UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	CONTROL ENGINEERING AND INSTRUMENTATION
COURSE CODE	:	BNJ 30703
PROGRAMME CODE	:	BNG/BNM
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION		1. ANSWER ALL QUESTIONS
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.
		3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

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

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ANSWER ALL QUESTIONS

Q1 (a) Differentiate open and closed loop system in a control system.

(3 marks)

(b) Simplify the block diagram shown in **Figure Q1(b)** to a single block and find transfer function, $T(s) = C(s)/R(s)$.

(5 marks)

(c) A mechanical system as shown in **Figure Q1(c)** is subjected to a known internal force $P(t)$, determine

(i) Free body diagram of each mass

(4 marks)

(ii) The differential equations of the suspension system

(4 marks)

(iii) Obtain the relationship between $X_1(s)$ as the output and $P(s)$, as the input by using mason's signal flow gain formula

(9 marks)

Q2 (a) Explain clearly **TWO (2)** advantages of using Root Locus method over Time Response analysis in control design problems.

(5 marks)

(b) Given a unity feedback system of a windmill control system has a forward transfer function of;

$$G(s) = \frac{K(s+2)(s-4)}{(s^2 + 6s + 25)}$$

(i) Plot all zeros and poles on the linear graph paper. Show the method of calculation for; asymptote angle, centroid for asymptotes, value of s at the imaginary-axis crossing and break-in point

(9 marks)

(ii) Sketch the overall root locus. Make sure the loci at the real axis are clearly shown.

(7 marks)

(iii) Find the gain K at the point where the locus crosses the damping ratio line of 0.5 .

(4 marks)

[**Instructions**; Use the scale of **4 cm : 1 unit** for both axes and choose the longer side of the graph paper as the real axis.]

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Q3   (a)   Give a brief explanation of Bode diagram.

(5 marks)

(b)   The transfer function of an electric shredding machine system is given by ;

$$G(s) = \frac{10K}{s(1 + 0.1s)(1 + 0.02s)}$$

(i) Sketch the Bode diagram for the system above if $K=1$.

(15 marks)

(ii) Determine the gain and phase margins from the Bode diagram sketched in section (b)(i).

(5 marks)

Q4   (a)   Define each term of measurand, data conditioning and measured value elements in overall process of measurement system..

(4 marks)

(b)   Measurement using a voltmeter introduces errors which expressed either as absolute or percentage of error. Given an expected voltage across a resistor as 80V, the measurement is 79V. Calculate:

(i)   the absolute error.

(1 marks)

(ii)   the percentage (%) of error.

(2 marks)

(iii)   the relative accuracy.

(2 marks)

(iv)   the percentage (%) of accuracy.

(3 marks)

(c)   Data acquisition (DAQ) typically converts analog waveforms into digital values. Define DAQ in terms of conversion processing, **THREE** (3) main of system components and **TWO** (2) of DAQ applications.

(6 marks)

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(d)   Analogue to digital converter (ADC) reading is determined by ADC resolution, system voltage and analogue measured. If the system voltage is 9V, ADC resolution is 1024 bit and the measured data shows 3.5V. Calculate the ADC reading.

(3 marks)

(e)   The PD controller is characterized by the transfer function given below. Describe the parameters K_p and K_d of the controller.
$$G_c(s) = K_p + K_d s$$

(4 marks)

-END OF QUESTIONS –

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FINAL EXAMINATION

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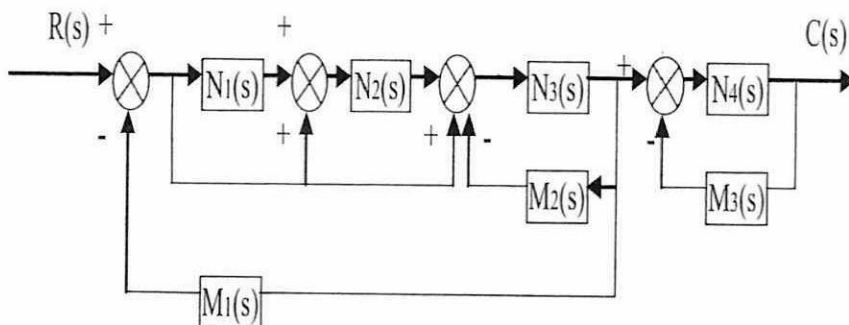COURSE NAME   : CONTROL ENGINEERING AND   COURSE CODE   : BNJ30703
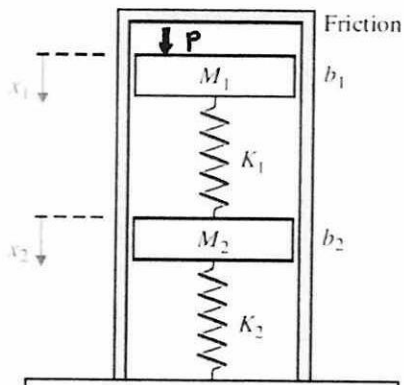   INSTRUMENTATION

Figure Q1(b)

Figure Q1 (c)