Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	INSTRUMENTATION AND PROCESS CONTROL
COURSE CODE	:	BNL 40202
PROGRAMME	:	3 BNL
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) Define the concept of feedforward and feedback control with supported diagram.

(8 marks)

(b) Discuss the needs and the objective of automatic process control. Give **ONE (1)** example to support your ideas.

(7 marks)

(c) Solve the following equation using Laplace transform:

$$f(t) = 0 \quad \text{for } t < 0$$
$$= \sin \omega t \cdot \cos \omega t \quad \text{for } t \geq 0$$

(5 marks)

(d) Rewrite the following s-domain equation into time domain equation using inverse Laplace transformation technique.

$$F(s) = \frac{5(s+2)}{s^2(s+1)(s+3)}$$

(5 marks)

Q2 (a) Using diagrams, explain **FOUR** (4) types of stability in control engineering.

(5 marks)

(b) A general second-order transfer function can be written as:

$$G(s) = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

Define the meaning of ω_n and ζ.

(4 marks)

(c) For the following transfer function, find the value of ζ and ω_n. Analyze the response of the system based on the result obtained.

$$G(s) = \frac{20}{s^2 + 8s + 20}$$

(6 marks)

(d) Consider the mechanical system as shown in **FIGURE Q2 (d)**. Suppose that the system is at rest initially [x(0) = 0, $\dot{x}(0) = 0$], and at t = 0 it is set into motion by a unit-impulse force.

(i) Obtain a mathematical model for the system.

(ii) Determine the type of the motion of the system.

(iii) What is the amplitude of the motion?

(10 marks)

Q3 (a) Explain the function of transducer and sensor.

(5 marks)

(b) As a plant engineer, justify **FIVE** (5) factors into the selection and suitability of sensor for boiler operation.

(10 marks)

(c) Differentiate the concept of interacting and non interacting system with appropriate examples and diagrams.

(10 marks)

Q4 (a) What is root locus? Describe **TWO** (2) ways to draw root locus diagram.

(5 marks)

(b) Sketch the root locus for the system shown in **FIGURE Q4 (b)**. Determine the range of K value that provides stability of the system.

(10 marks)

(c) There are three different control strategies namely P, PI and PID controllers. Differentiate the concept of these controllers.

(10 marks)

Q5 (a) Outline the transfer function of $\frac{C(s)}{R(s)}$ when $D(s) = 0$ and $\frac{C(s)}{D(s)}$ when $R(s) = 0$ for the system shown in **FIGURE Q5 (a)**.

(7 marks)

(b) Illustrate and discuss the concept of two level cascade systems and three level cascade systems.

(8 marks)

(c) **FIGURE Q5 (c)** shows an example of single loop control of an oleo tank system. Propose a cascade control system to improve the performance of the original system. Support your design with appropriate diagram and elaboration.

(10 marks)

- END OF QUESTION –

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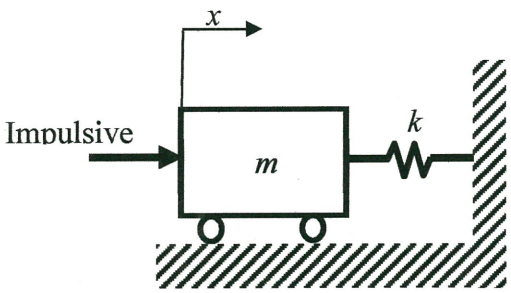

FIGURE Q2 (d)

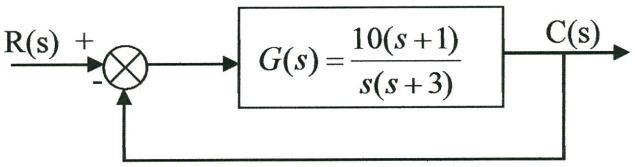

FIGURE Q4 (b)

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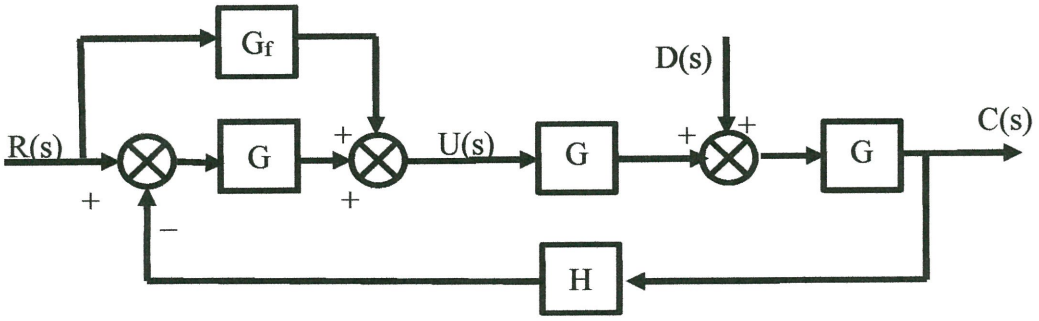

FIGURE Q5 (a)

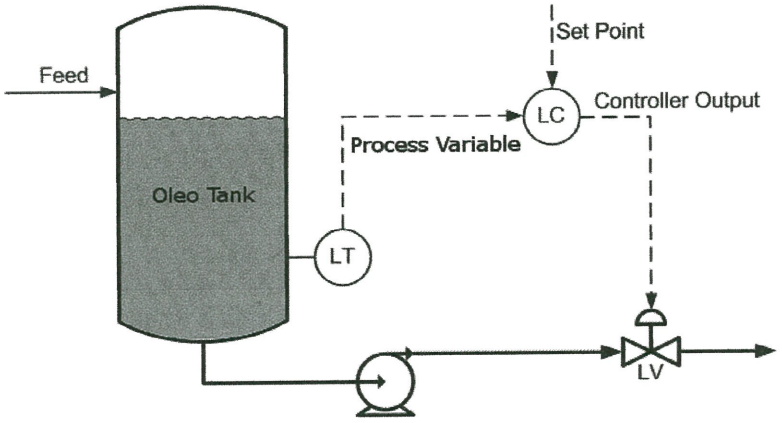

FIGURE Q5 (c)

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General Laplace Transformation Table

Item no.	f(t)	F(s)
1.	$\delta(t)$	1
2.	$u(t)$	$\frac{1}{s}$
3.	$tu(t)$	$\frac{1}{s^2}$
4.	$t^n u(t)$	$\frac{n!}{s^{n+1}}$
5.	$e^{-at}u(t)$	$\frac{1}{s+a}$
6.	$\sin \omega t u(t)$	$\frac{\omega}{s^2+\omega^2}$
7.	$\cos \omega t u(t)$	$\frac{s}{s^2+\omega^2}$