Department of Bioengineering, CMC-Vellore

Transducers and Instrumentation for Physiological Measurement
Mid-Term Test

1st March, 2019
1 hour

1. The following table gives the resistance of a thermistor measured at 3 different temperatures. Calculate the value of the thermistor constant β.

T (°C)	*20*	*30*	*40*
R_T (Ω)	2492	1611	1060

The Resistance vesus Temperature relation is approximated by the expression: R_T = 1611-55.1(T-30) where the temperature is in Celsius. This thermistor is to be used in the range 35° to 42°C. What will be the maximum error in this range, and at what temperature?

2. The resistance variation of a strain gauge gauge is given by: $\frac{\Delta R}{R}=G\frac{\Delta l}{l}+\alpha(T-T_o)$

The gauge factor of strain gauges made of Nichrome and Silicon are 2.5 and 170 respectively, while the temperature coefficients of resistivity are 0.0009 and 0.007, with 20°C being the reference temperature.

(a) Derive the expression for the output of a Wheatstone bridge for a load cell with (i) one strain gauge, and (ii) two strain gauges. (b) If 1% strain is present and 5°C temperature variation exists, calculate the following. Use an excitation voltage of 5V.

	Output due to 1% strain	Output due to 5°C	Total Output	Apparent strain
One active arm bridge				
Two active arm bridge				

3. We have two piezoelectric crystals: (a) quartz crystal of dimension x=5mm, y=5mm, z=2mm, and (b) barium titanate ceramic of dimension x=2mm, y=2mm, z=1mm. If a force of 100N is applied to each of them in the ***x*** direction for quartz and in the ***z*** direction for the ceramic crystal, what is the voltage in the preferred direction ? The value of the piezoelectric coefficient is: for Quartz, and $d_{p(33)}$=-for Barium Titanate Ceramic. Permittivity of free space, 8.8542×10^{-12} F·m^{-1}

	Relative permittivity (Dielectric constant)	Piezoelectric constant
Quartz ($d_{p\text{-}11}$)	4.5	$d_{p(11)}$=2.3x10^{-12} Coulombs/N
Barium Titanate Ceramic ()	1800	$d_{p(33)}$ =78x10^{-12} Coulombs/N