

**SULIT**



**BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENDIDIKAN POLITEKNIK  
KEMENTERIAN PENDIDIKAN TINGGI**

**JABATAN KEJURUTERAAN ELEKTRIK**

**PEPERIKSAAN AKHIR**

**SESI JUN 2016**

**DEP5303: MICROWAVE DEVICES**

**TARIKH : 23 OKTOBER 2016 (AHAD)**

**MASA : 2.30 PM – 4.30 PM (2 JAM)**

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Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.

Bahagian A: Struktur (4 soalan)

Bahagian B: Esei (2 soalan)

Dokumen sokongan yang disertakan : Formula, Carta Smith

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**JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN**

(CLO yang tertera hanya sebagai rujukan)

**SULIT**

**SECTION A : 60 MARKS**  
**BAHAGIAN A : 60 MARKAH**

**INSTRUCTION:**

This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.

**ARAHAN:**

*Bahagian ini mengandungi EMPAT (4) soalan berstruktur. Jawab SEMUA soalan.*

**QUESTION 1**  
**SOALAN 1**

CLO1  
C1

- (a) Define an electromagnetic wave.  
*Takrifkan gelombang elektromagnetik.*

[3 marks]  
[3 markah]

CLO1  
C2

- (b) Differentiate the propagation mode in free space with the propagation mode in waveguide that is between transverse electromagnetic (TEM), transverse electric (TE) and transverse magnetic (TM).

*Bezakan mod perambatan di dalam ruang bebas dengan mod perambatan di dalam pandu gelombang iaitu di antara elektromagnetik menegak (TEM), elektrik menegak (TE) dan magnetik menegak (TM).*

[6 marks]  
[6 markah]

CLO1  
C2

- (c) Discuss **TWO (2)** important characteristics of microwave that benefit to the communication systems.

*Bincangkan DUA (2) ciri penting gelombang mikro yang memberi manfaat kepada sistem komunikasi.*

[6 marks]  
[6 markah]

**QUESTION 2**  
**SOALAN 2**

CLO1  
C2

- (a) Diagram A2 shows how electromagnetic wave propagates inside a rectangular waveguide in order to fulfill the rule of Boundary Condition. Express this boundary condition.

*Rajah A2 menunjukkan bagaimana gelombang elektromagnetik merambat dalam pandugelombang empatsegi untuk mematuhi peraturan Syarat Sempadan. Nyatakan Syarat Sempadan ini.*

[3 marks]

[3 markah]

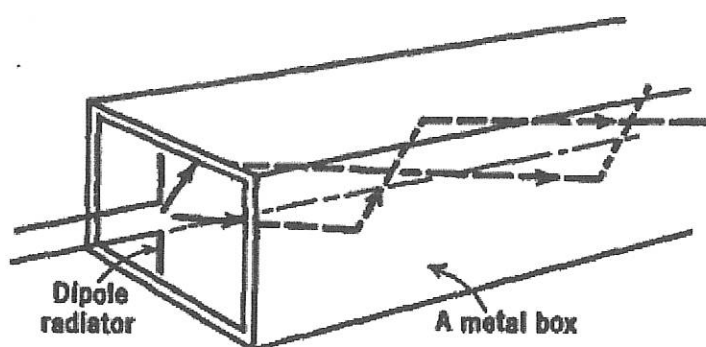


Diagram A2 / Rajah A2

CLO2  
C3

- (b) Calculate the cutoff conditions for the waveguide in the diagram A2, if its dimension is  $4.2 \times 2.1$  cm and the allowed propagation mode is dominant mode.

*Kirakan keadaan potong untuk pandugelombang bagi Rajah A2, sekiranya dimensi adalah  $4.2 \times 2.1$  cm dan mod perambatan yang dibenarkan adalah mod dominan.*

[6 marks]

[6 markah]

CLO2  
C3

- (c) A 9 GHz signal propagates inside the rectangular waveguide that is filled with lossy dielectric material with dielectric conductivity  $3.655 \times 10^{-4}$  S/m, dielectric permittivity 2.1 and dielectric permeability 1.0. Use the appropriate formula to determine the guide attenuation factor if the cut-off frequency is 4.5 GHz.

*Sebuah isyarat 9 GHz merambat di dalam pandugelombang empatsegi yang berisi dengan bahan dielektrik dengan kehilangan yang mempunyai dielectric conductivity  $3.655 \times 10^{-4}$  S/m, permittivity 2.1 dan permeability 1.0. Gunakan formula yang sesuai untuk menentukan faktor pelemahan pandu sekiranya frekuensi potong adalah 4.5 GHz.*

[6 marks]

[6 markah]

**QUESTION 3**  
**SOALAN 3**

CLO2  
C2

- a) Plot the following normalized values  $Z_1 = 1.5 - j2$ ,  $Z_2 = 2 + j0.8$  and  $Z_3 = j4$  on a Smith Chart:

*Plotkan nilai-nilai ternormal berikut  $Z_1 = 1.5 - j2$ ,  $Z_2 = 2 + j0.8$  and  $Z_3 = j4$  di atas sehelai Carta Smith.*

[3 marks]

[3 markah]

CLO2  
C3

- b) A transmission line has a characteristic impedance of  $50\Omega$  and is terminated by load of  $100 + j500\Omega$ . Calculate magnitude of reflection coefficient and voltage standing wave ratio

*Sebuah talian penghantaran mempunyai ciri galangan  $50\Omega$  dan ditamatkan dengan beban  $100 + j500\Omega$ . Kirakan magnitud pekali pantulan dan nisbah voltan pegun.*

[6 marks]

[6 markah]

CLO2  
C3

- c) By using a Smith Chart, plot the input impedance of a transmission line at a point of  $0.652\lambda$  from the load of  $75 - j25\Omega$  if the characteristic impedance of the line is  $50\Omega$ .

*Dengan menggunakan Carta Smith, plotkan galangan masukan bagi talian penghantaran pada kedudukan  $0.652\lambda$  dari beban  $75 - j25\Omega$  sekiranya galangan ciri bagi talian adalah  $50\Omega$ .*

[6 marks]

[6 markah]

**QUESTION 4**  
**SOALAN 4**

CLO1  
C1

- (a) List **THREE (3)** microwave sources of type's semiconductor.

*Senaraikan TIGA (3) sumber gelombang mikro jenis semi konduktor.*

[3 marks]  
[3 markah]

CLO1  
C2

- (b) Describe the microwave source of type vacuum tube.

*Huraikan sumber gelombang mikro jenis tiub.*

[5 marks]  
[5 markah]

CLO1  
C3

- (c) Sketch the radiation pattern for microwave antenna and label it completely.

*Lakarkan corak pancaran bagi antenna gelombang mikro serta labelkan selengkapnya.*

[7 marks]  
[7 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**

CLO2  
C3

- (a) An air-filled rectangular waveguide with a dimension of 7cm x 3.5cm operates in the  $TE_{11}$  mode with the frequency of 6GHz. Determine cut-off frequency, guide wavelength, velocity of the signal inside the waveguide and wave characteristic impedance.

*Suatu pandu gelombang segi empat tepat berisi udara dengan dimensi 7cm x 3.5cm beroperasi dalam mod  $TE_{11}$  dengan frekuensi 6GHz. Tentukan frekuensi potong, panjang gelombang pandu, halaju isyarat yang merambat dalam pandu gelombang dan galangan ciri gelombang.*

[10 marks]  
[10 markah]

CLO2  
C3

- (b) An air-filled circular waveguide with an inner diameter of 4cm operated in a dominant mode at 10GHz. Calculate cut-off frequency, guide wavelength and wave characteristic impedance.

*Sebuah pandu gelombang bulat berisi udara mempunyai garis pusat dalaman 4cm beroperasi dalam mod dominan pada 10 GHz. Kira frekuensi potong, panjang gelombang pandu dan galangan ciri gelombang.*

[10 marks]  
[10 markah]

**QUESTION 2**  
**SOALAN 2**

CLO2  
C4

The voltage standing wave caused by a mismatch load has a maximum value of 60V and a minimum value of 40V. Calculate the value of standing wave ratio (SWR) and reflection coefficient ( $\Gamma$ ) using suitable formula. If the reflection angle of the load is  $+30^\circ$  and the length of the transmission line is  $0.15\lambda$ , determine the value of the load (in  $\Omega$ ) and input impedance ( $\Omega$ ) using Smith Chart.

*Voltan bagi gelombang pegun yang disebabkan oleh beban tidak sepadan mempunyai nilai maksimum 50V dan nilai minimum 30V. Kirakan nilai bagi nisbah gelombang pegun (SWR) dan pekali pantulan ( $\Gamma$ ). Sekiranya sudut pantulan beban adalah  $+30^\circ$  dan panjang talian penghantaran adalah  $0.15\lambda$ , tentukan nilai bagi beban tersebut (dalam  $\Omega$ ) dan galangan masukan ( $\Omega$ ) dengan menggunakan Carta Smith.*

[20 marks]

[20 markah]

**SOALAN TAMAT**

APPENDIX: FORMULA TABLE

$$c = \lambda f = 3 \times 10^8 \text{ ms}^{-1}$$

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

$$\lambda_c = \frac{\pi d}{S_{mn}}$$

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

$$f_c = \frac{c S_{mn}}{\pi d}$$

$$\lambda_{\text{guide}} = \frac{\lambda_o}{\sqrt{1 - \left(\frac{\lambda_o}{\lambda_c}\right)^2}}$$

$$v_{\text{phase}} = \frac{c}{\sqrt{1 - \left(\frac{\lambda_o}{\lambda_c}\right)^2}}$$

$$v_{\text{group}} = c \sqrt{1 - \left(\frac{\lambda_o}{\lambda_c}\right)^2}$$

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

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

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

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

DEP5303 - MICROWAVE DEVICES

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

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

$$\text{Beam width} = \frac{70\lambda}{d}$$

$$G_p = 10 \log \frac{4\pi A k}{\lambda^2} \text{ (dB)}$$

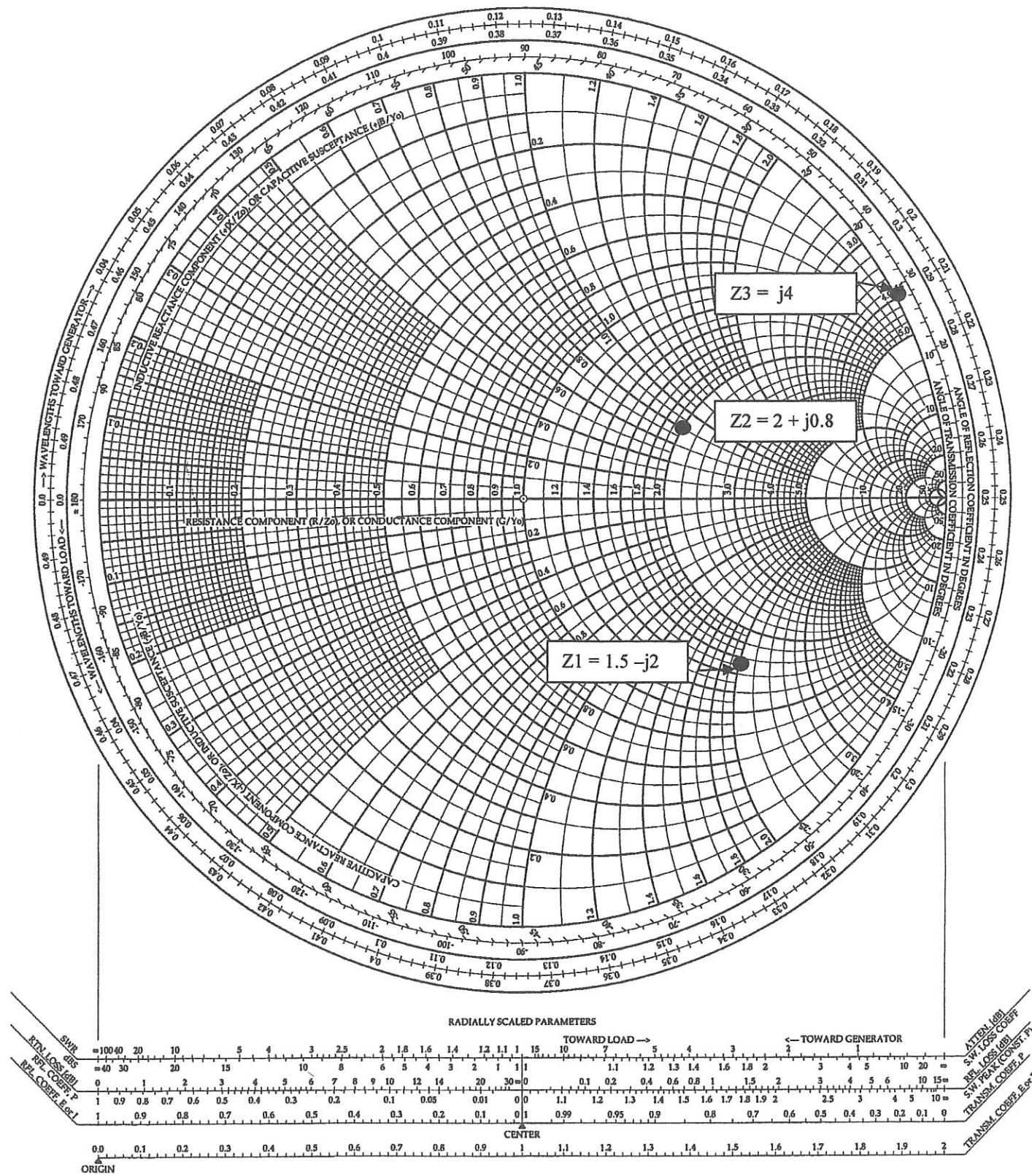
Bessel Equation's Schedule for Circular Waveguide:

Mode	$S_{mn}$	Mode	$S_{mn}$
TE <sub>01</sub>	3.832	TM <sub>01</sub>	2.405
TE <sub>11</sub>	1.841	TM <sub>11</sub>	3.832
TE <sub>21</sub>	3.050	TM <sub>21</sub>	5.136
TE <sub>02</sub>	7.016	TM <sub>02</sub>	5.520
TE <sub>12</sub>	5.330	TM <sub>12</sub>	7.016
TE <sub>22</sub>	6.710	TM <sub>22</sub>	8.420



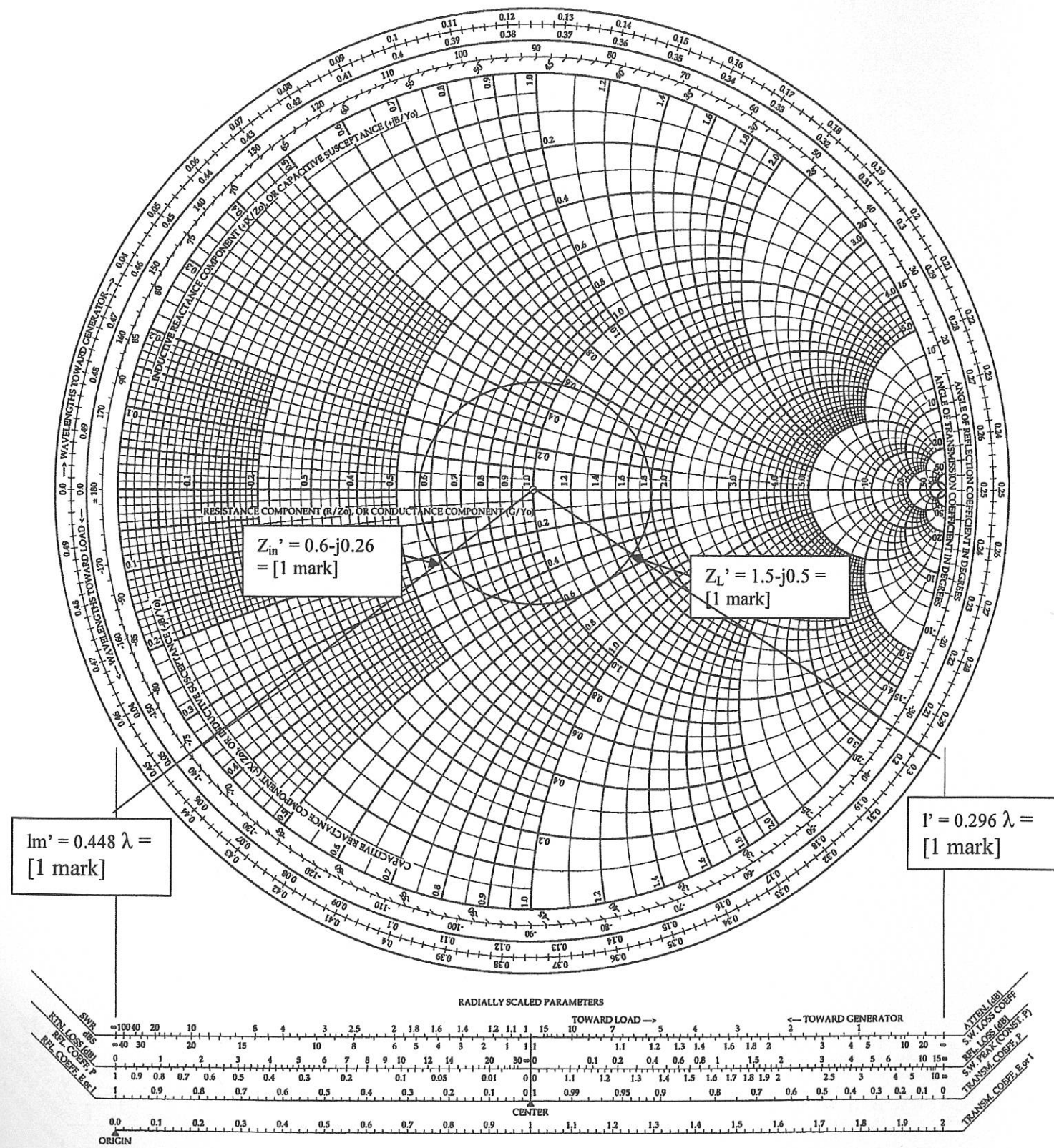
QUESTION 3(a)

The Complete Smith Chart  
Black Magic Design



QUESTION 3 (c)

The Complete Smith Chart  
Black Magic Design



# The Complete Smith Chart

## Black Magic Design

