UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2005/2006

April/Mei 2006

EEE 322 – KEJURUTERAAN GELOMBANG MIKRO DAN RF

Masa : 2 Jam

ARAHAN KEPADA CALON:-

Sila pastikan kertas peperiksaan ini mengandungi **TIGABELAS** muka surat termasuk **SEMBILAN** muka surat **Lampiran** bercetak sebelum anda memulakan peperiksaan ini.

Jawab **EMPAT** soalan.
Jawab **DUA** soalan dari **Bahagian A** dan **DUA** soalan dari **Bahagian B**.

Gunakan dua buku jawapan yang diberikan supaya jawapan-jawapan bagi soalan-soalan **Bahagian A** adalah di dalam satu buku jawapan dan bagi **Bahagian B** di dalam buku jawapan yang lain.

Semua soalan hendaklah dijawab dalam Bahasa Malaysia.

...2/-

Bahagian A

1. Suatu beban bernilai Z_L=25 – j45 hendak dipadankan dengan talian 50 ohm menggunakan rangkaian L yang terdiri daripada komponen tergumpal iaitu, satu kapasitor dan satu induktor. Dapatkan nilai–nilai induktor dan kapasitor bagi ke semua kemungkinan konfigurasi litar pemadan yang boleh digunakan untuk memadankan beban tersebut. Konfigurasi litar pemadan yang manakah yang lebih sesuai dan beri sebab kenapa ia dipilih.

   A load of impedance Z_L=25 – j45 is to be matched to a 50 ohm transmission line using L network comprised of lumped components of a capacitor and an inductor. Obtain the values of inductor and capacitor for all possible configurations of the matching circuits. Which is the most suitable configuration for the matching circuit and give the reason why you choose that.

   (25%)

2. Rekabentuk litar-litar mikrostrip berikut pada frekuensi 2 GHz daripada papan cetak FR4 dengan ketebalan 1.5 mm dan pemalar dieletrik relatif substraknya ε_r=4.5. Lakarkan bentangan litar tersebut bersama-sama dengan dimensi-dimensi yang diperlukan. Nyatakan berapakah nilai keluaran (iaitu magnitud dan fasa) dibandingkan dengan nilai masukan bagi kedua-dua litar tersebut.

   Design of the following microstrip circuits operating at frequency 2 GHz using FR4 substrate of 1.5 mm thickness and a relative dielectric constant of ε_r=4.5. Sketch the layout and the dimensions of the circuit . State what are magnitudes and phases of each output referred to the input signals for both of the circuits.

   (i) satu pembahagi kuasa Wilkinson.
   Wilkinson power divider. (12%)

   (ii) penganding hibrid cincin 3 dB.
   3 dB ring hybrid Coupler. (13%)

...3/-

3. Rekabentuk suatu penuras luluan rendah mikrostrip yang mempunyai sambutan Butterworth, bagi frekuensi potongnya 1 GHz dengan 30 dB atenuasi pada frekuensi 2.5 GHz. Papan cetak yang digunakan ialah jenis FR4 dengan ketebalannya 1.5 mm dan pemalar dieletrik relatif substraknya ε_r=4.5. Galangan input dan outputnya mestilah 50 ohm.

Design a microstrip Butterworth lowpass filter, having a cutoff frequency of 1 GHz with 30 dB attenuation at 2.5 GHz. The substrate used is a FR4 of 1.5 mm thickness and a relative dielectric constant of ε_r*=4.5. The input and output of the filter is 50 ohms.*

(25%)

Bahagian B

4. Rekabentuk penguat rendah hingar yang beroperasi pada frekuensi 3 GHz yang mempunyai angka hingar 0.5 dB. Peranti yang perlu digunakan adalah PHEMT ATF 36077. Gunakan pemadanan puntung untuk masukan dan pemadanan pengubah suku gelombang untuk keluaran. Pilih Γ_{in} pada titik C_{in}. Data-data bagi peranti ATF 36077 adalah seperti di Lampiran 1. Gunakan papan litar tercetak Duroid dengan ketebalan 0.8 mm dan pemalar dielektrik, ε_r = 2.5. Bekalan kuasa bagi penguat adalah 3V, lengkapkan rekabentuk anda dengan pincangan bekalan kuasa yang lengkap.

Design a low noise amplifier operating at a frequency of 3 GHz having a noise figure of 0.5 dB. The device that should be used is the PHEMT ATF 36077. Use a stub matching for the input and a quarter wave transformer matching for the output. Choose Γ_{in} *at a point of* C_{in}*. The data for the ATF 36077 is in Appendix 1. Use a Duroid printed circuit board with the thickness of 0.8 mm and the dielectric constant,* ε_r *= 2.5. The power supply for the amplifier is 3 V, finish your design with a complete power supply biasing.*

(25%)

...4/-

5. (a) Rekabentuk sebuah pencampur diod beroperasi pada frekuensi 10 GHz. Gunakan pengganding yang bersesuaian. Gunakan papan litar tercetak FR4 dengan ketebalan 1.5 mm dan pemalar dielektrik 4.5.

Design a diode mixer operating at a frequency of 10 GHz. Use a suitable coupler. Use a FR4 printed circuit board with the thickness of 1.5 mm and the dielectric constant of 4.5.

(20%)

(b) Terangkan apakah kehilangan penukaran bagi pencampur.
Explain what is the conversion loss of the mixer.

(5%)

6. (a) Terangkan konsep pengayun suapbalik. Apakah kriteria penting untuk pengayun berayun?

Explain the concept of a feedback oscillator. What are the important criteria for the oscillator to oscillate?

(10%)

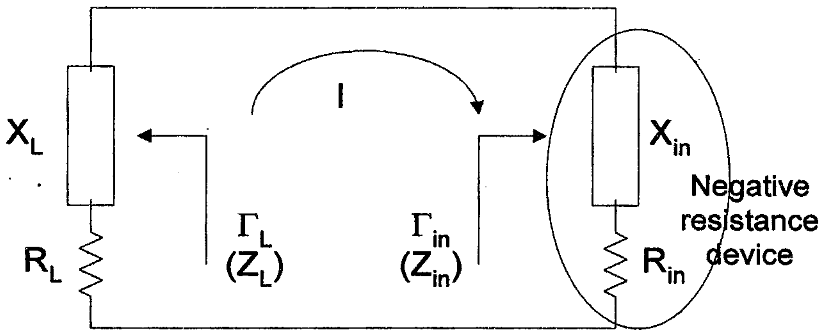
(b) Merujuk kepada Rajah 1, terangkan operasi pengayun rintangan negatif.

Referring to Figure 1, explain the operation of a negative resistance oscillator.

(10%)

(c) Terangkan apakah hingar fasa bagi sebuah pengayun.
Explain what is the phase noise of the oscillator.

(5%)



Rajah 1
Figure 1

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ATF-36077 Typical Noise Parameters,

Common Source, $Z_O = 50\ \Omega$, $V_{DS} = 1.5$ V, $I_D = 10$ mA

Freq. GHz	F_{min}[1] dB	Γ_{opt} Mag.	Γ_{opt} Ang.	R_n/Z_o -
1	0.30	0.95	12	0.40
2	0.30	0.90	25	0.20
4	0.30	0.81	51	0.17
6	0.30	0.73	76	0.13
8	0.37	0.66	102	0.09
10	0.44	0.60	129	0.05
12	0.50	0.54	156	0.03
14	0.56	0.48	-174	0.02
16	0.61	0.43	-139	0.05
18	0.65	0.39	-100	0.09

Note:
1. The F_{min} values at 2,4, and 6 GHz have been adjusted to reflect expected circuit losses that will be encountered when matching to the optimum reflection coefficient (Γ_{opt}) at these frequencies. The theoretical F_{min} values for these frequencies are: 0.10 dB at 2 GHz, 0.20 dB at 4 GHz, and 0.29 dB at 6 GHz. Noise parameters are derived from associated s parameters, packaged device measurements at 12 GHz, and die level measurements from 6 to 18 GHz.

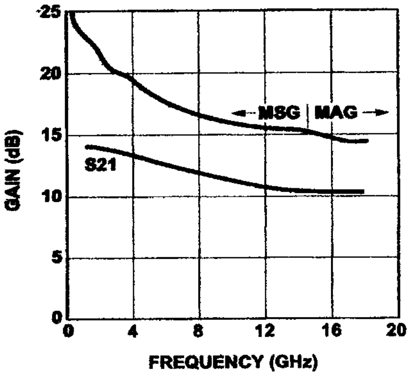
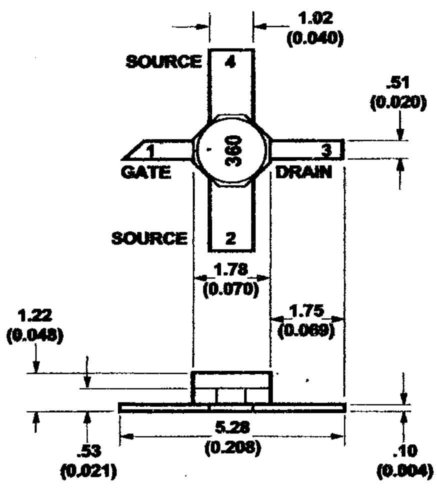


Figure 2. Maximum Available Gain, Maximum Stable Gain and Insertion Power Gain vs. Frequency. V_{DS} = 1.5 V, I_D = 10 mA.

77 Package Dimensions



TYPICAL DIMENSIONS ARE IN MILLIMETERS (INCHES).

Part Number Ordering Information

Part Number	No. of Devices	Container
ATF-36077-TR1[2]	1000	7" Reel
ATF-36077-STR	10	strip

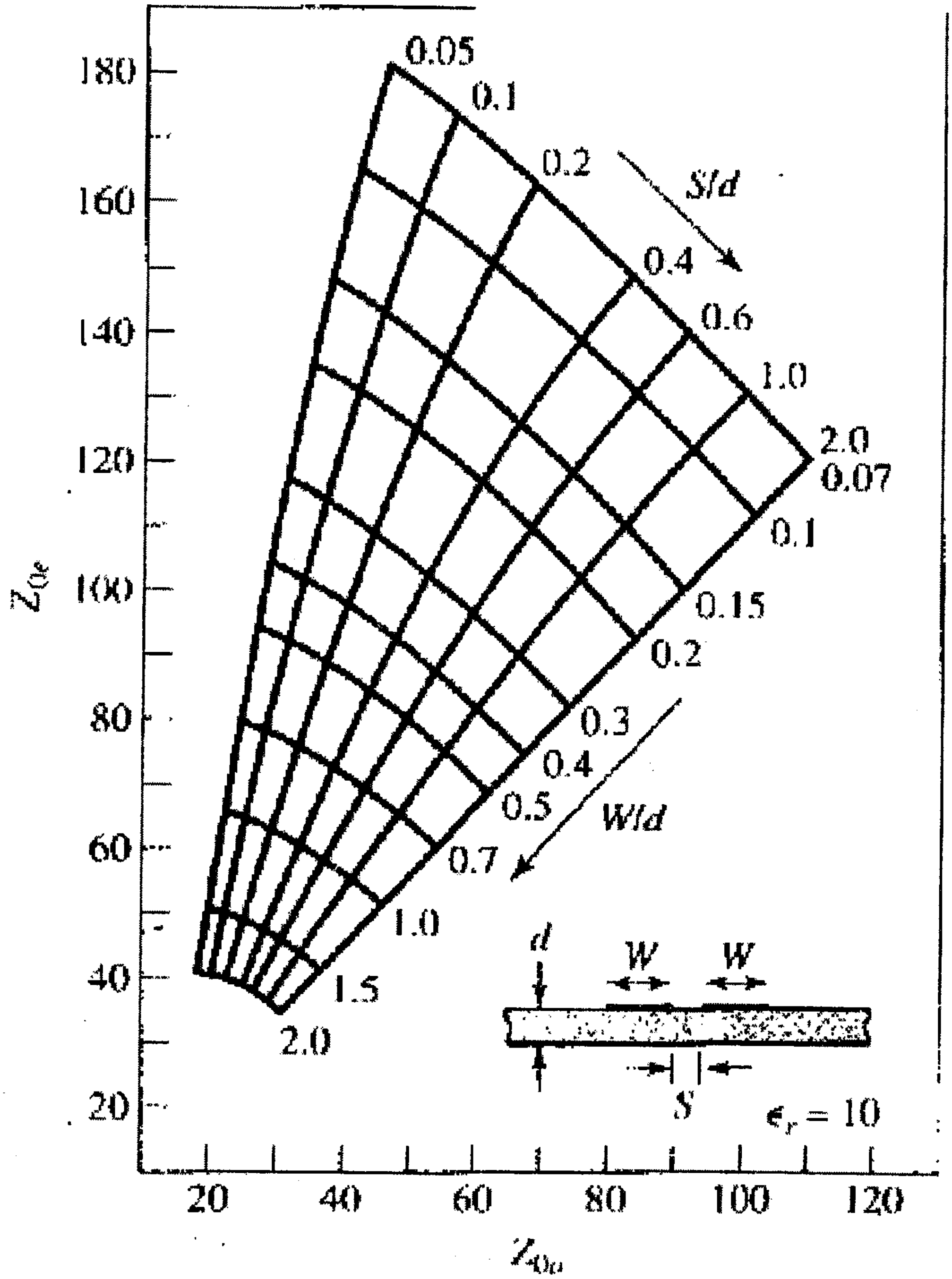
Note:
2. For more information, see "Tape and Reel Packaging for Semiconductor Devices," in "Communications Components" Designer's Catalog.

ATF-36077 Typical Scattering Parameters,
Common Source, $Z_O = 50\ \Omega$, $V_{DS} = 1.5$ V, $I_D = 10$ mA

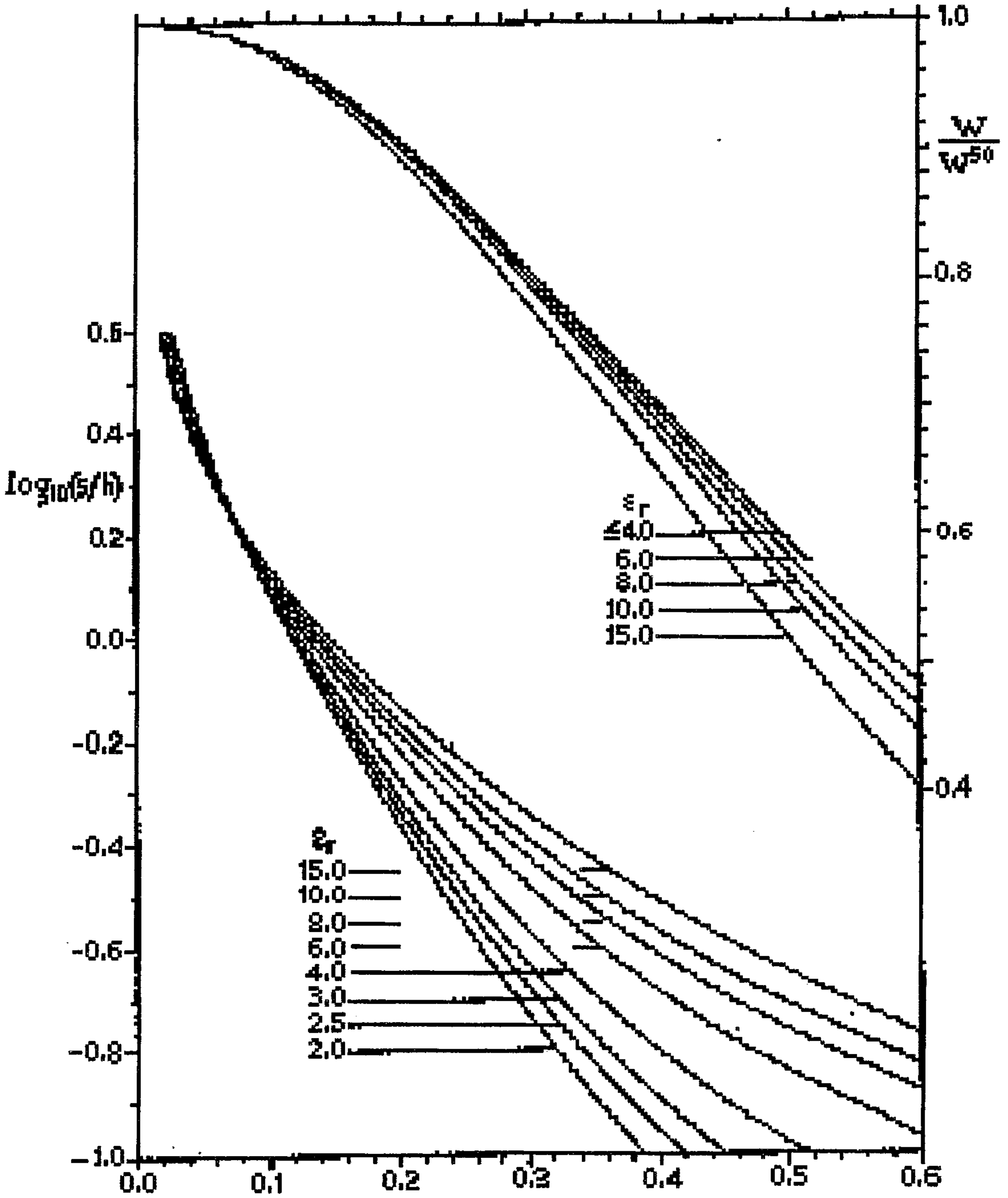
Freq. GHz	S_{11} Mag.	S_{11} Ang.	S_{21} dB	S_{21} Mag.	S_{21} Ang.	S_{12} dB	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
1.0	0.99	-17	14.00	5.010	163	-36.08	0.016	78	0.60	-14
2.0	0.97	-33	13.81	4.904	147	-30.33	0.030	66	0.59	-28
3.0	0.94	-49	13.53	4.745	132	-27.25	0.043	54	0.57	-41
4.0	0.90	-65	13.17	4.556	116	-25.32	0.054	43	0.55	-54
5.0	0.86	-79	12.78	4.357	102	-24.04	0.063	33	0.53	-66
6.0	0.82	-93	12.39	4.162	88	-23.17	0.069	24	0.50	-78
7.0	0.78	-107	12.00	3.981	75	-22.58	0.074	16	0.48	-89
8.0	0.75	-120	11.64	3.820	62	-22.17	0.078	8	0.46	-99
9.0	0.72	-133	11.32	3.682	49	-21.90	0.080	1	0.44	-109
10.0	0.69	-146	11.04	3.566	37	-21.71	0.082	-6	0.42	-119
11.0	0.66	-159	10.81	3.473	25	-21.57	0.083	-13	0.40	-129
12.0	0.63	-172	10.63	3.401	13	-21.44	0.085	-19	0.38	-139
13.0	0.61	175	10.50	3.349	1	-21.32	0.086	-25	0.37	-149
14.0	0.60	161	10.41	3.315	-12	-21.19	0.087	-32	0.35	-160
15.0	0.58	147	10.36	3.296	-24	-21.04	0.089	-39	0.33	-171
16.0	0.57	131	10.34	3.289	-37	-20.87	0.091	-47	0.31	177
17.0	0.56	114	10.34	3.289	-50	-20.69	0.092	-55	0.29	164
18.0	0.57	97	10.35	3.291	-64	-20.53	0.094	-65	0.26	148

ATF-36077 Typical "Off" Scattering Parameters,
Common Source, $Z_O = 50\ \Omega$, $V_{DS} = 1.5$ V, $I_D = 0$ mA, $V_{GS} = -2$ V

Freq. GHz	S_{11} Mag.	S_{11} Ang.	S_{21} dB	S_{21} Mag.	S_{21} Ang.	S_{21} dB	S_{21} Mag.	S_{21} Ang.	S_{22} Mag.	S_{22} Ang.
11.0	0.96	-139	-14.2	0.19	-43	-14.2	0.19	-43	0.97	-125
12.0	0.95	-152	-14.0	0.20	-56	-14.0	0.20	-56	0.97	-137
13.0	0.94	-166	-13.8	0.20	-69	-13.8	0.20	-68	0.96	-149



Geraf. 1. Pemisahan dan lebar talian jalur bagi penganding berarah berpasangan



Rajah 2 : Galangan ternomal J

* Nota:

Nilai komponen laluan rendah Butterworth ternormal ialah

$$g_k = 2\sin(2k-1)\frac{\pi}{2n} \qquad \text{di sini k=1,.........., n}$$

$$g_0 = g_{n+1} = 1$$

$$n = \frac{\log_{10}\left(10^{A/10}-1\right)}{2\log_{10}(\omega/\omega_c)}$$

$$C_k = \frac{g_k}{Z_o\omega_c}$$

$$L_k = \frac{Z_o g_k}{\omega_c}$$

Nilai-nilai regangan penuras lulusjalur

$$J_{01} = \left(\frac{\pi\,\Omega}{2g_0g_1}\right)^{\frac{1}{2}}$$

$$J_{k,k+1} = \left(\frac{\pi\,\Omega}{2}\right)\frac{1}{\sqrt{g_k \cdot g_{k-1}}} \qquad \text{di sini k=1,.........., n}$$

$$J_{n,n+1} = \left(\frac{\pi\,\Omega}{2 \cdot g_n \cdot g_{n+1}}\right)$$

Rekabentuk penguat

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

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

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

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

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

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

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

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

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

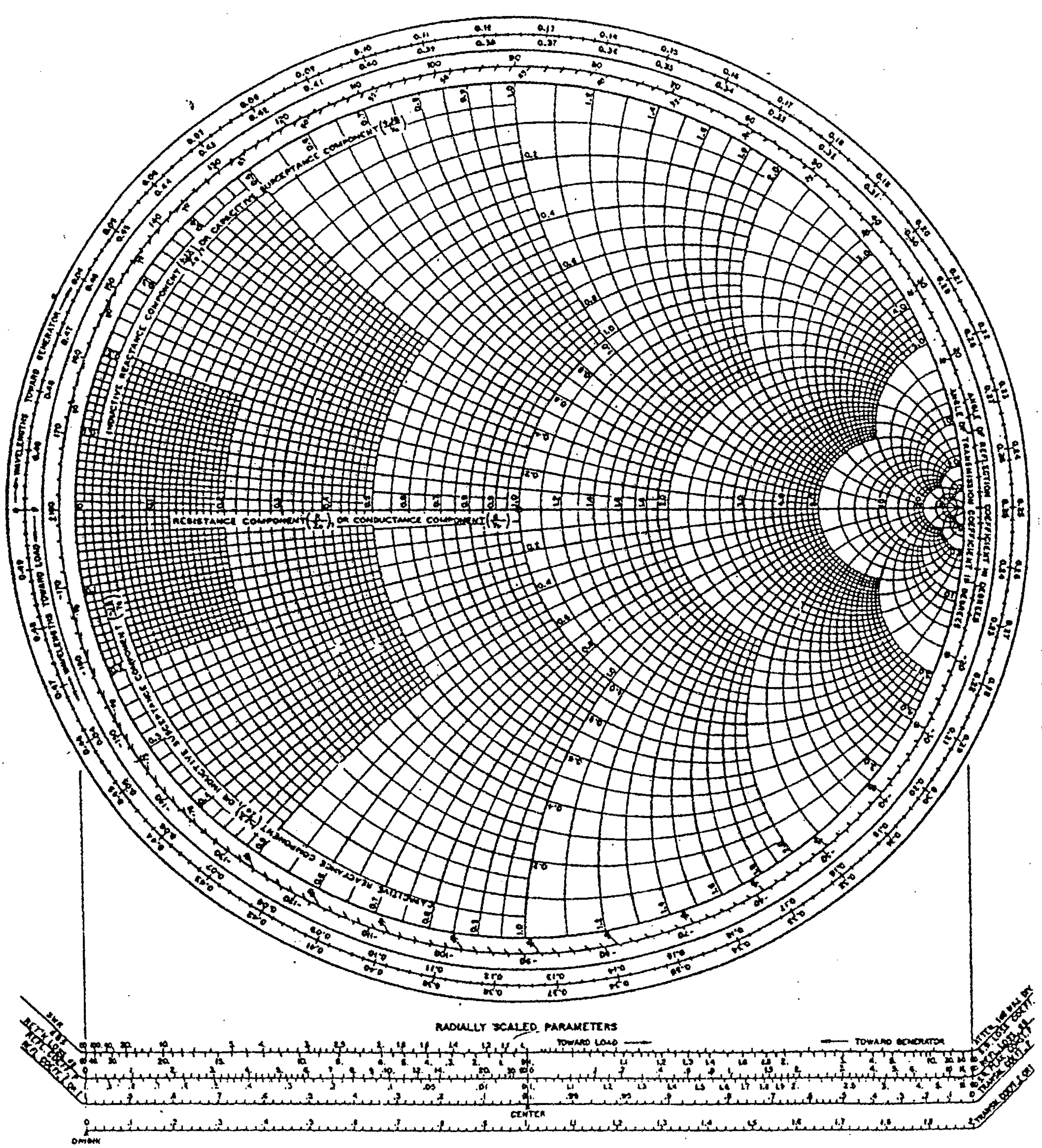


Figure 4.8 Smith chart, reprinted by permission of P.H. Smith, renewal copy-right 1976.

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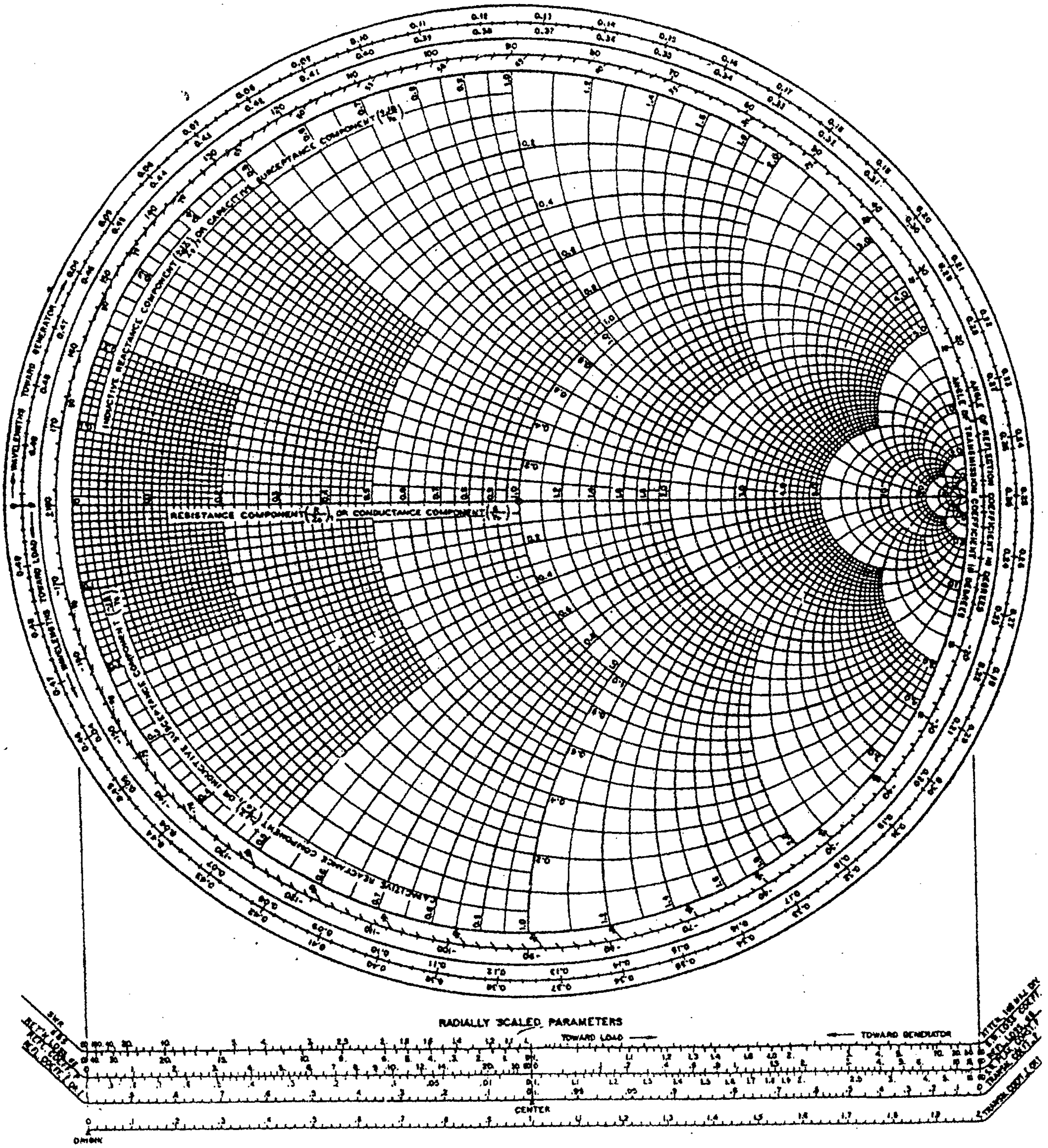

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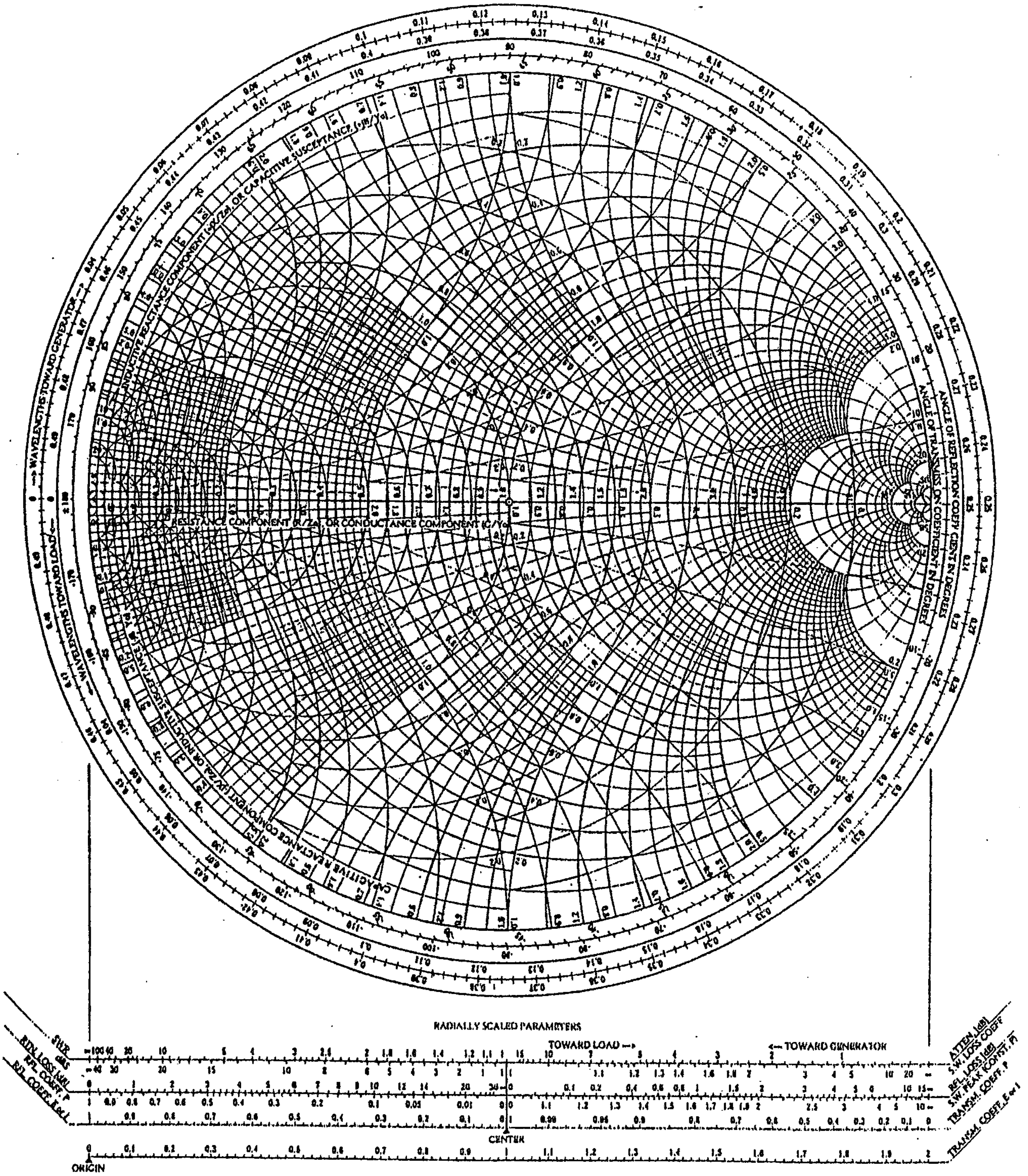
SMITH CHART FORM ZY-01-N	Microwave Circuit Design - EE523 - Fall 2000	DATE

NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES



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		DATE
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NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES