



AUSTRALIAN MARITIME COLLEGE

FACULTY OF MARITIME TRANSPORT AND ENGINEERING

SUPPLEMENTARY EXAMINATION

COURSE:	Bachelor of Engineering (Ocean Engineering) Bachelor of Engineering (Marine and Offshore Systems)
SUBJECT:	Instrumentation and Process Control
CODE:	E07-267
DATE:	xx-xx-2004
DAY:	xxxx
START TIME:	xx:xx
END TIME:	xx:xx
EXAMINER/s:	Hung Nguyen

MOBILE PHONES AND ELECTRONIC DICTIONARIES ARE STRICTLY PROHIBITED IN THE EXAMINATION VENUE	
THE FOLLOWING ARE PERMITTED AND REQUIRED FOR THIS EXAMINATION	
	Open Book
X	Calculator (Non-programmable)
	Calculator (Programmable)
	Graph paper
	Self Prepared Notes A4 sheet
X	Formula sheet

Note: Mark with an "X" the permitted items

INSTRUCTIONS TO CANDIDATES

Time allowed: 3 hours

Answer instructions: There are six (6) questions. Answer all questions.
You should read the questions very carefully before answering in order to avoid misunderstanding.
The mark for each question is indicated below each question.
There are total of 48 marks available in this supplementary examination.

Pass Level: You are required to achieve over 40% of the possible marks for this supplementary examination.

Note:

In order to ensure that the examiner is aware of your entire examination returns, please ensure that:

- *Your student I.D. number is entered clearly and legibly on all examination answer booklets that you use.*
- *You indicate which questions are answered in each booklet.*
- *All answer booklets are sequentially numbered in the box provided on the front page of each booklet.*
- *The total number of booklets that you use is also indicated in the box provided on the front page of each booklet.*

QUESTION 1

(a) Define the transfer function (continuous-time) of a dynamic system, its poles and zeros. [4 marks]

(b) A dynamic system is represented by the following ordinary differential equation:

$$5\ddot{y} + 7\dot{y} + 3y = 2u + 1.5\dot{u}$$

where y is output, and u is input.

(i) Find the transfer function with an assumption that all initial conditions are zero.

(ii) Find poles and zeros of the transfer function

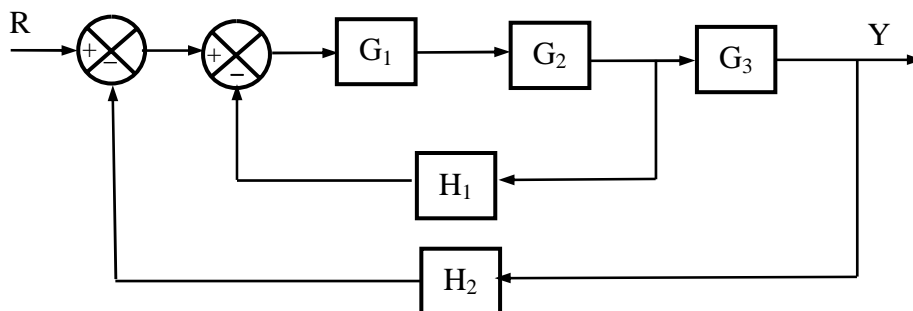
[2+2 marks]

QUESTION 2

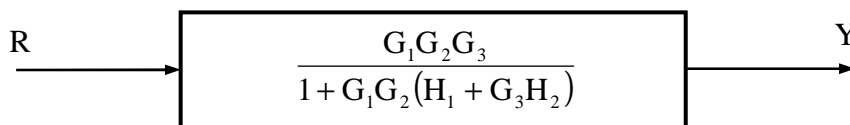
(a) State the block diagram, and define the open-loop control system and closed-loop control system in term of block diagram.

[4 marks]

(b) Confirm that the following block diagram



is equivalent to the contracted block diagram below.



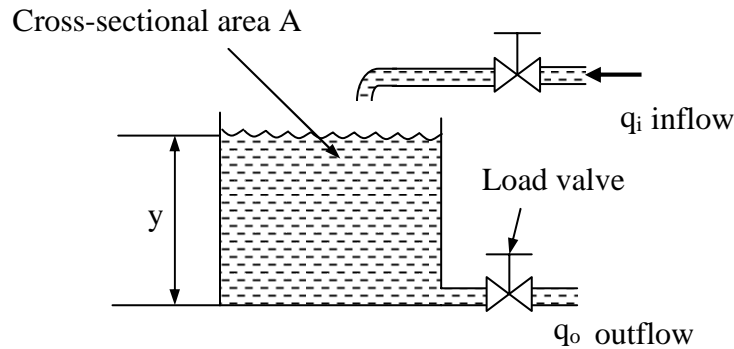
[4 marks]

QUESTION 3

(a) Describe a control system in marine and offshore industry, including simple structure, operating principle, features. [Hints: You may use block diagram or schematic diagram or formulae to illustrate your answers].

[4 marks]

(b) Consider the tank system shown in the following figure with an inflow q_i (rate of volume flow). The cross-sectional area of the tank is constant and equal to A .



(i) Write a differential equation characterizing the relationship between the water level (y in meter) and inflow (q in m^3/s) for this system with an assumption that the outflow (q_o)-level (y) relationship is linear, $q = y/R$ (R is resistance that is constant). Find the transfer function, assuming that the tank starts off empty, and its pole(s) and zero(s).

(ii) The water level (y) is measured by a level transmitter that has sensitivity K_m , and it is controlled by a PI controller that has control gains K_p and K_I . Draw a block diagram for the level control system and find the total feedback (closed-loop) transfer function.

[2+2 marks]

QUESTION 4

(a) State these terms: static sensitivity, accuracy and precision, possible and probable (root-sum-square) errors, linearity applied to a measuring system.

[4 marks]

(b) A pressure measuring system involves the use of a piezo-electric transducer, a charge amplifier and a recorder. The individual sensitivity is $K_1 = 80 \text{ pC/bar}$, $K_2 = 6.0 \text{ mV/pC}$, and $K_3 = 1 \text{ cm/V}$. The maximum errors are 0.14%, 1.55% and 1.75% respectively.

(i) Calculate the overall sensitivity

(ii) Calculate the maximum possible system error and probable (root-sum-square) error.

[4 marks]

QUESTION 5

(a) State the pressure and its units. List the methods to measure pressure. Describe a pressure measuring device (operating principle, simple structure, range, advantages and disadvantages) you have known the best.

[4 marks]

(b) A pressure transducer has a sensitivity of 2.5 mV/bar and an output impedance of 350 Ω . If this is connected to a galvanometer of resistance 50 Ω having a sensitivity of 10 mm/ μ A, calculate the pressure being measured if the galvanometer spot deflects 60 mm on the ultra-violet-sensitive paper.

[4 marks]

QUESTION 6

(a) Describe a differential/pressure transmitter (operating principle, simple structure, range, advantages and disadvantages) you have known the best.

[4 marks]

(b) A d.c.-excited potentiometer has a sensitivity of 0.8 V/mm and is connected directly to a pen recorder which has a sensitivity of 5 mm/V. Calculate the overall system sensitivity and the pen movement for an 18 mm displacement.

[4 marks]