Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	INSTRUMENTATION AND MEASUREMENT OIL AND GAS
COURSE CODE	:	BEJ44903
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ 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) Show the elements in designing an instrumentation system with a supportive associate block diagram?

(4 marks)

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

(6 marks)

Table Q1(b)

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

(c) A voltmeter having a sensitivity of 1 kΩ/V is connected across an unknown resistance in series with a milliammeter reading of 30 V on a 150 V scale. When the milliammeter reads 600 mA, calculate:

(i) Apparent resistance of the unknown resistance

(2 marks)

(ii) Actual resistance of the unknown resistance

(2 marks)

(iii) Error due to the loading effect of the voltmeter

(2 marks)

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

(i) Calculate the power dissipated in the resistor.

(2 marks)

(ii) Calculate the accuracy of the result.

(2 marks)

Q2 (a) The level of a liquid inside a tank can be determined from the pressure reading if the weight density (specific gravity) of the liquid is constant. Given the parameter of the liquid in the tank **Figure Q2(a)** as shown below.

Density of Water (ρ): 1000 kg/m³
Acceleration due to gravity (g): 9.81 m/s²
Pressure at the bottom of the tank (P): 250 kPa
Atmospheric Pressure (Patm): 101.3 kPa (standard atmospheric pressure at sea level)

(i) Calculate the absolute pressure at the bottom of the tank, accounting for atmospheric pressure.

(3 marks)

(ii) Calculate the level (h) of the water in the tank.

(3 marks)

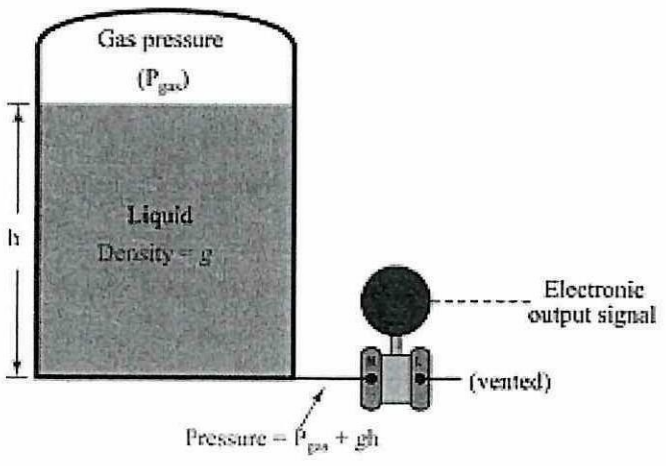


Figure Q2(a)

(b) A coal conveyor system moves at 100 ft/min as shown in **Figure Q2(b)**. A weighing platform is 5.0 ft in length, and a particular weighing shows that 75 lb of coal is on the platform. Analyse the coal delivery in lb/h.

(4 marks)

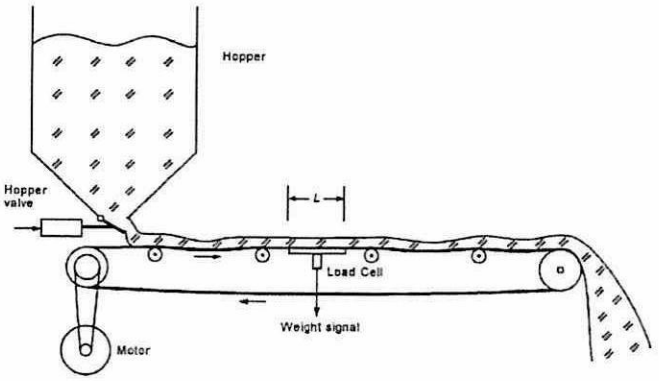
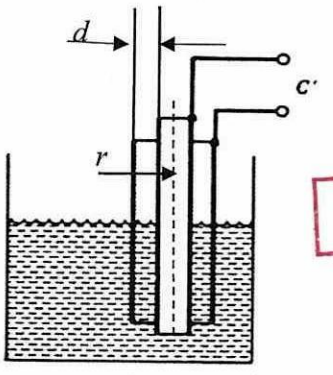


Figure Q2(b)

(c) The level of ethyl alcohol is to be measured from 0m to 5m using a Cylindrical Capacitance system as shown in **Figure Q2(c)**. Estimate the range of capacity variation as the alcohol level varies from 0m-5m. The specification of the system is described as follows:

Dielectric Constant: ethyl alcohol, K= 26 and for air, K=1
Cylinder separation: d= 0.5cm
Plate area:
A= 2πRL
The permittivity of free space: ε_o =3.141
Where,
R= r = 5.75cm (average radius)
L= 5m (distance along the cylinder axis)



Level measurement by a concentric cylindrical capacitor

(10 marks)

Figure Q2(c)

Q3 (a) Referring to the circuit shown in **Figure Q3(a)**, the connecting wires are made of Nickel.

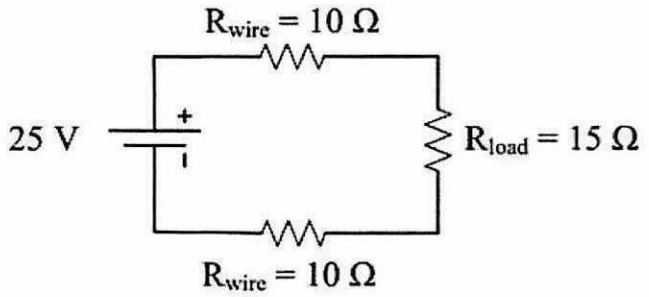


Figure Q3(a) Temperature Circuit

(i) Find 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: $\alpha nikel_{20}$ is 0.005866/°C.

(2 marks)

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

(2 marks)

(b) Estimate the expansion of an Aluminium rod of 10m in length at 20 °C when the temperature is changed from 0 to 100 °C.

Note: The Thermal Expansion Coefficient is **25** x$\mathbf{10^{-6}}$ **/°C**

(6 marks)

(c) Based on **Figure Q3(c)** if the RTD sensor measurement is 57°C.

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

(4 marks)

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

(4 marks)

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

(2 marks)

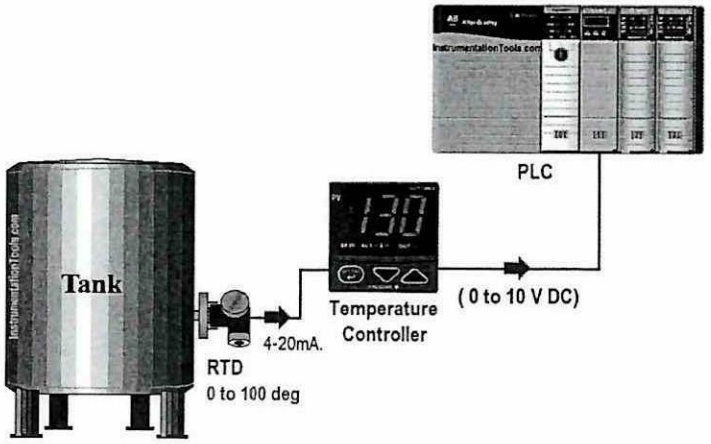


Figure Q3(c)

Q4 (a) A pressure difference of 1.1 psi occurs across a constriction in a 5 cm diameter pipe. The constriction constant is $0.009 m^3/s$ per kPa.

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

(4 marks)

(ii) Calculate the flow velocity in m/s.

(3 marks)

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

(6 marks)

(c) A solid-state pressure sensor that outputs 25 mV/kPa for a pressure variation of 0.0 to 25 kPa will be used to measure the level of a liquid with a density of 1.3 x $10^3 Kg/m^3$.

(i) Find the voltage output that will be expected for level variations from 0.0 to 2.0 m?

(5 marks)

(ii) Solve the sensitivity for level measurement expressed in mV/cm?

(2 marks)

Q5 (a) A magnetic amplifier requires a 5 to 10 V input signal from a 4 to 20 mA control signal using a resistor in the current line, 100 Ω as shown in **Figure Q5(a)**. Show a signal-conversion system to provide this relationship.

(10 marks)

(b) An equal percentage valve has a maximum flow of 50 cm^3/s and a minimum of 2 cm^3/s. If the full travel is 3 cm, determine the flow at a 1 cm opening valve.

(5 marks)

(c) Determine the proper valve flow coefficient, (Cv) for a valve that must allow 150 gals of liquid per minute with a specific gravity of a 0.8 maximum pressure of 50 psi.

(5 marks)

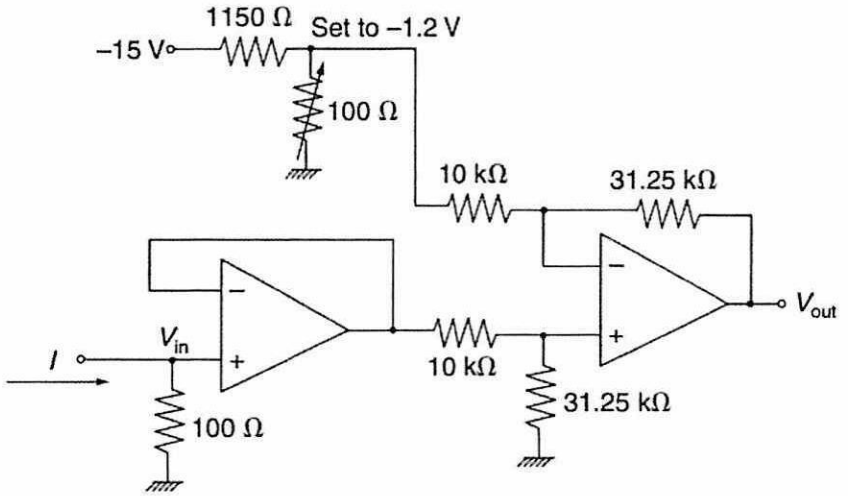


Figure Q5(a)

- END OF QUESTIONS -