



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
(TAKE HOME)  
SEMESTER II  
SESSION 2019/2020**

**COURSE** : INSTRUMENTATION FOR  
PROCESS CONTROL

**COURSE CODE** : BEF 45902

**PROGRAMME CODE** : BEV

**EXAMINATION DATE** : JUNE 2020

**EXAM CONCEPT** : BRING HOME (OPEN BOOK)

**DURATION** : 2 HOURS 30 MINUTES

**INSTRUCTION** : ANSWER **ALL** QUESTIONS  
**OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

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- Q1** (a) Process control can be defined as the act of controlling a final control element to change the manipulated variable.
- i. List **FOUR (4)** variable that commonly used in oil and gas industries. (4 marks)
  - ii. Discuss the advantages and disadvantages of the control systems illustrated in **Figure Q1(a)** (4 marks)
- (b) Consider the feedback control strategy shown in **Figure Q1(b)**;
- i. Explain process control and objective based on one appropriate case study found in practice. Draw the respective schematic block diagram complete with labels. (6 marks)
  - ii. Propose a feedback-forward control strategy to achieve the same control objective in **Q(b)(i)**. Include appropriate labels and arrows. (5 marks)
- (c) Crude oil flow in a pipeline, is to be maintained for a certain flow range. The pressure gauge with an LVDT is calibrated so that the output is 2.0 V/psi.
- i. Determine the orifice plate constant,  $K$  if the LVDT indicate voltage of 0.05V for oil flow at 20 gal/min. (3 marks)
  - ii. Determine the range of oil flow (gal/min) in the pipeline if the LVDT giving voltage range between 0.05V and 2.5V. (3 marks)
- Q2** (a) Differentiate linear sliding valve as compare to the rotary valve. Give **TWO (2)** examples of common control valve used in practice for each category. (4 marks)
- (b) A crude oil is pumped through a 0.5 m diameter pipeline at 35 m/s flow velocity.
- i. Predict the volume flow rate in the pipeline. (4 marks)

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- ii. Suggest the required flow velocity if the volume flow rate in Q2(a)(i) is reduced by 20% (3 marks)
- (c) Spring and diaphragm is one of common actuator type used in practice to control valve body.
- i. With the help of simple illustration complete with labels, explain the basic operation of spring and diaphragm actuator. (6 marks)
- ii. Suppose a force of 500 N is required to fully open a diaphragm having circumference of 30 cm. Determine the required gauge pressure setting for this condition. (4 marks)
- (d) An equal percentage valve has flow rate characteristic between 5 cm<sup>3</sup>/s to 40 cm<sup>3</sup>/s. If the full travel is 5 cm, estimate the flow at a 1.5 cm opening. (4 marks)
- Q3** (a) Describe **THREE (3)** signal transmission challenges in engineering practice. (6 marks)
- (b) A temperature is to be measured in the range of 0 °C to 180 °C. The sensor is a resistance that varies linearly from 60 Ω to 350 Ω for this temperature range. The power dissipated in the sensor must be kept below 5 mW.
- i. Determine the transfer function equation of the signal conditioning that provides a voltage varying linearly from 1 to 12 V for this temperature range. (7 marks)
- ii. Determine the current flow in the sensor at 90° so that the maximum power dissipated in the sensor is 4 mW. (4 marks)
- (c) A measurement of underground water level using an ultrasonic circuit has output of 6.5 mV/cm. The circuit to measure up to 95 cm with a 6-bit ADC and a 12 V reference is applied. Design a circuit to interface the sensor and the ADC. (8 marks)
- Q4** (a) Draw logic programming symbol for AND, OR, NAND and NOR that are used in ladder diagram. (4 marks)

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- (b) Propose a basic structure of the programmable logic controller (PLC) (4 marks)
- (c) A liquid level control of a process system is shown in **Figure Q4(c)**. Pump will run when the liquid is below the low level and pump will stop when the liquid is above the high level. Initially the tank is empty. The control system is added with the start push-button, the stop push-button and the pump motor starter.
- i. Design a programmed the ladder diagram of the liquid level control process of this system (6 marks)
  - ii. Briefly, explain the proposed diagram in Q(c)(i) (5 marks)
- (d) List and illustrate **THREE (3)** types of internet protocol in the instrumentation network design. (6 marks)

- END OF QUESTIONS -

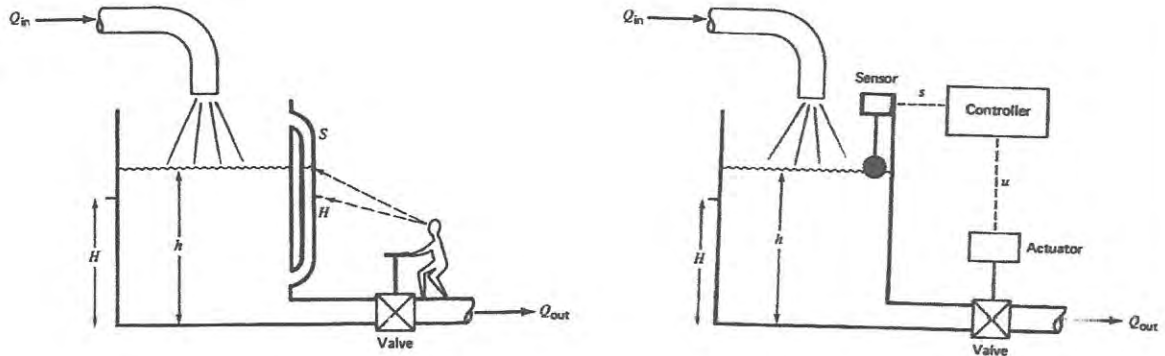
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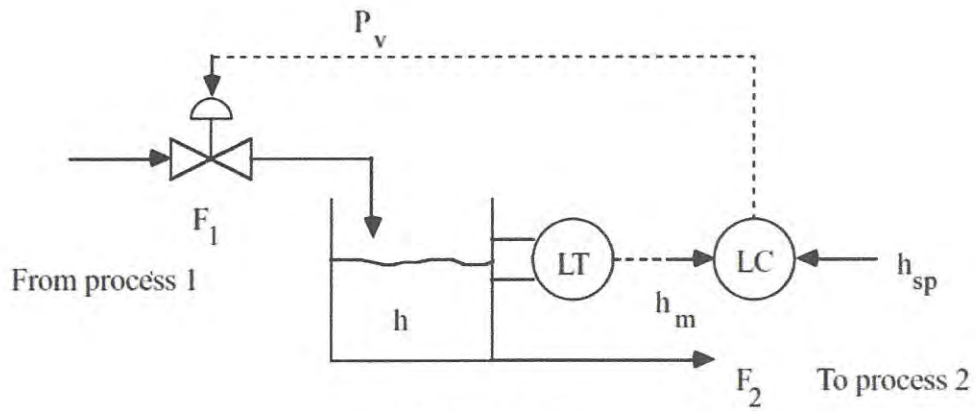
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**Figure Q1(a)**



**Figure Q1(b)**

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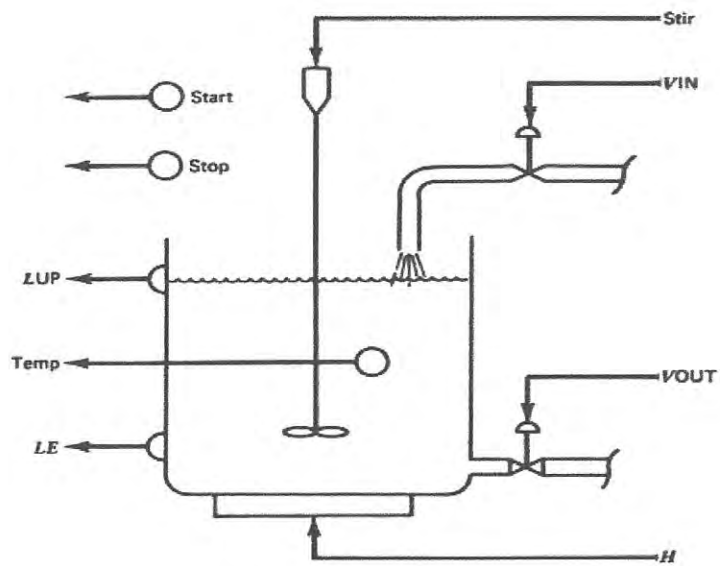


Figure Q4(c)