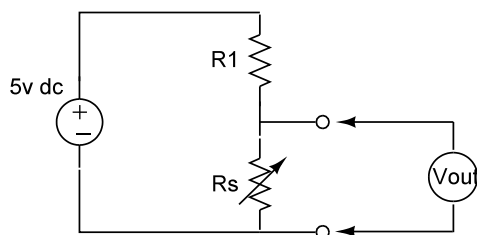


ENGR-325  
Homework 4  
(typo in problem 5 fixed)

- 1) Assume that a 180 Hz sine wave is sampled at a rate of 240 Hz.
  - a) Draw the wave and show on the waveform the points where it would be measured.
  - b) Observe the points where measurement occurs. What is the apparent frequency of a signal defined by those points?
  
- 2) An aircraft wing is being studied and it is noted that when wind gusts occur the wing will oscillate. Assume that oscillations are expected to be about 2 Hz. To study the observed vibration, strain gauges are mounted on the wing. Strain gauge signals are amplified and then connected to a +/- 5V, 12-bit A/D converter and data-acquisition system. The signal from the strain gauge is sampled for 10 seconds each time data is taken.
  - a) What is an appropriate sample rate to use? Explain.
  - b) Assume the signal is sinusoidal with peak amplitude of 2 volts. Sketch a plot of the expected amplitude spectrum. Show & label the frequency spacing (on the x-axis). What is the Nyquist frequency?
  
- 3) An RTD (temperature sensor) has a first order temperature coefficient of 0.004/degree C at 20°C. If its resistance is 100 ohms at 20°C what is its resistance at 25°C?
  
- 4) Sensor self heating can affect measurements. Suppose that the RTD in problem 3 has a power dissipation constant of 25 mW/°C and is used in a circuit that puts 8 mA through the sensor. If the RTD is placed in a bath at 100°C, what resistance will the RTD have? What will be the indicated temperature?
  
- 5) To create a voltage that changes with temperature, an RTD like that in problem 3 can be used in a voltage divider circuit as shown below. With  $R_1 = 100$  ohms, calculate the voltage resolution needed to measure  $V_{out}$  and resolve the voltage change produced by a 1.0°C change in temperature.



- 6) If the RTD in problem 5 is replaced with a thermistor with  $R=100$  ohms at 20°C and an  $R$  versus Temp of  $-5\%/^{\circ}\text{C}$  near 20° (i.e. a one degree temperature change causes the resistance to change by 5%), calculate the voltage resolution needed to resolve a 1.0°C change in temperature.
  
- 7) If the output of a type J thermocouple measures 22.5 mV with a 0°C reference, what is the junction temperature?
  
- 6) A type K thermocouple with a 0°C reference will be used to monitor oven temperature at about 300°C. What voltage will be expected?