Micro Pressure Sensors & The Wheatstone Bridge Knowledge Probe

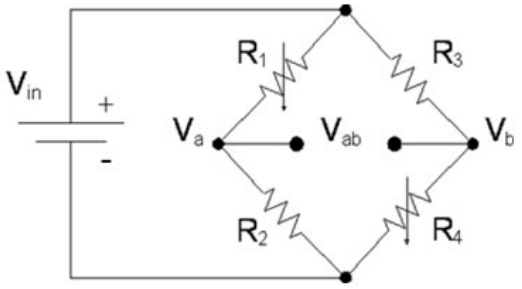
Participant Guide

Introduction

The purpose of this knowledge probe is to determine your current understanding of a Wheatstone bridge circuit and its application in microtechnology.

There are twelve (12) questions. Answer them to the best of your knowledge.

Below is a Wheatstone Bridge circuit with two sensing transducers. Use this circuit to answer questions 1 through 4.



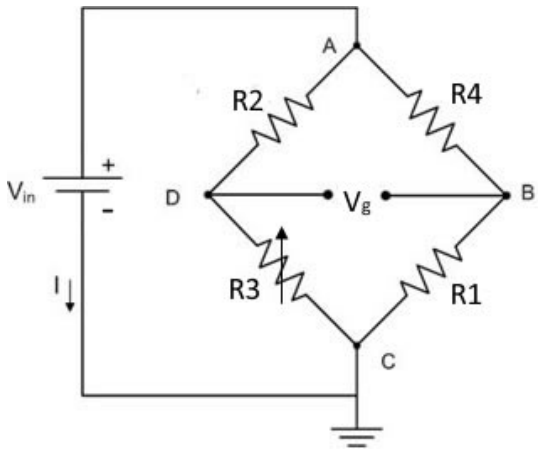
1. Which resistors are the sensing transducers?
   a. R1 and R2
   b. R2 and R3
   c. R3 and R4
   d. R4 and R1

2. What are the two voltage divider circuits in the bridge circuit?
   a. R_1 / R_2 and R_3 / R_4
   b. R_1 / R_3 and R_2 / R_4
   c. R_1 / R_4 and R_2 / R_3

3. Which of the following R values would yield a Vab = 0 V?
   a. R_1 / R_2 = R_3 / R_4
   b. R_1 / R_3 = R_2 / R_4
   c. R_1 / R_4 = R_2 / R_3

4. Given the following input voltage and resistor values, what is Vab?
(Vin = 5 v, R_1 = 300 Ω, R_2 = 100 Ω, R_3 = 100 Ω, and R_4 = 300 Ω)
   a. 5 volts
   b. 2.5 volts
   c. 0.0 volts
   d. -2.5 volts

5. What is the formula in terms of voltage and resistance for V_g in the following circuit?



a. $V_g = V_{in}\left(\frac{R_2}{R_3} - \frac{R_4}{R_1}\right)$

b. $V_g = V_{in}\left(\frac{R_3}{R_3 + R_1} - \frac{R_4}{R_4 + R_2}\right)$

c. $V_g = V_{in}\left(\frac{R_3}{R_3 + R_2} - \frac{R_1}{R_1 + R_4}\right)$

d. $V_g = V_{in}\left(\frac{R_3}{R_2} - \frac{R_1}{R_4}\right)$

6. The Wheatstone bridge is commonly used as an effective sensing circuit for which of the following MEMS devices?
   a. Accelerometer
   b. Cantilever array
   c. Pressure sensor
   d. Seismic sensor

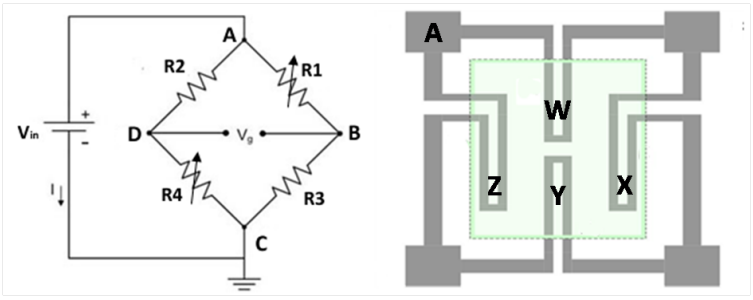
7. The sensing transducers of a Wheatstone bridge circuit are made from a piezoresistive material that changes in resistance when its length, width, and/or thickness change. What is this type of transducer called?
    a. Strain gauge
    b. Thermocouple
    c. Thermister
    d. Galvanometer

8. In a MEMS device, the Wheatstone bridge is normally fabricated on top of a flexible layer such as a membrane or diaphragm. This allows the transducers of the bridge to stretch as the membrane stretches. The thin film used to construct a Wheatstone bridge sensor circuit on a membrane is usually made of which of the following materials?
    a. Silicon nitride
    b. Silicon dioxide
    c. Polysilicon
    d. Metal or metal alloy

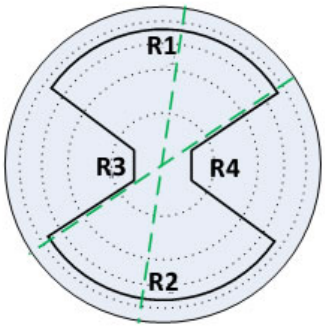
9. Which of the following statements BEST defines piezoresistive materials? Materials in which a change in electrical resistance occurs in response to changes in…
    a. an applied stress.
    b. the material's length.
    c. the material's cross-sectional area.
    d. temperature.

10. The resistance of piezoresistive material increases with
    a. a decrease in length and a decrease in cross-sectional area
    b. an increase in length and a decrease in cross-sectional area
    c. a decrease in length and an increase in cross-sectional area
    d. an increase in length and an increase in cross-sectional area

11. Below is the diagram for a fabricated MEMS Wheatstone bridge circuit. Referring to the components and contacts of the Wheatstone bridge circuit on the left, indicate which resistors are represented by W, X, Y, and Z, respectively, on the MEMS circuit to the right. Node A is indicated in both circuits.
    a. R2, R1, R4, R3
    b. R1, R3, R4, R2
    c. R1, R2, R3, R4
    d. R2, R1, R3, R4



12. In the following circular membrane configuration, which are the variable resistors?
    a. R1 / R2
    b. R3 / R4
    c. R1 / R4
    d. R2 / R3



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