Intro to ECSE

Quiz 2

Spring 2025

1.	**/7**
2.	**/12**
3.	**/16**
Total	**/35**

Name _____

RIN _____

Notes:

SHOW ALL WORK. BEGIN WITH FORMULAS, THEN SUBSTITUTE VALUES AND UNITS. No credit will be given for numbers that appear without justification.

Use the backs of pages if there is not enough room on the front.

For partial credit on some questions, you may want to re-draw circuit diagrams as you simplify the circuits. Work through a problem in terms of variables, then substitute numerical values when you are ready to solve it.

Many problems can be solved using more than one method. Check your answers by using a second method.

At least skim through the entire quiz before you begin and then start with the problems you know best. The proctor will only answer clarification questions where wording is unclear or where there may be errors/typos. No other questions will be responded to.

Problem 1 [7 pts]: Diodes

The circuit below (left) consists of a resistor of resistance **R**, a diode **D**, and voltage source with voltage **Vs** in series. The IV characteristic for the diode is also given below (right).

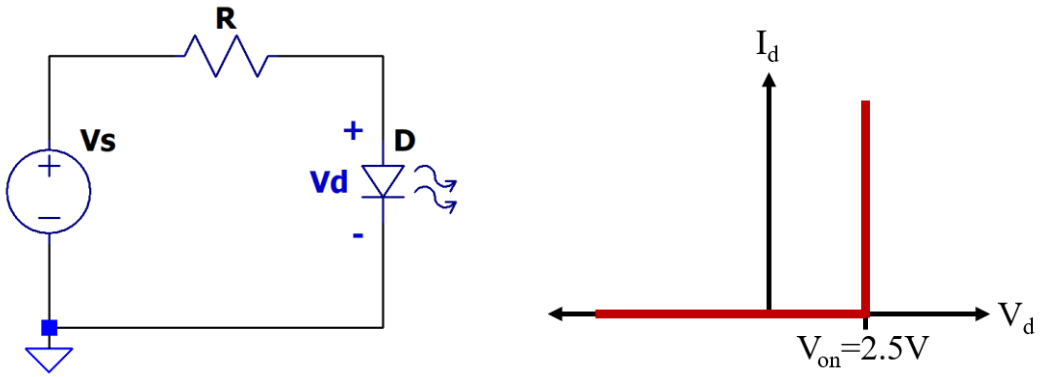


Figure 1 – (left) diode circuit and (right) diode IV characteristic.

a) [1 pt] What is the minimum voltage of the voltage source **Vs** for which current will flow through the circuit?

Vs:	**[V]**

b) [2 pts] What is the maximum current $\mathbf{I_{max}}$ that is able to be supported by the diode if its maximum allowable power is 0.1W?

$\mathbf{I_{max}}$**:**	**[A]**

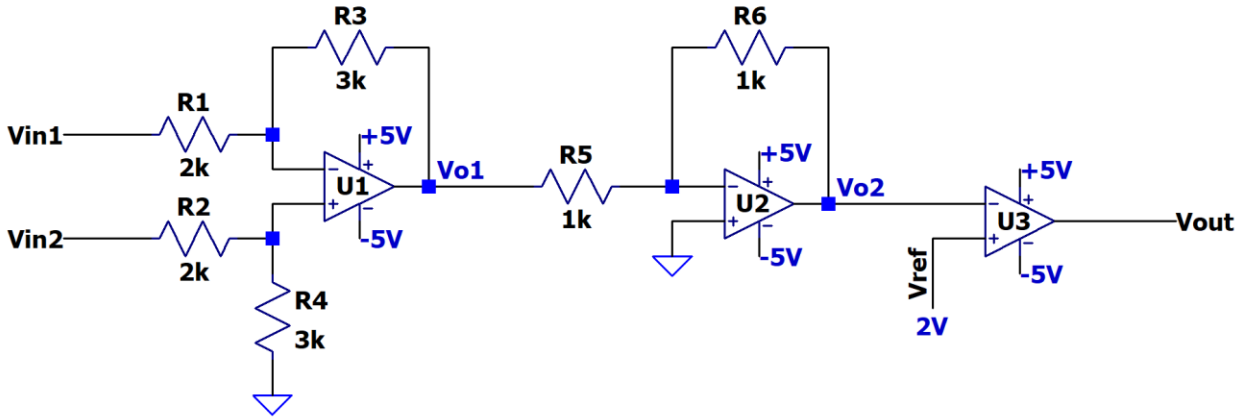
c) [2 pts] What is the minimum value of the resistor **R** that will keep the current in the circuit below the value you calculated in part (b) if **Vs = 5V**?

R_{min}: **[Ω]**

d) [2 pts] Does Ohm's law apply to diodes? Explain why or why not.

Problem 2 [12 Points]: Operational Amplifier Circuits

In the circuit shown below, all operational amplifiers are considered ideal and are powered by supply voltages of +5V and -5V.



a) [3 pts] Identify the stages in this op-amp circuit by drawing a box around each stage and labeling them “Stage 1”, “Stage 2”, etc.

b) [3 pts] In the space below, label each of the stages of the circuit that you identified in part (a) with what type of op-amp circuit it is. *Note*: where relevant, specify if the circuit is “inverting” or “non-inverting”.

c) [3 pts] For each stage, write the transfer function as a numerical value. In cases in which a transfer function cannot be written for a stage, state this clearly, and write the expression for the output voltage in terms of the input voltages (i.e. $Vin1$ or $Vin2$) instead. *Hint*: in some cases, Vin for a stage may be the sum or difference of two voltages. If this is the case, specify what you consider to be Vin.

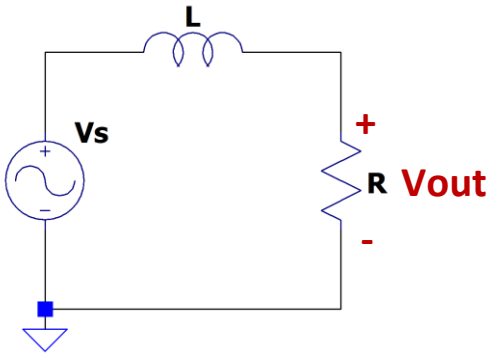
Transfer function or Vout(Vin) for each stage:

d) [3 pts] Calculate Vout for the circuit for the input voltages $Vin1 = 3V$ and $Vin2 = 1V$.

Vout: [V]

Problem 3 [16 Points]: Filter Circuits

1. First Order Filter Circuits



a) [3 pts] Find the transfer function $H(j\omega)$ for the circuit above in terms of L, R and ω.

$\boldsymbol{H(j\omega)}$**:**

b) [3 pts] Find the magnitude of the transfer function $|H(j\omega)|$ you derived in (a) in terms of L, R and ω.

$\boldsymbol{|H(j\omega)|}$**:**

c) [2 pts] Evaluate $|H(j\omega)|$ from part (b) at the limits $\omega \to 0$ and $\omega \to \infty$.

d) [2 pts] Sketch a ***log-linear*** plot of $|H(j\omega)|$ on the axes provided. Also label the location of the corner frequency on the frequency and $|H(j\omega)|$ axes.

e) [1 pt] What kind of filter does your sketch in part (d) represent?

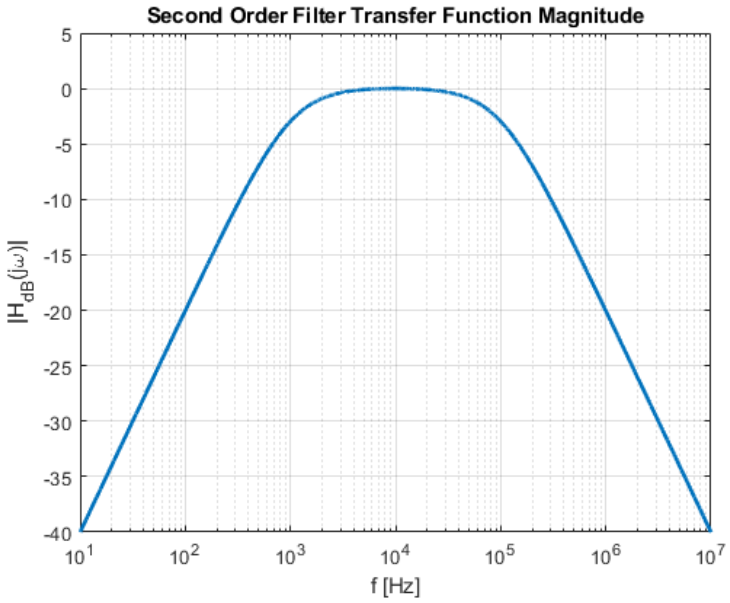
f) [2 pts] Choose values for L and R that would give a corner frequency in Hz, f_c, of 20 kHz.

R:	Ω

L:	H

2. Second Order Filter Circuits

Shown below is the magnitude of the transfer function for a second order filter on log-log axes. *Note*: $|H(j\omega)|$ is plotted in decibels.



a) [1 pt] What type of filter's transfer function is plotted in the figure above?

b) [1 pt] What is the center frequency in Hz for the filter?

c) [1 pt] What range of frequencies corresponds to the passband for the filter?