

CASE WESTERN RESERVE UNIVERSITY
Case School of Engineering
Department of Electrical Engineering and Computer Science

ENGR 210. Introduction to Circuits and Instruments (4)

Homework Set No. 9

References: [T&R4] section 4-6. [T&R5] sections 5-1 to 5-6.

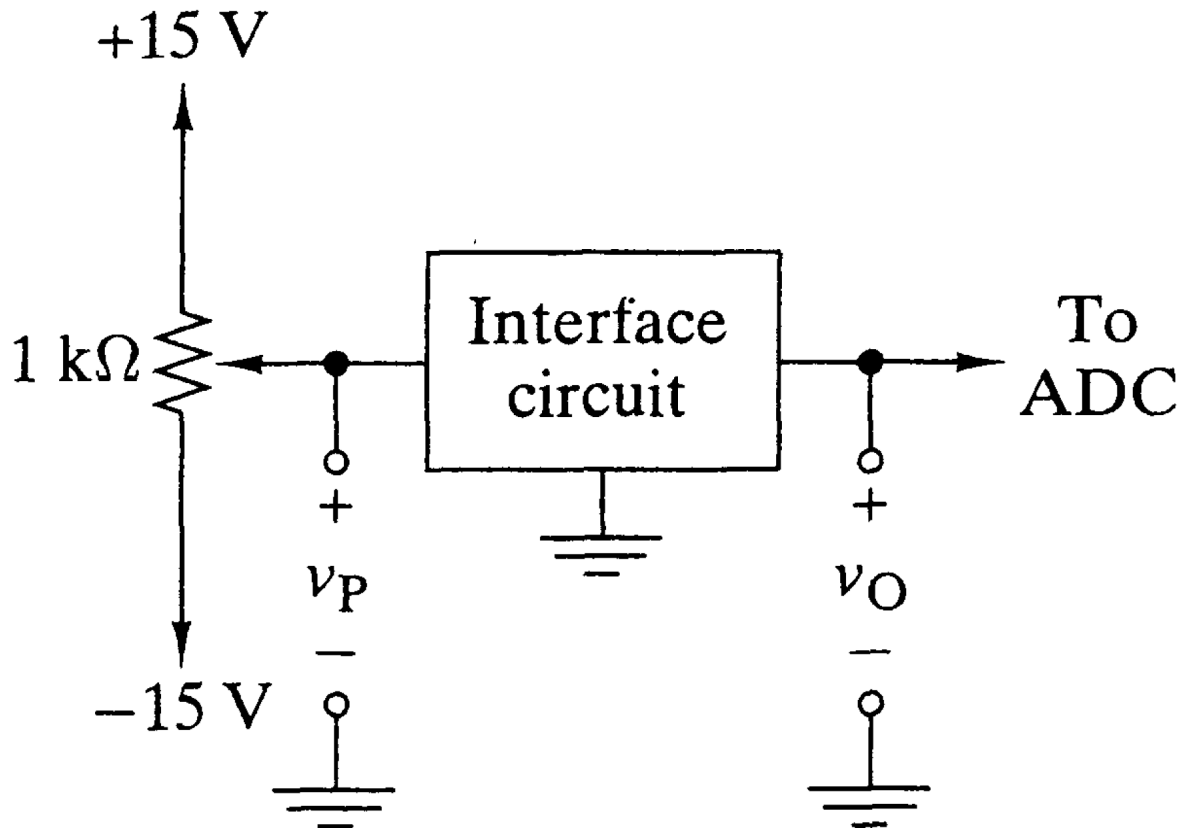
Issued 3/16/05

Due 3/23/05

TRANSDUCER INTERFACING

1) (5 pts) Design of a signal conditioning circuit.

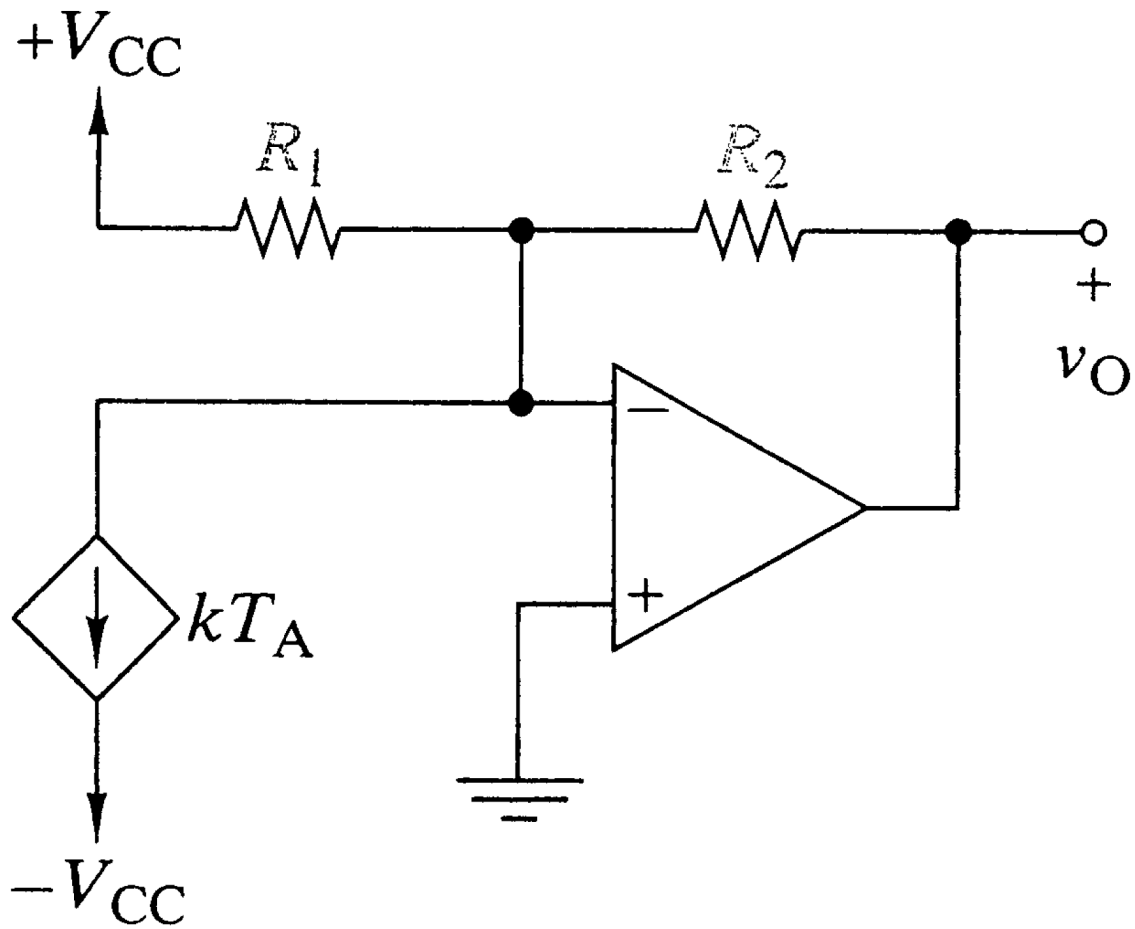
You are a mechanical engineering student working on a leg position sensor for a biorobot.



The range of mechanical movement moves the wiper (the arrow) between the bottom and the top of the potentiometer. An interface circuit is required to convert the potentiometer voltage v_p (-15 to +15 volts) to a v_o range (0 to 5 volts) suitable for input to the analog-to-digital converter of a computer. Design a suitable interface circuit.

2) (5 pts) Design of an instrument amplifier.

You are a chemical engineering student developing a chemical reactor and need to monitor the temperature in the reactor.



Your advisor tells you to use a semiconductor pressure sensor in the above circuit.

The sensor can be modeled as a temperature-controlled current source which senses absolute temperature T_A ($^{\circ}\text{K}$) and delivers a current kT_A , where $k=1\mu\text{A}/^{\circ}\text{K}$. The purpose of the OP AMP circuit is to make the output voltage proportional to $^{\circ}\text{C}$.

For $V_{CC}=10$ volts select values for R_1 and R_2 so that the output sensitivity is $100\text{ mV}/^{\circ}\text{C}$.

WAVEFORMS

3) (5 pts) Exponential waveform.

The value of an exponential waveform is 5 volts at $t=5\text{ms}$ and 3.5 volts at $t=7\text{ms}$.

(a) Find the amplitude and time constant of the waveform.

(b) What is the waveform's value at $t=2\text{ms}$?

4) (5 pts) Sinusoidal waveform.

A 100 kHz sinusoid has an amplitude of 75 volts and passes through 0 volts with a positive slope at $t=5\ \mu\text{s}$. Find the Fourier coefficients, phase angle, and time shift of the waveform.

5) (5 pts) Waveform partial descriptors.

The waveform $v(t)=V_o+10\cos(200\pi t)$ is applied at the input of an OP AMP voltage follower with $V_{cc}=\pm 15$ volts. What range of values of the dc component V_o ensures that the OP AMP does not saturate.

6) Measurements of a periodic sinusoidal waveform.

A periodic waveform can be expressed as $V(t)=100-200\cos\pi t-75\sin 40000\pi t+35\cos 80000\pi t$ millivolts

(a) What is the period of the waveform?

(b) What is the average value of the waveform?

(c) What is the amplitude of the fundamental component?

(d) What is the highest frequency in the waveform?

NOTE: Please put your section code AND your CWRU e-mail next to your name at the top of the page. Section codes are

MA (Monday Afternoon)

ME (Monday Evening)

TA (Tuesday Afternoon)

TE (Tuesday Evening)

WA (Wednesday Afternoon)

WE (Wednesday Evening)

There will be NO acceptance of this homework assignment AFTER the beginning of class on the day it is due