EE105 – Microelectronic Devices and Circuits
Spring 2026, Homework #1

Assigned: **January 27, 2026**
Due: **February 3, 2026 at 11:59 PM on Gradescope**

1 Notes

Upload your notes from Lectures 2 and 3.

2 Problem Set

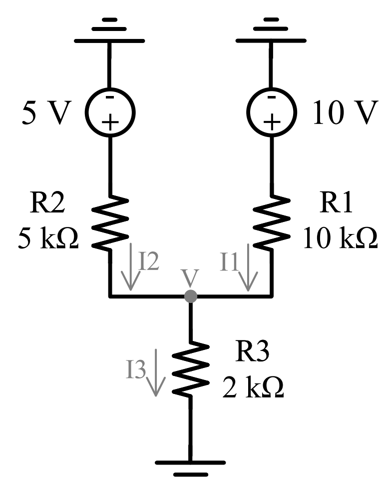
2.1 Problem 1: KCL and KVL

For the circuit shown in the figure below, find the current in each of the three resistors (I_1, I_2 and I_3) and the voltage (V) at their common node using two methods:

(a) Loop Equations: Start by writing two KVL loop equations and solving for two branch currents.

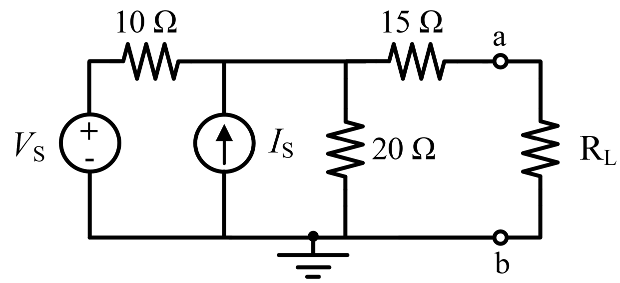
(b) Node Equation: Start by writing a single equation and solving for the common node voltage.

Which method do you prefer? Why?



2.2 Problem 2: Thevenin and Norton Equivalent Circuits

Thevenin's theorem states that any linear circuit can be simplified to an independent voltage source and a series resistance. Norton's theorem follows the same principle but with an independent current source and a parallel resistance. In this problem, we will review Thevenin and Norton equivalent circuits. All parts will be based off the following circuit (assume V_S is 10 V and I_S is 0.25 A):



(a) Re-draw the circuit with the load R_L removed and calculate the voltage across terminals a & b. This is the Thevenin equivalent voltage (V_{th}).

(b) Re-draw the circuit with the load removed, replace the voltage source with a short (i.e., connect the terminals of the voltage source together directly, or, equivalently, set $V_S =$ 0 V) and replace the current source with an open circuit (i.e., disconnect the terminals of the current source, or, equivalently, set $I_S = 0$ A) . Find the total resistance seen between terminals a & b. This is the Thevenin equivalent resistance R_{th}.

(c) Now that we have the Thevenin equivalent voltage and resistance, draw the Thevenin equivalent circuit with and without the load, R_L, connected to the output terminals.

(d) Assuming R_L is 25 Ω, what is the power dissipated across the load? *Hint:* Passive resistors do not generate power; they only dissipate it (as heat). Hence, the calculated power must have a positive value.

(e) Use the Thevenin equivalent voltage and resistance values to calculate the Norton equivalent current and resistance. Draw the Norton equivalent circuit with and without the load, R_L, connected to the output terminals.

2.3 Problem 3: Capacitor Charging and Discharging

In the following circuit, a capacitor is driven with ideal current sources. The switch SW_1 is toggled periodically with an enable signal as shown in Figure 1 (with period T and a 50% duty cycle).

At $t = 0$, the voltage across the capacitor is 0 V. The switching starts at $t = 0$ with the open switch (terminals disconnected) phase first and then continues as depicted.

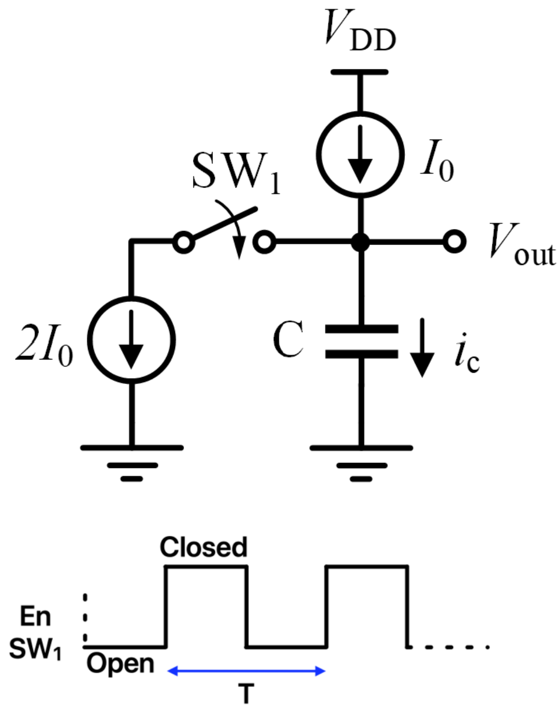


Figure 1: Capacitor driven by ideal current sources with periodic switching.

(a) Sketch the current $i_c(t)$ as a function of time and other given parameters. Label max and min values.

(b) Sketch the output voltage $V_{out}(t)$ as a function of time and other given parameters. Label max and min values.

(c) Now, consider a more realistic model for the capacitor shown in Figure 2: a series combination of an ideal capacitor and a small resistance R_s. Sketch the output voltage $V_{out}(t)$ considering the addition of R_s. How is it different from the waveform obtained in (b)?

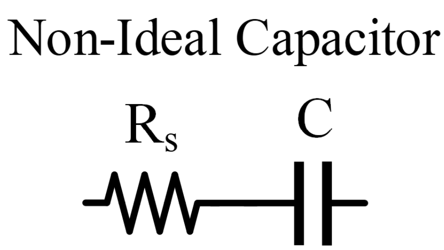
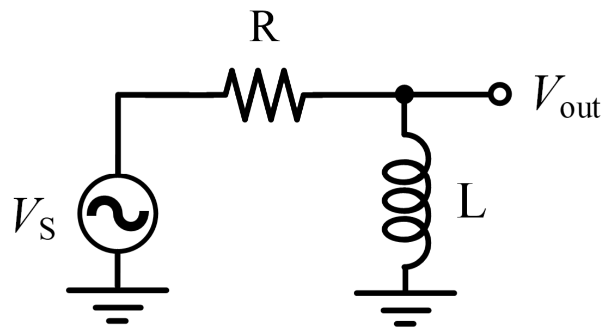


Figure 2: Non-ideal capacitor model including parasitic series resistance R_s.

2.4 Problem 4: RL Circuit, Time and Frequency Response

Below is a simple RL circuit. All questions can be answered as functions of V_i, R and L in addition to time and/or frequency variables.



(a) If $V_s(t)$ is a step of the form $V_s(t) = V_i\ u(t)$, find and sketch $V_{out}(t)$. $V_{out}(t)$ is referred to as the "step response" of the circuit (in time). Assume the inductor current is initially 0 A.

(b) If $V_s(t)$ is a step of the form $V_s(t) = V_i\ \delta(t)$, find and sketch $V_{out}(t)$. $V_{out}(t)$ is referred to as the "impulse response" of the circuit (in time). Assume the inductor current is initially 0 A.

(c) If $V_s(t) = \exp(j\omega t)$, find the amplitude and phase response of $\frac{V_{\text{out}}}{V_s}$ as a function of ω. What is the function of this circuit? *Hint:* Solve first for $I_L(t)$ and then derive $V_{out}(t)$.