Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	PROCESS CONTROL SYSTEMS
COURSE CODE	:	BEH42103
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	DECEMBER 2018 /JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF SEVEN (7) PAGES

Q1 (a) List **three (3)** main components in control system.

(3 marks)

(b) Explain the process variable (PV) and set point (SP).

(4 marks)

(c) Investigate what will happen to the process control system when:

i) PV-SP=0

ii)PV-SP≠0

(4 marks)

(d) Mikhail needs to design system for tank water heater system as in **Figure Q1(d)**.The water heater system temperature need to be controlled up to 70 degree celcius.

i) Determine the component listed from A until G from Figure Q1(c).

(3.5 marks)

ii) Establish the operation of tank water heater with help of block diagram of single feedback system.

(9 marks)

iii) Point out the action taken by the controller if PV less than 70 degree celcius.

(1.5 marks)

Q2 (a) List **one (1)** process sensor.

(1 mark)

(b) Calculate the pressure difference between High Pressure(HP) and Low Pressure(LP) port of the Level Temperature(LT) sensor of open tank measurement system as shown in **Figure Q2(b)** where liquid density(ρ) is 997 kg/m³ , gravitational acceleration (g) is 9.81 m/s^2 and height (H) of the tank is 20m.

(4 marks)

(c) Calculate pressure different between HP and LP port of LT sensor for close tank measurement system as in **Figure Q2(c)** in which liquid density(ρ) is 997 kg/m³, gravitational acceleration (g) is 9.81 m/s^2 and height (H) of the tank is 20m. Compare your answer with open tank measurement system.

(4 marks)

(d) Determine **three (3)** advantages and disadvantages using ball valve.

(6 marks)

(e) Point out **three (3)** similarities between diaphragm and pinch valve.

(6 marks)

(f) Different valve can withstand with certain pressure range. Differentiate the valve pressure range between globe, butterfly, ball and diaphragm valve.

(4 marks)

Q3 (a) Sketch block diagram of cascade control.

(5 marks)

(b) Hafiz Holding in a way for developing Proportional Integral Derivative (PID) controller for heat exchanger system. The plot of input and output open loop experimental data for the heat exchanger system is shown in **Figure Q3(b)**. As a engineer at Hafiz Holding and based on **Figure Q3(b)** ;

(i) Estimate the First Order Plus Dead Time (FOPDT) model for the system

(6 marks)

(ii) Calculate the value of Proportional Gain (K_p), Integral Gain (K_i) and Derivative Gain (K_d) for PID controller for the system based on Cohen Coon approach.

(8 marks)

(iii) Establish PID controller block diagram for the system.

(6 marks)

Q4 (a) The Proportional Integral Derivative (PID) controller is used for regulating temperature of palm oil bleaching process and the resulted response of the temperature is shown in **Figure Q4(a)**. As engineer, estimate the percentages overshoot ($\%\mu(s)$) and settling time (T_s) based on 2% band for the response as shown in **Figure Q4(a)**.

(10 marks)

(b) Haziq Sdn. Bhd. has proposed **two (2)** set tuning parameter of Proportional Integral Derivative (PID) controller namely Tune A and Tune B for controlling temperature of continuous Jacket Reactor in oil and gas industries handled by Zaza Holding. Haziq Sdn. Bhd. has attached a steady state data for both of PID tuning (Tune A and Tune B) in controlling temperature of continuous Jacket Reactor and the data are shown in **Table Q4(b)(i)** and **Table Q4(b)(ii)** respectively. Investigate the suitable controller by using Mean Square Error (MSE) analysis towards achieving small steady state error while controlling the temperature of continuous Jacket Reactor.

(11 marks)

(c) Differentiate the function of Supervisory Control and Data Acquisition (SCADA) system and Distributed Control System (DCS).

(4 marks)

- END OF QUESTIONS –

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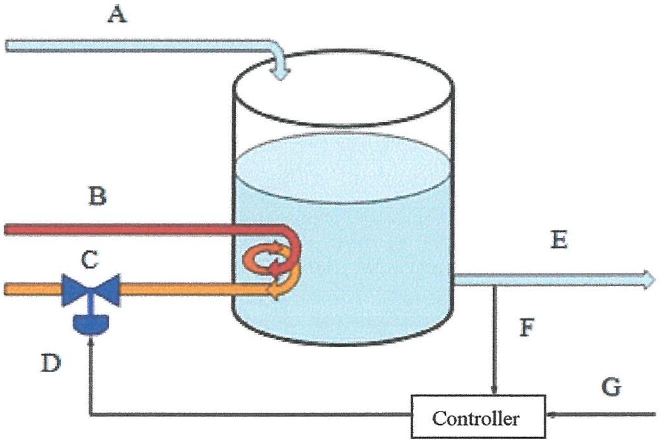

Figure Q1(d)

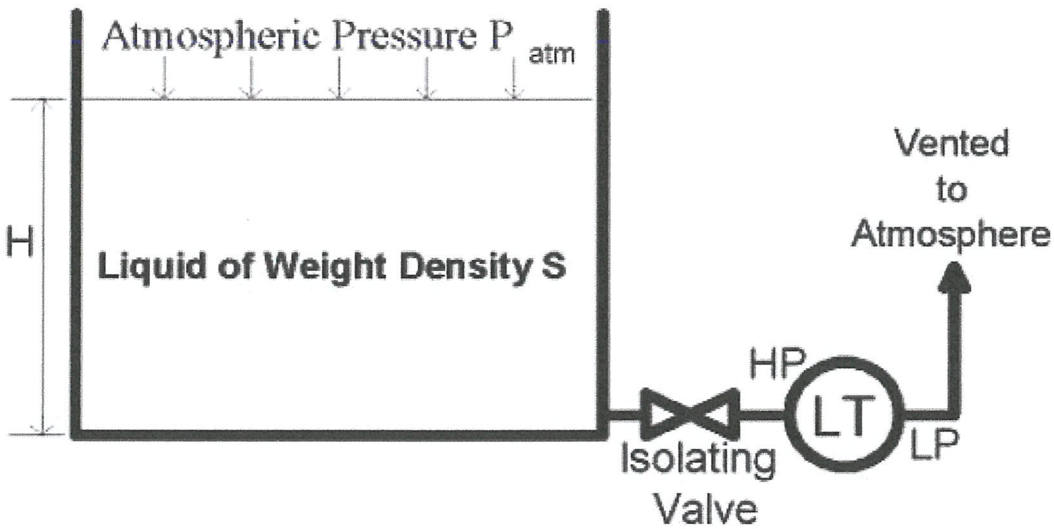

Figure Q2(b)

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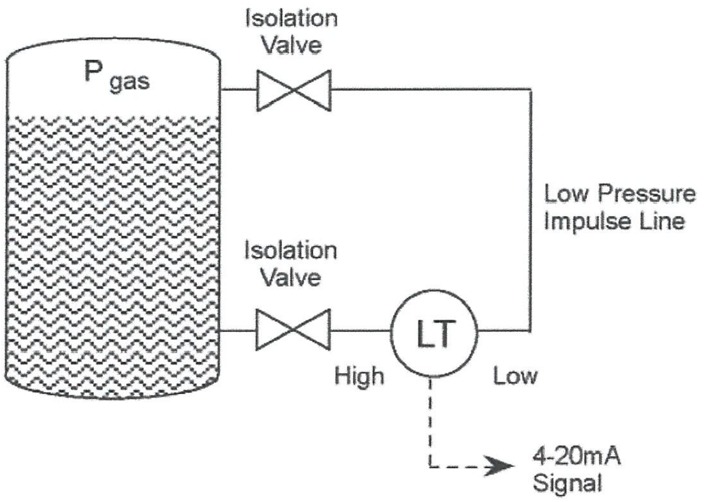

Figure Q2(c)

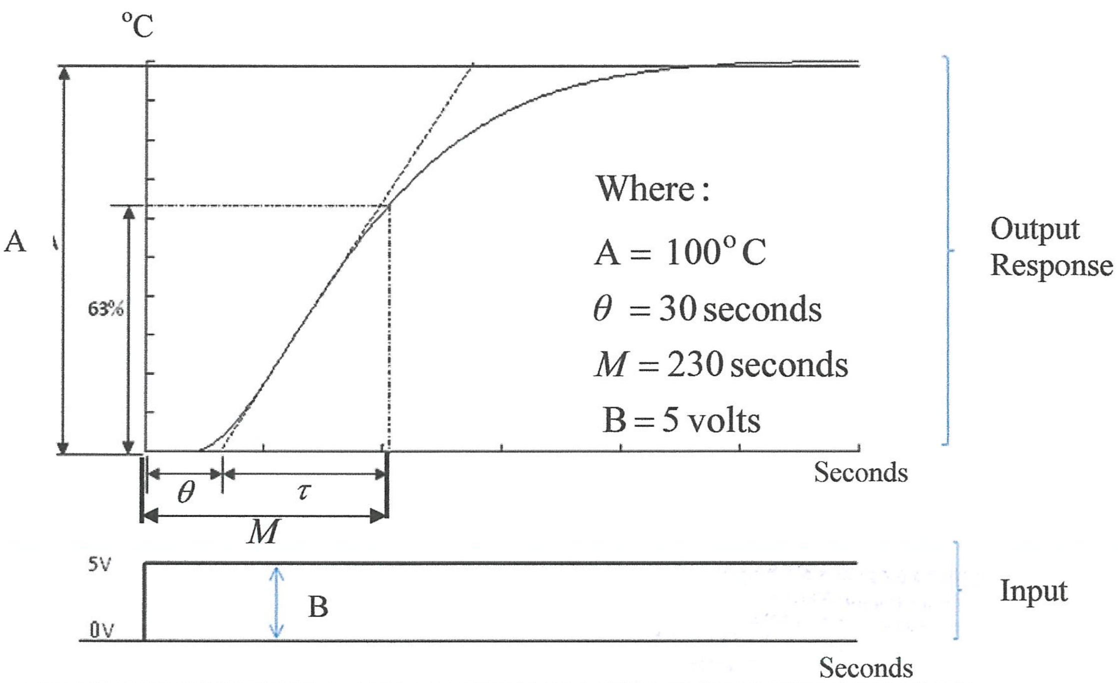

Figure Q3(b)

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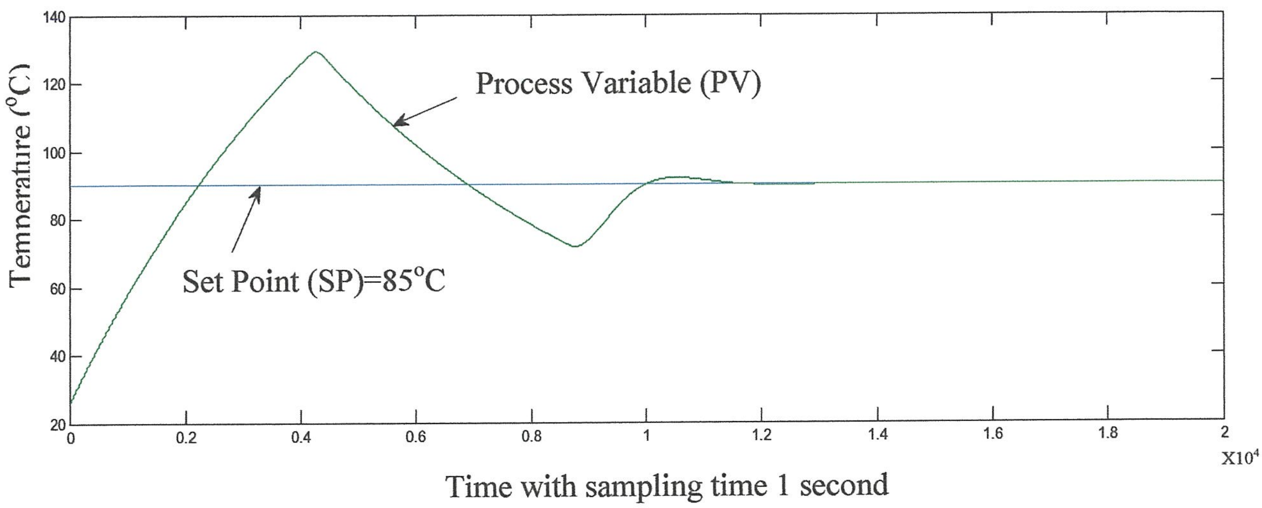

Figure Q4(a)

Table Q4(b)(i)

PID Tune A

No	Set Point (SP) in °C	Process Variable (PV) in °C
1	85	85.201
2	85	85.421
3	85	85.382
4	85	85.098
5	85	84.883

Table Q4(b)(ii)

PID Tune B

No	Set Point (SP) in °C	Process Variable (PV) in °C
1	85	85.301
2	85	85.221
3	85	85.182
4	85	85.298
5	85	84.783

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FORMULAE

Table A
Cohen Coon Tuning Formulae

Controller	K_p	T_i	T_d
P	$\frac{\tau}{K\theta}\left(1+\frac{\theta}{3\tau}\right)$		
PI	$\frac{\tau}{K\theta}\left(0.9+\frac{\theta}{12\tau}\right)$	$\theta\left(\frac{30+3\left(\frac{\theta}{\tau}\right)}{9+20\left(\frac{\theta}{\tau}\right)}\right)$	
PID	$\frac{\tau}{K\theta}\left(\frac{4}{3}+\frac{\theta}{4\tau}\right)$	$\theta\left(\frac{32+6\left(\frac{\theta}{\tau}\right)}{13+8\left(\frac{\theta}{\tau}\right)}\right)$	$\theta\left(\frac{4}{11+2\left(\frac{\theta}{\tau}\right)}\right)$

Table B
Process Model Equations

Model Name	Model Equation
FOPDT	$G(s)=\frac{Ke^{-\theta s}}{\tau s+1}$
SOPDT	$G(s)=\frac{Ke^{-\theta s}}{\tau^2 s^2+2\zeta\tau s+1}$

Table C
Steady State Analysis Formulae

MSE	$\frac{1}{n}\sum_{t=1}^{n} e_t^2$
RMSE	$\sqrt{\frac{1}{n}\sum_{t=1}^{n} e_t^2}$
ISE	$\int_0^{\infty}[e(t)]^2\,dt$
ITAE	$\int_0^{\infty} t\lvert e(t)\rvert dt$