Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	CONTROL ENGINEERING AND INSTRUMENTATION
COURSE CODE	:	BNJ 30703
PROGRAMME CODE	:	BNM
EXAMINATION DATE	:	JULY 2022
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 **SIX (6)** PAGES

TERBUKA

Q1 (a) Explain briefly the comparison between non-feedback and feedback systems.

(4 marks)

(b) Determine the transfer function $C(s)/R(s)$ using the block diagram reduction method for the case shown in **Figure Q1 (b)**.

(8 marks)

(c) A feedback control system is represented as the signal flow graph shown in **Figure Q1 (c)**. Calculate the following:

(i) Input node and Output node

(1 mark)

(ii) Forward path

(1 mark)

(iii) Feedback paths (loops)

(4 marks)

(iv) Non-touching loops

(4 marks)

(v) Apply Mason's Rule to resolve the transfer function of the system. Given:

$$\frac{Y(s)}{R(s)} = \frac{\sum P_k \Delta_k}{\Delta}$$

(3 marks)

Q2 (a) Spring is an element, which stores potential energy. By using a diagram and appropriate equations, show how spring is used in a translational mechanical system.

(2 marks)

(b) Derive the transfer function of the mechanical system as shown in **Figure Q2 (b)**.

(12 marks)

(c) (i) Define stability concept in control engineering.

(2 marks)

(ii) **Figure Q2 (c)** depicts a block diagram for a control system. Analyse the system stability by drawing the root locus for this control system. Show the calculation to obtain the angles of asymptotes, intersection of asymptotes, 'breakaway' and 'break-in' points for the root locus. Give your interpretation on the root locus.

(9 marks)

TERBUKA

Q3 (a) The expected voltage value across a resistor is 180 V but the actual measurement is 173 V. Determine the following:

(i) The absolute error

(1 mark)

(ii) The percentage (%) of error

(1 mark)

(iii) The relative accuracy

(1 mark)

(iv) The percentage (%) of accuracy

(1 mark)

(b) Errors in measurement systems can be divided into those that arise during the measurement process and those that arise due to later corruption of the measurement signal by induced noise during the transfer of the signal from the point of measurement. Discuss **THREE (3)** types of systematic error.

(6 marks)

(c) In electronics, an analog-to-digital converter (ADC) is a system that converts an analog signal, such as a sound picked up by a microphone or light entering a digital camera, into a digital signal.

(i) Describe the working principle of an ADC.

(2 marks)

(ii) ADC reading is determined by ADC resolution, system voltage and analogue voltage measured. Using an appropriate equation, calculate the ADC reading from a given resolution of 1027, system voltage of 4 V, and the measured analogue voltage of 2.32 V.

(3 marks)

(d) Data Acquisition (DAQ) hardware acts as the interface between a computer and signals from the outside world. The primary function of DAQ is as a device that digitizes incoming analog signals so that a computer can interpret them. Explain the DAQ system by highlighting the key components of a DAQ device through a flow diagram.

(3 marks)

(e) The proportional-integral (PI) controller is characterized by the transfer function given below. Describe the dynamic characteristics of the PI controller.

$$G_c(s) = K_p\left(1 + \frac{1}{T_i s}\right)$$

(3 marks)

TERBUKA

(f) Explain the differences between artificial intelligence, machine learning, and deep learning and how they are interrelated.

(4 marks)

Q4 The control system of an engine has an open-loop transfer function as follows;

$$G(s) = \frac{50}{s(s^2+6s+8)}$$

(a) Estimate the gain magnitude and the phase angle

(15 marks)

(b) Construct the Bode Diagram on graph paper

(6 marks)

(c) Examine the gain margin and the phase margin

(2 marks)

(d) Analyse the system's stability

(2 marks)

-END OF QUESTIONS –

TERBUKA

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2021/2022
COURSE NAME : CONTROL ENGINEERING AND INSTRUMENTATION
PROGRAMME CODE : BNM
COURSE CODE : BNJ 30703

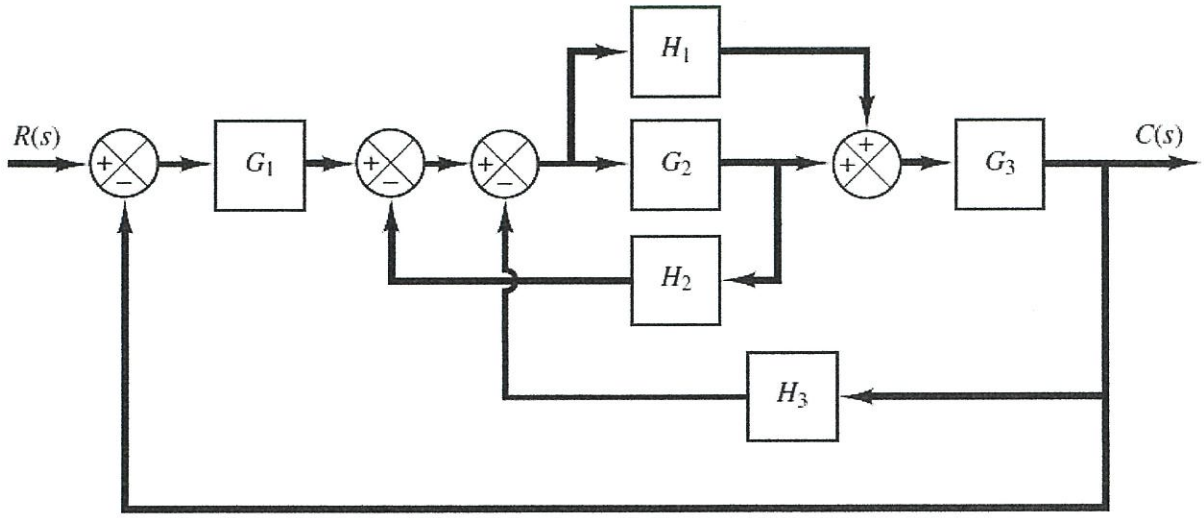

Figure Q1 (b)

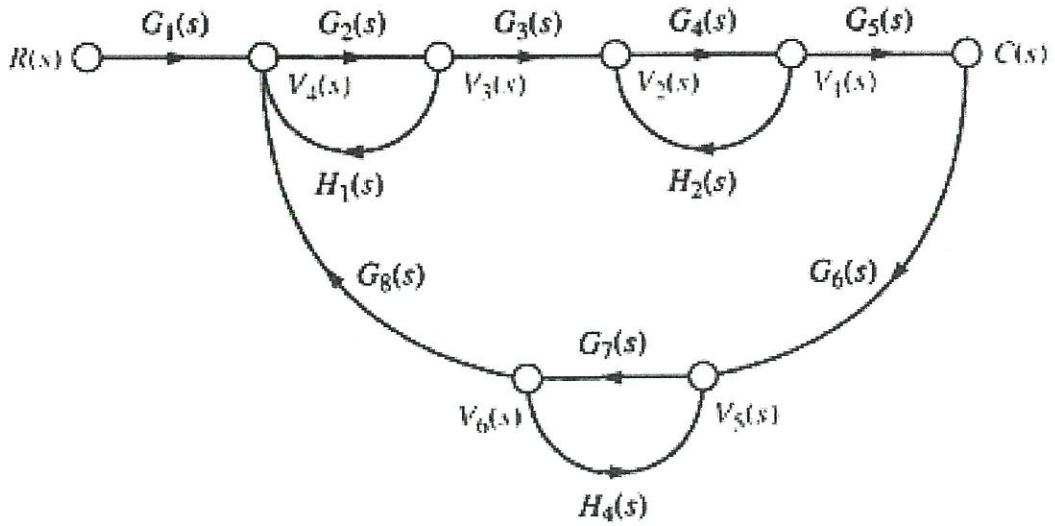

Figure Q1 (c)

TERBUKA

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2021/2022
COURSE NAME : CONTROL ENGINEERING AND INSTRUMENTATION

PROGRAMME CODE : BNM
COURSE CODE : BNJ 30703

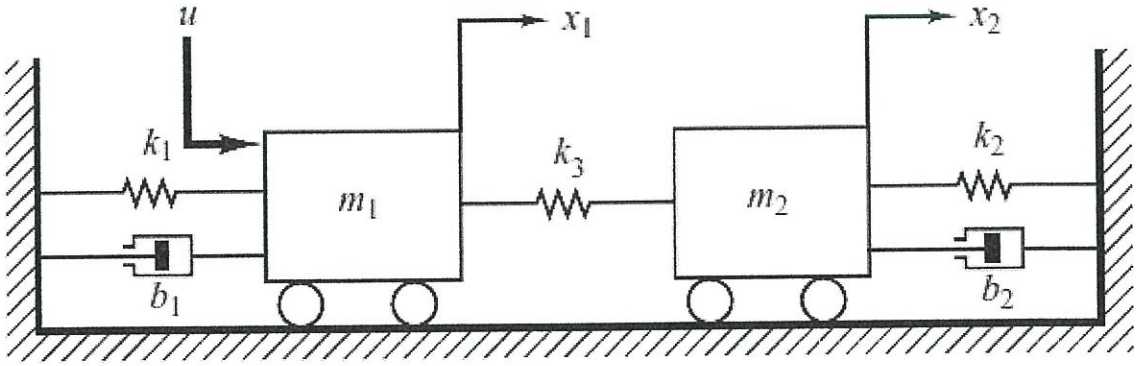

Figure Q2 (b)

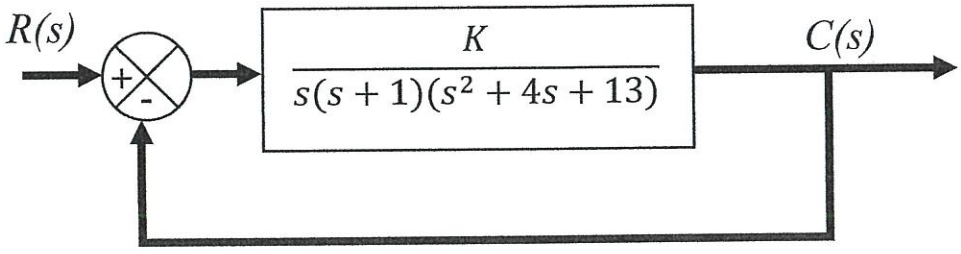

Figure Q2 (c)

TERBUKA