Program: BBA in TM (4th Semester)

Date:12 March, 2024
Time: 10:00 AM – 11:30 AM

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid-Semester Examination
Course Number: MCE 4461
Course Title: Mechanical Technology II

Summer Semester: 2022 - 2023
Full Marks: 75
Time: $1\frac{1}{2}$ Hours

There are **03 (Three)** questions. Answer **all** of them. Symbols carry their usual meanings. Marks of each question and the corresponding CO and PO are written in the bracket. Assume reasonable value for any missing data.

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1. (a) Explain the basic difference between sensors and transducers. Briefly describe a typical fluid flow measurement system. (8) (CO1) (PO1)

   (b) State the difference between dynamic and static characteristics of instruments. Briefly explain the following dynamic characteristics. (7) (CO1) (PO1)
   i. Speed of response and response time
   ii. Lag
   iii. Fidelity
   iv. Dynamic error

   (c) A load cell is calibrated in an environment at a temperature of 18 °C and has the following deflection/load characteristic: (10) (CO1) (PO2)

Load (kg)	0	50	100	150	200	250
Deflection (mm)	0	0.9	1.8	2.7	3.6	4.5

   When used in an environment at 35 °C, its characteristic changes to the following:

Load (kg)	0	50	100	150	200	250
Deflection (mm)	0.3	1.4	2.5	3.6	4.7	5.8

   i. Determine the sensitivity at 18 and 35 °C.
   ii. Determine the zero drift and sensitivity drift coefficients in units of (mm/°C) and (mm per kg/°C).
   iii. Calculate the total zero drift and sensitivity drift at 35 °C.

2. (a) State the difference between Systematic Errors and Random Errors. Briefly explain the method of opposing inputs and high gain feedback to reduce the systematic errors in a measurement system. (13) (CO1) (PO1)

   (b) Explain the term 'traceability' in calibration process. Briefly describe the steps and equipment needed to calibrate a Bourdon Tube Pressure Gauge. (12) (CO1) (PO1)

3. (a) Suppose you have been hired as an engineer in a nuclear power plant, where your responsibility includes maintaining a continuous power supply. Your current task involves designing an automatic water flow system for the plant while also ensuring a specified (12.5) (CO2) (PO3)

pressure level in the boiler. Describe how you would integrate an LVDT into the system to control the water level as required and how a capacitive sensor can be employed to monitor steam pressure in the boiler. Provide the relevant illustrations and working principle of the sensors to aid in your explanation.

(b) Suppose that an engineer has installed a chromel-constantan thermocouple but has incorrectly used iron-constantan extension leads (such that the two constantan wires were connected together and the iron extension wire was connected to the chromel thermocouple wire). If the thermocouple was measuring a hot fluid whose real temperature is 125 °C, the junction between the thermocouple and the extension leads was at 90 °C and the reference junction was at 0 °C. (12.5) (CO2) (PO2)

i. Calculate the emf (voltage) measured at the open ends of the extension wires.

ii. Determine the fluid temperature from this measured emf (assuming that the errors in using the incorrect leads was not known about).

Table for Type E Thermocouple (Ref Junction 0°C) http://reotemp.com

°C	0	1	2	3	4	5	6	7	8	9	10
	Thermoelectric Voltage in mV										
0	0.000	0.059	0.118	0.176	0.235	0.294	0.354	0.413	0.472	0.532	0.591
10	0.591	0.651	0.711	0.770	0.830	0.890	0.950	1.010	1.071	1.131	1.192
20	1.192	1.252	1.313	1.373	1.434	1.495	1.556	1.617	1.678	1.740	1.801
30	1.801	1.862	1.924	1.986	2.047	2.109	2.171	2.233	2.295	2.357	2.420
40	2.420	2.482	2.545	2.607	2.670	2.733	2.795	2.858	2.921	2.984	3.048
50	3.048	3.111	3.174	3.238	3.301	3.365	3.429	3.492	3.556	3.620	3.685
60	3.685	3.749	3.813	3.877	3.942	4.006	4.071	4.136	4.200	4.265	4.330
70	4.330	4.395	4.460	4.526	4.591	4.656	4.722	4.788	4.853	4.919	4.985
80	4.985	5.051	5.117	5.183	5.249	5.315	5.382	5.448	5.514	5.581	5.648
90	5.648	5.714	5.781	5.848	5.915	5.982	6.049	6.117	6.184	6.251	6.319
100	6.319	6.386	6.454	6.522	6.590	6.658	6.725	6.794	6.862	6.930	6.998
110	6.998	7.066	7.135	7.203	7.272	7.341	7.409	7.478	7.547	7.616	7.685
120	7.685	7.754	7.823	7.892	7.962	8.031	8.101	8.170	8.240	8.309	8.379

-90 Table for Type J Thermocouple (Ref Junction 0°C) http://reotemp.com

°C	0	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
	Thermoelectric Voltage in mV										
0	0.000	0.050	0.101	0.151	0.202	0.253	0.303	0.354	0.405	0.456	0.507
10	0.507	0.558	0.609	0.660	0.711	0.762	0.814	0.865	0.916	0.968	1.019
20	1.019	1.071	1.122	1.174	1.226	1.277	1.329	1.381	1.433	1.485	1.537
30	1.537	1.589	1.641	1.693	1.745	1.797	1.849	1.902	1.954	2.006	2.059
40	2.059	2.111	2.164	2.216	2.269	2.322	2.374	2.427	2.480	2.532	2.585
50	2.585	2.638	2.691	2.744	2.797	2.850	2.903	2.956	3.009	3.062	3.116
60	3.116	3.169	3.222	3.275	3.329	3.382	3.436	3.489	3.543	3.596	3.650
70	3.650	3.703	3.757	3.810	3.864	3.918	3.971	4.025	4.079	4.133	4.187
80	4.187	4.240	4.294	4.348	4.402	4.456	4.510	4.564	4.618	4.672	4.726
90	4.726	4.781	4.835	4.889	4.943	4.997	5.052	5.106	5.160	5.215	5.269