



UNIVERSITI KUALA LUMPUR
KAMPUS CAWANGAN MALAYSIAN SPANISH INSTITUTE

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE	: SAB 24102
COURSE NAME	: SENSOR TECHNOLOGY
PROGRAMME LEVEL	: BACHELOR OF ENGINEERING TECHNOLOGY
DATE	: 3 FEBRUARY 2026
TIME	: 09.00 AM – 11.30 AM
DURATION	: 2 HOURS 30 MINUTES

INSTRUCTIONS TO CANDIDATES

1. Please **CAREFULLY** read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of **FIVE (5) QUESTIONS**
4. Answer **FOUR (4)** questions only.
5. Please write your answers on the answer booklet provided.
6. Answer all questions in English language **ONLY**.

THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: Answer FOUR questions ONLY.

Please use the answer booklet provided.

Question 1

A pressure transducer is designed to measure pressures in the range of 0 - 10 bar. It has a diaphragm with a strain gauge cemented to it to detect diaphragm deflections. The strain gauge has nominal resistance of $160\ \Omega$ and forms one arm of a Wheatstone bridge circuit as shown in Figure 1. Given the value of resistors R_1 , R_2 , R_3 are $80\ \Omega$, $120\ \Omega$, $480\ \Omega$ respectively and assuming the lead wire, R_{wire1} and R_{wire2} , are negligible.

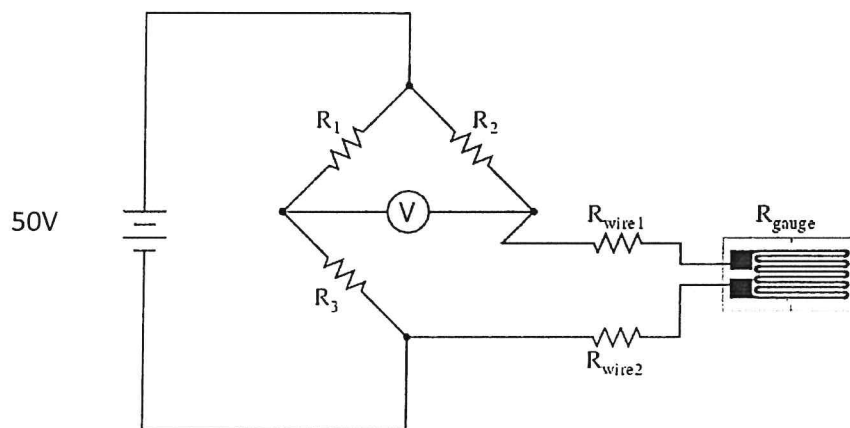


Figure 1: Wheatstone bridge of a pressure transducer.

- (a) Calculate the output voltage, V , of the strain gauge. (10 marks)
- (b) Determine the appropriate resistance value of the strain gauge, R_{gauge} , required to achieve a balanced bridge condition. (8 marks)
- (c) If the sensitivity of the strain gauge is $338\ \text{m}\Omega/\text{bar}$, calculate the bridge output voltage, V , when measuring a pressure of 10 bar. (7 marks)

Question 2

A non-inverting amplifier of a signal conditioning circuit as shown in Figure 2 is designed using the μ A741 op-amp to achieve a closed-loop voltage gain of 10. The op-amp is designed to ensure an optimal performance within the operational bandwidth.

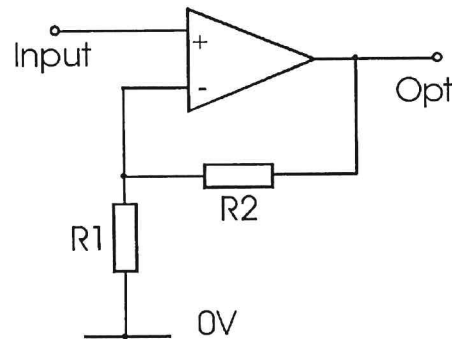


Figure 2: A non-inverting amplifier of signal conditioning.

- (a) Determine a suitable resistor value of R_2 if R_1 is $1\text{ k}\Omega$ that satisfies the required gain using the appropriate circuit principles. (8 marks)
- (b) Evaluate the bandwidth limitation by estimating the cut-off frequency based on the characteristics of the μ A741 op-amp if the gain-bandwidth product (GBW) of μ A741 is approximately 1 MHz . (7 marks)
- (c) Analyze the resulting phase shift at an input signal frequency of 10 kHz and interpret its significance in signal amplification. (10 marks)

Question 3

(a) You are tasked with selecting a suitable pressure measurement method for different types of industrial applications. Identify the most appropriate type of pressure measurement method for each application (Absolute, Gauge or differential). Justify your choices based on engineering principles and operating conditions. Discuss how incorrect pressure selection may lead to faulty system behaviour in any of the applications below.

- i) Measuring tire pressure in automotive systems
- ii) Measuring pressure drop across a filter in a pneumatic system.

(10 marks)

(b) As part of designing an efficient pressure monitoring system for an industrial pneumatic process, a differential pressure (DP) transmitter is used. The transmitter converts a pressure input range of 0 to 1023 PSI into an output current range of 4 to 20 mA. Determine the corresponding pressure reading when the system outputs 14.7 mA is produced.

(10 marks)

(c) A pressure sensor model E8F2-A01C operates within a rated pressure range of 0 to 100 kPa. During system operation, the sensor activates (ON) at 80 kPa and deactivates (OFF) at 50 kPa. Analyse the sensor's behaviour and determine the percentage hysteresis based on the rated pressure range. Present your solution using appropriate engineering reasoning and justifying the steps involved.

(5 marks)

Question 4

An AD560 integrated circuit (IC) is used in a temperature measurement system, accompanied by a signal conditioning circuit as shown in Figure 3. The sensor produces an output of $2 \mu\text{A}/^\circ\text{K}$ and is connected to a current-to-voltage converter with a sensitivity of $5 \text{ mV}/\mu\text{A}$. The system is required to operate over a temperature range from -15°C to 120°C , corresponding to an output voltage range of 0 V to 10 V .

Analyze the relationship between the temperature input and the voltage output by determining the required values of the offset and gain in the signal conditioning circuit to meet the specified output characteristics. Justify your approach with appropriate calculations.

(25 marks)

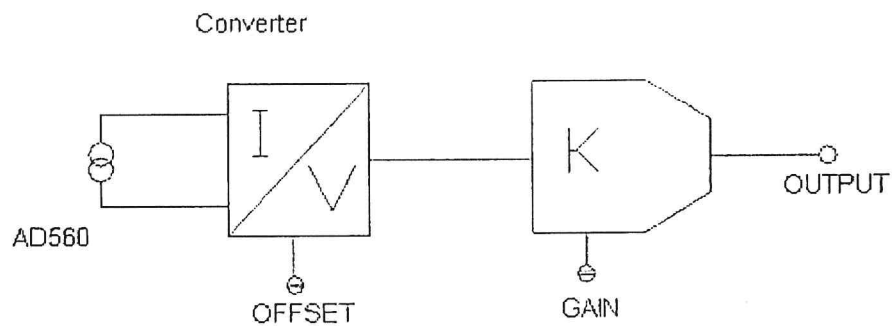


Figure 3: AD560 conditioning circuit temperature sensor

Question 5

A thermocouple is a temperature-measuring device that produces a voltage based on the temperature difference between its hot and cold junctions. Table 1 provides the reference thermoelectric voltage values for a Type J thermocouple at different temperatures.

Table 1: Type J Thermocouple Reference Table

°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
100	5.269	5.323	5.378	5.432	5.487	5.541	5.595	5.650	5.705	5.759	5.814

- (a) Explain the purpose of cold-junction compensation (CJC) in thermocouple measurements. Provide one practical example of the application. (10 marks)
- (b) Using the thermoelectric voltage values from Table 1, determine the corresponding hot-junction temperature when the measured thermocouple voltage is 2.602 mV, assuming the cold-junction temperature is at 0 °C. (5 marks)
- (c) A thermocouple measurement system records a thermocouple emf of 4.000 mV. Using Table 1, determine the actual hot-junction temperature when the cold-junction temperature is 25 °C. (10 marks)

END OF QUESTION

