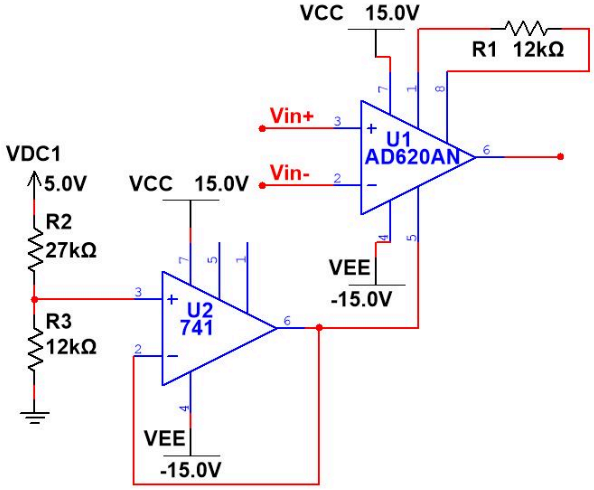
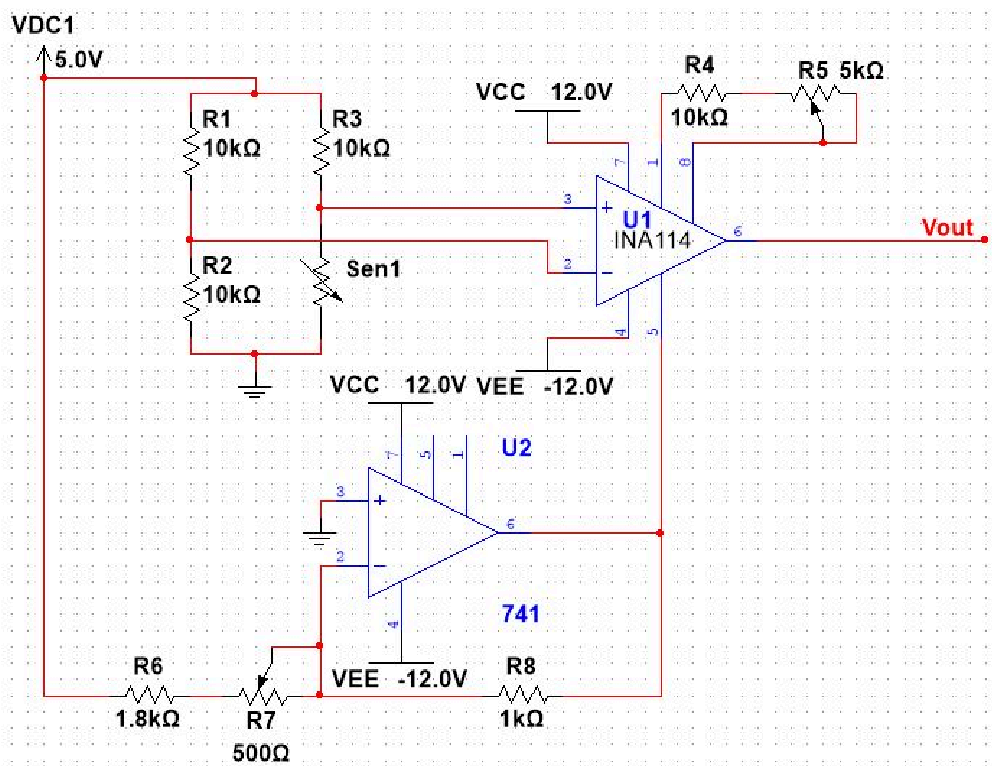
Analyze the following circuit to determine its transfer function.



1. The internal resistors for the AD620 are 24.7 kΩ, probably just so they can say they're not copying Burr Brown. Determine the gain for the instrumentation amplifier. This amplifier has the same pinout and functionality as the Burr Brown INA114, discussed previously. 5.12
2. Determine the DC offset presented to pin #5. 1.54 V_{DC}
3. Fill in the following Transfer Function expression for this amplifier:
4. v_{out} = 5.12 x(v_{in+} - v_{in-}) + 1.54
5. If v_{in+} = +1.34 V and v_{in-} = -0.52 V, what should v_{out} be? 11.1 V_{DC}

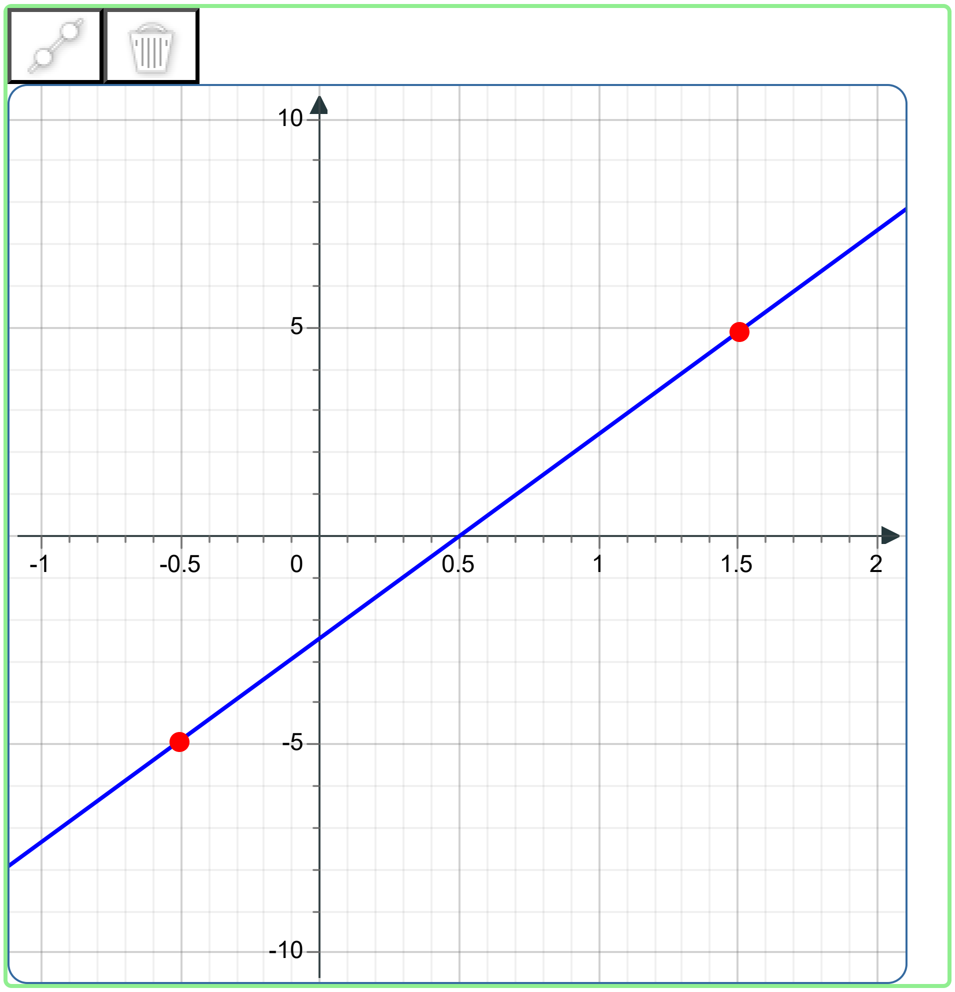
Analyze the following circuit to determine its transfer function.



6. The sensor, Sen_1, varies from 6.667 kΩ to 40.0 kΩ. This translates to V_+ ranging from [2] V to [4] V.

7. The differential input signal would range from [-0.5] V to [1.5] V

8. The output signal for this circuit is intended for an A to D converter than handles signals from -5.0 V to +5.0 V. Plot the endpoints of the transfer function graph below, using the differential input signal and the A to D output range.



9. What gain is required? [5]

10. When the amplifier is properly calibrated, what do you expect the R_5 resistance to be? [2.5] kΩ

11. What offset voltage is required? (rearrange y=mx+b and use one of the endpoints for (x,y) to solve for b).

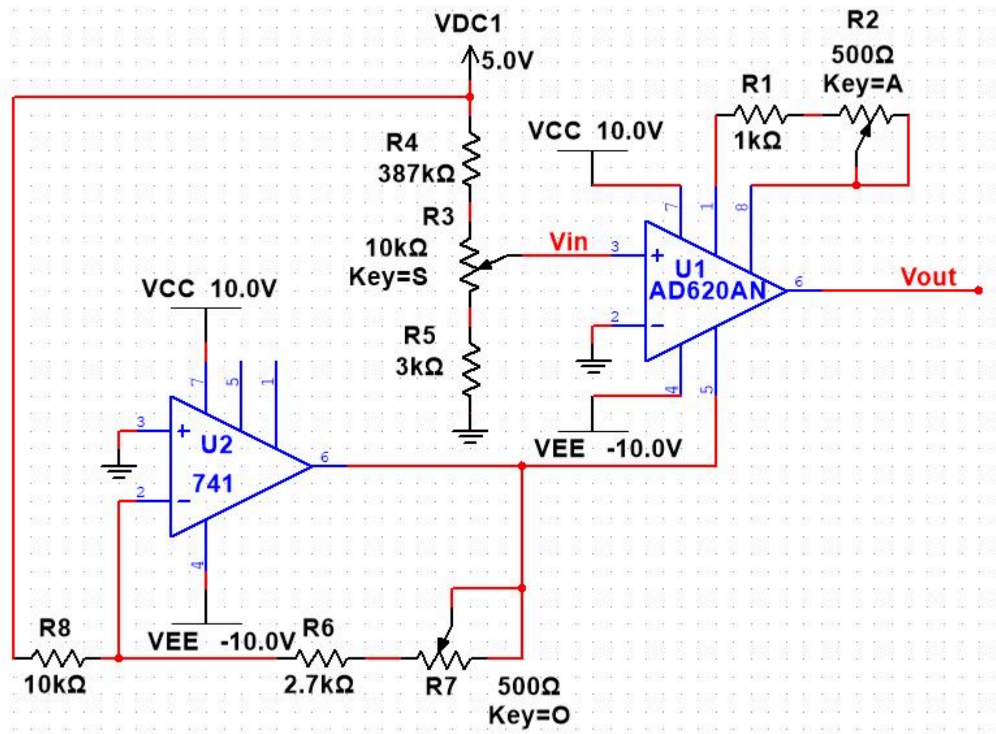
[-2.5] V

12. What gain is required for the 741 op amp to produce this offset voltage? [-0.5]

13. When the amplifier is properly calibrated, what do you expect the R_7 resistance to be? [200] Ω

14. Fill in the transfer function for this amplifier: $V_{out} =$ [5] $\cdot (v_+ - v_-) -$ [2.5] ,V

Here's a worked example from an old exam in this course.



The intended transfer function for this circuit is

$$V_{out} = 41 \cdot V_{in} - 1.6,\ V$$

The gain of this amplifier, therefore, is intended to be 41. From the formula for the gain rearranged, we can determine what the combination of R_1 and R_2 (i.e. R_G) should be:

$$R_G = \frac{2\ R}{A_v - 1} = \frac{2 \cdot 24.7\ k\Omega}{41 - 1} = 1.235\ k\Omega$$

This is within the range of available resistances, which is from 1.0 kΩ to 1.5 kΩ.

The offset voltage for this circuit, from the transfer function, is expected to be -1.6 V_{DC}. Since the offset-providing circuit is an inverting amplifier using +5 VDC as its input, the required gain is

$$A_{v(off)} = -\frac{1.6}{5} = -0.32$$

Using the gain expression for an inverting amplifier rearranged, we can determine the appropriate setting for the combination of R_6 and R_7 (i.e. R_f) to be

$$R_f = -A_{v(off)} \cdot R_i = -(-0.32) \cdot 10\ k\Omega = 3.2\ k\Omega$$

Again, this is within the range of available resistances, which is from 2.7 kΩ to 3.2 kΩ.

Now for the expected output range of voltages:

When the R_3 sweeper is all the way to the bottom, using the voltage divider formula we can determine that the voltage at V_{in} will be

$$V_{in} = 5\left(\frac{R_5}{R_3 + R_4 + R_5}\right) = 0.0375\ V$$

In this position, the output voltage is expected to be

$$V_{out} = 41 \cdot (0.0375) - 1.6 \ = \ -0.0625\ V$$

and when the R_3 sweeper is all the way to the top, V_{in} will be

$$V_{in} = 5\left(\frac{R_3 + R_5}{R_3 + R_4 + R_5}\right) = 0.1625\ V$$

In this position, the output voltage is expected to be

$$V_{out} = 41 \cdot (0.1625) - 1.6 \ = \ 5.0625\ V$$

For an input voltage of 87.5 mV, the output voltage is expected to be

$$V_{out} = 41 \cdot (0.0875) - 1.6 \ = \ 1.9875\ V$$