

Tutorial 2

Chapter 4 Principles of Transducers

Chapter 5 Signal Conditioning

Chapter 4 Principles of Transducers

4.1 The output voltage of a potentiometer-type resistance transducer is to be measured by a recorder having an input resistance of $20\text{ k}\Omega$. If the error of measurement is not to exceed -2% at 50% f.s.d, determine resistance value of the potentiometer. [$1.633\text{k}\Omega$]

4.2 A linear variable differential transformer is excited with a 100 Hz 6 V peak-to-peak waveform. The input core motion is sinusoidal at 10 Hz and has the displacement amplitude of $\pm 3\text{ mm}$. If the LVDT sensitivity is 2 V/mm , draw the waveforms of the excitation voltage, input displacement and output voltage.

4.3 A quartz pressure transducer has a sensitivity of 80 pC/bar . If, when the input pressure is 3 bars , an output voltage of 1 V is produced, determine the capacitance of the device. [240 pF]

4.4 A capacitive displacement sensor is used to measure rotating shaft wobble, as shown in the following figure:

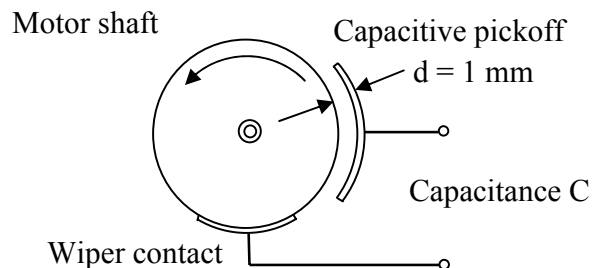


Figure 4.1 Figure for Problem 4.9

The capacitance is 880 pF with no wobble. Find the change in capacity for a $+0.02\text{- to }-0.02\text{ mm}$ shaft wobble. [35 pF]

4.5 A $50\text{-k}\Omega$, a wire-wound potentiometer is used to measure the displacement of a work piece.



Figure 4.2 Examples of wire-wound potentiometer

A linkage is employed so that as the work piece moves over a distance of 12 cm, the potentiometer varies by the full 50 k Ω . The potentiometer is wound on a 3-cm-diameter form, 5 cm long, and the distance between wires in the potentiometer is 0.25 mm. What is the resolution in work-piece motion? What resistance change corresponding to this resolution? [0.6 mm] [250 Ω]

Chapter 5 Signal Conditioning

5.1 An addition amplifier circuit is shown in the following figure. If $R_1 = 1\text{k}\Omega$, $R_2 = 2\text{k}\Omega$, $R_F = 10\text{k}\Omega$, $V_1 = 1.5\text{ V}$, and $V_2 = 2\text{ V}$.

(a) Determine the output voltage. [-25 V]

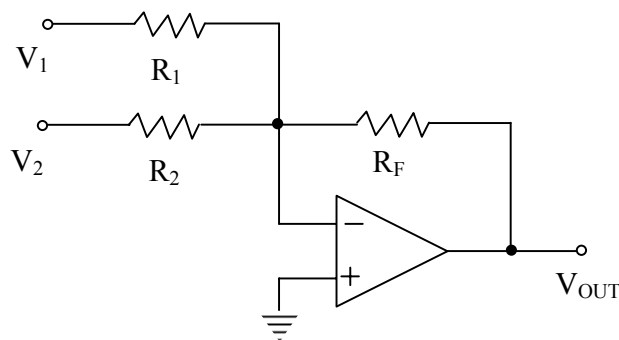


Figure 5.1 Addition amplifier circuit with two input voltages

(b) If the addition amplifier circuit is arranged as shown in the following figure with $R_3 = 1.5\text{k}\Omega$ and $V_3 = 3\text{ V}$, what is the output voltage? [-45 V]

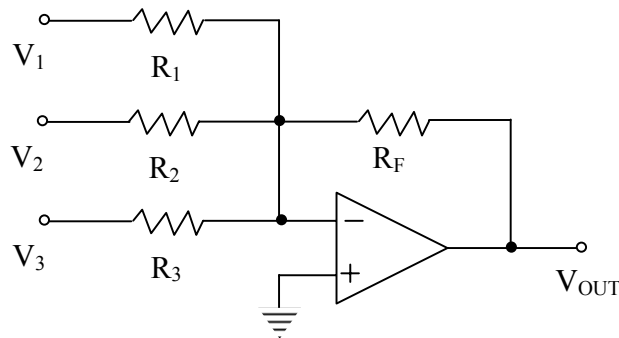


Figure 5.2 Addition amplifier circuit with 3 input voltages

5.2. The following figure shows an signal conditioning circuit for a temperature measuring system (transmitter) employing an RTD (resistance temperature detector) to measure temperature in range of 0 $^{\circ}\text{C}$ to 100 $^{\circ}\text{C}$. The RTD has a resistance of $R_x = 100\ \Omega$ (at 0 $^{\circ}\text{C}$), $R_1 = R_2 = 100\ \Omega$ and R_3 is a variable resistor used to null the bridge at 0 $^{\circ}\text{C}$. What is the value of R_3 ? [100 Ω]

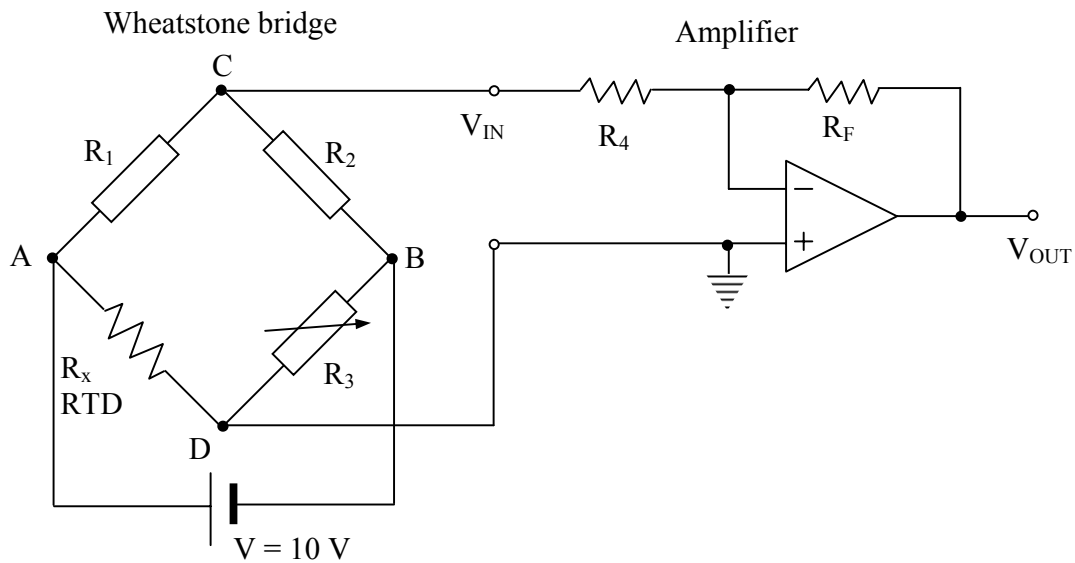


Figure 5.3 A temperature measuring system

- The RTD resistance R_x at 100°C is $138.5\ \Omega$, determine V_{CD} at 100°C if the excitation voltage is $10\ \text{V}$. [$-0.80713\ \text{V}$]
- At 100°C , determine resistance R_F if the output voltage of the amplifier is $5\ \text{V}$ and $R_4 = 1\ \text{k}\Omega$. [$6.1948\ \text{k}\Omega$]
- What is the sensitivity of the temperature measuring system?

5.3 The resistors in the following bridge are given by $R_1 = R_2 = R_3 = 120\ \Omega$ and $R_4 = 121\ \Omega$. If the supply voltage is $10.0\ \text{V}$, find the output voltage V_o . [$-20.7\ \text{mV}$]

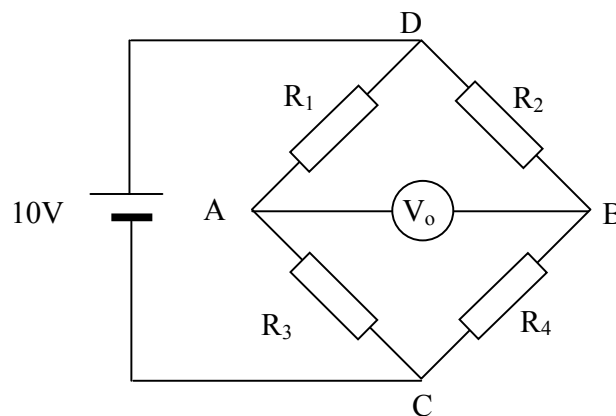


Figure 5.4 A DC Wheatstone bridge

5.4 If the Wheatstone bridge, as shown in **Fig. 5.4**, nulls with $R_1 = 1000\ \Omega$, $R_2 = 842\ \Omega$ and $R_3 = 500\ \Omega$, find the value of R_4 . [$421\ \Omega$]

5.5 A differential amplifier (as shown in the following figure) having a differential voltage gain of 1000 is used to amplify the output voltage from a pressure transducer. Determine the output voltage of the amplifier when (a) input $V_1 = +5\text{V}$, and input $V_2 = +5\text{V}$; (b) input $V_1 = +5\text{ V}$ and input $V_2 = +5.001\text{ V}$. [(a) 0 V, (b) -1.0 V]

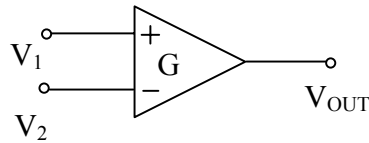


Figure 5.5 Differential amplifier

5.6 A resistance type of transducer is shown in the following figure. The transducer is used to measure the tank level in range of 0 to 10 m. The potentiometer has a total resistance of $100\ \Omega$ and the total length of 2 cm. The rack and pinion mechanism is arranged such that the wiper is at the high position when the level is at the maximum value and the wiper is at the low position when the level is at the minimum value. The supply voltage is 12 V.

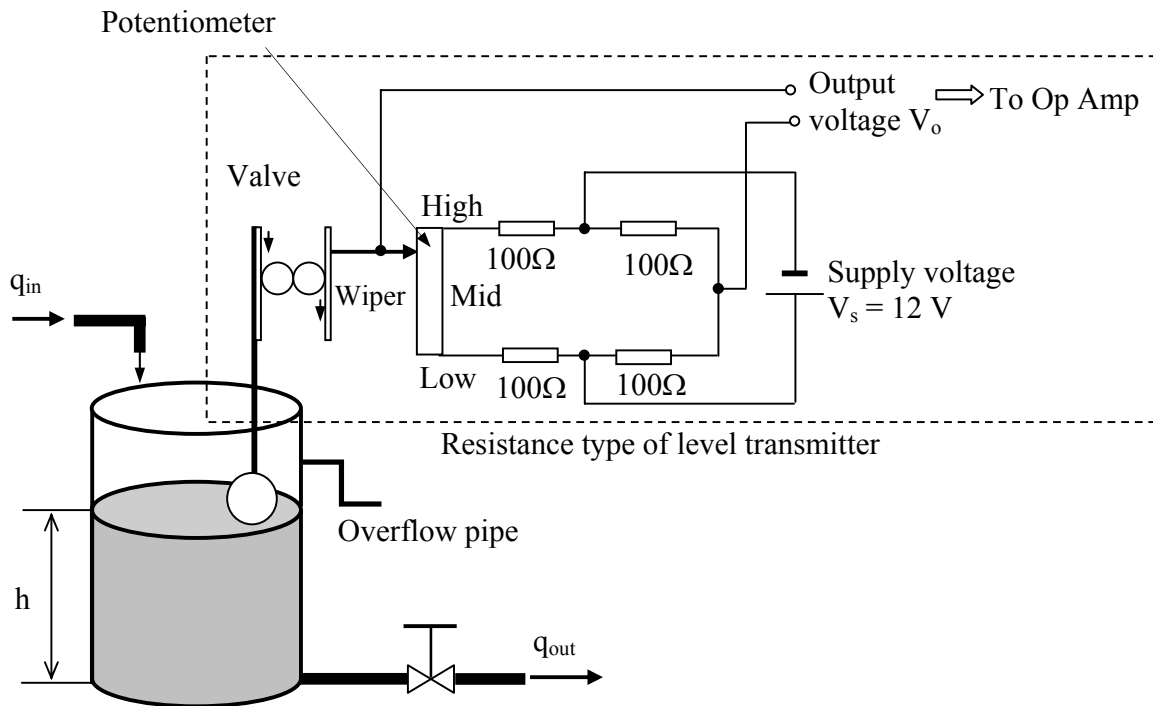


Figure 5.6 Resistance type of transducer

- (a) Determine the output voltage in the following cases:
1. The wiper in the midpoint of the potentiometer
 2. The wiper at High position
 3. The wiper at Low position.
- (b) What is the sensitivity of the transducer?