SECTION A: 60 MARKS
BAHAGIAN A: 60 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** structured questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan berstruktur. Jawab semua soalan.*

QUESTION 1
SOALAN 1

CLO1
C3

(a) An air-filled rectangular waveguide with an inside dimension of 7 cm x 3 cm operates in the TE_{10} and TE_{11} mode. Calculate the cut-off frequency of the guide for both modes.

Sebuah pandu gelombang segiempat berisi udara yang mempunyai dimensi dalaman 7 cm x 3 cm beroperasi pada mode TE_{10} and TE_{11}. *Kirakan nilai frekuensi potong bagi pandu gelombang untuk kedua-dua mod tersebut.*

[10 marks]
[*10 markah*]

CLO1
C3

(b) A 9GHz signal propagates inside a rectangular waveguide that is filled with dielectric material with dielectric conductivity 3.655×10^{-4} S/m, dielectric permittivity 2.1 and dielectric permeability 1.0. Use the appropriate formula to calculate the guide attenuation factor in dB if the cutoff frequency is 4.5GHz.

Isyarat 9GHz merambat di dalam sebuah pandu gelombang segiempat yang diisi dengan bahan dielektrik dengan nilai konduktiviti 3.655×10^{-4} *S/m, dielektrik "permittivity" 2.1 dan dielektrik "permeability" 1.0. Gunakan formula yang sesuai untuk mengira faktor pelemahan pandu gelombang dalam dB sekiranya frekuensi potong adalah 4.5GHz.*

[10 marks]
[*10 markah*]

CLO1
C3

(c) A 50Ω lossless line is connected to a matched signal of 100kHz with load of 50 + j50Ω. Calculate the reflection coefficient and Voltage Standing Wave Ratio (VSWR) in decibel of the load.

Talian tanpa kehilangan 50Ω disambungkan serta dipadankan isyarat 100kHz untuk beban 50 + j50Ω. Kirakan pekali pantulan dan Nisbah Voltan Gelombang Pegun (VSWR) dalam decibel bagi beban tersebut.

[10 marks]
[*10 markah*]

QUESTION 2
SOALAN 2

CLO1
C3

(a) A line impedance of 50Ω has a load impedance (150 – j50) Ω. By using Smith Chart, show the following elements:
Talian bergalangan 50Ω mempunyai beban galangan (150 – j50) Ω. Dengan menggunakan Carta Smith, tunjukkan elemen-elemen berikut:

i. Normalized impedance value
Nilai galangan ternormal

ii. Voltage Standing Wave Ratio (VSWR)
Nisbah Voltan Gelombang Pegun (VSWR)

iii. Reflection coefficient
Pekali Pantulan

iv. Angle of reflection coefficient
Sudut Pekali Pantulan

[10 marks]
[*10 markah*]

CLO1
C3

(b) Show how a dipole antenna is used as a feeder for parabolic antenna.

Tunjukkan bagaimana antena dipole digunakan sebagai penyuap kepada antena parabola.

[10 marks]
[*10 markah*]

CLO1
C3

(c) A parabolic antenna with a diameter of 22m operates at a frequency of 2.5GHz (assumed uniform illumination). Calculate the beamwidth angle and the power gain in dB.

Sebuah antena pemantul parabola yang mempunyai diameter piring 22m, beroperasi pada frekuensi 2.5GHz (anggapkan iluminasi yang sekata). Kirakan sudut alur dan gandaan kuasa dalam dB.

[10 marks]
[*10 markah*]

SECTION B: 40 MARKS
BAHAGIAN B: 40 MARKAH

INSTRUCTION:
This section consists of **TWO (2)** essay questions.

ARAHAN:
*Bahagian ini mengandungi **DUA (2)** soalan esei.*

QUESTION 1
CLO1
C4
SOALAN 1

A copper rectangular waveguide of 20cm long is installed from RF amplifier to horn antenna as a transmission medium. It has an inner dimension of (3 x 1.5) cm and is used for propagating a microwave signal at a dominant mode. The waveguide is matched with characteristic impedance 400Ω and is operating at 9GHz frequency. Determine the cutoff frequency, cutoff wavelength, wavelength guide, velocity inside the waveguide, characteristic impedance and attenuation in the waveguide.

Satu pandu gelombang kuprum berbentuk segiempat dengan panjang 20cm dipasang daripada penguat RF ke antenna hon sebagai medium penghantaran. Ia mempunyai dimensi dalaman (3 x 1.5) cm dan digunakan untuk merambat isyarat gelombang mikro pada mod dominan. Pandu gelombang ini dipadankan dengan galangan ciri bernilai 400Ω dan ia beroperasi pada frekuensi 9GHz. Tentukan nilai frekuensi potong, panjang gelombang potong panjang gelombang pandu gelombang, halaju pandu gelombang, galangan ciri dan pelemahan di dalam pandu gelombang.

[20 marks]
[*20 markah*]

CLO1
C4

QUESTION 2
SOALAN 2

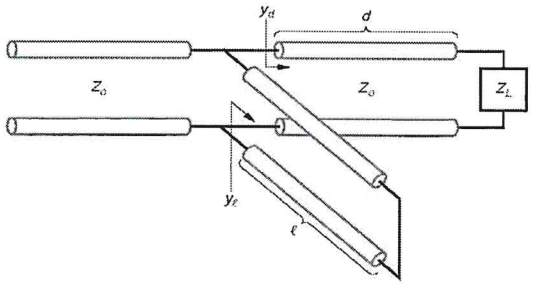


Figure 1

A parallel single stub is located at a point where the reflected wave from the stub and the reflected wave from the load on the main line are completely cancelled by each other, so that no reflected wave beyond that point is returned to generator. Impedance matching can be achieved by inserting another transmission line (stub) as shown in **Figure 1**. Find the position and length of the short-circuited stub to match the transmission line if a 50Ω transmission line of 6m length is terminated in an impedance of $Z_L = 100 + j100\ \Omega$ by using Smith Chart.

Satu puntung tunggal selari diletakkan pada satu titik di mana gelombang pantulan dari puntung itu dan gelombang pantulan dari beban pada talian utama memadamkan satu sama lain secara penuh supaya tiada gelombang pantulan yang berlaku selepas titik tersebut yang akan menghala balik ke penjana. Padanan galangan boleh dicapai dengan memasukkan talian penghantaran (puntung) lain seperti yang ditunujukkan dalam ***Rajah 1****. Carikan kedudukan dan panjang puntung litar yang dipintaskan untuk menamatkan talian penghantaran sekiranya satu talian penghantaran 50Ω yang mempunyai panjang 6m ditamatkan pada beban $Z_L = 100 + j100\ \Omega$ dengan menggunakan Carta Smith.*

[20 marks]
[*20 markah*]

SOALAN TAMAT

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

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

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

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

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

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

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

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

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

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

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

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

W/d > 1

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

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

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

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

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

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

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

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

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

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

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

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

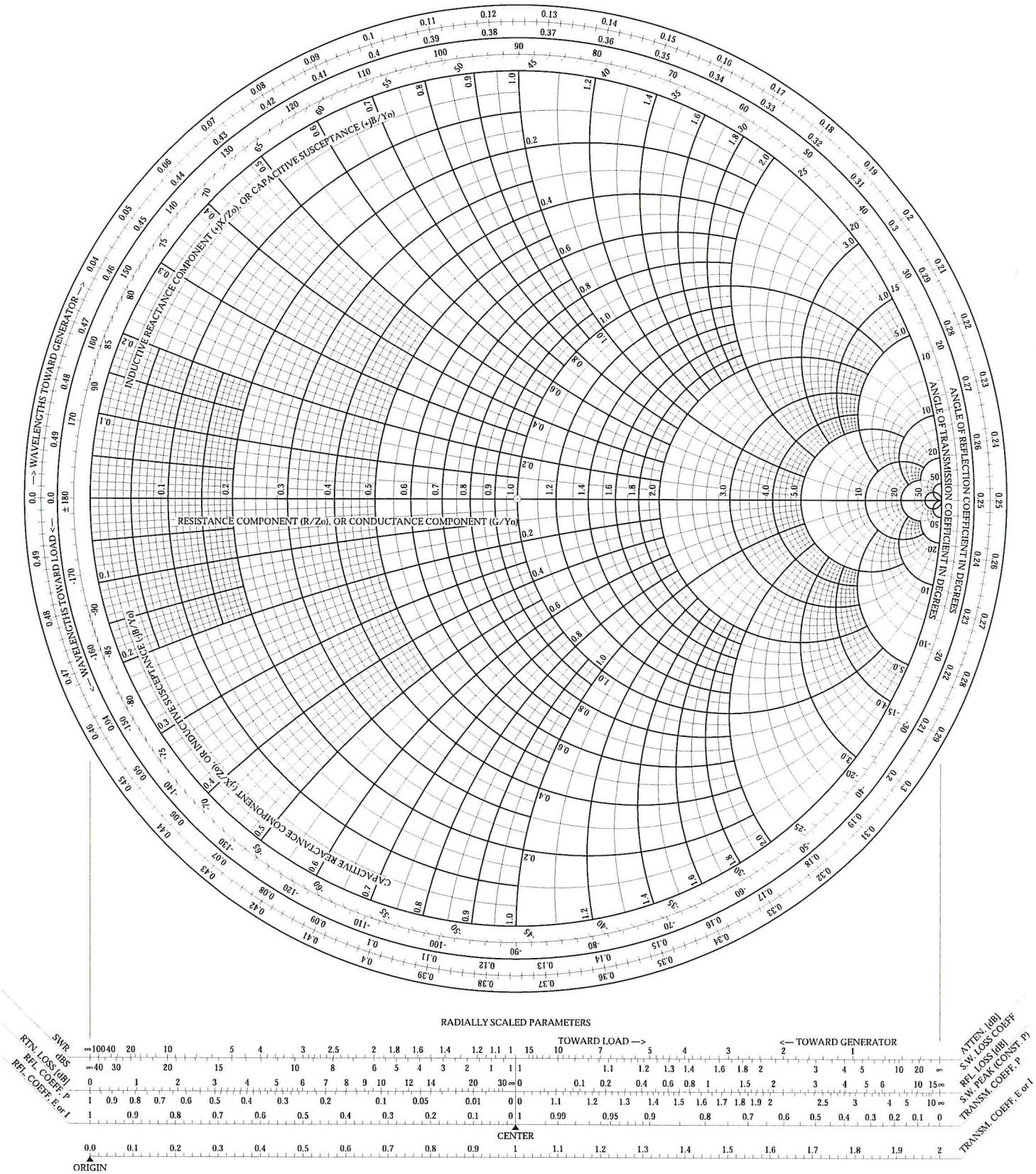
$$G_R(dB) = 10log\frac{4\pi kA}{\lambda^2}$$

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

$P_T = P_R\,G$

The Complete Smith Chart

Black Magic Design



The Complete Smith Chart

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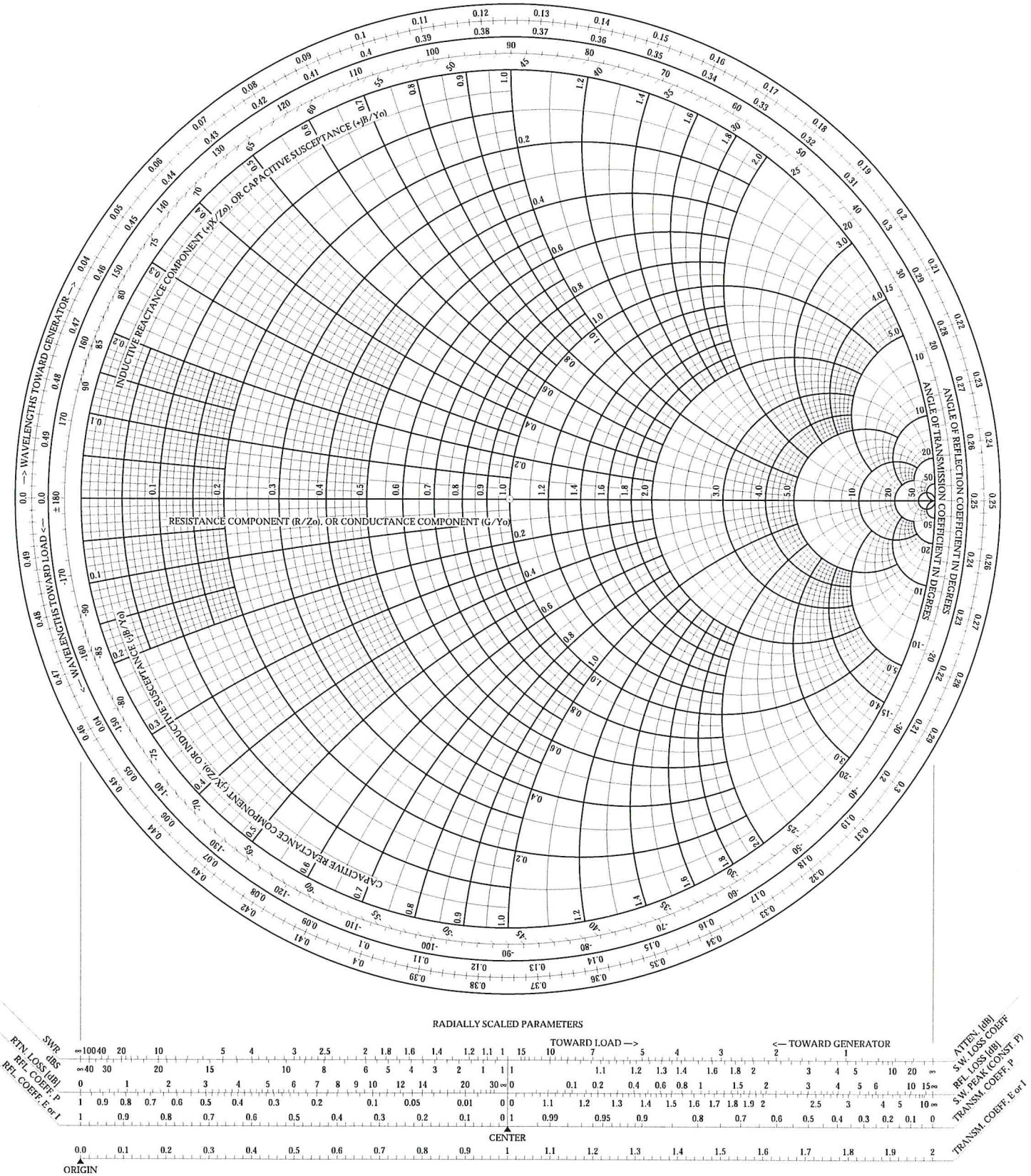

The Complete Smith Chart

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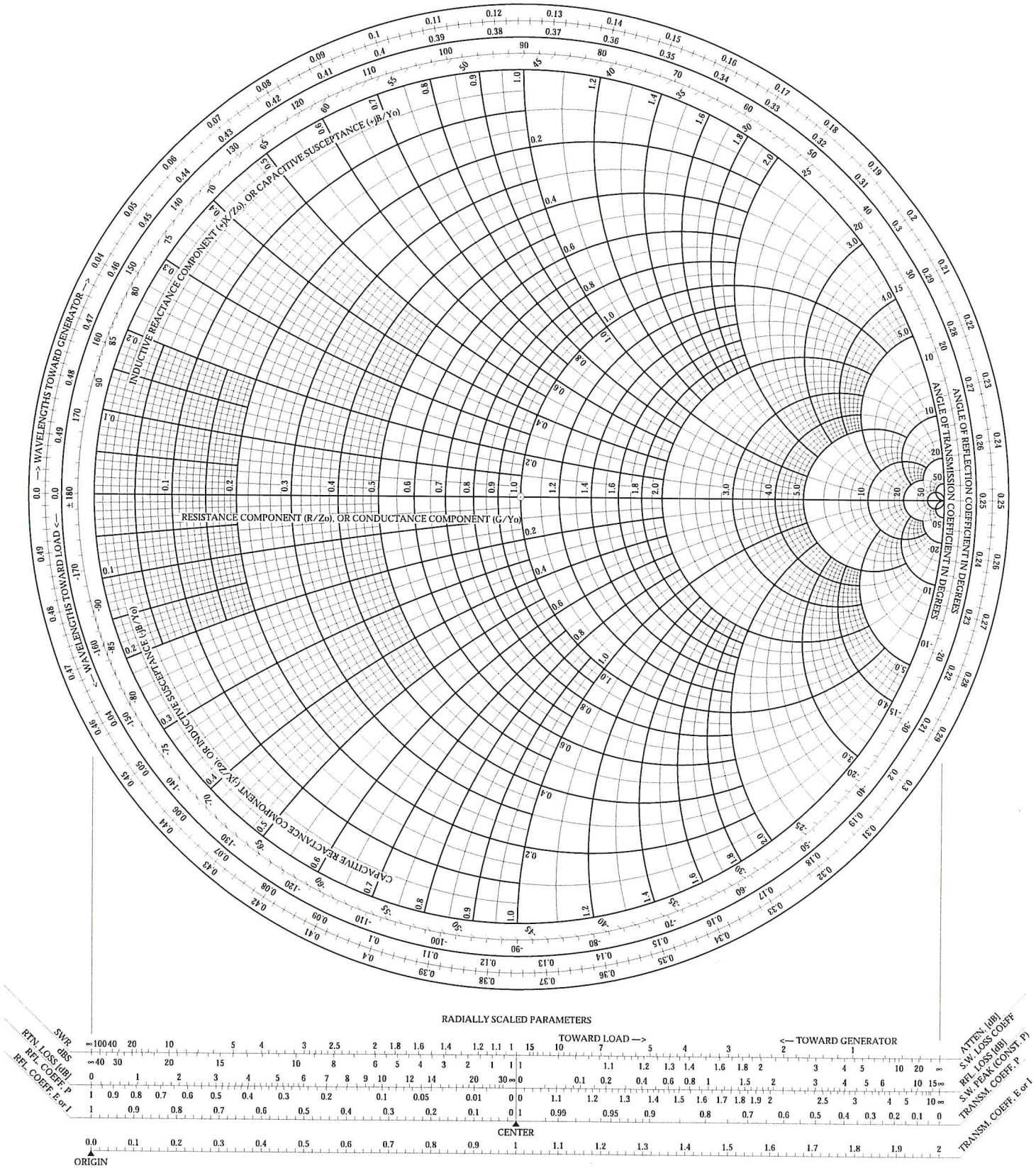

The Complete Smith Chart

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