Blast From the Past!

Final Exam

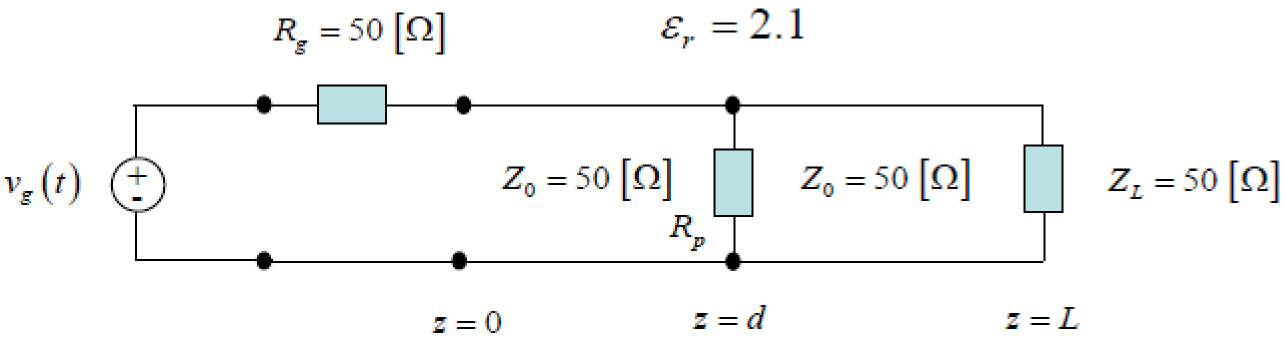
Fall 2018

Problem 1 (20 pts.)

A Time Domain Reflectometer (TDR) is being used to determine a fault on a transmission line. The TDR has a voltage generator $v_g(t)$ that applies a voltage step function with an amplitude of $V_0 = 2.0$ [V] at the input to the transmission line circuit shown below. The transmission line has a relative permittivity of 2.1. The voltage waveform $v_0(t)$ that is recorded by the TDR at $z = 0$ is shown below. A partial short on the line (the fault) is modeled as a parallel resistance R_p as shown.

Determine the unknown resistance R_p and the distance d between the short and the TDR.

Support your answer by constructing a bounce diagram and using it to get the voltage $v_0(t)$ in terms of d and R_p.



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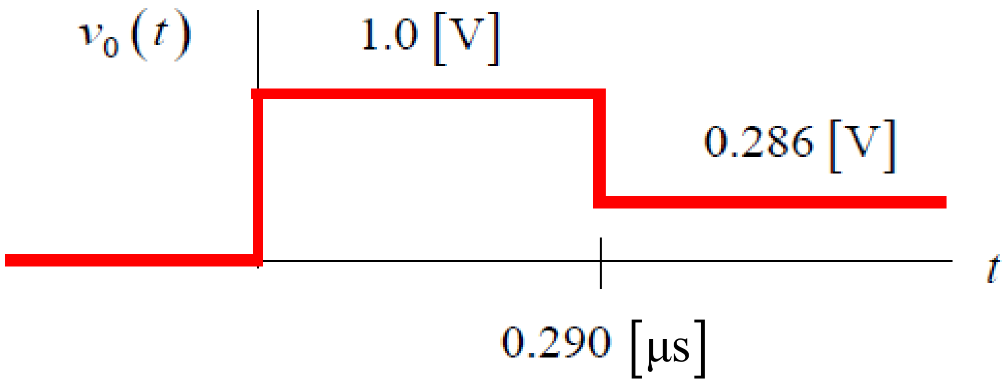
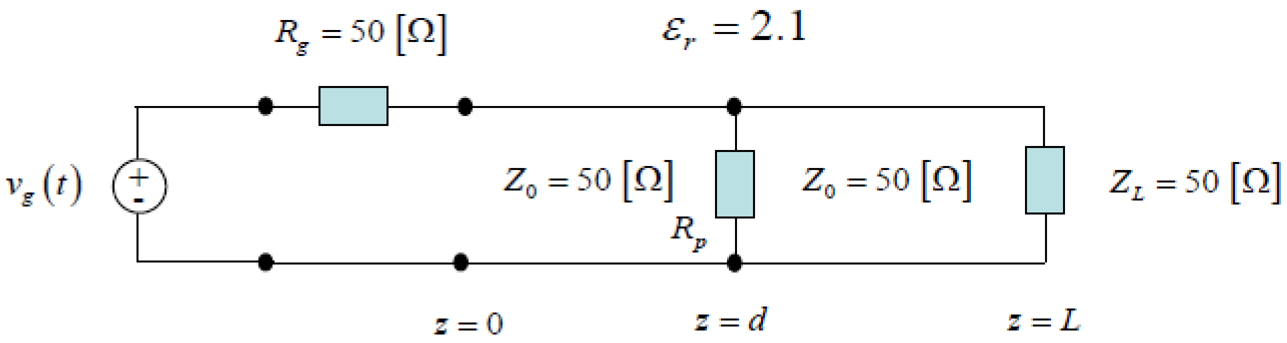
Measured Waveform

$(z = 0)$





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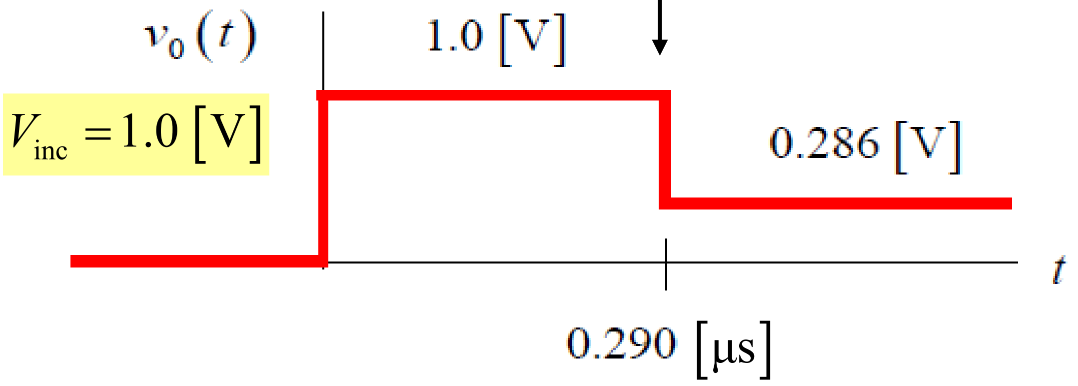
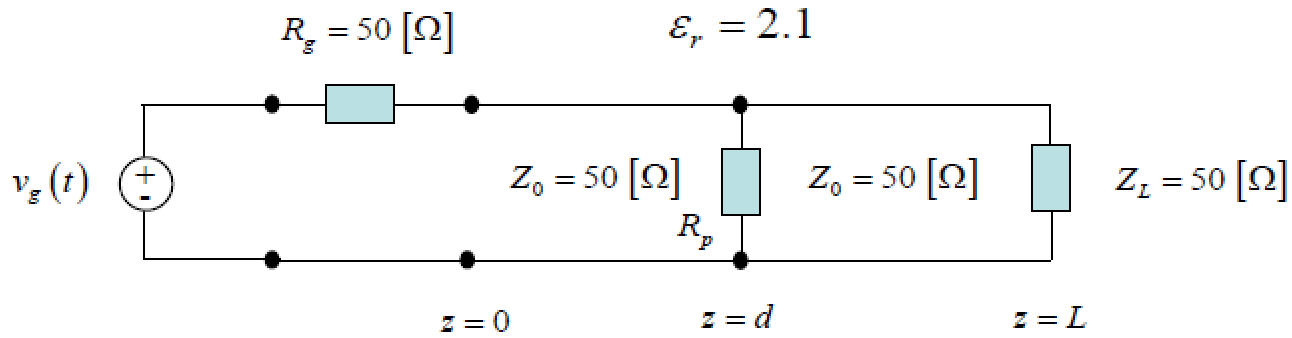
$T_{\text{jump}} = 0.290\ [\mu\text{s}]$



$$T_{\text{jump}} = \frac{2d}{c_d} = \frac{2d}{c/\sqrt{\varepsilon_r}} = d\left(\frac{2}{c}\sqrt{\varepsilon_r}\right) = d\left(9.6676\times 10^{-9}\right)$$ (solve for d)

$$d = 30.0\ [\text{m}]$$



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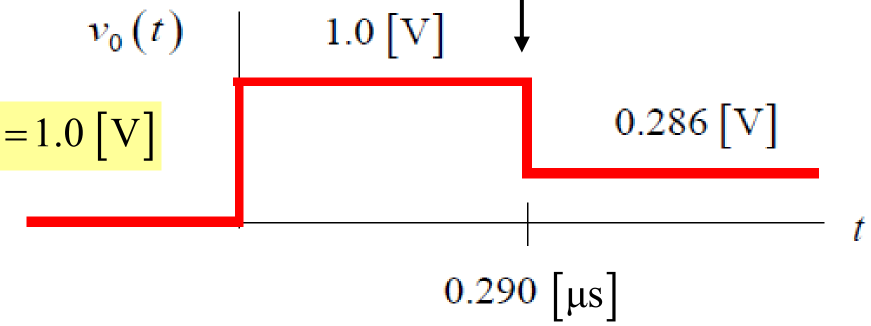
$$T_{\text{jump}} = 0.290\ [\mu\text{s}]$$



(See next slide for bounce diagram.)

$$(V_{\text{inc}})(1.0 + \Gamma_J^+) = 0.286$$

$$\Downarrow$$

$$(1.0)(1.0 + \Gamma_J^+) = 0.286$$

$$\Downarrow$$

$$\Gamma_J^+ = -0.714$$

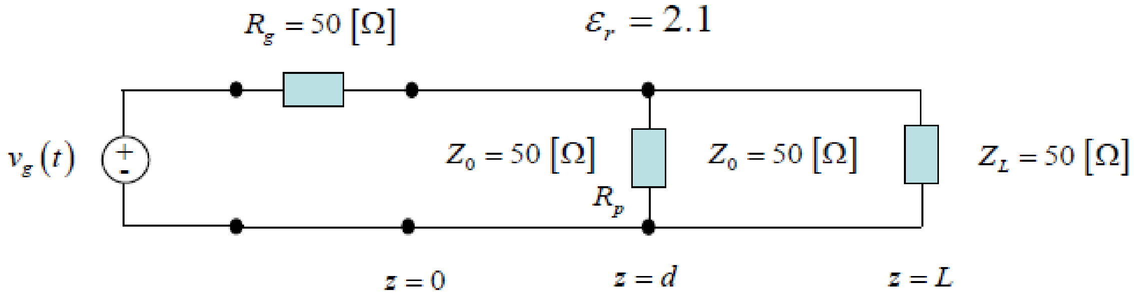
$$\Gamma_J^+ = \frac{(50 \parallel R_p) - 50}{(50 \parallel R_p) + 50}$$

$$50 \parallel R_p = \frac{50 R_p}{50 + R_p}$$

$$\frac{\left(\dfrac{50R_p}{50+R_p}\right) - 50}{\left(\dfrac{50R_p}{50+R_p}\right) + 50} = -7.14$$

(solve for R_p)

$$R_p = 10\ [\Omega]$$



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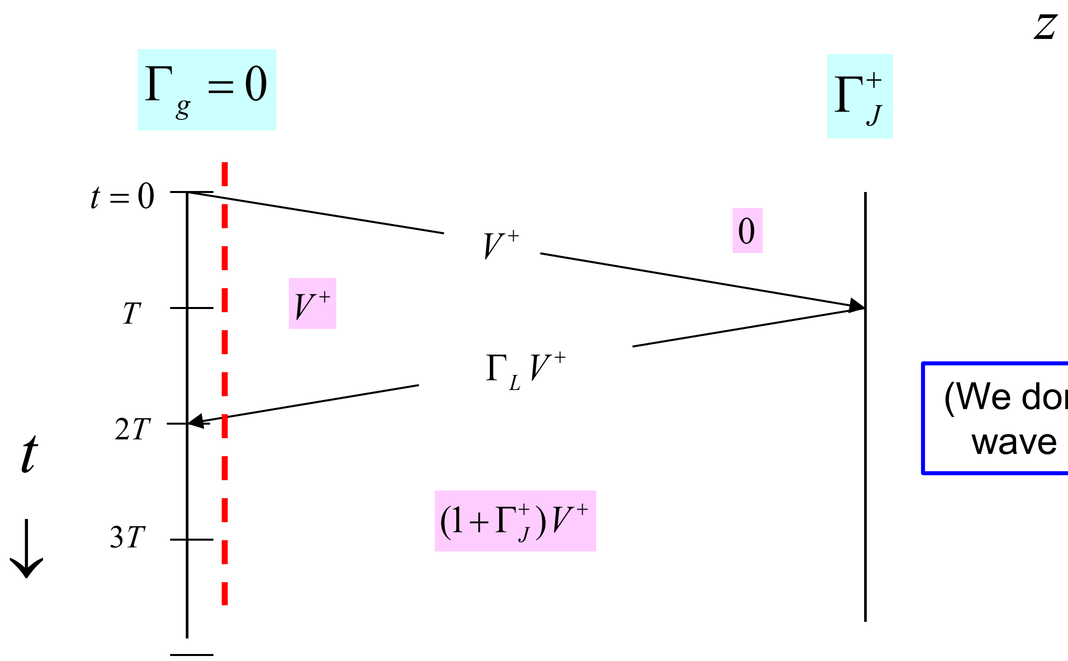

(We don't have to worry about the transmitted wave (there is no reflection from the load).

$$T_{\text{jump}} = 2T$$