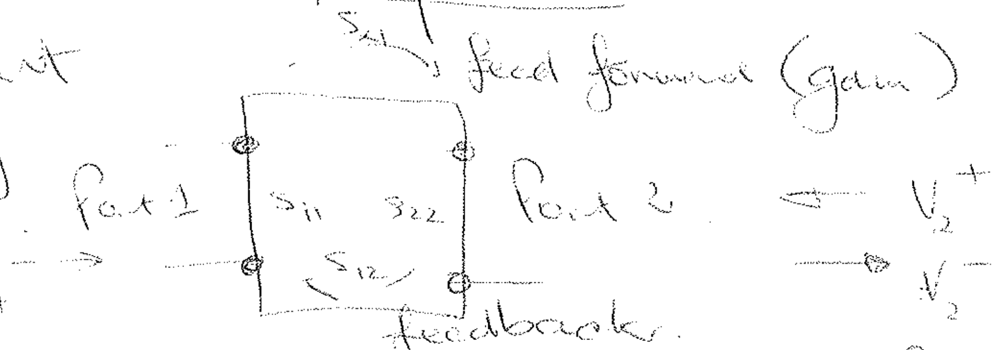
ENEL 434 Electronics II

(3)

Lecture 12

Scattering parameters 3rd April

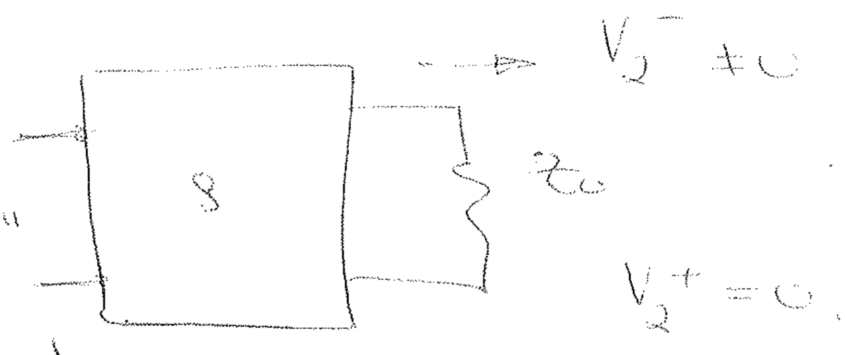
Two port scattering matrix



$$\begin{bmatrix} V_1^- \\ V_2^- \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} \begin{bmatrix} V_1^+ \\ V_2^+ \end{bmatrix}$$

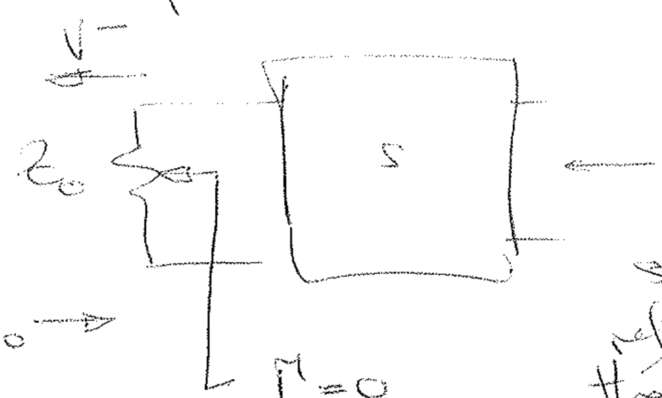
NB S_{11} etc are all COMPLEX

Recall $\Gamma = \frac{V^-}{V^+}$



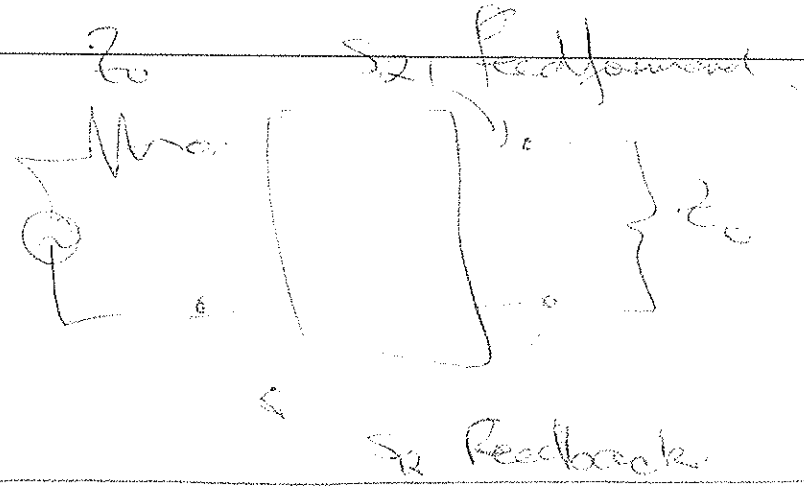
S_{11} $\quad \Gamma_1 = \Gamma_{in} = S_{11}$

input reflection coeff with the output matched.



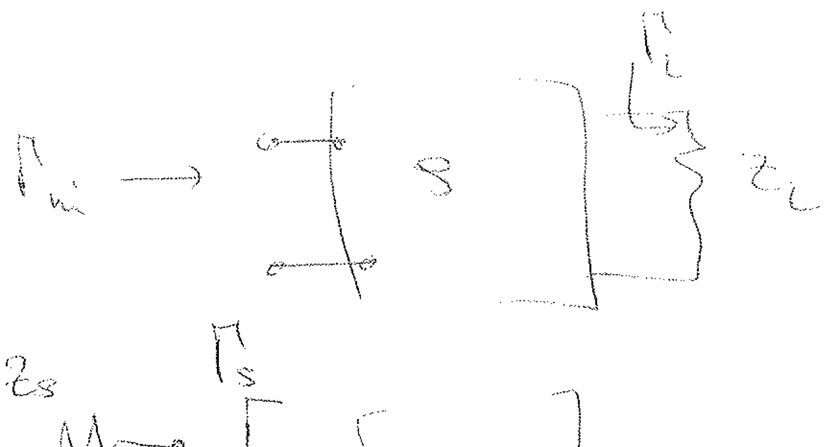
$\Gamma_2 = \Gamma_{out} = S_{22}$

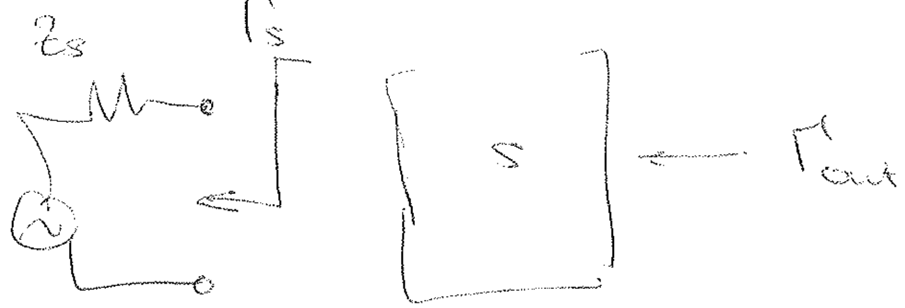
S_{22} = output reflection coeff with the input matched



$$\Gamma_1 = \Gamma_{in} = S_{11} + \frac{S_{12} S_{21} \Gamma_L}{1 - S_{22} \Gamma_L} \qquad Z_L \neq Z_0$$

$$\Gamma_2 = \Gamma_{out} = S_{22} + \frac{S_{12} S_{21} \Gamma_S}{1 - S_{11} \Gamma_S} \qquad Z_S \neq Z_0$$





biosecurity

@ $f = 4\,GHz$ (5)

$\lambda = 7.5\,cm$ in air

$\approx 5\,cm$ in a PCB or trans line.

Example If $Z_0 = 50$

$$\begin{bmatrix} S_{11} = 0.72 \angle -116^\circ & S_{21} = 2.6 \angle 76^\circ \\ S_{12} = 0.03 \angle 57^\circ & S_{22} = 0.73 \angle -54^\circ \end{bmatrix}$$

(a) What is Z_{in} for $Z_L = 50\Omega$

If $Z_L = 50$ $\therefore$ $\Gamma_L = 0$

$\therefore \Gamma_{in} = S_{11} + 0$

$= 0.72 \angle -116^\circ$

$\therefore z_{in} = 0.21 - j0.6$

$\therefore Z_{in} = 10.5\Omega - 30j\Omega$

(b) What is Z_{in} for $Z_L = 60\Omega + j50\Omega$

$z_L = 1.2 + j1$

$\Gamma_L = 0.42 \angle 54^\circ$

$\Gamma_{in} = S_{11} + \dfrac{(S_{21} S_{12} \Gamma_L)}{(1 - S_{22}\Gamma_L)}$

$= 0.747 \angle -119^\circ$ (note: close to S_{11})

(c) What is Z_{in} for $Y_L = 25\,m℧ + j\,15\,m℧$

$y_L = 1.25 + j\,0.75$, $z_L = 0.6 - j0.35$

Turn Y_L in $Z_L = 29 - 18j$

$\therefore \Gamma_L = 0.33 \angle -127^\circ$

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

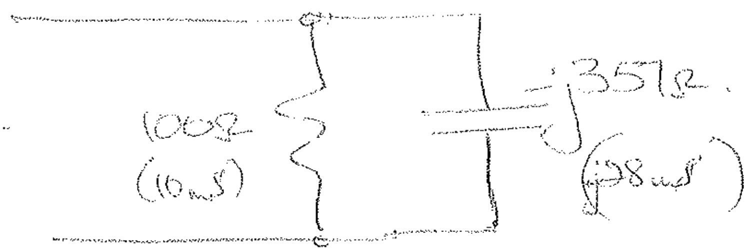
$= 0.71 \angle -114^\circ$ (note: close to S_{11})

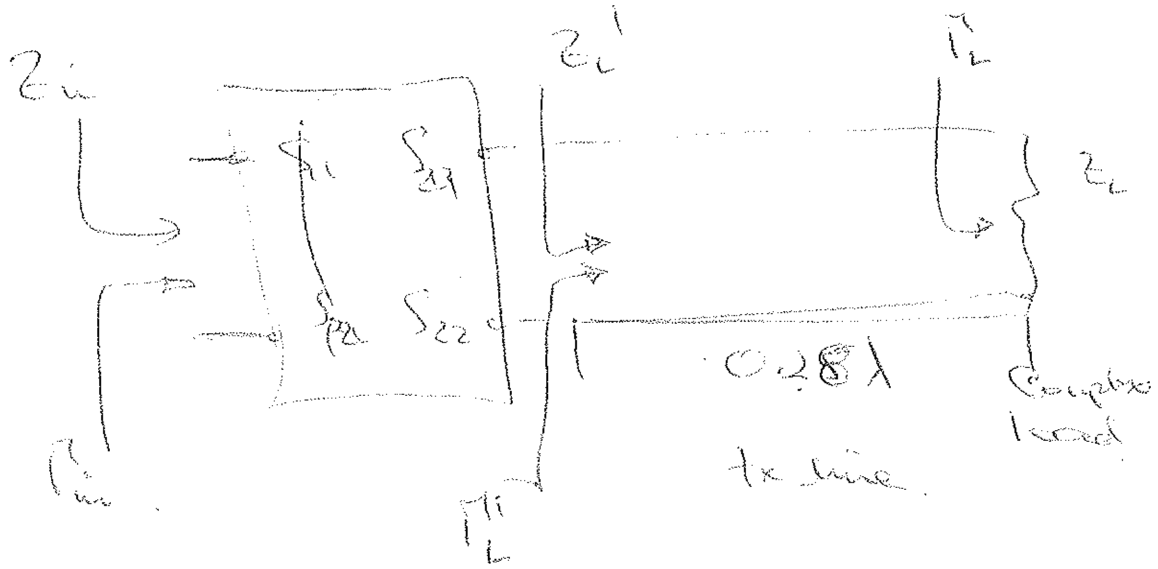
CRC biosecurity

$\therefore z_{in} = 0.22\,\Omega - j\,0.65$

$\therefore y_{in} = 0.5 + j\,1.4$

$\therefore Y_{in} = 10\,mS + j\,28\,mS$





Summary

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

Special Cases

① $Z_L = 50\,\Omega$ $\Gamma_L = 0$

$$\Gamma_{in} = S_{11}$$

② $Z_L = \infty$ ie Open circuit $\Gamma_L = 1$

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

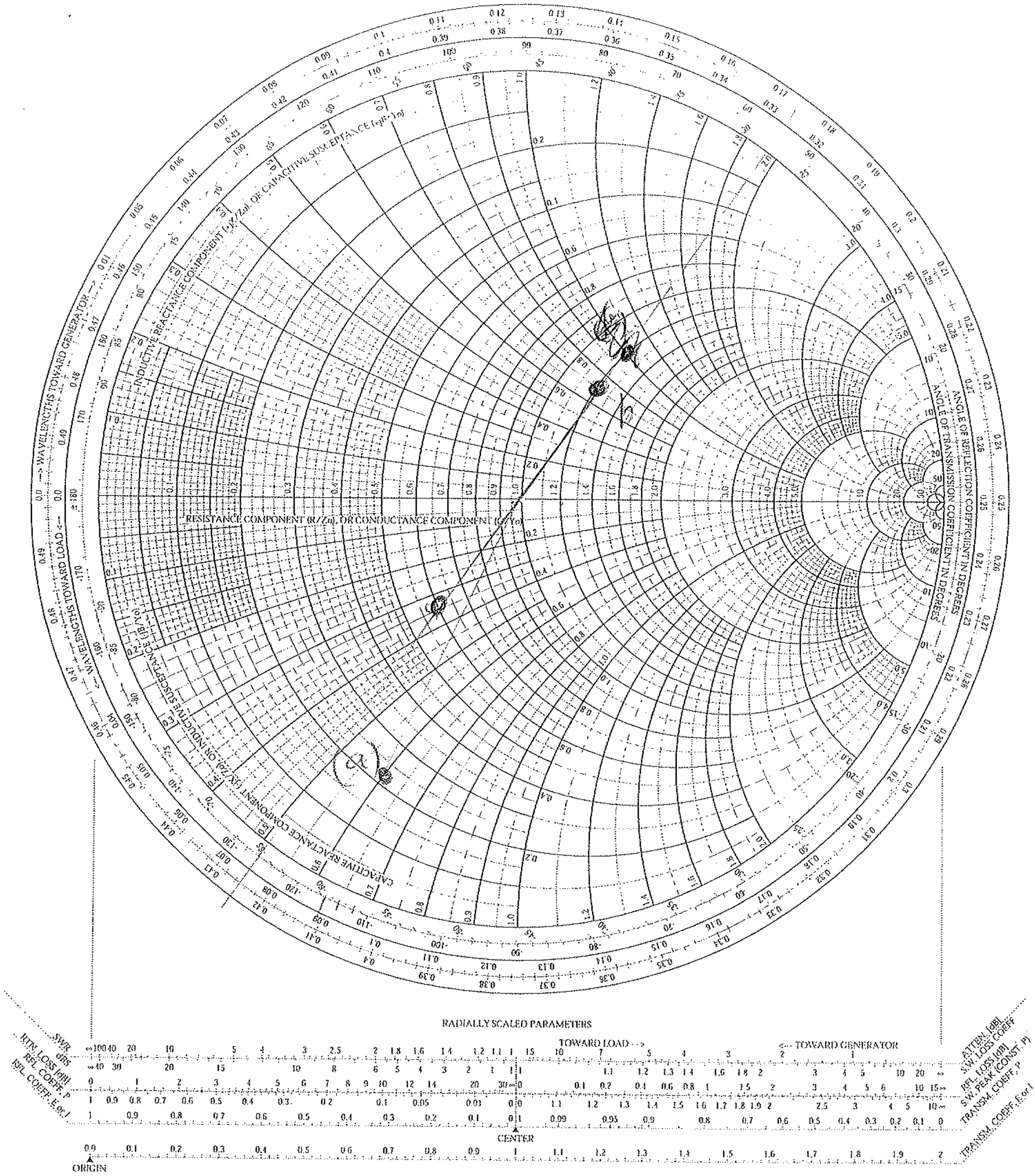
③ $Z_L = 0$ ie short circuit $\Gamma_L = -1$

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

④ S_{12} (feedback) $= 0$

Student Name.......................................Student ID...................................ENEL434

Smith Chart



To be handed in with your answer booklet