INTERNAL ASSESSMENT - I

TRANSMISSION LINES AND WAVEGUIDES

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Saturday

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BE - ECE

Part - B :-

6)b) Lossless transmission line:
(i)

A transmission line is lossless if the conductors of the line are perfect ($\sigma_c \approx \infty$) and the dielectric medium separating them is lossless ($\sigma \cong 0$). For such line,

$\boxed{R = 0 = G}$ is the necessary condition,

Then,

$$\gamma = \sqrt{(R+j\omega L)(G+j\omega C)} = \alpha + j\beta$$

$\because R = 0 = G$,

$$\gamma = \sqrt{(j\omega L)(j\omega C)} = \alpha + j\beta = j\omega\sqrt{LC}$$

$$\Rightarrow \alpha = 0, \quad \beta = \omega\sqrt{LC}, \quad u = \frac{\omega}{\beta} = \frac{1}{\sqrt{LC}} = f\lambda$$

Also, $$Z_0 = \sqrt{\frac{R+j\omega L}{G+j\omega C}} = R_0 + jX_0 = \sqrt{\frac{L}{C}}$$

$$\Rightarrow X_0 = 0, \quad Z_0 = R_0 = \sqrt{\frac{L}{C}} \;//$$

6) b

ii) $Z_i = 200\,\Omega$, $Z_L = 600 - j150\,\Omega$

$Z_0 = 400$

Normalised $Z_L = \dfrac{600 - j150}{200} = 3 - j(3/4)$

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{3 - j(0.75) - 400}{3 - j(0.75) + 400} = \frac{-397 - j(0.75)}{403 - j(0.75)}$$

$$= \frac{[-397 - j(0.75)][403 + j(0.75)]}{(403)^2 + (0.75)^2} = \frac{159990.4375 - j(0.75)(403+397)}{162408.4375}$$

$$= \frac{159990.4375 - j(600)}{162408.4375}$$

$$\Gamma = 0.985 - j(0.00369)$$

$$|\Gamma| = \sqrt{0.970440 + 0.00001}$$

$$= 0.98511$$

Return loss $= 20 \log(0.98511) = 20 \times (-0.006511)$
$= \underline{-0.130\,dB}$ //

Reflection loss $= 10 \log(1 - \Gamma^2)$
$= 10 \log(0.0295) = \underline{-15.295\,dB}$ //

7)

1. Normalised impedance = $0.5 + 0.6j = A$

VSWR = 2.8

2. Normalized admittance

$= B = (0.84 - 0.96j)$

3. $S_1 = 0.84 + 0.01j$, $S_2 = 0.84 + 2j$

4. $S_1 - B = 0.84 + 0.01j - 0.84 + 0.96j = 0.97j$

$S_2 - B = 0.84 + 2j - 0.84 + 0.96j = 2.96j$

5. Since D_1 is nearer to the load surface

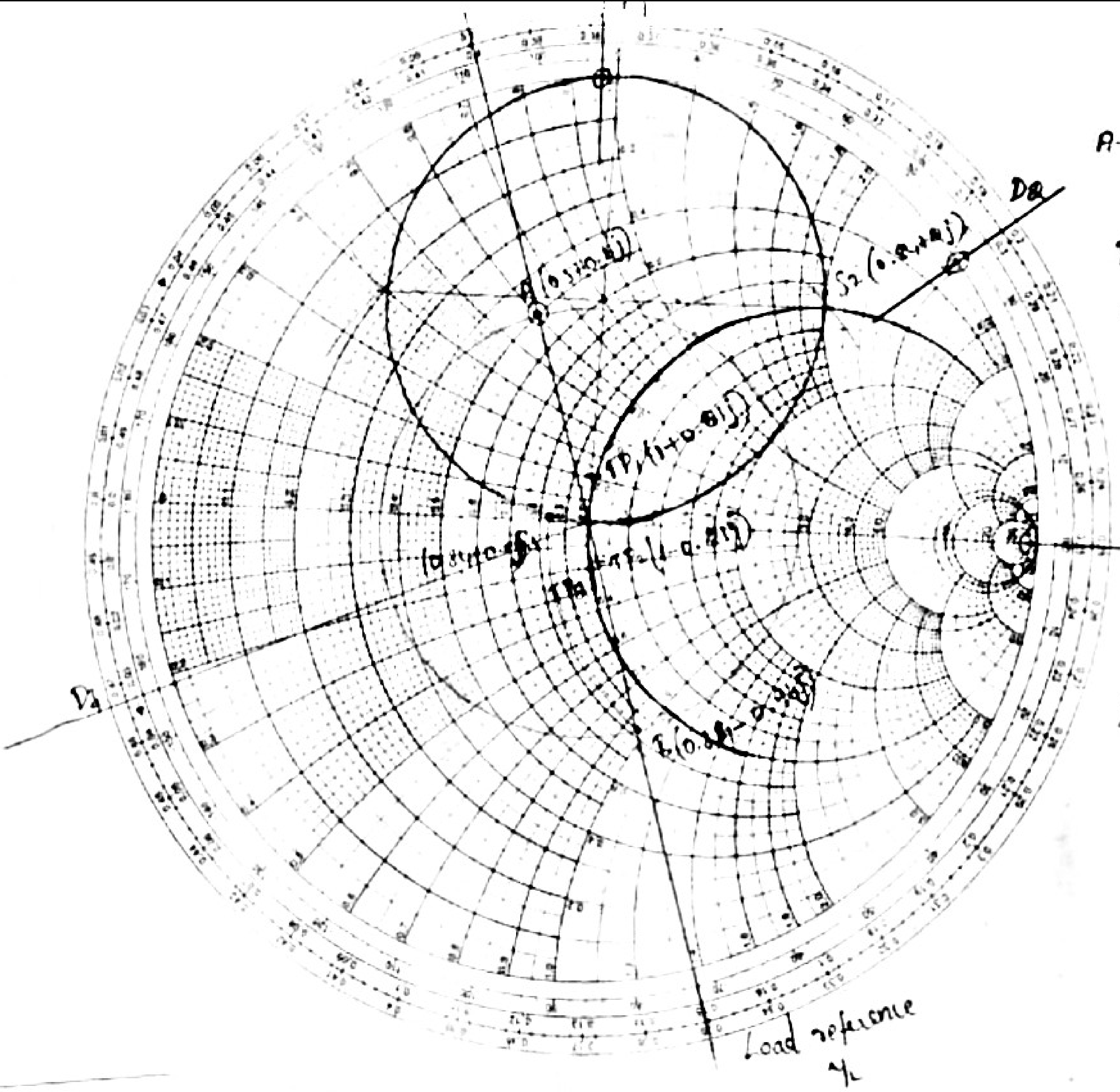
$\boxed{\text{length of first stub} = 0.35\lambda}$ Short circuit to D_1

6. OS_1 as radius, mark TP_1 $(1 + 0.21j)$ and TP_2 $(1 - 0.21j)$ as intersection of unit resistance circle and OS_1 radius circle.

7. AS TP_1 is nearer to the load ~~surface~~ reference

Hence, $\boxed{\text{Length of second stub} = 0.217\lambda}$

Short circuit to D_3



A-(0.3+0.6j) Normalized impedance

B-(0.84-0.96j) Normalized admittance

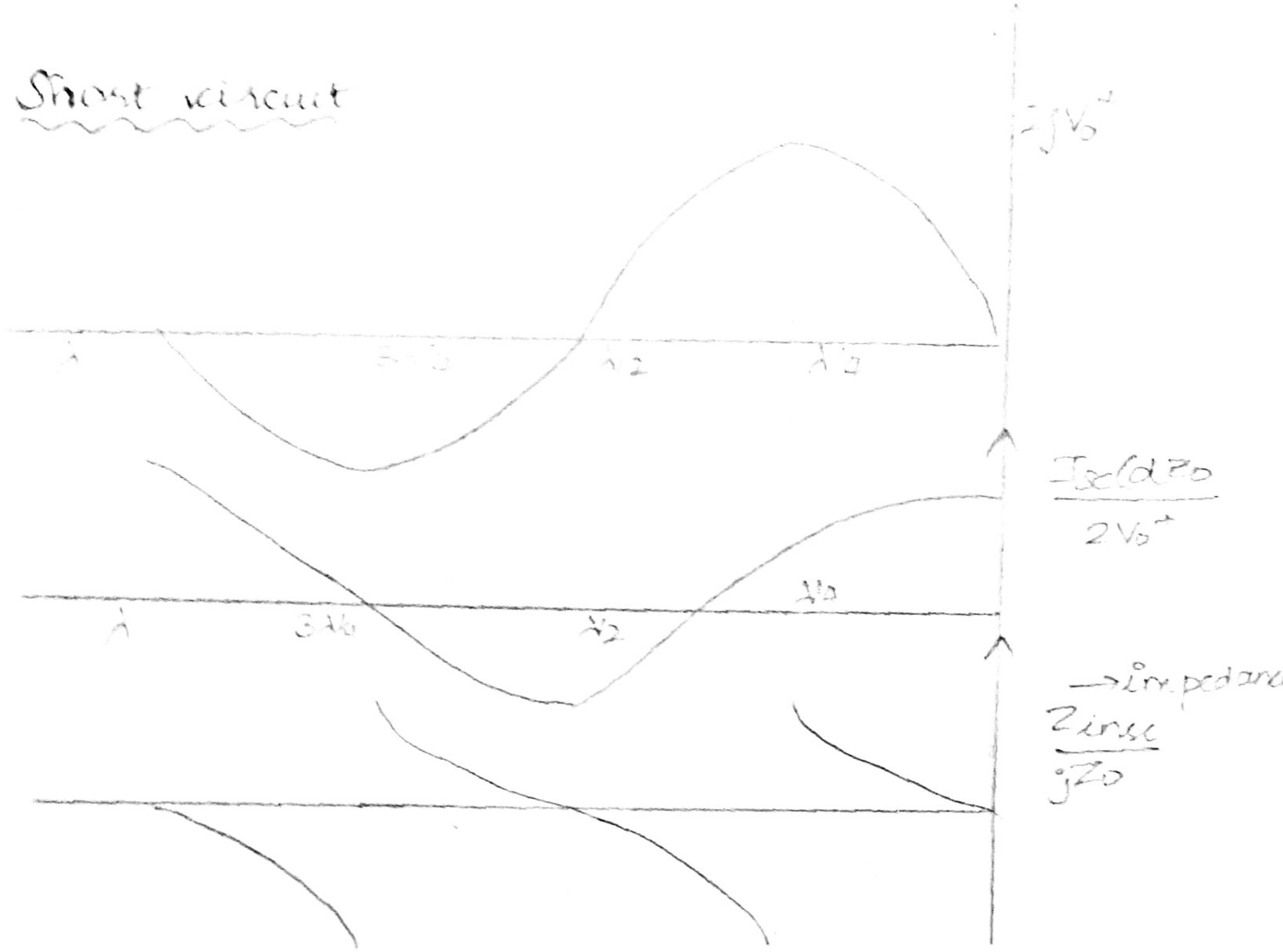
$B - S_1 = 0.84 - 0.96j - 0.84$

$S_1 - B = 0.84 + 0.01j - 0.84 + 0.96j = 0.97j.$

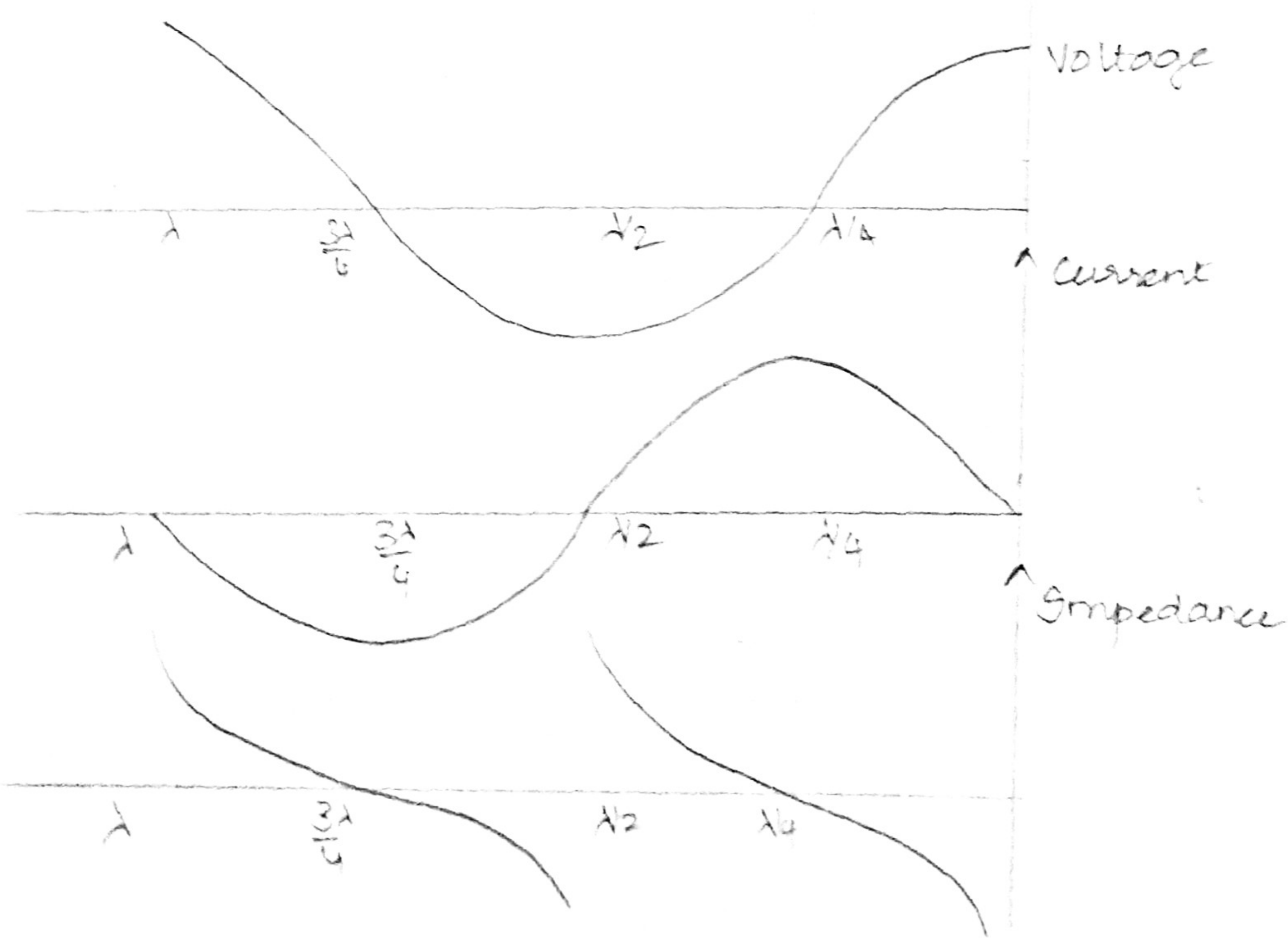
$S_2 - B = 0.84 + 2j - 0.84 + 0.96j = 2.96j.$

Part - A

3. Short circuit



Open circuit



1. $Z_0 = 50\Omega$

$Z_L = R + jX_L$

$\Gamma_L = 0.6$

$R = 50\Omega$

We know that

$$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{50 + jX_L - 50}{50 + jX_L + 50} = \frac{jX_L}{100 + jX_L}$$

$\Rightarrow \quad 0.6 = \frac{jX_L}{100 + jX_L}, \quad \Rightarrow 60 + j(0.6)X_L = jX_L$

$\Rightarrow \quad 60 = j(1 - 0.6)X_L = (0.4)jX_L$

$jX_L = \frac{60}{0.4} = \frac{600}{4} = 150$

$\Rightarrow X_L = -150j$

$\therefore Z_L = 50 + j(150) \Omega$ //

2. Coaxial cable impedance = 25Ω (on one end)

Other end is short - circuited.

Impedence (when it is open circuited) = 100Ω

To find: characteristic impedance (Z_0)

$Z_{sc} = jZ_0 \tan \beta l \qquad Z_{oc} = -jZ_0 \cot \beta l$

$Z_0 = \sqrt{Z_{sc} \cdot Z_{oc}} = \sqrt{25 \times 100} = \sqrt{2500}$

$\Rightarrow \underline{50}$

$\underline{\underline{Z_0 = 50}}$

4) $L = 10\mu H/m$ $\quad f = 25$ ~~m~~ MHz

$C = 40pF/m$ $\quad$ length $= 100cm = l$

$\omega = 2 \times 3.14 \times 25 \times 10^6$

$= 157 \times 10^6$ rad/sec

$\beta = \omega\sqrt{LC} = 157 \times 10^6 \sqrt{10 \times 10^{-6} \times 40 \times 10^{-12}}$

$= 157 \times 10^{+6} \sqrt{400 \times 10^{-18}}$

$= 157 \times 10^{+6} \times 20 \times 10^{-9} = 3140 \times 10^{-3}$

$\Rightarrow \underline{\beta = 3.14}$

Electrical length $= \beta l = 3.14 \times 100cm$

$= \underline{314\ cm}$

5) Condition for TE to exist in wave guide

$$E_x = +\frac{j\omega\mu}{h^2}\frac{\partial H_z}{\partial x}$$

$$H_x = -\frac{\gamma}{h^2}\frac{\partial H_z}{\partial x}$$

Condition for TM to exist in wave guide

$$H_y = -\frac{j\omega\epsilon}{h^2}\frac{\partial E_z}{\partial x}$$

$$E_x = -\frac{\gamma}{h^2}\frac{\partial E_x}{\partial x}$$

7)