$$\frac{\partial^2 V(z,t)}{\partial z^2} - lc\frac{\partial^2 (z,t)}{\partial t^2} = 0$$

$$\Rightarrow \frac{-w^2}{u^2} V(z,t) + l c w^2 V(z,t) = 0$$

$$\Rightarrow u^2 = lc \Rightarrow u = \frac{1}{\sqrt{lc}} = \frac{1}{\sqrt{\mu\varepsilon}}$$

$$= \frac{1}{\sqrt{\mu_0 \varepsilon_r \varepsilon_0}} = 1.98 \times 10^8 m/s$$

$$t_{delay} = \frac{d}{u} = \frac{4m}{1.98\times10^8 m/s} = 2.02\times10^{-8} s = 20.2ns$$

$$Z_0 = \sqrt{\frac{l}{c}} = \sqrt{\frac{2.51\times10^{-7} H/m}{1.02\times10^{-10} F/m}} = 49.6\Omega$$

(b) Coax spool

Time delay $\Delta t = a$ (different group has different value)

Input: V_{in}

Output: V_{out}

V_{in} should be larger than V_{out}: $V_{in} > V_{out}$

the length of Coax spool $l = \Delta t \cdot u = a \cdot u = a \cdot 1.98\times10^8 m/s$

Lumped line

Measure several nodes

For the artificial line, measure the whole cable

Time delay $\Delta t = b$

the length of Coax spool: $l = \Delta t \cdot u = b \cdot u = b \cdot 1.98\times10^8 m/s$