Course Title: Industrial Instrumentation
Course Number: EE 434

Exam Type: Final Exam
Date: Sat Jan 7, 2012
Time: 7:00 PM-9:00PM

Student Name: ________________________________
Student ID: ________________________________

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**Question No. 1 (10 points)**

State what each of the sensors below measures:

(a) Hall effect
(b) Piezoelectric
(c) Diaphragm
(d) Thermocouple
(e) Bourdon tube
(f) HIH400
(g) LM35

State two types of sensors that could be used to measure each of the following:

(a) Displacement

(b) Light intensity

(c) Speed

(d) Smoke
(i) The length of segment in foundation field bus is
   (a) 9 meter
   (b) 32 meters
   (c) 1900 meter
   (d) 190 meter
(ii) The flow of liquid can be assured using
   (a) Volume flow rate
   (b) Flow velocity
   © Weight or mass of liquid
   (e) All of the above
   (f) None of the above
(iii) The tune decoder is used to
   (a) Detect the type of a signal
   (b) Compare incoming frequency with decoder frequency
   (c) Detect the tone of ultrasound signal
   (d) Detect the tune of bat
(IV) ultrasound is used in
   (a) Cars maintenance
   (b) Medical imaging because it is safe
   (c) In displacement measurement
   (d) In force measurement
Question # 3 (10 point)

Explain each of the following applications (sensors used, how it works, how to get electrical signal, application)
**Question No.4 (10 points)**

A link type load cell (four strain gages are used) with elasticity $E = 30,000$ psi, $v = 0.3$, and fatigue strength $S_f = 80,000$ psi. The cell is excited by 10 volt DC supply if the ratio of the output voltage to the supply voltage at maximum load is $\frac{V_o}{V_s} = 3.75$ mv/v.

1. Find the gage factor GF.
2. Write the expression for the sensitivity of the cell.
3. Show how one can improve the sensitivity of the cell.

\[ V_o = V_s \frac{G_F \cdot P(1 + v)}{2AE} \]
Question No.5 (20 points)

The circuit shown is a thermometer based on two matched transistors. Assume ideal op-Amps, design the circuit in order to have 1mv/K at the output.

Given: \( I_c = I_s e^{\frac{T_v}{T}} \)
\( V_t = K T / q \)
\( K = 1.3807 \times 10^{-23} \), \( q = 1.60 \times 10^{-19} \) C