

# Microwaves

## Series 7

### Problem 1

Find the properties of the following 5 two-port components, given by their scattering matrix. Are they reciprocal, lossless, matched, symmetrical ? What kind of components are they ?

a)  $\begin{bmatrix} 0 & 250 \\ 0,2 & 0 \end{bmatrix}$     b)  $\begin{bmatrix} 0,6 & j0,8 \\ j0,8 & 0,6 \end{bmatrix}$     c)  $\begin{bmatrix} 0 & -j \\ j & 0 \end{bmatrix}$     d)  $\begin{bmatrix} 0 & 0,1 \\ 0,1 & 0 \end{bmatrix}$     e)  $\begin{bmatrix} 1,5 & j0,1 \\ j0,5 & 0 \end{bmatrix}$

### Problem 2

A three port circuit is characterized by the following scattering matrix :

$$\begin{bmatrix} j0,2 & j0,9 & 0,1 \\ 0,1 & j0,2 & j0,9 \\ j0,9 & 0,1 & j0,2 \end{bmatrix}$$

Draw its flowchart, end determine if it is a linear, reciprocal, lossless, matched element. What could be its use ?

### Problem 3

Prove that the scattering matrix of the following circuits



are given by:

$$[S] = \begin{bmatrix} \Gamma_1 & 1 - \Gamma_1 \\ 1 - \Gamma_1 & \Gamma_1 \end{bmatrix} \quad \text{et} \quad [S] = \begin{bmatrix} \Gamma_2 & 1 + \Gamma_2 \\ 1 + \Gamma_2 & \Gamma_2 \end{bmatrix}$$

with

$$\Gamma_1 = \frac{Z_1}{Z_1 + 2Z_0} \quad \text{et} \quad \Gamma_2 = -\frac{Y_2}{Y_2 + 2Y_0}$$

The characteristic impedance at the reference planes is  $Z_0$