Department of Agricultural and Food Engineering
Indian Institute of Technology, Kharagpur - 721 302

END - SPRING SEMESTER EXAMINATION 2012 – 13

Subject – Instrumentation and Research Techniques | Date of Exam – 20/04/2013

Subject No. – AG60082 | Time – 3 Hr

Total students – 14 (UG - 03; PG - 11) | Full Marks – 50

Q1. Answer following 02 x

a. Give relationship of balanced Wheatstone's bridge. Also give expression for output voltage?
b. Enlist static and dynamics characteristics of measurement systems.
c. A capacitance based displacement transducer of area 400mm^2 and distance h between plates is 7mm and is filled with air. What is maximum possible displacement of plates so that the non-linearity does not exceed 2%. Also calculate sensitivity of transducer. (Take $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m)
d. Compare standard, secondary-standard and industrial platinum resistance thermometers.
e. Enlist different types of errors.

Q2. Consider a single strain gage of 120Ω resistance mounted along the axial direction of an axially loaded steel. If percent change in length due to loading is 3% and corresponding change in resistivity of strain gage material is 0.3%, estimate percentage change in the resistance of strain gage and its gage factor. If the strain gage is connected to measurement device capable of determining change in resistance with an accuracy of ±0.02Ω, what is the uncertainty in stress and strain that would result in using this resistance measurement device. (Take E = 200GPa and Poisson's ratio = 0.3) 05

Q3. Explain thermocouple laws and give their significance. 05

Q4. A load ring is under action of forces F and P as shown in Figure 1. (R = mean ring radius, t = ring thickness, b = width of ring) 06

a. Give expressions for the movement M at an angle φ when $0 < \varphi < \pi$ and $\pi < \varphi < 2\pi$.
b. Find out strain node points for installing strain gages to measure forces F and P, independently.
c. Give complete bridge circuits to measure forces F & P.
d. Derive expressions to calculate strains at strain nodes due to the forces F and P, respectively.

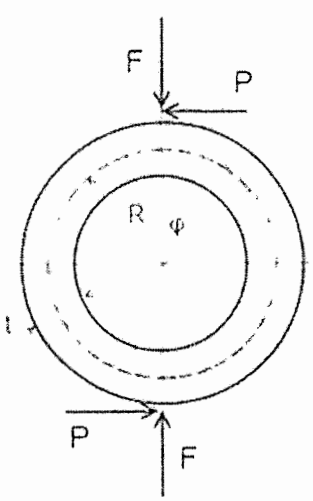

Figure 1

P.T.O.

Q5. An experiment is conducted to calibrate a copper – constantan thermocouple. With cold (reference) junction at 0°C, emf obtained at boiling point of water (100°C) and boiling point of sulfur (445°C) are 5mV and 25 mV, respectively. If relation is assumed to be 05

$$e_{(t_1-t_2)} = a(t_1 - t_2) + b(t_1^2 - t_2^2)$$

a. Determine constants a and b

b. If above thermocouple indicates 2mV when cold junction moved to 40°C, determine unknown hot junction temperature.

c. If cold junction is maintained at 40°C, what would be the emf when hot junction temperature is at 500°C.

Q6. Explain translational linear variable differential transformer (LVDT). 05

Q7. What is encoder? Explain different types of encoders. 06

Q8. A randomized complete block design is considered to study effect of three different lubricating oils on fuel economy of five different diesel engines. Fuel economy is measured in terms of break-specific fuel consumption after running each engine for 15 minutes as indicated in the table. 08

	Diesel Engines				
Oils	1	2	3	4	5
1	0.500	0.634	0.487	0.329	0.512
2	0.535	0.675	0.520	0.435	0.540
3	0.513	0.595	0.488	0.400	0.510

a. Analyze data and find out whether there is any difference between performances of different engines and use of different oils.

b. If yes, then use Fisher LSD to identify which lubricating oil has different effect.