Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE	:	INSTRUMENTATION FOR PROCESS CONTROL
COURSE CODE	:	BEF 45902
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	DECEMBER 2018/JANUARY 2019
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1 (a) Sketch block diagram of a closed loop process control system.

(5 marks)

(b) In order to maintain the output flow rate from an oil storage tank, a flow rate control system is added in the output pipe of the tank. Design a piping and instrumentation diagram (P&ID) for the flow rate control system that consists of an orifice plate, a control valve, a flow element, a flow transmitter, a flow indicating controller and a flow valve.

(6 marks)

(c) The flow of a water drinking process is to be controlled from 0.8 to 6 gallon per second. A bellows measures the pressure using an orifice plate with a constant for the pipe and liquid type of K=119.5 gal/min/psi$^{1/2}$ and a linear variable differential transformer (LVDT) with an output sensitivity of 1.8 V/psi. Determine the range of output voltage of the LVDT.

(7 marks)

(d) List **THREE (3)** types of the level measurement sensors.

(3 marks)

(e) The terminal voltage of A thermocouple is 3.2 mV. if the thermocouple has a seebeck coefficient of 30 μV/°C and the reference temperature is 20 °C , determine the measured temperature in degree Celsius.

(4 marks)

Q2 (a) State **TWO (2)** types of the control valve characteristics.

(2 marks)

(b) A control valve is operated under the following condition:

- vapor pressure of the flowing liquid is 0.7 psi,
- vane contraction pressure at choke flow is 0.665 psi,
- inlet valve pressure is 40 psi,
- outlet valve pressure is 15 psi and
- valve recovery coefficient is 0.5.

(i) Analyse whether the valve will cavitate under these service condition.

(5 marks)

(ii) If the actual ΔP maintain at 25psi, determine the inlet valve pressure so that the valve will not cavitate.

(4 marks)

(c) An equal percentage control valve has maximum flow rate of 100 m^3/hr and rangeability of 32. Determine the flow at 2/3 and 4/5 open setting.

(7 marks)

(d) A force of 400 N is required to fully open a control valve that is equipped with a pneumatic diaphragm valve actuator. The valve input control signal for the actuator has a range 20 to 100 kPa. Calculate the diaphragm area that is required to fully open the control valve.

(3 marks)

(e) Select the required valve size from the valve sizing coefficient table in **Table Q(2)(e)** for a valve that must regulate 6.5 gal per second of ethanol with specific gravity of 0.8 at a pressure drop of 80 psi.

(4 marks)

Q3 (a) A temperature is to be measured in the range of 0 °C to 250 °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 6 mW.

(i) Determine the transfer function equation of the signal conditioning that provides a voltage varying linearly from 1 to 5 V for this temperature range.

(7 marks)

(ii) Determine the maximum current flow in the sensor so that the maximum power dissipated in the sensor is 6 mW.

(4 marks)

(b) A measurement of a liquid level using an ultrasonic circuit has output of 6.5 mV/cm. The circuit to measure up to 100 cm with a 6-bit ADC and a 10 V reference is applied. Develop a circuit to interface the sensor and the ADC.

(10 marks)

(c) State **FOUR (4)** types of communication protocols used in distributed control system.

(4 marks)

Q4 **Figure Q4** shows a liquid process control. The event sequence is to fill the tank until the up-limit (LUP), then to heat and stir the liquid for 30 minutes, then to empty the tank until the empty-limit (LE), and then repeat the process.

(a) Determine the input elements of the liquid process.

(5 marks)

(b) Determine the output elements of the liquid process.

(4 marks)

(c) Determine the physical ladder diagram of the liquid process.

(8 marks)

(d) Design the programmed ladder diagram of the liquid process.

(8 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER/SESSION : SEMESTER I/ SESSION 2018/2019 PROGRAMME CODE : BEV

COURSE NAME : INSTRUMENTATION FOR PROCESS CONTROL COURSE CODE : BEF 45902

Table Q(2)(e)

Control-valve flow coefficients

Valve Size (inches)	C_v
$\frac{1}{4}$	0.3
$\frac{1}{2}$	3
1	14
$1\frac{1}{2}$	35
2	55
3	108
4	174
6	400
8	725

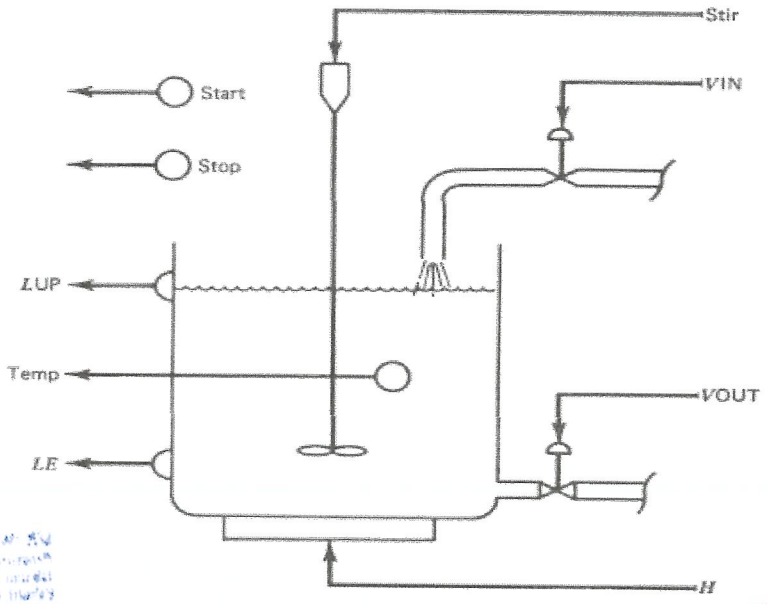

Figure Q4