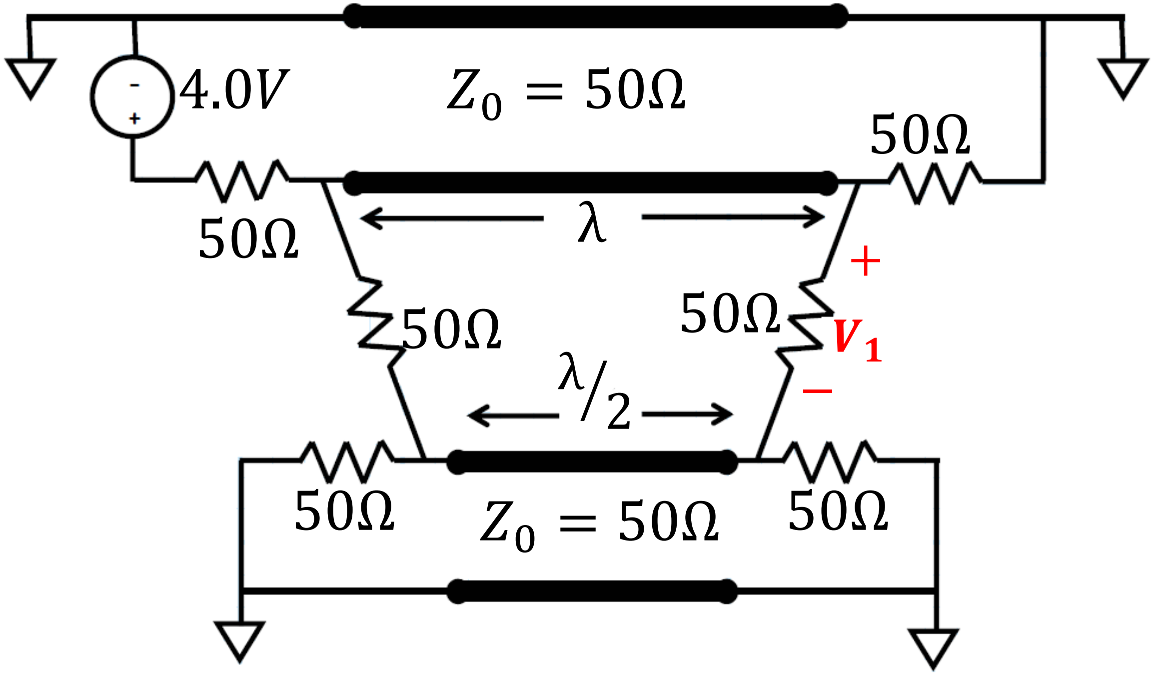
HA # 3

Part-1: Carefully (**very** carefully) consider the **symmetric** circuit below:



Use **odd-even mode analysis** to determine the value of voltage V_1.

HA # 3

Part-2: let's consider a **perfect connector**—an electrically **very small** two-port device that allows us to connect the ends of different transmission lines together.

Determine the S-matrix of this ideal connector:

1. First case: it connects two transmission lines with same characteristic impedance of Z_0.
2. Second case: it connects two transmission lines with characteristic impedances of Z_{01} and Z_{02} respectively.

HA # 3

Part-3: A four-port network has the scattering matrix shown as follows.

$$[S] = \begin{bmatrix} 0.178\angle 90^\circ & 0.6\angle 45^\circ & 0.4\angle 45^\circ & 0 \\ 0.6\angle 45^\circ & 0 & 0 & 0.3\angle -45^\circ \\ 0.4\angle 45^\circ & 0 & 0 & 0.5\angle -45^\circ \\ 0 & 0.3\angle -45^\circ & 0.5\angle -45^\circ & 0 \end{bmatrix}.$$

(a) Is this network lossless? (b) Is this network reciprocal? (c) What is the return loss at port 1 when all other ports are terminated with matched loads? (d) What is the insertion loss and phase delay between ports 2 and 4 when all other ports are terminated with matched loads?

HA # 3

Part-4: A certain three-port network is lossless and reciprocal, and has $S_{13} = S_{23}$ and $S_{11} = S_{22}$. Show that if port 2 is terminated with a matched load, then port 1 can be matched by placing an appropriate reactance at port 3.