UNIVERSITY OF OULU

FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

DEGREE PROGRAMME IN ELECTRONICS (MASTER'S)

Course Name: Radio Engineering 1
Homework #5

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Sol^n.

(a). We can determine the stability of the transistor by using Δ, K parameters which is defined below with μ.

i). $|\Delta| < 1$.

ii) $K > 1$

iii) $\mu > 1$.

Here, $|\Delta| = |S_{11} S_{22} - S_{12} S_{21}|$
$= (0.70 \angle -155)(0.66 \angle -55) - (0.07 \angle 32)(3.0 \angle 77)$
$= -0.33 + j\,0.03$
$= 0.33 \angle 174.4.$

$\therefore |\Delta| < 1$, $\boxed{\text{valid}}$.

Now,
$$K = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |\Delta|^2}{2\,|S_{12} S_{21}|}$$
$$= \frac{1 - 0.70^2 - 0.66^2 + 0.33^2}{2 \cdot |0.21|}$$
$= 0.4364.$

$\therefore K < 1$ $\boxed{\text{not valid}}$

As, we can see that $K < 1$, Unconditinally stable is not trew for the transiton. So, the instability depends on matching of the input and output. i.e. So, it can become unstable for certain passive source or load impedance. From Pozar it is state that, " If a two port network is unconditional stable it will not oscillate for any passive source and load impedance."

(5) Input stability circle:-

$$\text{Center, } C_S = \frac{(S_{11} - \Delta S_{22}^*)^*}{|S_{11}|^2 - |\Delta|^2} = \frac{0.70\angle{-155} - [(0.33\angle 174.4)(0.66\angle 55)]^*}{0.70^2 - 0.33^2}$$

$$= \frac{0.5\angle{+165.45}}{0.380}$$

$$= 1.34\angle{+165.45}$$

$$\text{Radius. } R_S = \left|\frac{S_{12} S_{21}}{|S_{11}|^2 - |\Delta|^2}\right| = \frac{(0.7\angle 32)(3\angle 77)}{0.7^2 - 0.33^2}$$

$$= -0.179 + j0.52$$

$$= 0.55$$

$$\therefore R_S = 0.55$$
$$C_S = 1.34\angle{+165}$$

Output circle:-

$$C_L = \frac{(S_{22} - \Delta S_{11}^*)^2}{|S_{22}|^2 - |\Delta|^2} = \frac{(0.66\angle{-55} - (0.33\angle 175)(0.70\angle 155))^*}{0.66^2 - 0.33^2}$$

$$= 1.3\angle 67.3$$

So

$$\& \; R_L = \left|\frac{S_{12} S_{21}}{|S_{22}|^2 - |\Delta|^2}\right| = \frac{(0.07\angle 32)(3\angle 77)}{0.66^2 - 0.33^2}$$

$$= 0.64\angle 100$$

$$\therefore \; \text{Sol} \quad \boxed{\begin{aligned} R_L &= 0.64 \\ C_L &= 1.3\angle 67.3 \end{aligned}}$$

(c) $Z_L = 5 + 75j$

$\therefore Z_L = \frac{5+75j}{50} = 0.1 + 1.5j$ [Normalized.

Reflection,

$\Gamma_L = \frac{Z_L - 1}{Z_L + 1} = \frac{0.1 + j1.5 - 1}{0.1 + j1.5 + 1}$

$= 0.94 \angle 67.2$.

Now, the input reflection co-efficient of the transistor is,

$\Gamma_{in} = S_{11} + \frac{S_{12} S_{21} \Gamma_L}{1 - S_{22} \cdot \Gamma_L}$.

Here,

$S_{12} S_{21} \Gamma_L = 0.21 \angle 109 \times 0.94 \angle 67.2$

$= 0.2 \angle 176.5$

$S_{22} \Gamma_L = 0.66 \angle -55 \times 0.94 \angle 67.2$

$= 0.6 \angle 12.5$

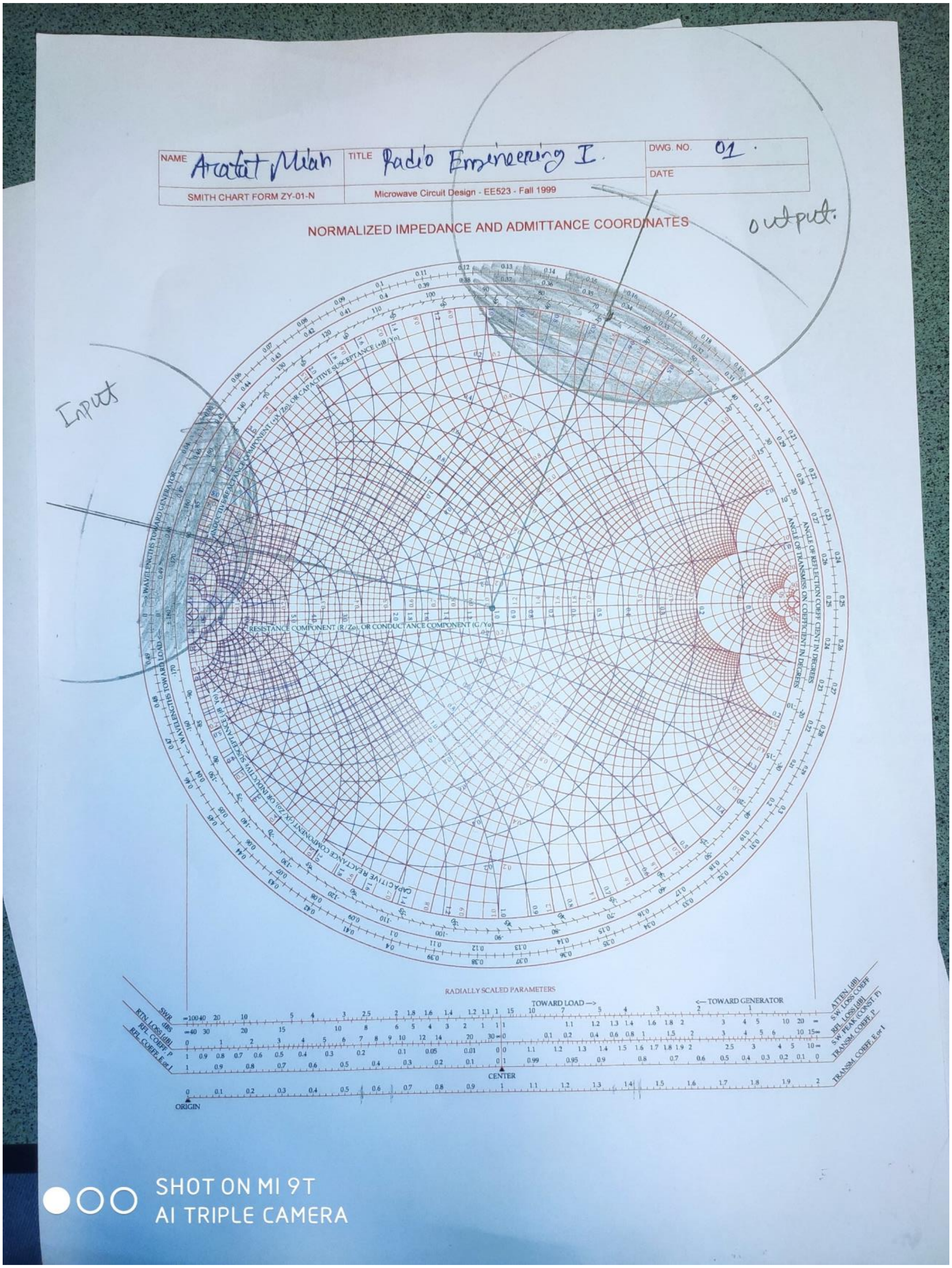
$= 0.70 \angle -155^\circ + \frac{0.2 \angle 176.5}{1 - 0.6 \angle 12.5}$.

$= -1.08 - j \cdot 0.4065$.

$\therefore |\Gamma_{in}| = \sqrt{1.08^2 + (0.4065)^2}$

$= 1.15 > 1$.

So, using part b, we determined that the stable region is situated outside the stability circle. For the given load, reflection co-efficient falls inside the circle, which places the device in an unstable region. In this condition, the magnitude of the input reflection co-efficient becomes larger than one meaning that the reflected wave exceed the incident wave in input.



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TITLE Radio Engineering I.
DWG. NO. 01.
DATE
SMITH CHART FORM ZY-01-N
Microwave Circuit Design - EE523 - Fall 1999
NORMALIZED IMPEDANCE AND ADMITTANCE COORDINATES
output.
Input
RESISTANCE COMPONENT (R/Zo), OR CONDUCTANCE COMPONENT (G/Yo)
RADIALLY SCALED PARAMETERS
TOWARD LOAD —>
<— TOWARD GENERATOR
CENTER
ORIGIN
SHOT ON MI 9T
AI TRIPLE CAMERA