Solutions

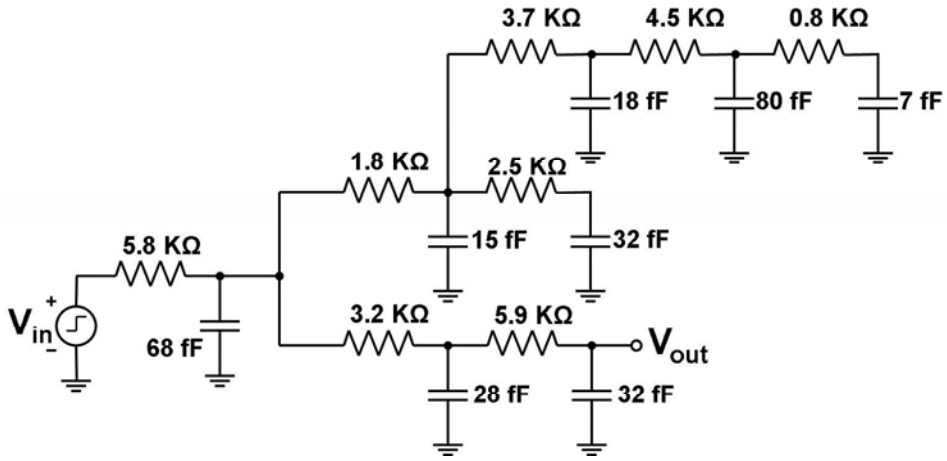
University of New Mexico
Department of Electrical and Computer Engineering

ECE 520 - VLSI Design (spring 2026) Homework #9

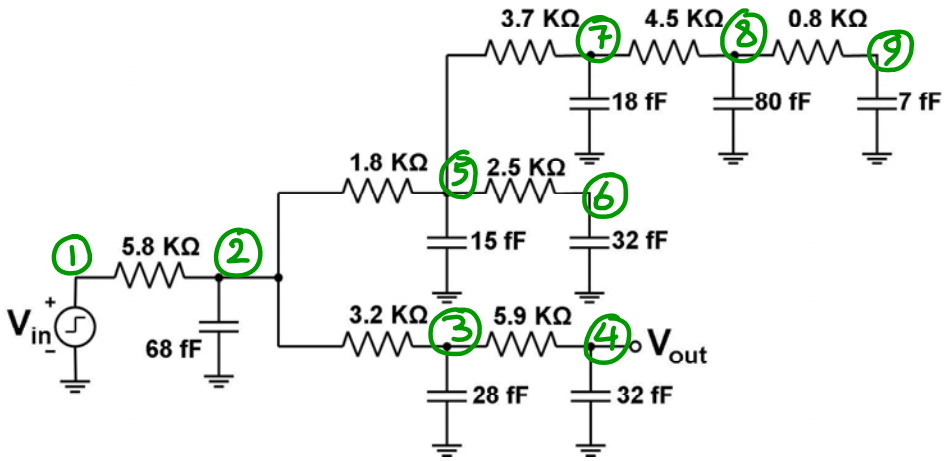
Due in class on Thursday April 9, 2026

This homework is to prepare you for the class project. It requires working with SPICE tool.

1. Feel free to use any version of SPICE tool for this homework. A comprehensive user's guide for PSPICE can also be helpful.
2. After you familiarize yourself with the tool, write a SPICE file to do transient analysis on the following RC circuit.



3. After successful simulation, measure the rise and fall propagation delays (t_{pLH} and t_{pHL}) from the input to the output (V_{out}).
4. Using the Elmore delay model, hand calculated the t_{pLH} and t_{pHL} in this circuit.
5. Determine the percentage of error between Elmore model and exact SPICE simulation for the propagation delays.



SPICE File:

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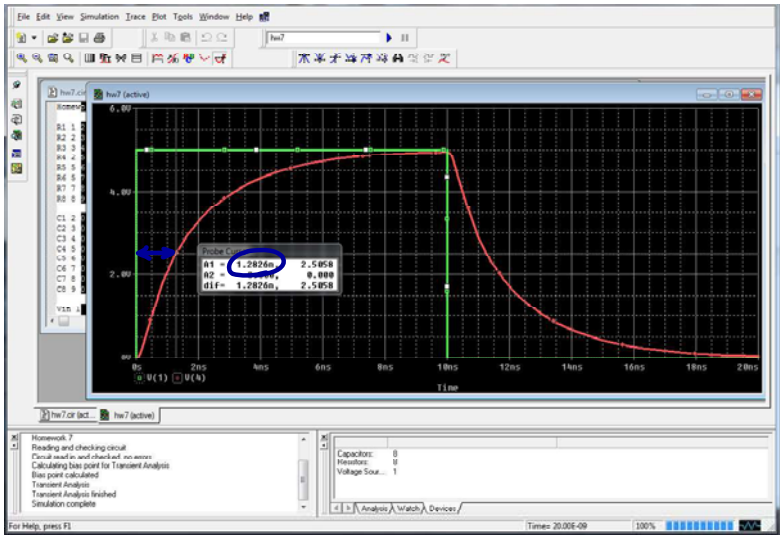
R1 1 2 5.8K
R2 2 3 3.2K
R3 3 4 5.9K
R4 2 5 1.8K
R5 5 6 2.5K
R6 5 7 3.7K
R7 7 8 4.5K
R8 8 9 0.8K

C1 2 0 68f
C2 3 0 28f
C3 4 0 32f
C4 5 0 15f
C5 6 0 32f
C6 7 0 18f
C7 8 0 80f
C8 9 0 7f

Vin 1 0 PULSE(0 5 0 1ps 1ps 10ns 20ns)
.tran 10ps 20ns
.probe V(1) V(4)
.end



SPICE Simulation:

$$t_{PLH} = t_{PHL} = 1.2826 \text{ ns}$$

Hand Calculation:

$$\tau_{eff} = 5.8^{K}(68+15+32+18+80+7)$$
$$(5.8^{K}+3.2^{K})(28)+14.9^{K}(32) = 2.00 \text{ ns}$$

$$\Rightarrow t_{PLH} = t_{PHL} \approx 0.69\,\tau_{eff} = 0.69 \times 2.00^{ns} = 1.38 \text{ ns}$$

$$\Rightarrow \%\text{ error} = \frac{1.38-1.28}{1.28} = 7.8\%$$