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 II : 2022/2023

DEP50043: MICROWAVE DEVICES

TARIKH : 14 JUN 2023
MASA : 11.15 PG – 1.15 PTG (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.
Bahagian A: Subjektif (3 soalan)
Bahagian B: Esei (2 soalan)
Dokumen sokongan yang disertakan : Formula dan 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** the questions.

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

QUESTION 1
SOALAN 1

CLO1 (a) Electromagnetic waves is created by the vibrations produced between an electric field and the magnetic field. It can propagate through any medium such as waveguide, microstrip line and air space. Explain the types of electromagnetic wave that can propagate in the rectangular waveguide.
Gelombang elektromagnet dicipta oleh getaran yang dihasilkan antara medan elektrik dan medan magnet. Ia boleh merambat melalui sebarang medium seperti pandu gelombang, garis jalur mikro dan ruang udara. Terangkan jenis-jenis gelombang elektromagnetik yang boleh merambat di dalam pandu gelombang segiempat.

[6 marks]
[*6 markah*]

CLO1 (b) By using a suitable diagram, explain clearly the operation of E-plane T-junction.
Dengan bantuan gambar rajah yang sesuai, terangkan dengan jelas operasi simpang-T satah-E.

[7 marks]
[*7 markah*]

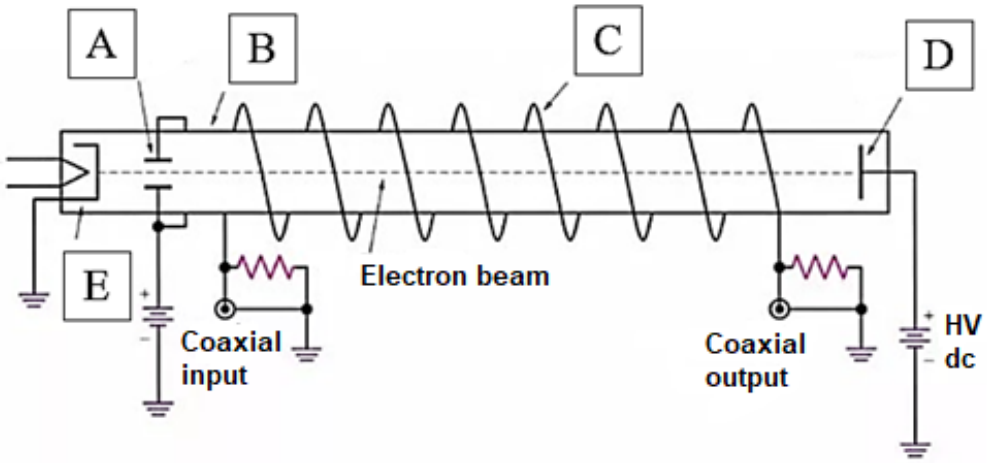


Diagram A1(c) / Rajah A1(c)

CLO1 (c) Diagram A1(c) shows the microwave tube source called Travelling Wave Tube (TWT). It consists of several parts. Among those parts are cathode, helix, collector plate and coaxial output. Explain clearly the function of the parts that have been mentioned earlier. Next, locate the cathode, helix and collector plate either on label A, B, C, D or E.

Rajah A1(c) menunjukkan sumber tiub gelombang mikro yang dipanggil Travelling Wave Tube (TWT). Ia terdiri daripada beberapa bahagian. Antara bahagian tersebut ialah katod, heliks, plat pengumpul dan keluaran sepaksi. Terangkan dengan jelas fungsi bahagian-bahagian yang telah dinyatakan tadi. Seterusnya, tentukan kedudukan katod, heliks dan plat pengumpul sama ada pada label A, B, C, D atau E.

[7 marks]

[*7 markah*]

QUESTION 2
SOALAN 2

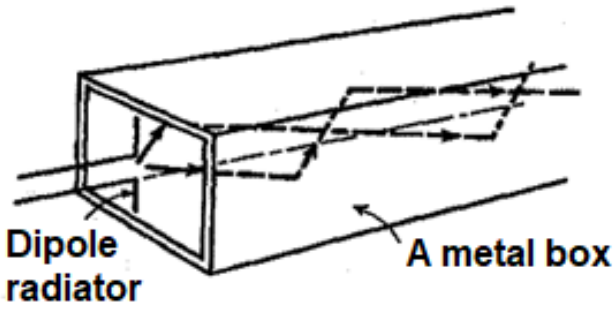


Diagram A2(a) / Rajah A2(a)

CLO1 (a) Diagram A2(a) shows how electromagnetic wave propagates inside a rectangular waveguide in order to fulfill the rule of Boundary Condition. Explain clearly this boundary condition.
Rajah A2(a) menunjukkan bagaimana gelombang elektromagnet merambat di dalam pandu gelombang segi empat tepat untuk memenuhi peraturan syarat sempadan. Terangkan dengan jelas syarat sempadan ini.

[4 marks]
[*4 markah*]

CLO1 (b) A rectangular waveguide with the inner dimension of 5 cm × 2 cm is used for propagating a microwave signal at a dominant mode. If the characteristic impedance of the waveguide is 500 **Ω**, calculate the operation frequency and guide wavelength.
Pandu gelombang segi empat tepat yang mempunyai dimensi dalam 5 cm × 2 cm digunakan untuk menyebarkan isyarat gelombang mikro pada mod dominan. Jika galangan ciri pandu gelombang ialah 500 Ω, kirakan frekuensi operasi dan panjang gelombang pandu gelombang.

[8 marks]
[*8 markah*]

CLO1 (c) A transmission line has a characteristic impedance of (50 + j0.01) Ω and terminated in a load impedance of (73 – j42.5) Ω. Calculate the reflection coefficient, standing-wave ratio and standing-wave ratio in decibel for the transmission line.

Satu talian penghantaran mempunyai galangan ciri (50 + j0.01) Ω dan ditamatkan dalam galangan beban (73 – j42.5) Ω. Kirakan pekali pantulan, nisbah gelombang pegun dan nisbah gelombang pegun dalam desibel untuk talian penghantaran.

[8 marks]
[*8 markah*]

QUESTION 3
SOALAN 3

CLO1 (a) Hazard of electromagnetic radiation is the negative effects that caused by electromagnetic radiation. Explain **TWO (2)** types of hazard of electromagnetic radiation that can give dangerous to the general public.

*Terangkan **DUA (2)** jenis bahaya pancaran gelombang elektromagnet yang boleh memberi bahaya kepada orang awam.*

[4 marks]
[*4 markah*]

CLO1 (b) A parabolic antenna with a diameter of 6 m operates at a frequency of 5 GHz. Calculate the effective area and beamwidth angle of the antenna if the aperture efficiency is 0.65.

Antena parabola dengan diameter 6 m beroperasi pada frekuensi 5 GHz. Kirakan luas berkesan dan sudut lebar pancaran antena jika kecekapan apertur ialah 0.65.

[8 marks]
[*8 markah*]

CLO1 (c) A horn antenna with dimension of 0.6 m × 0.4 m is used to transmit a signal at a frequency of 10 GHz. If the aperture efficiency is 0.582, calculate the gain and gain in decibel of the antenna.

Antena hon dengan dimensi 0.6 m × 0.4 m digunakan untuk menghantar isyarat pada frekuensi 10 GHz. Jika kecekapan aperture antena ialah 0.582, kirakan gandaan dan gandaan dalam desibel antena.

[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.*

QUESTION 1
SOALAN 1

CLO1 An air-filled rectangular waveguide with dimension of 7.04 cm × 5.04 cm and an inner thickness of 0.02 cm is used to propagate a 4 GHz signal in a dominant mode. Calculate the cut-off frequency, guide wavelength, velocity inside waveguide, phase velocity and characteristic impedance.

Satu pandu gelombang segiempat berisikan udara dengan dimensi 7.04 cm × 5.04 cm dan ketebalan dalaman 0.02 cm digunakan untuk merambat isyarat pada 4 GHz di dalam mod dominan. Kirakan frekuensi potong, panjang gelombang pandu, halaju dalam pandu gelombang, halaju fasa dan galangan ciri.

[20 marks]
[*20 markah*]

CLO1 **QUESTION 2**
SOALAN 2

The voltage standing wave caused by a mismatched load as shown in Diagram B2 has a maximum voltage value of 40 V and a minimum voltage value of 12.5 V. Calculate the value of voltage standing wave ratio and reflection coefficient. In order to solve this mismatched problem, 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 the

generator. Find the position and length of the short-circuited stub to match the 50 Ω transmission line if the minimum distance of standing wave is 0.358λ by using Smith Chart.

Voltan bagi gelombang pegun yang disebabkan oleh beban tidak sepadan seperti yang ditujunjukkan pada Rajah B2 mempunyai nilai voltan maksimum 40 V dan nilai voltan minimum 12.5 V. Kirakan nilai bagi nisbah voltan gelombang pegun dan pekali. Dalam menyelesaikan masalah tidak sepadan ini, 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. Dapatkan kedudukan puntung dan panjang puntung litar yang dipintaskan untuk talian penghantaran 50 Ω sekiranya jarak minimum gelombang pegun ialah 0.358λ dengan menggunakan Carta Smith.

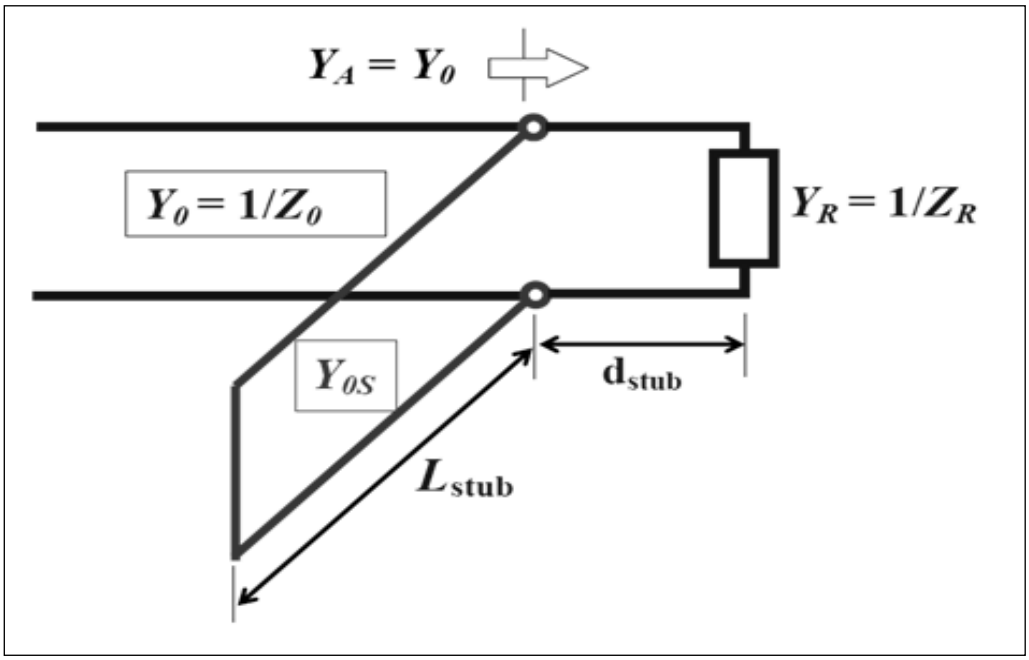


Diagram B2 / Rajah B2

[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 $Z_{OTE} = \frac{\eta}{\sqrt{1-\left(\frac{\lambda_0}{\lambda_C}\right)^2}}$

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

$A_{\text{dB}} = 20\log_{10} e^{\alpha z}$ 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 $\delta = \frac{1}{\sqrt{\pi f \mu \sigma_c}}$

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

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

$\Gamma = \frac{Z_0 - Z_L}{Z_0 + Z_L}$ 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 $\theta = \frac{70\lambda}{d}$

$A_e = \eta A$

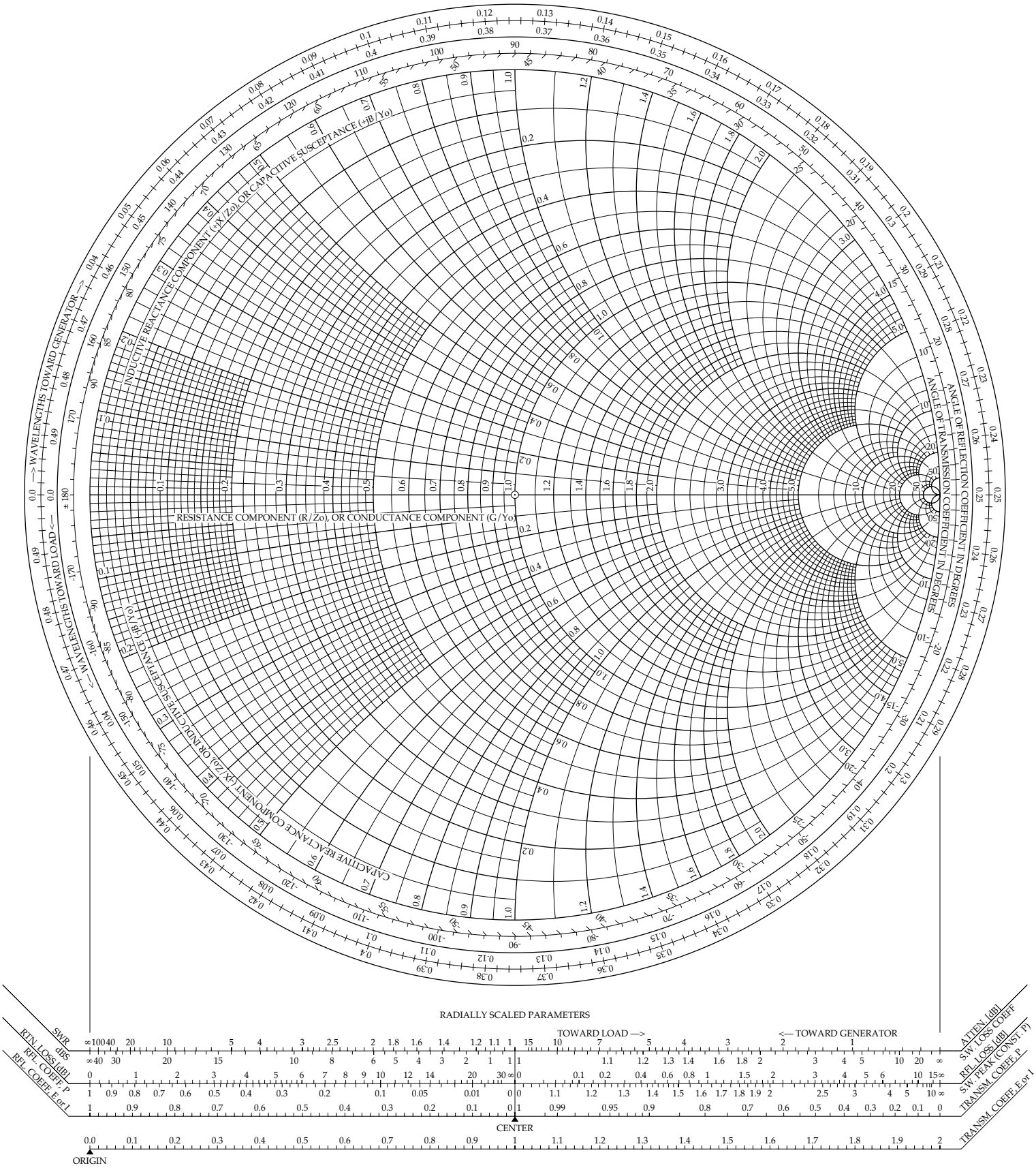
$A = \frac{\pi d^2}{4}$ or $A = \pi r^2$ or $A = W \times H$

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