University of California, Davis
Society of Manufacturing Engineers at UC Davis

ENG 17* Circuits I Unofficial

Mock Practice Final Examination

*Disclaimer: This document is a sample final exam of a Circuits I midterm. It is a mock exam and does not necessarily reflect the format—in the length of the exam, content covered, the protocol, and other aspects—of an actual final exam of ENG 17 in University of California, Davis. However, this covers multiple topics that seems to be a complete agenda of ENG 17 and this document is an attempt to give students extra practice. The problems in this document are written entirely by the author. Any similarity, either in part or in whole, is a complete coincidence. If an error is caught, or if you have any questions and inquiries, please contact the author at mnhyu@ucdavis.edu.

Some topics below are not necessarily in your ENG 17 course, as some instructors cover some more than others. Do not feel pressured to study those not covered.

This examination has thirteen (13) pages, including this front cover page.

Question 1) Simple Resistive Circuits	
Question 2) Independent and Dependent Sources	
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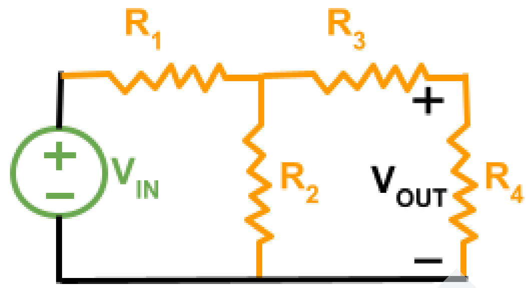
Question 1) Simple Resistive Circuits

Given the circuit with four resistors

- R_1 = 5 kΩ
- R_2 = 15 kΩ
- V_{IN} = 20 V

Find V_{OUT} if

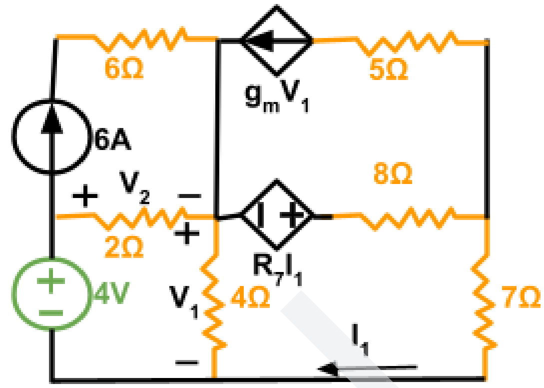


a)	R_3 = 16 kΩ and $R_4 = \infty$	V_{OUT} =
b)	$R_3 = \infty$ and R_4 = 26 kΩ	V_{OUT} =
c)	R_3 = 11 kΩ and R_4 = 4 kΩ	V_{OUT} =

Question 2) Independent and Dependent Sources

Given the circuit with six resistors, two independent and two dependent sources

Find V_2 in terms of R_7 and g_m using any analysis method you choose.

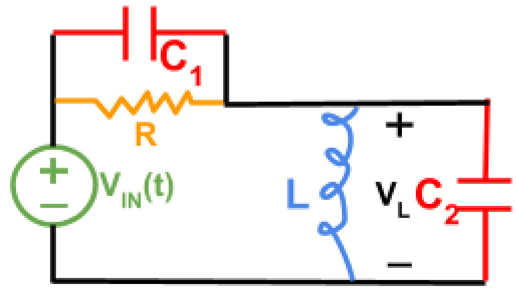


V_2 =

Extra space for question 2)

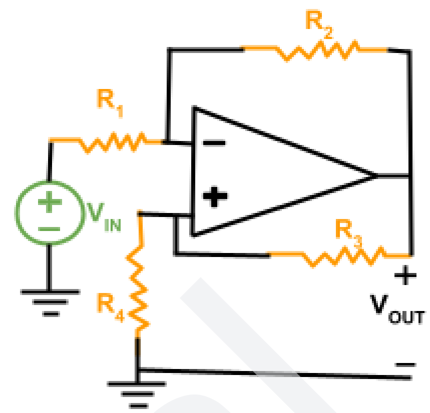
Question 3) RLC Circuits

For the RLC circuit here, write the second order differential equation for $V_L(t)$ as a function of $V_{IN}(t)$ in terms of C_1, C_2, R, and L. The coefficient of one of the two highest order derivatives should be unity. (One of the d^2/dt^2 terms should have a coefficient of 1).



Question 4) Operational Amplifiers

Given a circuit with four resistors and one ideal operational amplifier



a) Derive V_{OUT}/V_{IN} in terms of R_1, R_2, R_3, and R_4.

$V_{OUT}/V_{IN} =$

b) Now, $R_1 = R_3 = 2$ kΩ, and $R_4 = 3$ kΩ. Design the amplifier by choosing the value of R_2 so that the gain is positive 50.

$R_2 =$

c) Repeat part b) to achieve a gain of -50.

$R_2 =$

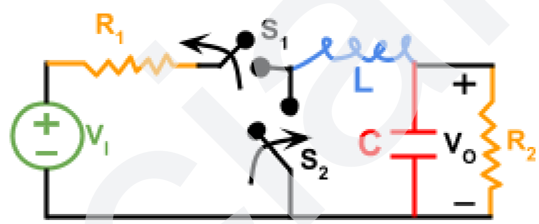
Extra space for question 4)

Question 5) Switches

A model of a Buck Converter is shown below, with one input voltage source, two resistors, one inductor, one capacitor, and two switches. Usually, the switch on top, S_1, switches on and off very fast to trigger conversion of voltage (and S_2 is modeled here as a diode - read more about it!). However, in this circuit, the Buck converter is broken and cannot function like it usually does. Instead, we model this as having S_1 being closed for a very long time, and S_2 being open for a very long time. At t = 0, both switches are toggled. S_1 will stay permanently open and S_2 stay permanently closed. C = ⅛ F, L = 2 H, R_2 = 2 Ω, and R_1 = 2 Ω. V_S = 2 V. (underlined text is background materials and is for fun/extra purposes only! Not needed to solve this problem)

Completely derive the expression of the current through the inductor.

Completely derive the expression of $V_O(t)$.



Extra space for question 5)

Question 6) Second Order Differential Equations

The differential equation of the 2H inductor in an RLC circuit is

$$\frac{d^2}{dt^2}i(t) + 12\frac{d}{dt}i(t) + 100i(t) = 408sin(2t)$$

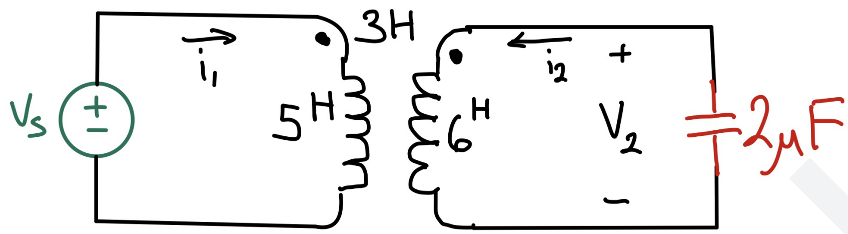
At t = 0, i(t) = 2 A and the voltage across the inductor is 12 V. Find the complete response of i(t).

i(t) =

Extra space for question 6)

Question 7) Transformers and Power

Given a circuit with a transformer and a capacitive load



a) Derive i_1 and i_2 in terms of V_S. (Hint: a derivative with respect to time can be represented as an operator jω)

i_1 =
i_2 =

b) Now, the capacitor is replaced with a 2 Ω resistor. If $V_S(t) = 4\cos(7t)$, find the dissipated power of the resistor in watts.

P_R =

Extra space for question 7)