FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

DEGREE PROGRAMME IN ELECTRONICS (MASTER'S)

Course Name: Radio Engineering 1
Homework #4

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Theory.

As, $S_{12} = 0$, this mean the transistor is unilateral, which also means that there is no reverse transmission from output to input.

For unilateral device, maximum gain occurs when the transistor is matched at both ports. The required source & load reflection co-efficients are:

$$\Gamma_s = S_{11}^* = 0.44 \angle 103^\circ$$

$$\Gamma_L = S_{22}^* = 0.65 \angle 72^\circ$$

Now, we need to use lossless components and only inductors and capacitors to tranform the 50Ω source into an impedance that has Γ_s (reflection co-efficient) and 50Ω load into an impedance that has Γ_L as seen by the transistor.

If we follow this, we will get maximum power transfer ~~and~~ which will lead to maximum transducer gain.

The equation from Pozar (12.42), the maximum transducer gain for an unilateral device is,

$$G_{T max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$$

$$= \frac{3.4^2}{(1-0.44^2)(1-0.65^2)}$$

$$= \frac{11.56}{0.76 \times 0.58} = 26.3$$

Into dB value = 14.2 dB.

So, Maximum transducer gain is 14.2 dB.

Now, LC matching network design:-

$Z_s = Z_0 \frac{1+\Gamma_s}{1-\Gamma_s}$ & $Z_L = Z_0 \frac{1+\Gamma_L}{1-\Gamma_L}$.

Here, $\Gamma_s = 0.49(\cos 103 + j\sin 103)$ | $\Gamma_L = 0.65(\cos 72 + j\sin 72)$.

$= 0.11 + 0.477j$ | $= 0.2 + 0.62j$

$\therefore Z_s = 50\left(\frac{1-0.11+j0.477}{1+0.11-j0.477}\right)$ | $Z_L = Z_0 \frac{1+\Gamma_L}{1-\Gamma_L}$

$= 50 \times \frac{0.89 + j0.477}{1.11 - j0.477}$ | $= 50 \cdot \left(\frac{1+0.2+0.62j}{1-0.2-j0.62}\right)$

$= 28.93 + j60.5$.

$= 26 + j32.7\Omega$.

Given, $f = 2.8$ GHz.

As, the real part transition impedance $< 50\Omega$,
so, we have same L-matching topology.

$Z_0 = 50 + j0\Omega$ need to transform $Z_A = 26.0 + j32.7\Omega$

Normalize value $z = 1 + j0$ and $z_A = 0.52 + j0.655$

Now, in the smith chart I locate the point z_A on the smith chart and then read the admittance of $Y_A = (0.76 - j0.94)$

Beside, for shunt capacitor adding, I move downward following the admittance circle until I find the unit circle $y_B = (0.76 + j0.44)$

Z_b at this point is $(0.98 - j0.57)$. To cancel the imaginary part I add an inductor in series.

$X_L = 0.57 \times 50 = 28.3\Omega$

Subsequence change,

$$\Delta b = 0.44 - (-0.94)$$
$$= 1.38.$$

$$X_C = -\frac{1}{\Delta b} = -\frac{1}{1.38} = -0.724.$$
$$X_C = 50 \times (-0.724) = -36.23.$$

$$C = \frac{1}{\omega |X_C|} = \frac{1}{2\pi \times 2.8 \times 10^{9} \times 36.23}$$
$$= 1.56\,pF.$$

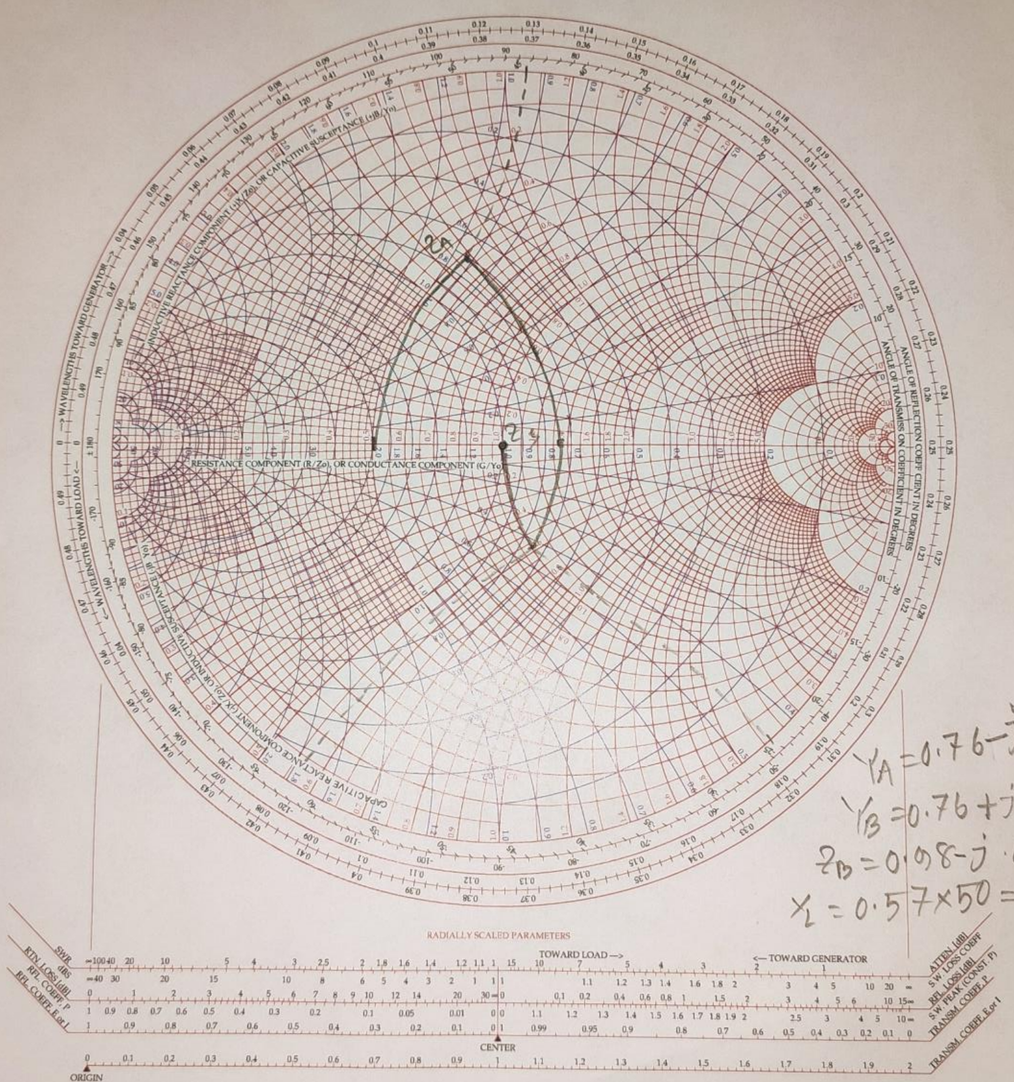
$$L = \frac{X_L}{\omega} = \frac{28.3}{2\pi f} = 1.6\,nH.$$

SHOT ON MI 9T
AI TRIPLE CAMERA

sd

NAME Arafat Miah	TITLE Input	DWG. NO.
SMITH CHART FORM ZY-01-N	Microwave Circuit Design - EE523 - Fall 1999	DATE

NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES



$Y_A = 0.76 - j0.94$

$Y_B = 0.76 + j0.44$

$Z_B = 0.98 - j\,0.57$

$X_L = 0.57 \times 50 = 28.5$

On the load side, $Z_L = 28.03 + j60.5$.

So, the Normalized value is, $Z_L = 0.58 + j1.21$.

Now, located point Z_L on the smith chart, then move with the admittance circle to add the shunt capacitor.

$$Y_L = 0.3 - j0.64$$
$$Y_1 = 0.3 + j0.44$$

$$\Delta b = 0.44 - (-0.64)$$
$$= 1.08$$
$$= $$

$$\therefore Z_1 = 1.05 - j1.55$$

So, value for $X_L = +1.55$ to move the Z_1 to $Z_L = 1 + j0\ \Omega$

$$= 1.55 \times 50 = 77.5\ \Omega$$

$$X_C = -\frac{1}{\Delta b} = \frac{-1}{1.08} = -0.93$$

$$X_C = 50 \times (-0.93) = -46.5\ \Omega$$

$$\therefore L = \frac{77.5}{2\pi f} = 4.4\,nH$$

$$C = \frac{1}{w|X_C|} = \frac{1}{2\pi \times f \times 46.5} = 1.22\,pF$$

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NAME Arralata Mian	TITLE output	DWG. NO.
		DATE
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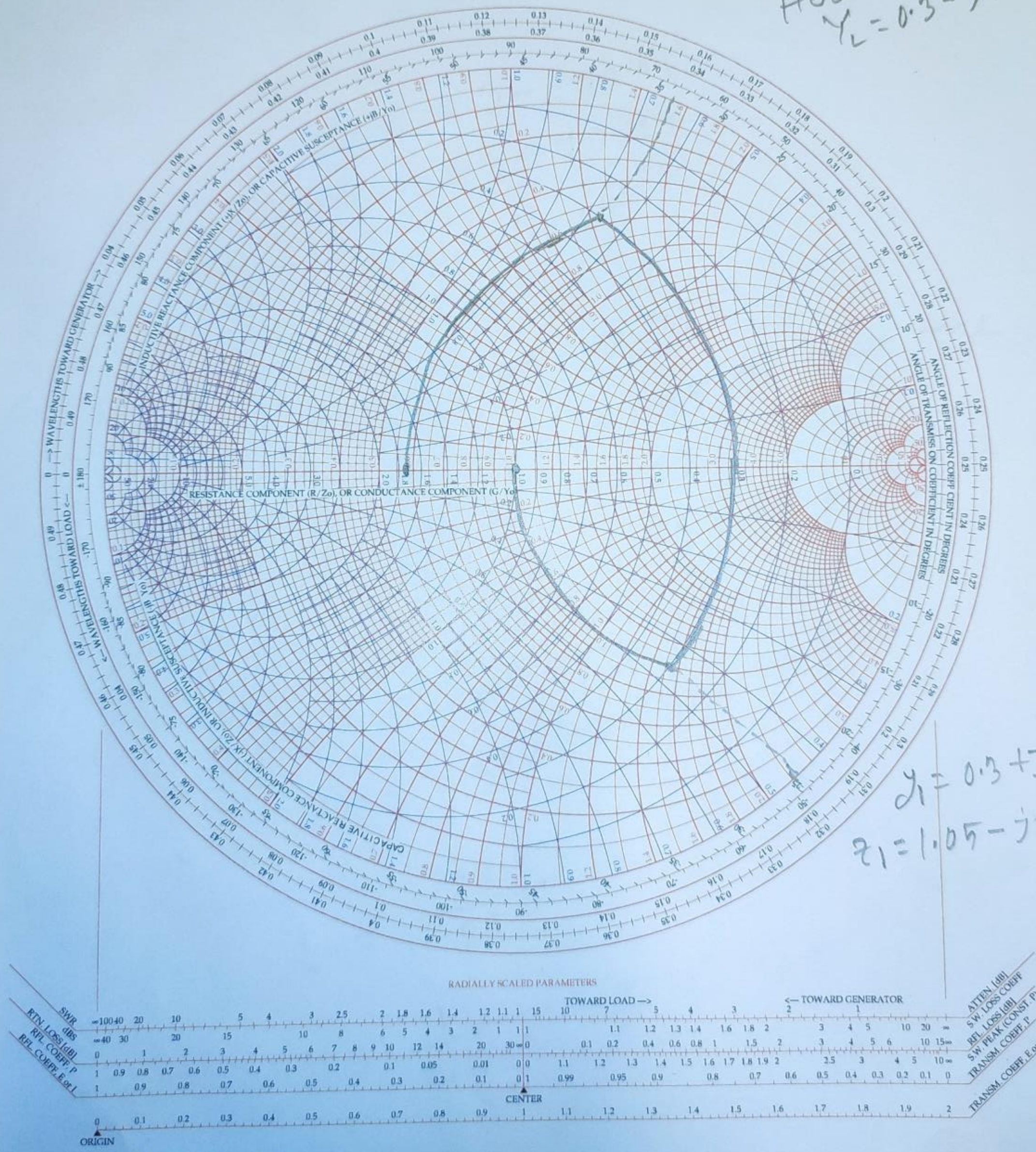
NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES

Here, $Y_L = 0.3 - j0.64$.



$y_1 = 0.3 + j0.44$

$z_1 = 1.05 - j1.55$