Physics 322 Study Guide 2

November 9, 2026

Your name: _____

This exam happens in 3 steps:

75 min	You will complete Problems 1–5 on your own. Problems 1 and 2 are written questions. Problems 3 and 4 are done at the lab bench. Problem 5 asks you to design a circuit.
15 min.	We discuss as a group the circuit you designed in Problem 5.
45 min	You will build the circuit on your own (Problem 6).

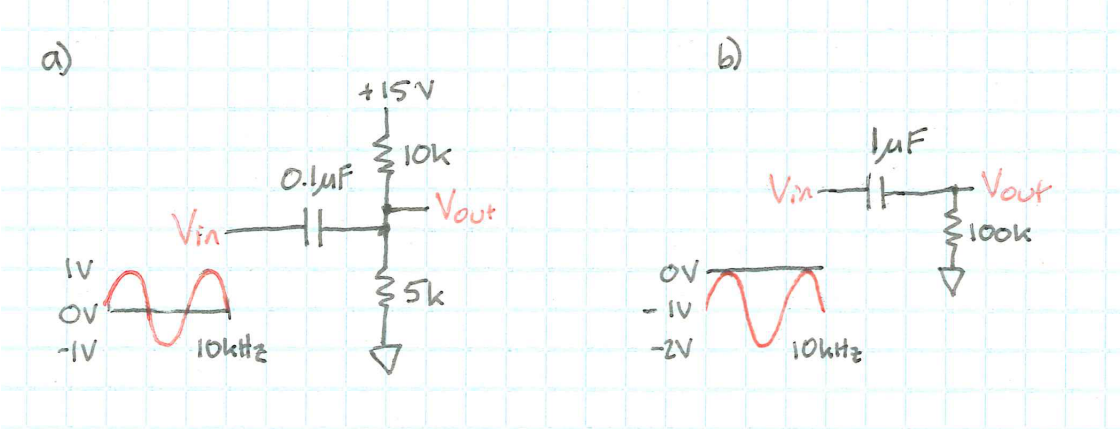
The exam is in a limited open-book format: you may bring your notes and a laptop or tablet and refer to any course materials on the Canvas site, including pre-labs, labs, and lectures (and their solutions), as well as any of your own notes. Calculators, including graphing calculators or app equivalents such as Desmos, are also allowed. However, you may not search the open Internet or ask for answers from classmates, AI, or others on the internet.
If you do not understand what a question is asking for, please ask for clarification.
During the hands-on portions, if you become stuck and need to ask me for help, you must be able to describe the problem (what you expected to see, and how your observation differs from that expectation) as well as at least **three** things you have already tried to fix the problem.

Below is a list of learning goals with associated questions. Some are questions that you can (and should) work out on paper; others are about skills (e.g. "can you set the trigger level on the scope?"). For the skills questions, you can answer yes or no, and come to open lab to practice until your answer is "yes"! Keep in mind that the questions don't necessarily cover the whole learning goal (especially e.g. the learning goals about recognizing several different types of circuits), but should give you an idea of your understanding and what you should look back on in the labs, prelabs and lectures.

You should also be able to do everything on the first study guide for the first exam!

1 Reading/Building Circuits

- Know how to use AC coupling to view a signal on an oscilloscope, to remove a DC bias from a signal, or to add a DC bias to a signal. AC coupling
  Draw the output waveforms for the following two circuits and input waveforms.

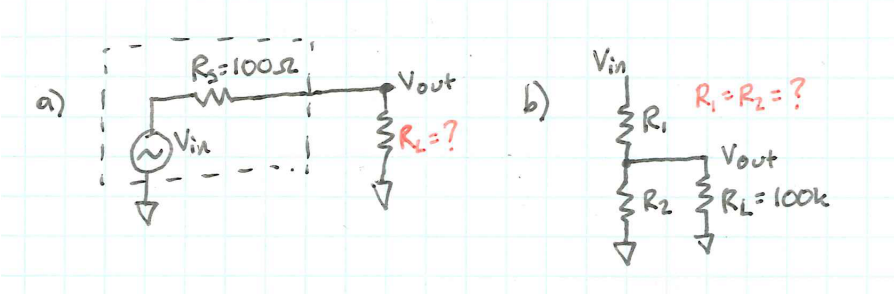


- Reading simple circuit diagrams: identify in a diagram and explain the purpose of a voltage divider, clamp, op amp, BJT, potentiometer (used as a voltage divider and used as a variable resistor), pushbutton switch, SPDT switch, rectifier, and RC filter. Recognition
  On the PB503 schematic attached at the end of this file, find and circle an SPST switch, SPDT switch, fuse, and voltage divider. Explain what each of these circuit pieces (in isolation) does.

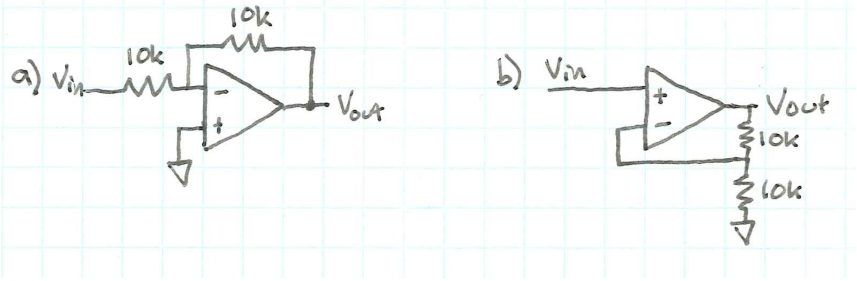
2 Circuit Analysis

- Determine input and output impedance (aka load and source resistance) of circuit blocks. See prelabs for more example problems.

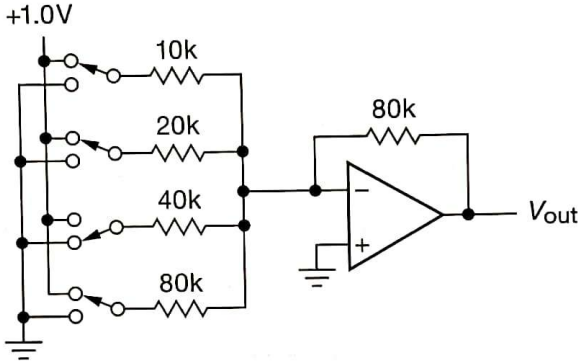
- How to choose input and output impedances to cascade circuits. Cascading
  What resistor values would you choose for the two situations shown below, to prevent the input voltage from dropping by more than 10% when loaded?



- Identify and explain common transistor circuits (emitter-follower and current source). Calculate their gain and input/output impedances.
- Explain and calculate quiescent operation in transistors.
- Explain the benefits of using transistors. How do they affect voltage gain, current gain, and input/output impedance?
- What are the limits on transistor performance? (input voltage and power rails) What are some ways to get around these limitations?
- Recognize and calculate the gain for inverting and noninverting amplifier circuits with op-amps. Amplifier Gain
  What is the gain of each of the circuits shown below?

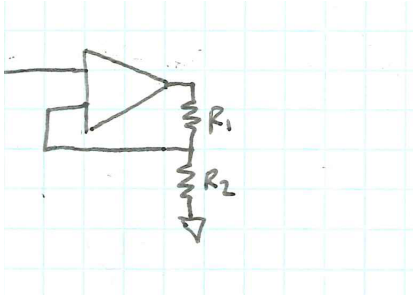


- Recognize and explain the use of common op-amp circuits: voltage amplifiers, unity gain buffers, summing amplifiers, integrators, instrumentation amplifiers, active filters. Op-amp circuits
  What type of op-amp circuit is shown below?[1] What does it do?



[1] Art of Electronics Figure 13.3

- Recognize whether feedback is positive or negative, and explain the effects of positive and negative feedback. Feedback
  Complete the circuit below to have negative feedback, and explain what would happen if the inputs were accidentally switched.



- Read datasheets to determine safe limits and characteristics of a given part.

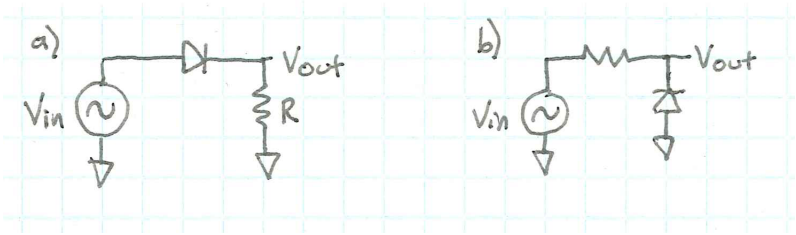
  Limitations
  For a 1N914 signal diode, what is the maximum rated power dissipation?

- Identify the limitations of op amps: output voltage, output current, slew rate, unity-gain bandwidth, offset voltage and bias current. Find these parameters on a datasheet.

  Limitations
  Would an LF411 be able to drive a low-resistance load such as an 8Ω speaker with a ±1 V signal? What about an AD8010?

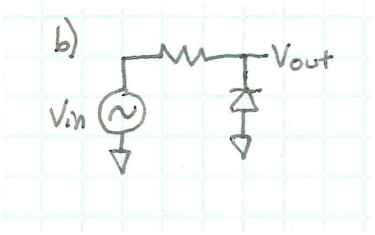
- How to limit a signal with a diode clamp, and how to rectify a signal.

  Diodes
  What do each of the following circuits do?



- Calculate power dissipation in a circuit.

  Power
  How much total power is dissipated in the below circuit if V_{in} is -5.6 V and R = 1 kΩ? Which part dissipates more power, the resistor or the diode? What if the input voltage were 7 V?



- I-V curves: what they look like for a resistor and diode, and how to interpret this graph. I-V Curves
  Sketch a graph of current vs voltage for a) a 100 Ω resistor, b) a 100kΩ resistor, and c) an ordinary silicon diode. When the forward voltage across the diode is greater than +0.6 V, what is the slope of the graph (qualitatively)? What about when the voltage is less than +0.5 V? How do you interpret these slopes?

- Combine circuit blocks such as amplifiers, filters, and clamps, following the rules for cascading circuits by input and output impedance, to form multi-stage circuits that meet a set of specifications. Circuit Design
  Design a circuit that meets the following specifications, given power supplies of 5 V and $\pm$15 V:

  - Takes input from a sensor with $\leq$ 100 kΩ output impedance. The signal of interest is expected to be at 10 kHz.
  - Attenuates low-frequency noise. (A first-order filter is adequate.)
  - Amplifies the signal of interest by a factor of 100 ($\pm 10\%$).
  - Drives a load of $\geq$ 10 kΩ input impedance.
  - The load can only tolerate positive voltages, and should be protected from voltages below ground (within ≈ 1 V).