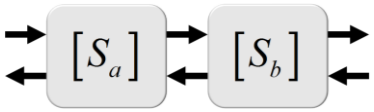
MICROWAVE ENGINEERING

Problem #1: Cascading Two [S] Matrices

Two two-port networks (*A* and *B*) are to be connected in series as illustrated below.



Each network is described by its own set of four scattering parameters as expressed in Eq. (1).

$$[S_a]=\begin{bmatrix} S_{11}^a & S_{12}^a \\ S_{21}^a & S_{22}^a \end{bmatrix} \qquad [S_b]=\begin{bmatrix} S_{11}^b & S_{12}^b \\ S_{21}^b & S_{22}^b \end{bmatrix} \tag{1}$$

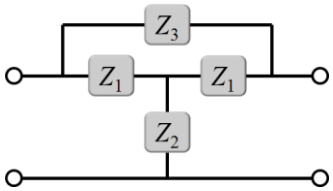
Derive expressions to calculate the four scattering parameters S_{11}, S_{12}, S_{21}, and S_{22} of the combined network. This is NOT simple matrix multiplication.

$$[S]=[S_a]\otimes[S_b]=\begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} \tag{2}$$

Show all of your steps in detail and simplify your final expressions as much as possible.

Problem #2: Impedance and Admittance Matrices

A two-port network is composed of four impedance elements as shown in the circuit below.



Part (a)

Derive the admittance matrix [*Y*] for this network as a function of the impedance elements in this circuit Z_1, Z_2, and Z_3. Show all your work. You may use computer software to derive symbolic solutions to the matrix inverses if you wish.

Part (b)

Similarly, derive the corresponding impedance matrix [*Z*] for this network as a function of the impedance elements in this circuit Z_1, Z_2, and Z_3. Show all your work.

Problem #3: Power

A two-port network is formed from two shunt 5 Ω resistors separated by a quarter-wavelength length of lossless 100 Ω transmission line. This network is inserted between a source and load which both have an impedance of 50 Ω. Draw the circuit and calculate the transducer and dissipative losses of the network in decibels.