



UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE : FAD 10102
SUBJECT TITLE : SENSOR TECHNOLOGY
LEVEL : DIPLOMA
TIME/DURATION : 12.30 pm – 2.30 pm
(2 HOURS)
DATE : 14 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper **CAREFULLY**.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of **TWO (2)** sections. Section A and B. Answer all questions in Section A. For Section B, answer two (2) questions only.
6. Answer all questions in English.

THERE ARE 10 PAGES OF QUESTION, EXCLUDING THIS PAGE.

SECTION A (Total: 60 marks)

INSTRUCTION: Answer ALL questions.

Please answers all in answer booklet provided.

Question 1

- (a) State a difference between analog and discrete signal. Draw the output signal waveforms and give **one (1)** example of device that produces these signals. (6 marks)
- (b) Explain the difference between inductive and capacitive proximity sensor and draw their symbol. (Discuss in term of material detection ability) (6 marks)
- (c) State **two (2)** reasons why limit switch is widely used as a position sensor in industrial control devices and consumer electronic products. State **two (2)** advantages of using limit switch. (4 marks)
- (d) Briefly explain the operating principle of Reed Switch in **Figure 1** and draw the symbol (4 marks)

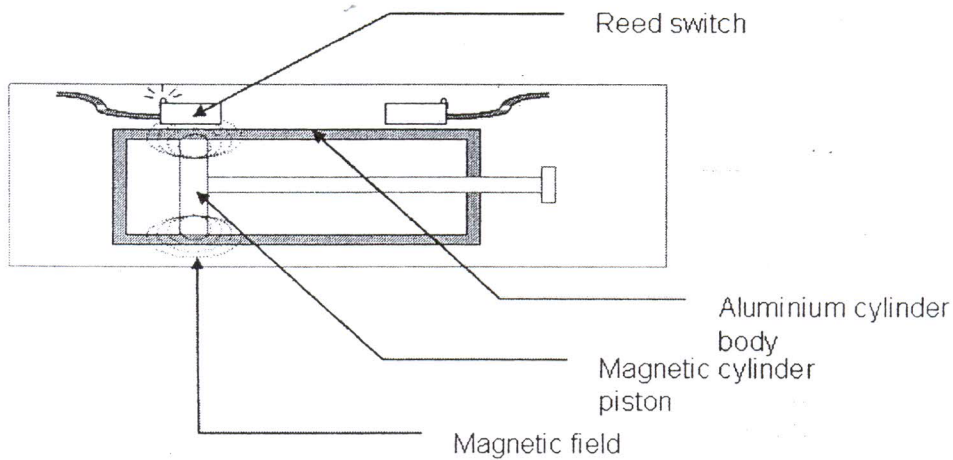


Figure 1: Reed Switch

Question 2

(a) Answer all questions below based on **Figure 2**;

(i). Name the element in block 1, 2, and 3. (3 marks)

(ii). State type of proximity sensor when a sensing element in Block 4 is coil (2 marks)

(iii). Based on your answer in 2(a)ii, draw the oscillator amplitude condition when a target approaches and moves away from the sensor (2 marks)

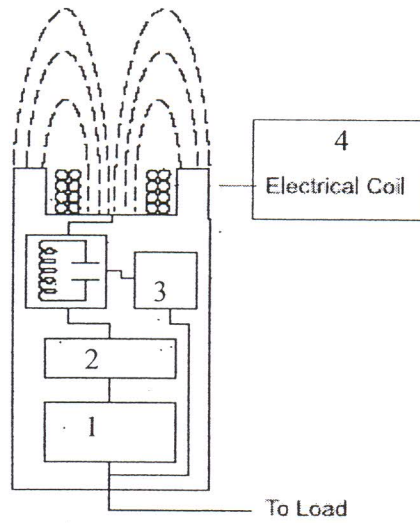


Figure 2: Composition of Proximity Sensor

(b) Calculate the Sensing assurance (Sa) for the three sensors in **Table 1**. (6 marks)

Table 1: Type of Proximity Sensor

No	Sensor Model	Type	Sn	Target Material
i.	XS1-N18PA340	Inductive	5mm	Copper
ii.	XS1-N18PA349	Inductive	10mm	Mild Steel
iii.	XS2-N18PA340	Inductive	8mm	Aluminum Foil

(c) State **two (2)** factors that affects sensing range.

(2 marks)

(d) Find the target size (length x width x thickness) for selected sensor below:

Sensor diameter: **18 mm**

Nominal Sensing Distance, S_n : **5 mm**

(2 marks)

Question 3

(a) There are 6 considerations on choosing an analog sensor. State any **two (2)** considerations and give the explanation for your answer

(4 marks)

(b) Select the most suitable sensor for applications in **Figure 3**.

(4 marks)

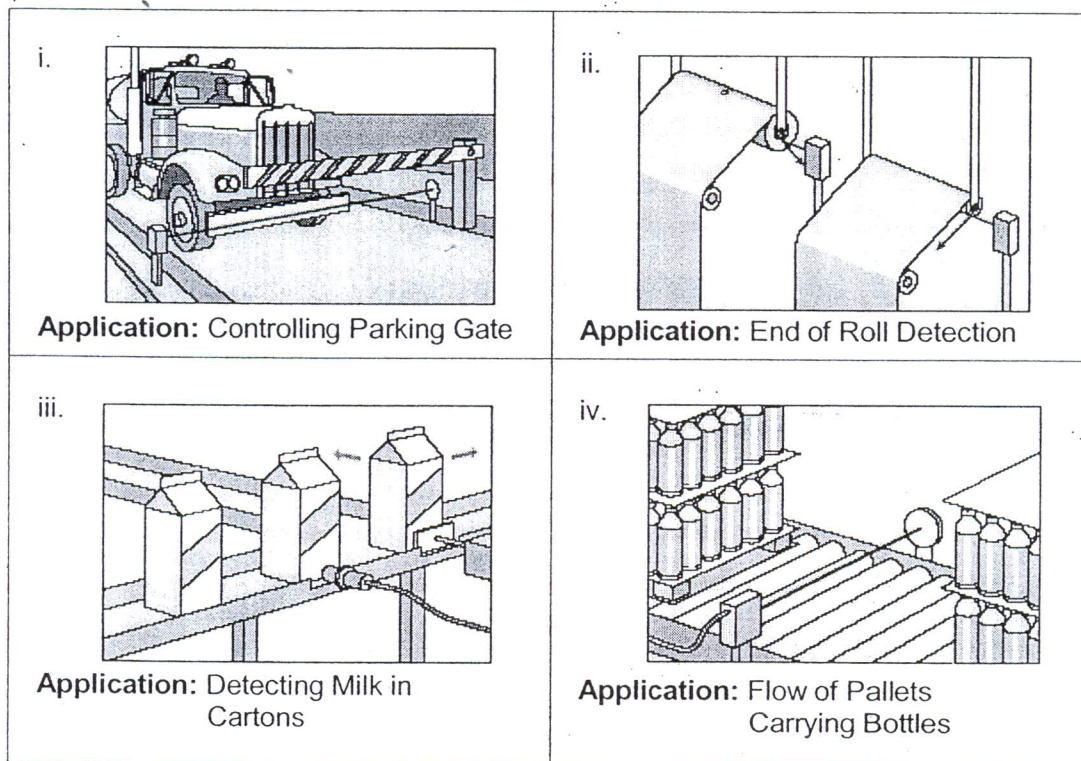


Figure 3: Sensor applications

- (c) Determine the resistance of platinum RTD at 25°C if the resistance at 20°C is 106 Ω and if $\alpha (20^\circ\text{C}) = 0.00392$ (2 marks)

- (d) **Figure 4** shows a non inverting amplifier. Given input voltage (V_{in}) = 5V and output voltage (V_{out}) = 15V. Calculate the resistance value of **R1** if $R_2 = 375\text{k}\Omega$ (4 marks)

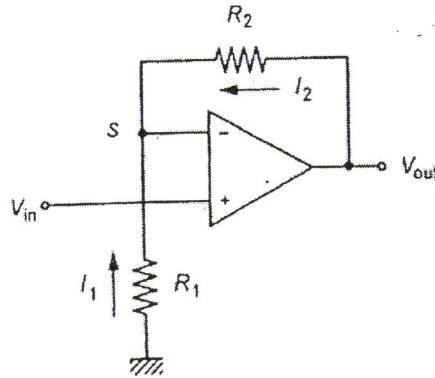


Figure 4: Non Inverting Amplifier

- (e) Complete the sentences below with the appropriate answers
- i. A _____ sensor able to detect washer or screw thread in industrial application
 - ii. A _____ is made of two dissimilar metal wires joined at one end
 - iii. A _____ act like an electrical transducer, converting changes in temperature to voltage signals by the measurement of resistance
 - iv. A _____ is a type of sensor that requires physical contact with the target.
 - v. _____ is the distance or angle traveled in moving the actuator from the free position to the operating position.
 - vi. The _____ and _____ are two types of data code given by the absolute encoder
 - vii. _____ is a nonliquid pressure measurement device
 - viii. Bourdon tube, Diaphragm and _____ are examples of mechanical analogue pressure sensor
- (9 marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer TWO (2) questions only.

Please answers all in answer booklet provided.

Question 4

(a) **Graph 1 and Table 2 are the approximate reduction factor for target material**

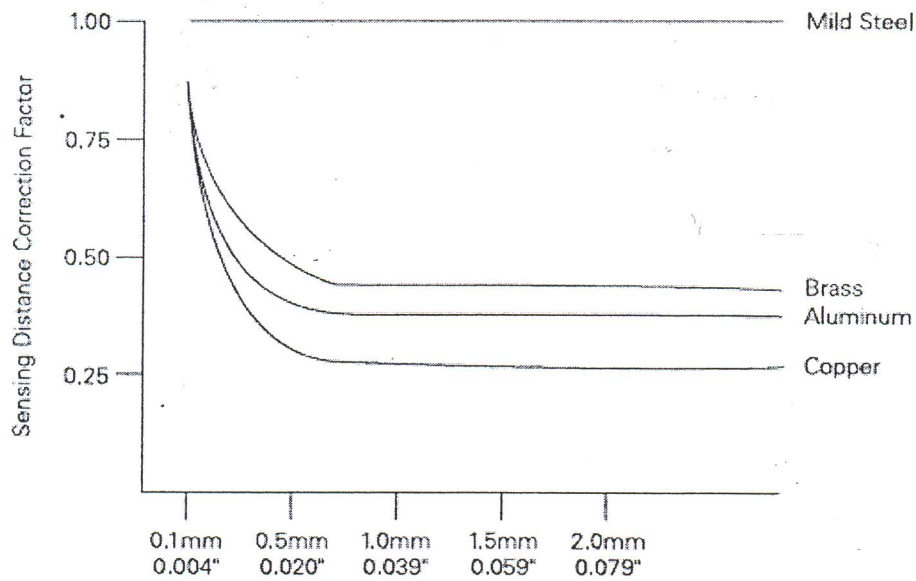
- i. Calculate the actual sensing distance for all the three materials A, B and C in **Table 3** for a proximity sensor with sensing distance, $S_n = 12\text{mm}$ (6 marks)
- ii. Explain why material C has better sensing distance compared to material A and B. State your reason. (2 marks)
- iii. Correction Factor can be applied when the targets are smaller than the standard target size. Find S_a for a shielded type proximity sensor with sensing distance $S_n=12\text{mm}$ if the target size is half the size of sensor diameter. (2 marks)

Table 2: Target Size Correction Factor

Size of Target Compared to Standard Target	Correction Factor	
	Shielded	Unshielded
25%	0.56	0.50
50%	0.83	0.73
75%	0.92	0.90

Table 3: Target Material Data

Material (Brass)	Target Size
A	24mm x 24mm x 0.5mm
B	24mm x 24mm x 1.5mm
C	24mm x 24mm x 0.25mm

Graph 1: Target Thickness Reduction Factor

(b) Draw the control wiring circuit base on the explanation below:

(10 marks)

- When we push a start button (ST1) then release, contactor 1 (KM1) and contactor 2 (KA1) will energized.
- Red lamp (LR) will ON and the conveyer will move the boxes to the right. The conveyer is moved by 3-phase inductance motor (M1)
- When the limit switch (S1) detect object the conveyer will stop and red lamp (LR) will OFF.
- When the object is removed, red lamp (LR) and conveyer (M1) will continue to run
- The operation will stop when we push the stop button (SP1)

Note: Don't forget to insert the self holding circuit/latching using relay (KA1)

Question 5

- (a) U-tube mercury manometer and an orifice plate are applied in measurement of weight of oil flowing through a pipe in an offshore production system as shown in **Figure 5**. The pipe has the internal diameter of 150 mm, and a constant k of 1.25. The difference in the mercury levels in the two legs is 50 mm. The oil density is 850 kg/m^3 , and mercury density is $13.56 \times 10^3 \text{ kg/m}^3$.

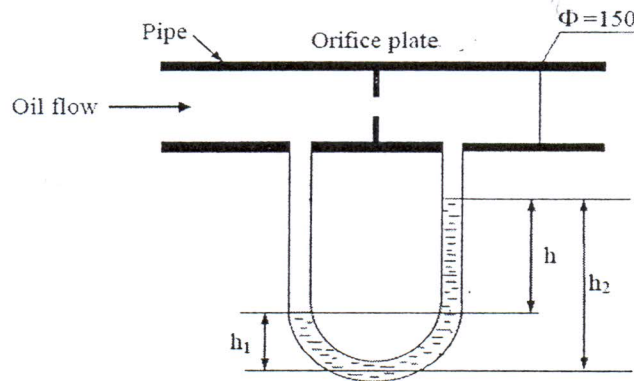


Figure 5: Turbine flow sensor

- i. State at least **two (2)** type of pressure sensors type besides than U-tube
(2 marks)
- ii. Calculate the differential pressure
(4 marks)
- iii. Calculate the volumetric flow of oil in the pipe
(4 marks)

(b) **Figure 6** shows Wheatstone bridge application with tank level transmitter system.

- i. State type of level sensor A used in **Figure 6** (2 marks)
- ii. If the Wheatstone bridge, as shown in **Figure 6**, nulls with $R_1 = 1000 \Omega$, $R_2 = 842 \Omega$ and $R_3 = 500 \Omega$, find the value of R_4 (3marks)
- iii. A tank holds water with a depth of 7.0 ft. What is the pressure at the tank bottom in psi (2marks)

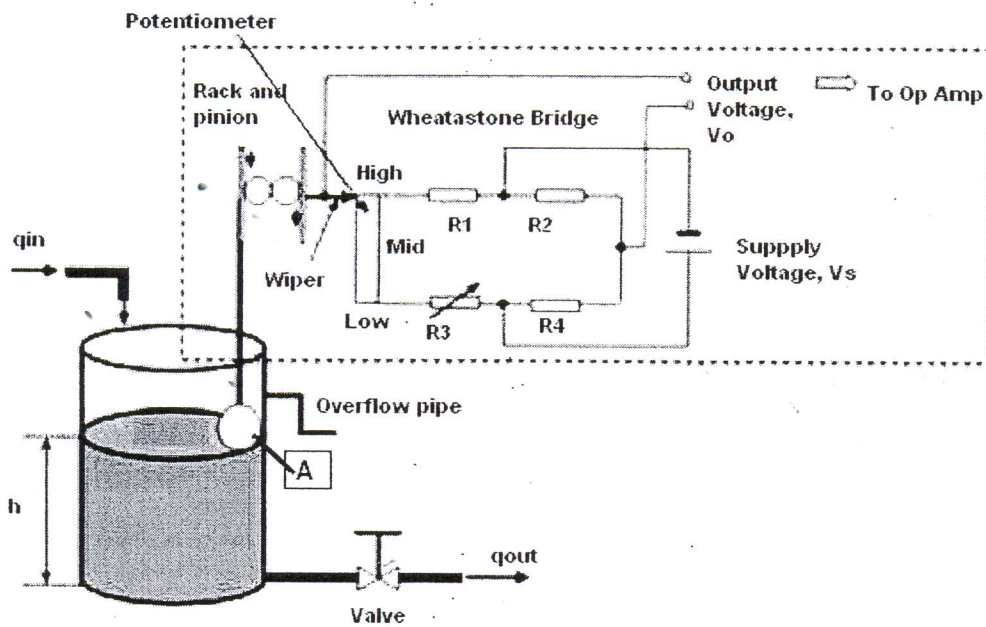


Figure 6: Tank Level System Control

- iv. State **three (3)** functions of Operational Amplifier (Op-Amp) in signal processing (3 marks)

Question 6

- (a) Complete the diagram in **Figure 7** (in a provided box A) with suitable symbol of a photoelectric sensor

(2 marks)

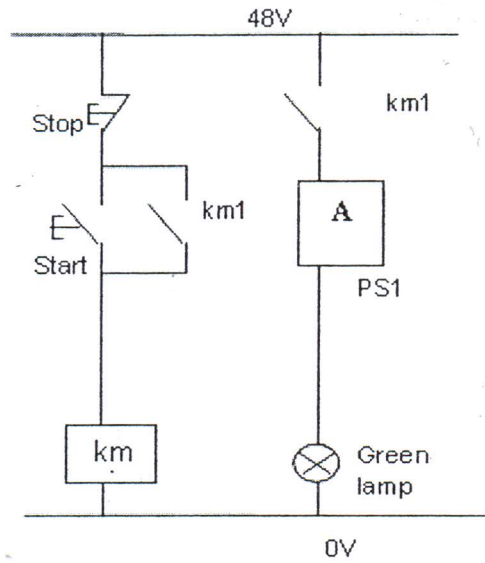


Figure 7: Circuit diagram

- (b) Green lamp will on whenever PS1 detect a presence of a carton box.

- i. Name the most suitable photoelectric sensor for the above application.

(2 marks)

- ii. State **two (2)** advantages of photoelectric sensor compared to proximity sensor

(2 marks)

- (c) **Figure 8** shows an inverting amplifier circuit.

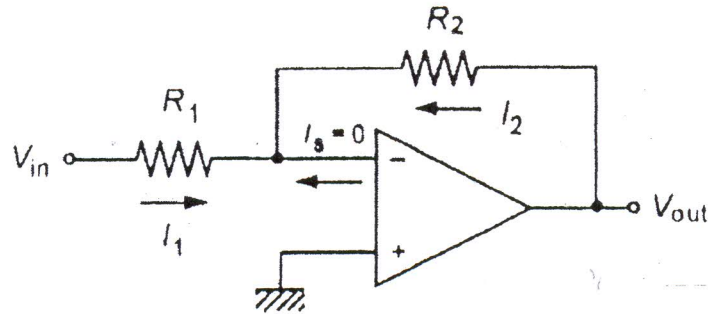


Figure 8: Inverting Amplifier Circuit

- i. Calculate the output voltage for an input voltage of 2.5mV. Given $R_1 = 2k\Omega$ and $R_2 = 200k\Omega$ (4 marks)
 - ii. State the function of resistor R_1 in **Figure 8** (2 marks)
 - iii. State **two (2)** types of Op-Amp other than non-inverting amplifier and inverting amplifier (2 marks)
- (d) Explain the principle of operation of the platinum resistance thermometer (RTD-100). What are its advantage and disadvantage over the thermocouple temperature sensor (6 marks)

END OF QUESTION