Find the ABCD parameters for the Figure 1.

(50%)



Rajah 1
Figure 1

2. Merekabentuk sebuah penapis laluan rendah Butterworth dengan frekuensi potong 1 GHz pada 3dB dan aras pelemahan lebih besar daripada 20dB pada 1 GHz. Pelapis ini direkabentuk pada papan litar bercetak dengan pemalar dielektrik ε_r =2.5, h=0.7878mm dan galangan Z_0 =50 Ω.

Design a Butterworth lowpass filter with a cutoff frequency of 1 GHz at 3dB and attenuation level greater than 20 dB at 2.5 GHz. The filter is design on the printed circuit board with a dielectric constant, ε_r *=2.5, h=0.7878mm and impedance* Z_0 *=50* Ω.

(100%)

3. Rekabentuk suatu seksyen pemadanan untuk memadan talian 50 ohm dengan beban Z_L= 10 – j 20 ohm pada frequensi 1GHz menggunakan:

Design a matching section to match a 50 ohm transmission line to a load Z_L*= 10 – j 20 ohm at frequency 1GHz using:*

(i) Rangkaian LC
LC network (all possibilities) (35%)

(ii) Transformer suku-gelombang
A quarter wave transformer (30%)

(iii) Kaedah grafik
Graphical method (35%)

4. (a) Rekabentuk pengganding gandingan talian menggunakan FR4 dengan ε_r=4.5, h=1.5mm pada frekuensi 2GHz. Diberikan W_{50}=3mm dan

Design a 9 dB couple line coupler using FR4 of ε_r*=4.5, h=1.5mm at frequency 2GHz. Given that* W_{50}*=3mm and*

...4/-

$$C = 10^{-x/20};$$

$$Z_{oe} = Z_o\sqrt{\frac{1+C}{1-C}}$$

$$Z_{oo} = Z_o\sqrt{\frac{1-C}{1+C}}$$

$$\frac{1}{2}(Z_{oe} - Z_{oo}) = JZ_o$$

Pemalar adalah mengikut definasi seperti biasa.

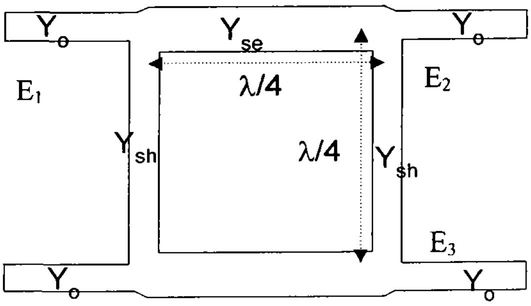
The variable are defined as usual.

(50%)

(b) Pengganding cabang ditunjukkan dalam Rajah 4(b). Rekabentuk pengganding cabang 9dB dengan mengambil Y_{sh} =0.8 menggunakan FR4 ε_r=4.5, h=1.5mm pada frekuensi 2GHz. Diberikan W_{50}=3mm dan

A branch coupler is shown Figure 4(b). Design a 9 dB branch coupler taking Y_{sh}=0.8 using FR4 of ε_r=4.5, h=1.5mm at frequency 2GHz. Given that W_{50}=3mm and

$$Y_{se}^2 = 1 + Y_{sh}^2 \qquad \frac{E_3}{E_2} = \frac{2Y_{sh}}{1 - Y_{sh}^2 + Y_{se}^2} \qquad \frac{E_3}{E_1} = 10^{(-x/20)} \qquad E_1^2 = E_2^2 + E_3^2$$



$$Z_0 = \frac{377}{\sqrt{\varepsilon_r}\left[\frac{w}{h} + 1.6\right]}$$

Rajah 4(b)
Figure 4(b)

Pemalar adalah mengikut definasi seperti biasa.
The variable are defined as usual.

(50%)

5. Transistor ATF36077 mempunyai parameter S seperti di Jadual 1. Parameter S tersebut diukur menggunakan sistem 50Ω pada V_{DS} = 1.5V and I_{DS} = 10 mA.

A transistor ATF36077 has the S parameters as tabulated in Table 1. The S parameter was measured on 50Ω systems at V_{DS} = 1.5V and I_{DS} = 10 mA.

S_{11}		S_{21}		S_{12}		S_{22}	
Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
0.94	-17	4.745	132	0.043	66	0.57	-41

Jadual 1
Table 1

Galangan masukan adalah Z_S = 30Ω dan galangan beban adalah Z_L = 40Ω. Hitung:

The source impedance is Z_S = 30Ω and the load impedance is Z_L = 40Ω. Calculate:

(i) Kuasa Gandaan
Power Gain. (20%)

(ii) Gandaan Terada
Available Gain. (20%)

(iii) Kuasa Gandaan Transduser
Transducer power gain. (20%)

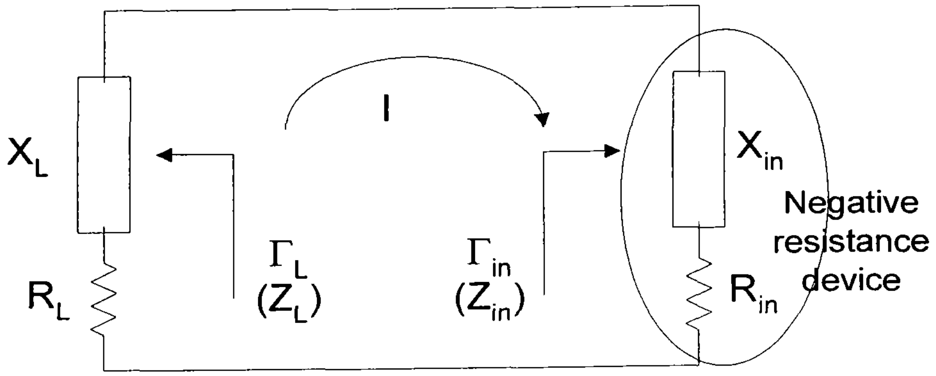
(iv) Dapatkan kestabilan transistor
Determine the transistor stability. (40%)

6. (a) Terangkan apakah pengayun frekuensi radio.
Explain what is the radio frequency oscillator.

(30%)

(b) Terangkan operasi litar pengayun di Rajah 5.
Explain the operation of the oscillator circuit in Figure 5.

(30%)



Rajah 5
Figure 5

(c) Rekabentuk sebuah pengayun 3 GHz suapbalik siri penyalun dielektrik menggunakan S-parameter seperti di Jadual 2. Panjang talian penghantaran boleh diberi dalam bentuk λ.

Design a 3 GHz series feedback dielectric resonator oscillator using an S-parameter in Table 2. The length of the transmission line can be given in λ form.

(40%)

S_{11}		S_{21}		S_{12}		S_{22}	
Mag	Ang	Mag	Ang	Mag	Ang	Mag	Ang
0.94	-49	4.745	132	0.043	54	0.57	-41

Jadual 2
Table 2

oooOooo

LAMPIRAN A

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |D|^2}{2|S_{12}||S_{21}|}$$

$$D = S_{11}S_{22} - S_{12}S_{21}$$

BULATAN KESTABILAN

Pusat $$Cg = \frac{(S_{11} - DS_{22}^*)^*}{|S_{11}|^2 - |D|^2}$$

Jejari $$Rg = \frac{|S_{12}S_{21}|}{\left||S_{11}|^2 - |D|^2\right|}$$

$$\Gamma_L = \left(S_{22} + \frac{S_{12}S_{21}\Gamma_{in}}{1 - S_{11}\Gamma_{in}}\right)^*$$

$$Z_L = Z_o \frac{(1+\Gamma_L)}{(1-\Gamma_L)}$$

BULATAN HINGAR:

Pusat $$C_i = \frac{\Gamma_o}{(1+N_i)}$$

Jejari $$R_i = \frac{1}{1+N_i}\sqrt{N_i^{\,2} + N_i(1 - |\Gamma_o|^2)}$$

$$Ni = \frac{R_n}{Z_o} = \frac{\left[(Fr - F\min)|1 + \Gamma o|^2\right]}{4\Gamma_o r_n}$$

Di mana:

F_r adalah faktor hingar yang dikehendaki
Γ_o adalah pantulan terendah bagi transistor

Biasan bagi transistor:

$V_{DD} = I_D S_{RD} + V_{DS}$

MIKROSTRIP:

Galangan Ciri $Zo \approx \dfrac{377}{\sqrt{\varepsilon_r}\left(\dfrac{W}{h}+2\right)}$

Di mana: **W** adalah kelebaran dan **h** adalah ketebalan mikrostrip

PENAPIS:

Frekuensi potong, $W_c = 1$

$$go = g_{n+1} = 1$$

$$go = 2\sin\left[\frac{(2k-1)\pi}{2n}\right]$$

$$n = \frac{\log_{10}(10^{\frac{S}{10}} - 1)}{2\log_{10}(\frac{\omega}{\omega_c})}$$

S = Atenuasi pada frekuensi yang dikehendaki

$C_k = \frac{g_k}{Z_o \omega_c}$ Bagi **k** ganjil

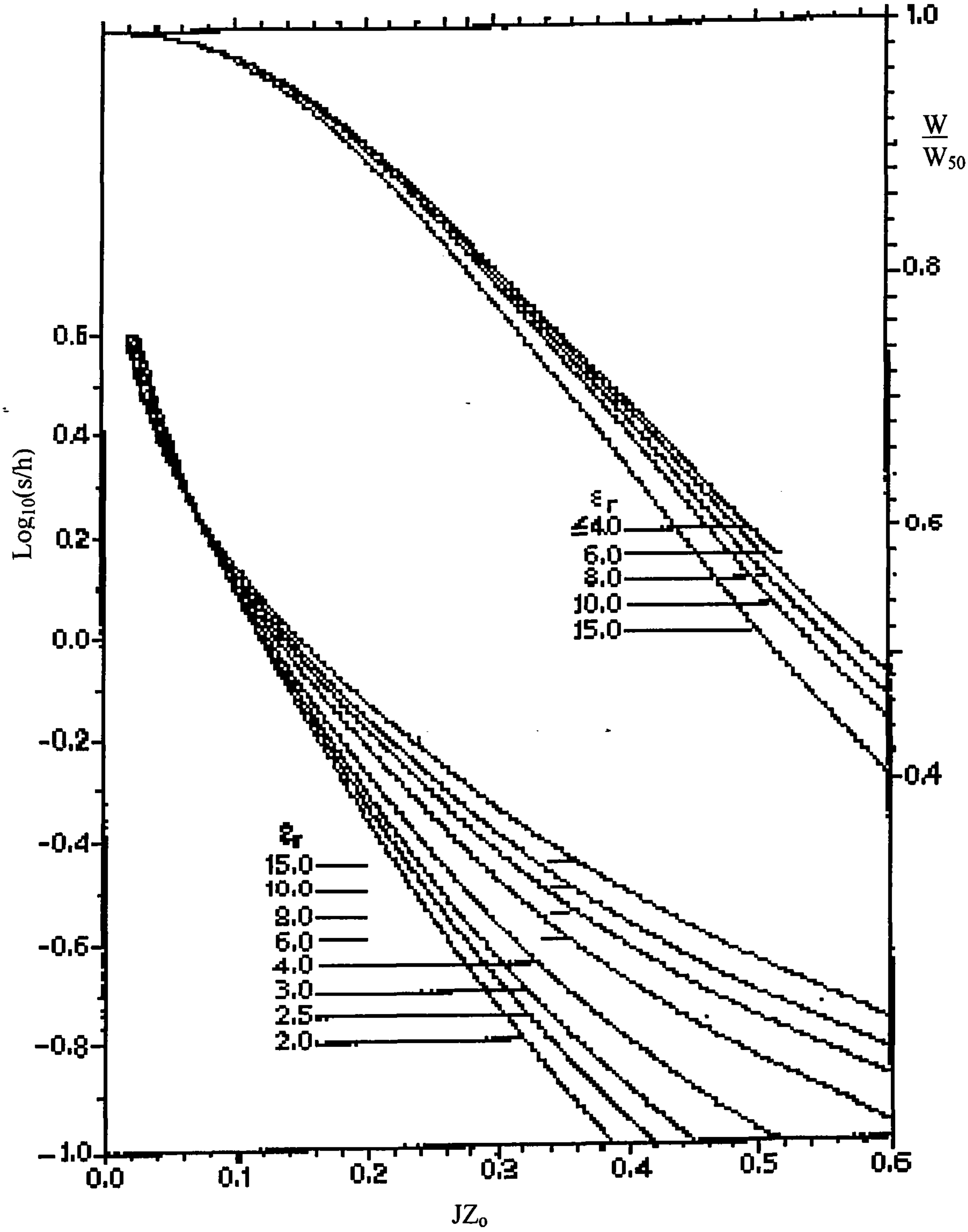
$L_k = \frac{Z_o g_k}{\omega_c}$ Bagi **k** genap

Induktor $l = \frac{\lambda d}{2\pi} \sin^{-1}(\frac{\omega_c L}{Z_o})$

Kapasitor $l = \frac{\lambda d}{2\pi} \sin^{-1}(\omega_c C Z_o)$

Di mana:

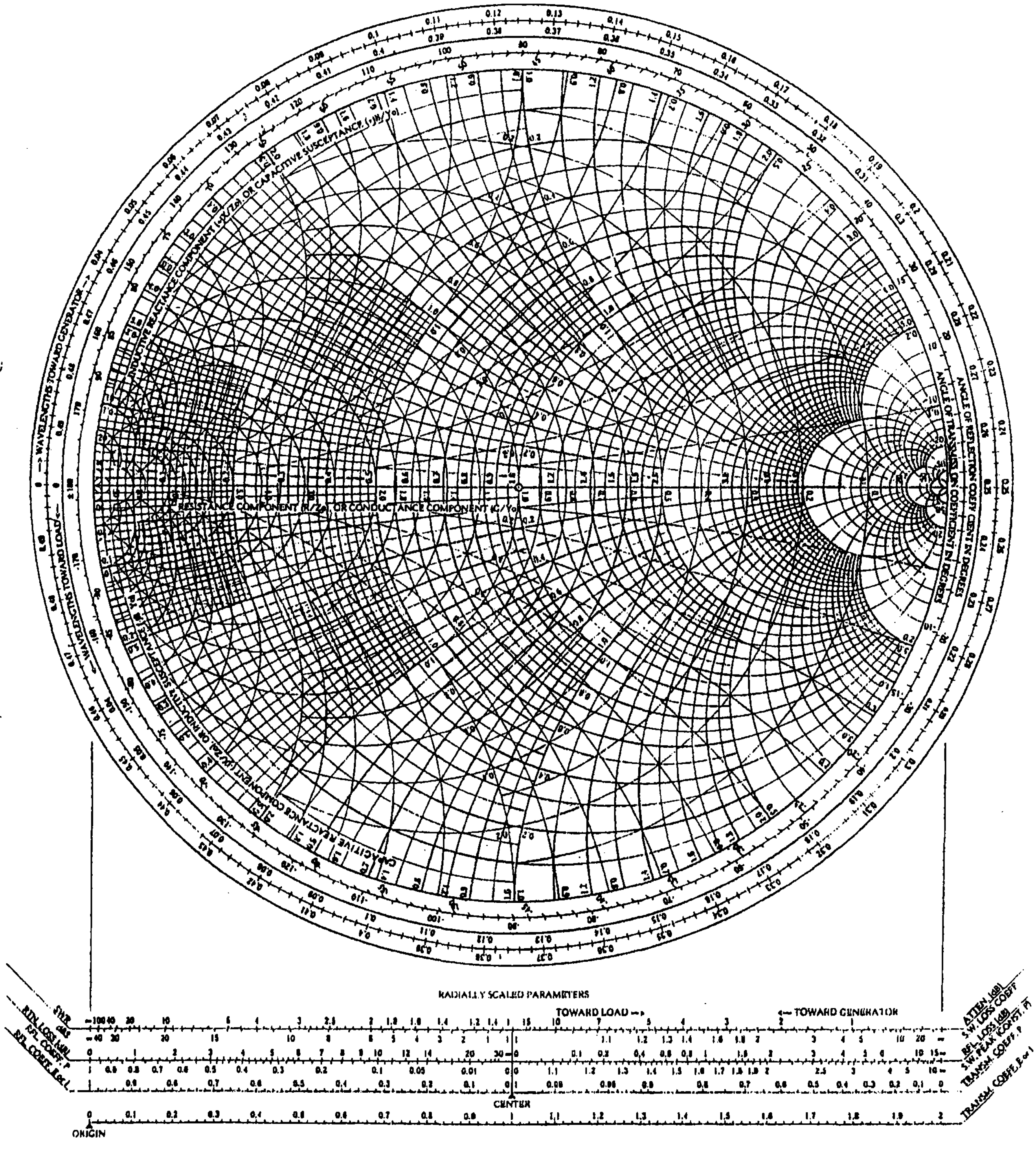
$\lambda_d = \frac{\lambda_o}{\sqrt{\varepsilon_r}}$


1.0
W / W50
0.8
0.6
0.4
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
Log10(s/h)
εr
≤4.0
6.0
8.0
10.0
15.0
εr
15.0
10.0
8.0
6.0
4.0
3.0
2.5
2.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
JZo

LAMPIRAN B

NAME	TITLE	DWG. NO.
		DATE
SMITH CHART FORM ZY-01-N	Microwave Circuit Design - EE523 - Fall 2000	

NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES



NAME	TITLE	DWG. NO.
SMITH CHART FORM 82-BSPR (9-66)	KAY ELECTRIC COMPANY, PINE BROOK, N.J. © 1966. PRINTED IN U.S.A.	DATE

IMPEDANCE OR ADMITTANCE COORDINATES

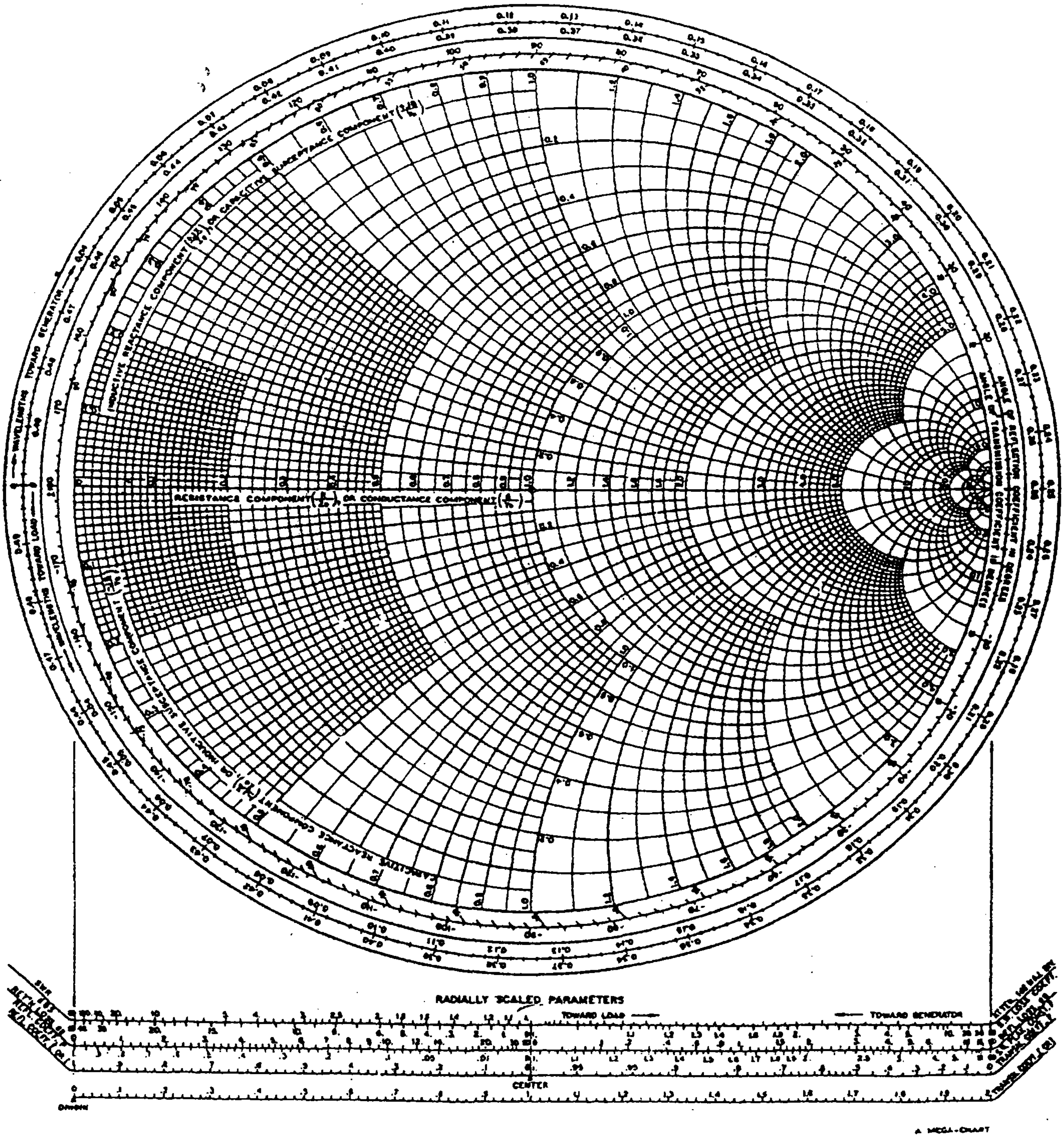


Figure 4.8 Smith chart, reprinted by permission of P. H. Smith, renewal copyright, 1976.

PENGUAT

$\Delta = S_{11}S_{22} - S_{12}S_{21}$

$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|}{2|S_{12}S_{21}|}$$

$$\Gamma_s = \frac{B_1 \pm \sqrt{B_1^2 - 4|C_1|^2}}{2C_1} \qquad B_1 = 1 + |S_{11}|^2 - |S_{22}|^2 - |\Delta|^2 \qquad C_1 = S_{11} - \Delta S_{22}^*$$

$$\Gamma_L = \frac{B_2 \pm \sqrt{B_2^2 - 4|C_2|^2}}{2C_2} \qquad B_2 = 1 + |S_{22}|^2 - |S_{11}|^2 - |\Delta|^2 \qquad C_2 = S_{22} - \Delta S_{11}^*$$

$$\Gamma_{in} = \Gamma_S^* = S_{11} + \frac{S_{12}S_{21}\Gamma_L}{1 - S_{22}\Gamma_L} \qquad \Gamma_{out} = \Gamma_L^* = S_{22} + \frac{S_{12}S_{21}\Gamma_S}{1 - S_{11}\Gamma_S}$$

$$C_L = \frac{\left(S_{22} - \Delta S_{11}^*\right)^*}{|S_{22}|^2 - |\Delta|^2} \qquad R_L = \left|\frac{S_{12}S_{21}}{|S_{22}|^2 - |\Delta|^2}\right|$$

$$C_S = \frac{\left(S_{11} - \Delta S_{22}^*\right)^*}{|S_{11}|^2 - |\Delta|^2} \qquad R_S = \left|\frac{S_{12}S_{21}}{|S_{11}|^2 - |\Delta|^2}\right|$$

$$G_{T\max} = \frac{1}{1 - |\Gamma_s|^2}|S_{21}|^2 \frac{1 - |\Gamma_L|^2}{|1 - S_{22}\Gamma_L|^2}$$

BULATAN HINGAR:

Pusat $$C_i = \frac{\Gamma_o}{(1 + N_i)}$$

Jejari $$R_i = \frac{1}{1 + N_i}\sqrt{N_i^2 + N_i(1 - |\Gamma_o|^2)}$$

$$Ni = \frac{R_n}{Z_o} = \frac{\left|(Fr - F\min)|1 + \Gamma o|^2\right|}{4\Gamma_o r_n}$$