Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	INTTRUMENTATION AND MEASUREMENT IN OIL AND GAS
COURSE CODE	:	BEJ 44903
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER ALL QUESTIONS 2.THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK** 3.STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Illustrate the block diagram of an instrumentation system.

(4 marks)

(b) A digital thermometer reads from -120 to + 300°C. The accuracy is guaranteed to be plus or minus 2%f.s.d. Analysis of the possible temperature range when it indicates 80°C. The range of the instrument is the same as the f.s.d (Full-Scale Deflection) is 420.

(4 marks)

(c) An 820Ω resistance with an accuracy of ±10% carries a current of 10mA. The current was measured by an analog ammeter on a 25mA range with an accuracy of ±2% of full scale.

(i) Calculate the power dissipated in the resistor

(3 marks)

(ii) Determine the accuracy of the result.

(3 marks)

(d) Weather research has been carried out to measure the fluctuation of temperature of the industrial area near the neighborhood. The readings are recorded for half of the month every day continuously at 7:00am at the same location by the researcher. **Table Q1(d)** shows the recorded data. Determines the mean and the standard deviation of the data.

(6 marks)

Q2 (a) Show how the bubbler system is used to measure the level in an;

(i) Open tank

(3 marks)

(ii) Closed tank

(3 marks)

(b) A wet leg level transmitter (LT) installation is measuring the level of a hot water tank. Discuss what happens to the level and the level indication if the temperature of the tank is increased.

(6 marks)

(c) The level of ethyl alcohol is to be measured from 0m to 4m using a Concentric Cylindrical Capacitor as shown in **Figure Q2(c)**. The specification of the system is described as follows:

Dielectric Constant : ethyl alcohol, K= 26 and for air, K=1
Cylinder separation : d= 0.3cm
Plate area : A= 2πRL
The permittivity of free space: ε_o =3.141

Where;
R= r = 5.5cm (average radius)
L= 4m (distance along the cylinder axis)

Predict the range of capacity variation as the alcohol level varies from 0m-4m.
(8 marks)

Q3 (a) Water is pumped through a 1.5-inch diameter pipe with a flow velocity of 2.5ft/s.

(i) Formulate the volume flow rate (ft^3/min)
(4 marks)

(ii) Evaluate the weight flow rate (lb/min) if the weight is 62.4lb/ft^3.
(5 marks)

(b) Define types of errors in flow measurement?
(5 marks)

(c) Flow is to be controlled from 20 to 150gal/min. The flow is measured using an orifice plate system such as that shown in **Figure Q3(c)**. The orifice plate with K=119.5(gal/min)/$psi^{1/2}$. A bellows measures the pressure with an LVDT so that the output is 1.8V/psi. Solve the range of voltages that result from the given flow range.
(6 marks)

Q4 (a) RTDs are used to measure the temperature of the reactor outlet feeders. Thermocouples are used to measure temperatures on the turbine. Explain the reasons for the selection of these devices for their respective applications.
(6 marks)

(b) Referring to the circuit shown in **Figure Q4(b)**, the connecting wires are made of Nickel.

(i) Estimate the resistance in each of the nickel wires, R wire if the temperature of the circuit rises from 20°C to 40°C. Given the temperature coefficient of nickel, Note: αnikel-20 is 0.005866/°C.
(2 marks)

(ii) Predict the temperature when the total resistance of the nickel wires has the value of 25Ω.
(2 marks)

(c) Based on **Figure Q4(c)** if the RTD sensor measurement is 57°C answer the following.

(i) Calculate the output current from the RTD sensor if the output range is 4 – 20mA
(3 marks)

(ii) Evaluate the output voltage from the temperature controller if the output range is 0 – 10VDC.
(2 marks)

(iii) Propose a type of sensor if the process temperature is increased to 1000°C.
(1 marks)

(d) Estimate an aluminum rod of 10m in length at 20°C expand when the temperature is changed from 0 to 100°C?
Note: The Thermal Expansion Coefficient is **25 x10^{-6} /°C**
(4 marks)

Q5 (a) A pressure difference of 1.1psi occurs across a constriction in a 5 cm diameter pipe. The constriction constant is 0.009m^3/s per kPa.

(i) Calculate the flow rate in m^3/s
(4 marks)

(ii) Evaluate the flow velocity in m/s.
(3 marks)

(b) A tank holds water with a depth of 7.0ft. Estimate the pressure at the tank bottom in psi and Pa (density =10^3Kg/m^3).
(6 marks)

(c) A SS pressure sensor that outputs 25mV/kPa for a pressure variation of 0.0 to 25kPa will be used to measure the level of a liquid with a density of.

(i) Predict voltage output will be expected for level variations from 0 to 2.0m?
(5 marks)

(ii) Evaluate the sensitivity for level measurement expressed in mV/cm?
(2 marks)

-END OF QUESTIONS –

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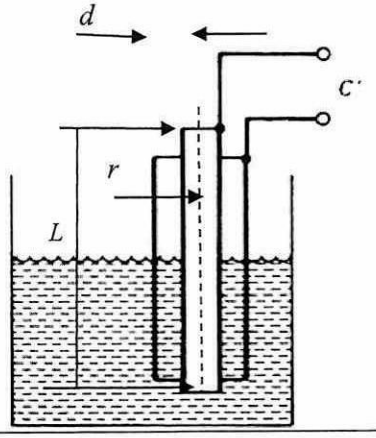
Table Q1 (d)

Day	Temperature ^{0}C
1	32.1
2	29.8
3	30.2
4	31.1
5	32.0
6	29.7
7	30.1
8	34.3
9	31.2
10	31.7
11	30.2
12	29.9
13	29.5
14	30.1
15	29.8



Level Measurement by a Concentric Cylindrical Capacitor

Figure Q2(c)

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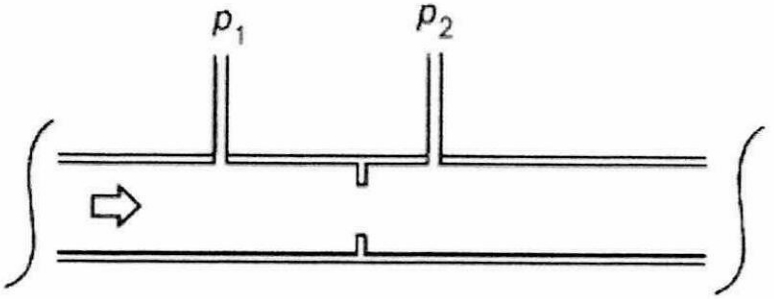

Figure Q3(c)

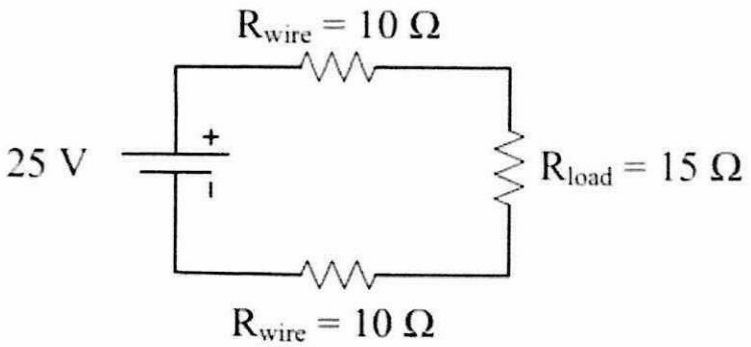

Figure Q4(b)

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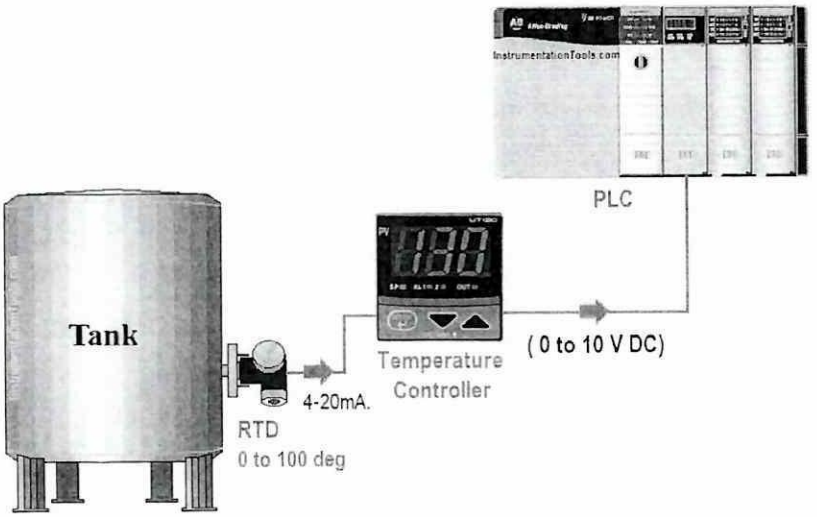

Figure Q4(c)