SULIT

KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI I : 2023/2024

DEP50043 : MICROWAVE DEVICES

TARIKH : 19 DISEMBER 2023
MASA : 11.15 AM – 1.15 PM (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.
Bahagian A: Subjektif (3 soalan)
Bahagian B: Esei (2 soalan)

Dokumen sokongan yang disertakan : Formula, Smith Chart

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SECTION A : 60 MARKS
BAHAGIAN A : 60 MARKAH

INSTRUCTION:
This section consists of **THREE (3)** subjective questions. Answer **ALL** questions.

ARAHAN :
*Bahagian ini mengandungi **TIGA (3)** soalan subjektif. Jawab semua soalan.*

CLO1 **QUESTION 1**
SOALAN 1

(a) There are multiple types of electromagnetic wave. Categorize the Transverse Electric (TE) and Transverse Magnetic (TM) using the suitable diagram.
Terdapat pelbagai jenis gelombang elektromagnetik. Kategorikan Elektrik Melintang (TE) dan Magnetik Melintang (TM) dengan bantuan diagram yang sesuai.

[6 marks]
[*6 markah*]

(b) Diagram A1(b) shows microwave communication link from point A to point B. Based on that diagram, explain the function of X, Y and Z.
Rajah A1(b) menunjukkan pautan komunikasi gelombang mikro dari kedudukan A kepada kedudukan B. Merujuk kepada rajah tersebut, terangkan fungsi bagi X, Y dan Z.

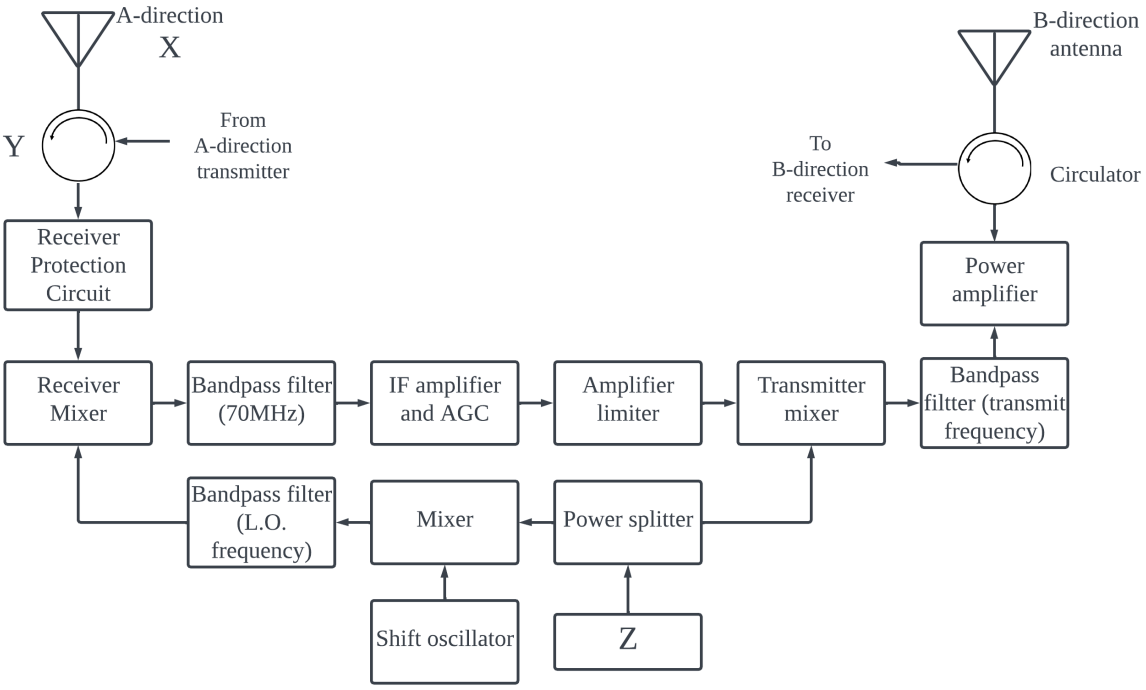


Diagram A1(b) / *Rajah A1(b)*

[7 marks]

[*7 markah*]

(c) Microwave sources have differences from each other. Fill in Table A1(c) to compare in term of efficiency and power.

Sumber gelombang mikro mempunyai perbezaan antara satu sama lain. Lengkapkan Jadual A1(c) untuk menunjukkan perbezaan dari segi kecekapan dan kuasa.

Table A1(c) / *Jadual A1(c)*

Microwave Sources / *Sumber gelombang mikro*	Efficiency / *Kecekapan*	Power / *Kuasa*
Magnetron		
Travelling Wave Tube		

[7 marks]

[*7 markah*]

CLO1

QUESTION 2

SOALAN 2

(a) Explain the guide wavelength, λ_g in waveguide.

Terangkan panjang gelombang terpandu, λg dalam pandu gelombang.

[4 marks]

[*4 markah*]

(b) A waveguide with internal dimension of (0.5 × 1) cm, 25 cm length, transmits a signal with operating frequency 1.5 GHz in dominant mode. Show that propagation does not exist in that waveguide because of high attenuation from the rule $\lambda_o > \lambda_c$.

Sebuah pandu gelombang dengan dimensi dalaman (0.5 × 1) cm, 25 cm panjang, menghantar isyarat dengan frekuensi operasi 1.5 GHz pada mod dominan. Tunjukan bahawa perambatan tidak wujud di dalam pandu gelombang tersebut *kerana gangguan tinggi berdasarkan syarat* $\lambda_o > \lambda_c$.

[8 marks]

[*8 markah*]

(c) By using Smith Chart, plot the input impedance of a transmission line at a point of 0.6λ from the load of (75 - j25) Ω if the characteristic impedance of the line is 50 Ω.

Dengan menggunakan Carta Smith, plotkan galangan masukan bagi talian penghantaran pada kedudukan 0.6λ dari beban (75 - j25) Ω sekiranya galangan ciri bagi talian adalah 50 Ω.

[8 marks]

[*8 markah*]

CLO1

QUESTION 3

SOALAN 3

(a) Diagram A3(a) shows the radiation pattern of an antenna. Based on that diagram, explain the parameter X and Y.

Rajah A3(a) menunjukkan corak sinaran bagi antenna. Merujuk kepada rajah tersebut terangkan parameter yang berlabel X dan Y.

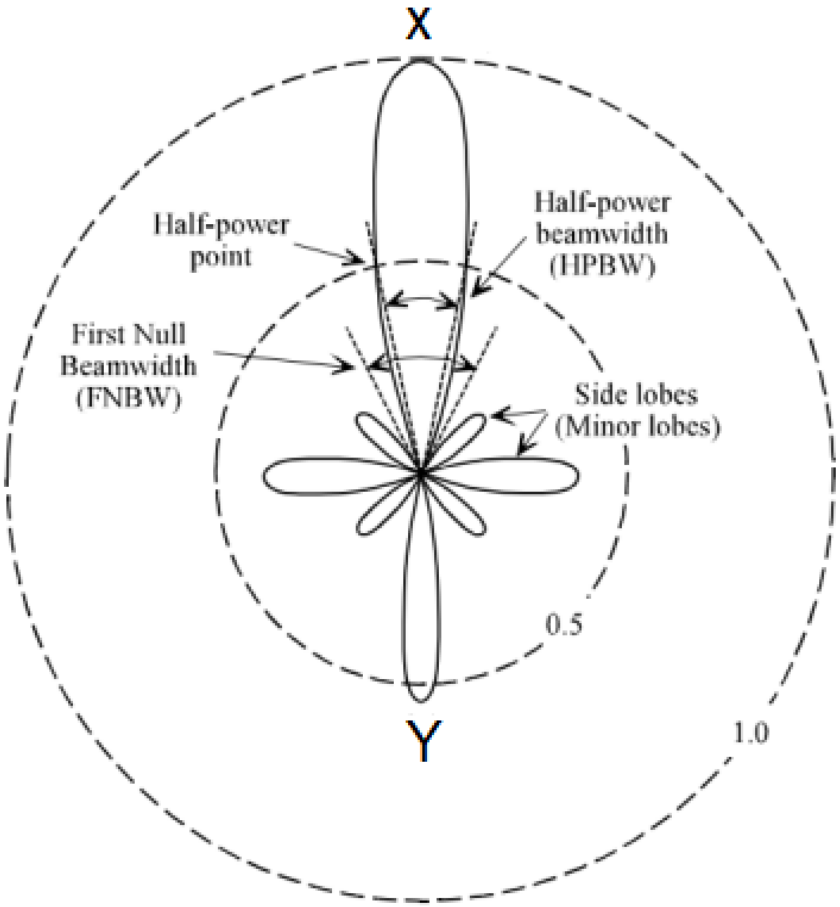


Diagram A3(a) / *Rajah A3(a)*

[4 marks]

[*4 markah*]

(b) Calculate the free space wavelength, effective aperture area, antennas beamwidth, and antennas gain if data is given as follows:
Kirakan panjang gelombang ruang udara (kosong), apertur efektif, lebar jalur antenna, dan gandaan antenna jika data adalah seperti berikut:

Diameter parabolic dish antenna / *Diamater antena dish parabolik* = 4 m

Frequency operate / *Frekuensi beroperasi* = 2 GHz

Aperture efficiency / *kecekapan apertur* = 50%

[8 marks]
[*8 markah*]

(c) An experiment using an antenna horn has been set as in the Diagram A3(c). As a group member from that experiment, calculate the value of frequency and beamwidth.
Eksperimen menggunakan horn antena telah dilaraskan seperti Rajah A3(c). Sebagai ahli kumpulan dalam eksperimen tersebut, kirakan nilai frekuensi dan nilai jalur lebar.

Received power / *Kuasa Penghantar* – 2 W

Transmitted power / *Kuasa Penerima* – 10 W

Electromagnetic field amplitude across the aperture / *Amplitud medan elektromagnet merentasi apertur* – 0.5

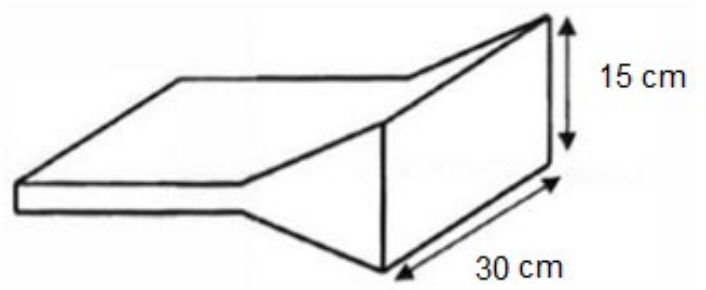


Diagram A3(c) / *Rajah A3(c)*

[8 marks]
[*8 markah*]

SECTION B : 40 MARKS
BAHAGIAN B :40 MARKAH

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

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

CLO1 **QUESTION 1**
SOALAN 1

A rectangular waveguide with dimension of 4.02 cm × 6.02 cm and an inner thickness of 0.01 cm is used to propagate a 3 GHz signal in dominant mode. Calculate the cut off frequency, guide wavelength, guide waveguide, phase velocity and characteristic impedance in TE mode.

Sebuah pandu gelombang segi empat dengan dimensi dalaman 4.02 cm × 6.02 cm dan ketebalan dalaman 0.01 cm digunakan untuk merambat isyarat pada 3 GHz di dalam mod dominan. Kirakan frekuensi potong, panjang gelombang pandu, halaju panduan pandu gelombang, halaju fasa dan galangan ciri dalam mod TE.

[20 marks]
[*20 markah*]

CLO1

QUESTION 2

SOALAN 2

The voltage standing wave caused by a mismatched load has a maximum value of 80 V and minimum value of 19 V when the 75 Ω transmission line is terminated with an unknown load. Use Smith Chart to determine the voltage standing wave ratio (VSWR) in decibel, load impedance if the minimum distance of the standing wave from the load is 0.15λ, magnitude of reflection coefficient, angle of reflection coefficient, load admittance and input impedance at 0.3λ from the load.

Voltan Gelombang Pegun yang disebabkan oleh beban yang tidak sepadan mempunyai nilai maksimum 80 V dan nilai minimum 19 V apabila talian penghantaran 75 Ω ditamatkan dengan beban yang tidak diketahui. Dengan menggunakan Carta Smith, tentukan Nisbah Voltan Gelombang Berdiri (VSWR) dalam desibel, galangan beban jika jarak minimum gelombang berdiri dari beban ialah 0.15λ, magnitud pekali refleksi, sudut pekali refleksi, penerimaan beban dan galangan masukan pada 0.3λ dari beban.

[20 marks]

[*20 markah*]

SOALAN TAMAT

APPENDIX: FORMULA TABLE

$c = f\lambda = 3 \times 10^8$ m/s or $c = \frac{1}{\sqrt{\mu_o \varepsilon_o}}$ m/s

$\varepsilon_o = 8.85 \times 10^{-12}$ F/m

$\mu_o = 4\pi \times 10^{-7}$ H/m

$\mu = \mu_o \mu_r$

$\varepsilon = \varepsilon_o \varepsilon_r$

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

$f_{c\,mn} = \frac{1}{2\sqrt{\mu\,\varepsilon}}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$

$\lambda_{c_{mn}} = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}}$ or $\lambda_{c_{mn}} = \frac{2\sqrt{\varepsilon_r \mu_r}}{\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}}$

$\lambda_g = \frac{\lambda_o}{\sqrt{1-\left(\frac{f_c}{f_0}\right)^2}}$ or $\lambda_g = \frac{\lambda_o}{\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}}$

$v_g = c\sqrt{1-\left(\frac{f_c}{f_0}\right)^2}$ or $v_g = c\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}$

$v_p = \frac{c}{\sqrt{1-\left(\frac{f_c}{f_0}\right)^2}}$ or $v_p = \frac{c}{\sqrt{1-\left(\frac{\lambda_0}{\lambda_c}\right)^2}}$

$\eta = \sqrt{\frac{\mu}{\epsilon}}$ or $\eta = 377\sqrt{\frac{\mu_r}{\varepsilon_r}}$

$Z_{OTE} = \frac{\eta}{\sqrt{1-\left(\frac{f_c}{f_0}\right)^2}}$ or $Z_{OTE} = \frac{\eta}{\sqrt{1-\left(\frac{\lambda_o}{\lambda_C}\right)^2}}$

$Z_{OTM} = \eta\sqrt{1-\left(\frac{f_c}{f_0}\right)^2}$ or $Z_{OTM} = \eta\sqrt{1-\left(\frac{\lambda_o}{\lambda_C}\right)^2}$

$A_{\mathrm{dB}} = 20\log_{10} e^{\alpha z}$ or $A_{dB} = \frac{54.5z}{\lambda_c}$

$\alpha_{d_{mn}} = \frac{\sigma_d \eta}{2\sqrt{1-\left(\frac{f_{c_{mn}}}{f_0}\right)^2}}$

$\alpha_{c_{TM_{mn}}} = \frac{2\,R_s}{b\,\eta\sqrt{1-\left(\frac{f_{c_{mn}}}{f_0}\right)^2}}\left[\frac{b^3m^2+a^3n^2}{ab^2m^2+a^3n^2}\right]$

$R_s = \frac{1}{\sigma_c \delta}$ and $\delta = \frac{1}{\sqrt{\pi f \mu \sigma_c}}$

$\alpha_{c_{TE_{m0}}} = \frac{2\,R_s}{b\,\eta\sqrt{1-\left(\frac{f_{c_{mn}}}{f_0}\right)^2}}\left[\frac{1}{2}+\frac{b}{a}\left(\frac{f_{c_{mn}}}{f_0}\right)^2\right]$

$\alpha_{c_{TE_{mn}}} = \frac{2\,R_s}{b\,\eta\sqrt{1-\left(\frac{f_{c_{mn}}}{f_0}\right)^2}}\left\{\left[1+\frac{b}{a}\right]\left(\frac{f_{c_{mn}}}{f_0}\right)^2 + \frac{b^2m^2+abn^2}{b^2m^2+a^2n^2}\left[1-\left(\frac{f_{c_{mn}}}{f_0}\right)^2\right]\right\}$

$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$ and $|\Gamma| = \frac{VSWR-1}{VSWR+1}$

$VSWR = \frac{V_{max}}{V_{min}}$ or $VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$

$Z_L{}' = \frac{Z_L}{Z_0}$

$\theta = \frac{80\lambda}{W}$ or $\theta = \frac{70\lambda}{d}$

$A_e = \eta A$

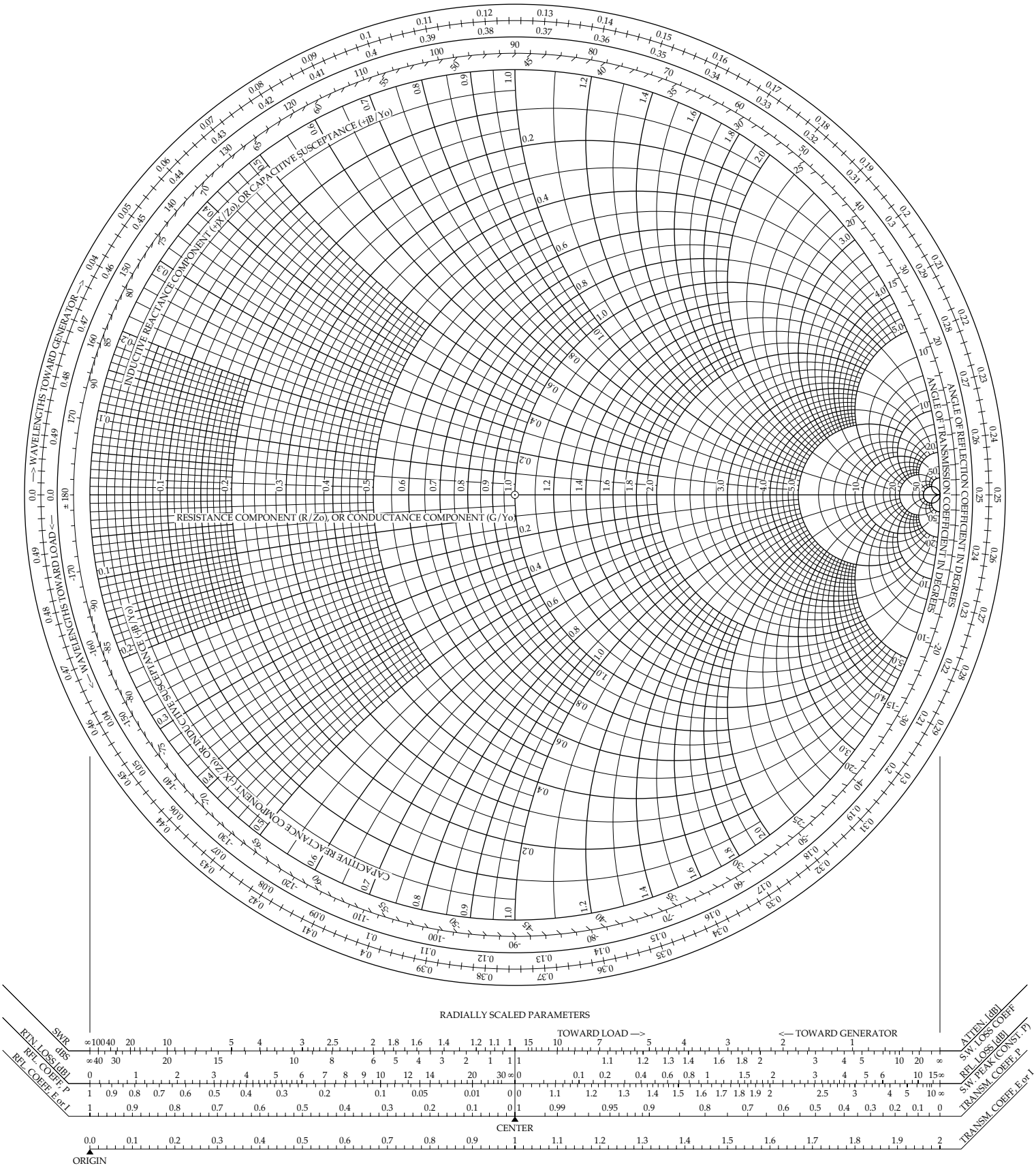
$A = \frac{\pi d^2}{4}$ or $A = \pi r^2$ or $A = W \times H$

$G = \frac{4\pi\eta A}{\lambda^2}$ or $G = \frac{4\pi A_e}{\lambda^2}$

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

$P_{TX} = P_{RX}\,G$

Smith Chart


RESISTANCE COMPONENT (R/Zo), OR CONDUCTANCE COMPONENT (G/Yo)
INDUCTIVE REACTANCE COMPONENT (+jX/Zo) OR CAPACITIVE SUSCEPTANCE (+jB/Yo)
CAPACITIVE REACTANCE COMPONENT (-jX/Zo) OR INDUCTIVE SUSCEPTANCE (-jB/Yo)
ANGLE OF REFLECTION COEFFICIENT IN DEGREES
ANGLE OF TRANSMISSION COEFFICIENT IN DEGREES
—> WAVELENGTHS TOWARD GENERATOR —>
<— WAVELENGTHS TOWARD LOAD <—
RADIALLY SCALED PARAMETERS
TOWARD LOAD —>
<— TOWARD GENERATOR
SWR
RTN. LOSS (dB)
REFL. COEFF. P
REFL. COEFF. E or I
ATTEN. (dB)
S.W. LOSS COEFF
REFL. LOSS (dB)
S.W. PEAK (CONST. P)
TRANSM. COEFF. P
TRANSM. COEFF. E or I
CENTER
ORIGIN