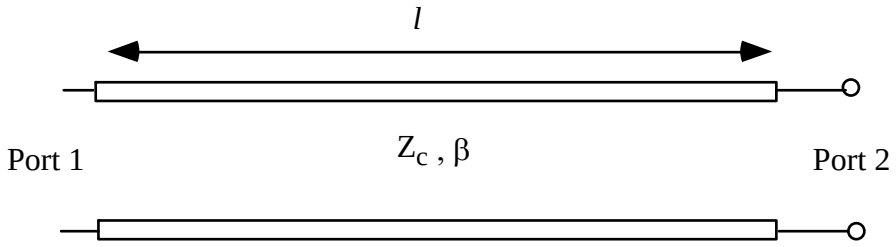
ECE 451 **Homework 3** **Due Wednesday, March 7, 2018**

1. A transmission line has characteristic impedance Z_C, propagation constant β and length l. Use Z_O as the reference impedance. Define $X = e^{-j\beta l}$ and $\Gamma = \dfrac{Z_c - Z_o}{Z_c + Z_o}$.



(a) Find S_{11} in terms of X and Γ.

(b) Find S_{21} in terms of X and Γ.

2. The *S* parameters of a three-port are as follows (the *S* parameters are referred to a 50 Ω system reference impedance):

$$\begin{bmatrix} 0.2\angle 180° & 0.8\angle -45° & 0.1\angle 45° \\ 0.8\angle -45° & 0.2\angle 0° & 0.1\angle 90° \\ 0.1\angle 45° & 0.1\angle 90° & 0.1\angle 180° \end{bmatrix}$$

(a) Is the three-port reciprocal? Explain your answer.

(b) Write down the criteria for a network to be lossless.

(c) Is the three-port lossless? You must show your working.

(d) Draw the SFG of the three-port.

(e) A 50 Ω load is attached to Port 3. Use SFG operations to derive the SFG of the two-port with just Ports 1 and 2. Write down the two-port *S* parameter matrix of the simplified network.

3. Perform the one-port three-term error correction analysis (i. e. find the equations for the error terms and the relation between measured and actual S_{11}) using the following combinations of calibration standards

(a) matched termination, offset short and open

(b) matched termination, offset short and shielded open

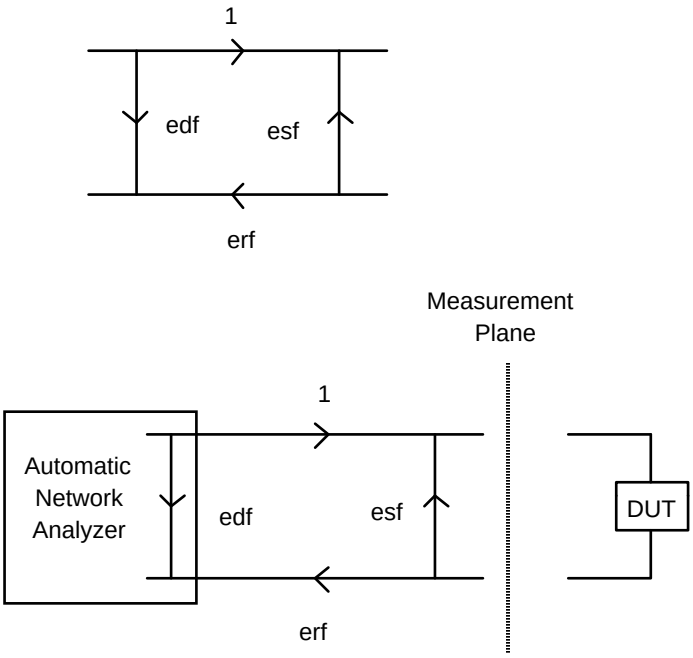


Figure 2