UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BCE 2293
COURSE	: INSTRUMENTATION
SEMESTER/SESSION	: 1-2022/2023
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 7 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Define what the purpose of instrumentation system and give ONE (1) example of instrumentation system. (3 marks)

b) Explain the element of instrumentation system below.

i. Sensor/Transducer (2 marks)
ii. Signal Processor (2 marks)
iii. Data Presentation (2 marks)

c) Transducer is a converter of one type of energy into another. Transducer may be used as actuator. Describe the function of an actuator and give an example of application of actuator in our daily life. (3 marks)

d) Smart transmitter is a device that used a microprocessor as an integral unit. Explain the application of smart transmitter in instrumentation systems. (8 marks)

QUESTION 2

a) Sketch the basic thermocouple connection. (2 marks)

b) Describe how the voltage is produced from a thermocouple. (3 marks)

c) Identify the combinations of materials used for the thermocouple type below.

i. Type T (1 mark)
ii. Type E (1 mark)
iii. Type J (1 mark)

d) Referring to the Thermocouple Table in Appendix 1, a type K thermocouple with 0°C reference will monitor an oven temperature at about 215°C. Calculate the voltage produce by the thermocouple.

(5 marks)

e) Referring to the Thermocouple Table in Appendix 1, a type K thermocouple with the 21°C reference measures 4.286 mV. Calculate the junction temperature. (7 marks)

QUESTION 3

a) A signal is a function representing a physical quantity or variable that contains the information about the behavior or nature of the phenomenon. Sketch the behavior of Continuous-time Signals and Discrete-time Signals. (6 marks)

b) Describe the temperature adjustment process based on the block diagram of analog digital conversion (ADC) in Figure 1. (10 marks)

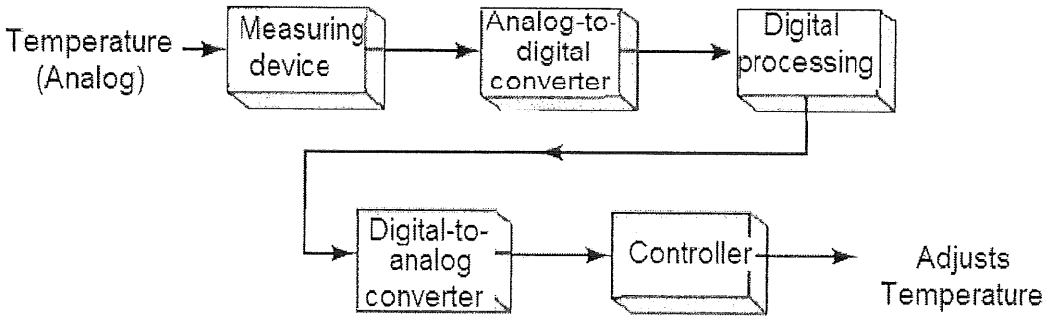

Figure 1

c) A 20 - 100kPa(g) output pneumatic transmitter is used to monitor the water level inside a tank. The calibrated range is 50cm to 250cm of water above the base of the tank. Calculate the output of the transmitter when the water level is at 200cm above the base of the tank. (8 marks)

d) An electronic transmitter with an output of 4-20mA is calibrated for a pressure range of 5-25MPa(g). Calculate the pressure for the signal of 16mA. (8 marks)

e) A system used a Digital to Analog Converter (DAC) circuit to convert the digital output to analog value. If the component value in the circuit are R_2= 75KΩ, R_3=37.5KΩ, R_F=20KΩ, V_{ref}=3V, Calculate the output voltage, Vout for the binary input 0110. (8 marks)

f) An analog-to-digital converter (ADC) is a system that converts an analog signal into a digital signal. Calculate output voltage and current for a binary weighted resistor DAC of 4 bits in Figure 2.

Where:

R = 10 k Ohms, R_f = 5 k Ohms and V_R = 10 Volts.

Applied binary word is 1001. (10 marks)

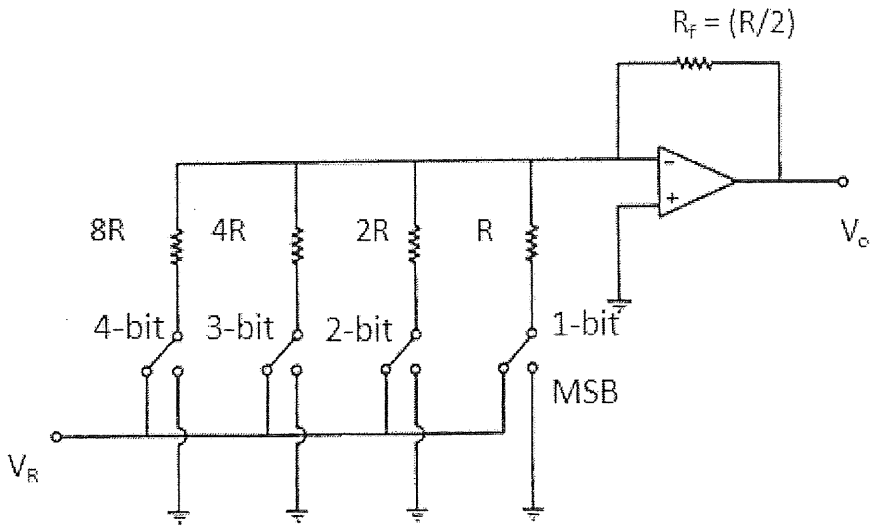

Figure 2

QUESTION 4

a) Describe what is meant by final control element? (2 marks)

b) Valve is a mechanical device specifically designed to direct, start, stop and mix or regulate variable of a process fluid. Describe the function of the categorized valve below:

i. On-Off (2 marks)

ii. Non return Valves (2 marks)

c) Two control valves calibration split range is show in Table 1.

Table 1

Control signal	Valve A	Valve B
4 mA	Fully closed	Fully closed
8 mA	50% open	Fully closed
12 mA	100% open	Fully closed
16 mA	100% open	50% open
20 mA	100% open	100% open

i. Calculate the stem position of each control valve at a signal value of 6.34 mA (2 marks)

ii. Calculate the stem position of each control valve at a signal value of 15.81 mA. (2 marks)

----------**End of question**----------

Appendix 1

INSTRUMENTS

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

K

°C	0	1	2	3	4	5	6	7	8	9	10
	Thermoelectric Voltage in mV										
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.163	1.203
30	1.203	1.244	1.285	1.326	1.366	1.407	1.448	1.489	1.530	1.571	1.612
40	1.612	1.653	1.694	1.735	1.776	1.817	1.858	1.899	1.941	1.982	2.023
50	2.023	2.064	2.105	2.147	2.188	2.230	2.271	2.312	2.354	2.395	2.436
60	2.436	2.478	2.519	2.561	2.602	2.644	2.685	2.727	2.768	2.810	2.851
70	2.851	2.893	2.934	2.976	3.017	3.059	3.100	3.142	3.184	3.225	3.267
80	3.267	3.308	3.350	3.391	3.433	3.474	3.516	3.557	3.599	3.640	3.682
90	3.682	3.723	3.765	3.806	3.848	3.889	3.931	3.972	4.013	4.055	4.096
100	4.096	4.138	4.179	4.220	4.262	4.303	4.344	4.385	4.427	4.468	4.509
110	4.509	4.550	4.591	4.633	4.674	4.715	4.756	4.797	4.838	4.879	4.920
120	4.920	4.961	5.002	5.043	5.084	5.124	5.165	5.206	5.247	5.288	5.328
130	5.328	5.369	5.410	5.450	5.491	5.532	5.572	5.613	5.653	5.694	5.735
140	5.735	5.775	5.815	5.856	5.896	5.937	5.977	6.017	6.058	6.098	6.138
150	6.138	6.179	6.219	6.259	6.299	6.339	6.380	6.420	6.460	6.500	6.540
160	6.540	6.580	6.620	6.660	6.701	6.741	6.781	6.821	6.861	6.901	6.941
170	6.941	6.981	7.021	7.060	7.100	7.140	7.180	7.220	7.260	7.300	7.340
180	7.340	7.380	7.420	7.460	7.500	7.540	7.579	7.619	7.659	7.699	7.739
190	7.739	7.779	7.819	7.859	7.899	7.939	7.979	8.019	8.059	8.099	8.138
200	8.138	8.178	8.218	8.258	8.298	8.338	8.378	8.418	8.458	8.499	8.539
210	8.539	8.579	8.619	8.659	8.699	8.739	8.779	8.819	8.860	8.900	8.940
220	8.940	8.980	9.020	9.061	9.101	9.141	9.181	9.222	9.262	9.302	9.343
230	9.343	9.383	9.423	9.464	9.504	9.545	9.585	9.626	9.666	9.707	9.747
240	9.747	9.788	9.828	9.869	9.909	9.950	9.991	10.031	10.072	10.113	10.153
250	10.153	10.194	10.235	10.276	10.316	10.357	10.398	10.439	10.480	10.520	10.561
260	10.561	10.602	10.643	10.684	10.725	10.766	10.807	10.848	10.889	10.930	10.971
270	10.971	11.012	11.053	11.094	11.135	11.176	11.217	11.259	11.300	11.341	11.382
280	11.382	11.423	11.465	11.506	11.547	11.588	11.630	11.671	11.712	11.753	11.795
290	11.795	11.836	11.877	11.919	11.960	12.001	12.043	12.084	12.126	12.167	12.209
300	12.209	12.250	12.291	12.333	12.374	12.416	12.457	12.499	12.540	12.582	12.624
310	12.624	12.665	12.707	12.748	12.790	12.831	12.873	12.915	12.956	12.998	13.040
320	13.040	13.081	13.123	13.165	13.206	13.248	13.290	13.331	13.373	13.415	13.457
330	13.457	13.498	13.540	13.582	13.624	13.665	13.707	13.749	13.791	13.833	13.874
340	13.874	13.916	13.958	14.000	14.042	14.084	14.126	14.167	14.209	14.251	14.293
350	14.293	14.335	14.377	14.419	14.461	14.503	14.545	14.587	14.629	14.671	14.713
360	14.713	14.755	14.797	14.839	14.881	14.923	14.965	15.007	15.049	15.091	15.133
370	15.133	15.175	15.217	15.259	15.301	15.343	15.385	15.427	15.469	15.511	15.554
380	15.554	15.596	15.638	15.680	15.722	15.764	15.806	15.849	15.891	15.933	15.975
390	15.975	16.017	16.059	16.102	16.144	16.186	16.228	16.270	16.313	16.355	16.397
400	16.397	16.439	16.482	16.524	16.566	16.608	16.651	16.693	16.735	16.778	16.820
410	16.820	16.862	16.904	16.947	16.989	17.031	17.074	17.116	17.158	17.201	17.243
420	17.243	17.285	17.328	17.370	17.413	17.455	17.497	17.540	17.582	17.624	17.667
430	17.667	17.709	17.752	17.794	17.837	17.879	17.921	17.964	18.006	18.049	18.091
440	18.091	18.134	18.176	18.219	18.261	18.303	18.346	18.388	18.431	18.473	18.516
°C	0	1	2	3	4	5	6	7	8	9	10