UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: May 2023

Module Number: MN 5303   **Module Name: Marine Engineering Instrumentation and Control Systems I**

[Three Hours]

[Answer all **Five Questions**, each question carries **14 marks**]

Instructions:

i.   Start your answers to each question on a fresh page.

Q1 Instrumentation and control system uses many different transducers for input signals and uses different methods to analyze system performance/ response for effectiveness.

(a)   What is a "Sensor"? What is a "Transducer"? Briefly explain their functions and list 2 main features for each of them.

[04 Marks]

(b)   Draw a schematic circuit diagram of a potentiometer and briefly explain its measuring principle.

[04 Marks]

(c)   Encoders use in many applications to get exact position information. Explain the operation of an "Absolute Encoder" with suitable sketches (Hint: use an example reading to explain).

[03 Marks]

(d)   Briefly explain "Frequency response" and mention 4 frequency domain specifications.

[03 Marks]

Q2 Control systems are designed in various ways according to the functionality required and the nature of the application.

(a)   Briefly explain "Open-loop" and "Closed loop" control system with block diagrams.

[02 Marks]

(b)   Explain 4 main functions of a closed loop control system.

(c) Briefly explain following terminology,

      i.   Set point

      ii.   Process Variable – PV

      iii.   Error

      iv.   Off set

      v.   Feedback

[05 Marks]

(d) Define what a "Servomechanism" is and briefly explain the operational concept of the position control system given in Figure Q2 on page 5.

[05 Marks]

Q3 One of the response analysis of a control system is the time domain analysis.

(a) What is "Time response"? Explain.

[02 Marks]

(b) When considering the performance of a feedback control system, there are mainly 2 response states which can be identified. Name them in a graph and briefly explain.

[04 Marks]

(c) Name and briefly explain standard test signals together with graphs.

[04 Marks]

(d) List the time domain specifications and briefly explain. Mark them in a graph.

[04 Marks]

Q4 A mathematical model of a dynamic system is defined as a set of equations that represents the dynamics of the system accurately.

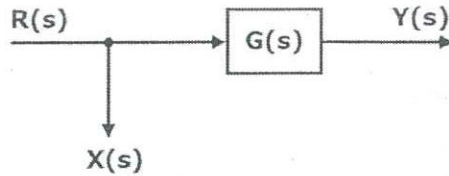(a) Briefly explain what is a "Transfer function"?

[01 Marks]

(b) Block diagram algebra is nothing but the algebra involved with the basic elements of the block diagram. Workout the necessary transfer functions for below using basic rules and suitable block diagrams.
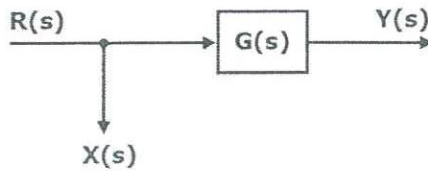
i. Shifting the summing point before the block.
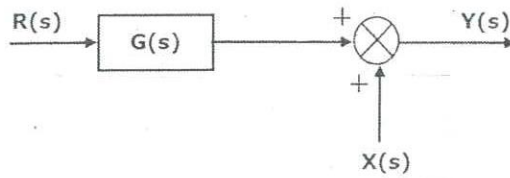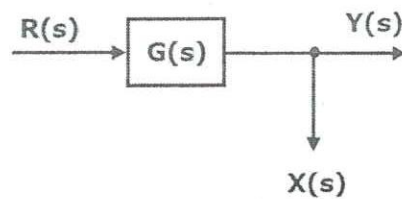

[02 Marks]

ii. Shifting summing point after the block.

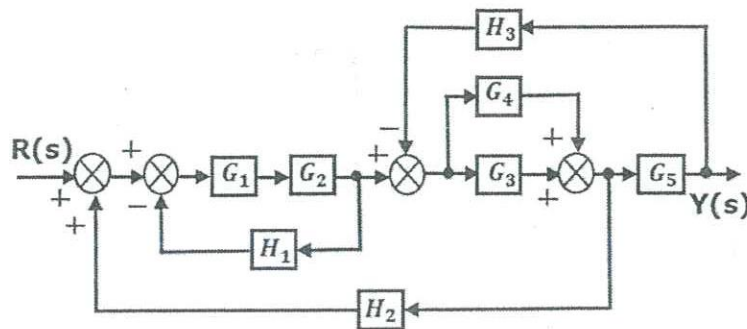[02 Marks]

iii. Shifting take-off point after the block.

[02 Marks]

iv. Shifting take-off point before the block.

[02 Marks]

(c) Consider the block diagram shown in the following figure. Simply using the block diagram reduction rules to get the final transfer function of the system.

[05 Marks]

Q5 Various types of control system components are used in systems based on the application requirement. Precise controlling, speed, performance are some of the major factors which are considered as most important.

(a) Briefly explain the construction and operating principle of AC and DC Servo motors using the electrical diagrams of each (for AC Servo motor, consider 2 – phase servo motor).

[04 Marks]

(b) Briefly mention the comparison of DC motor and Servo motor in terms of Wire system, Assembly and Rotation.

[03 Marks]

(c) Name 3 types of DC Servo motors.

[03 Marks]

(d) Briefly explain the operational concept of an AC Tachogenerator as shown in Figure Q5 on page 5.
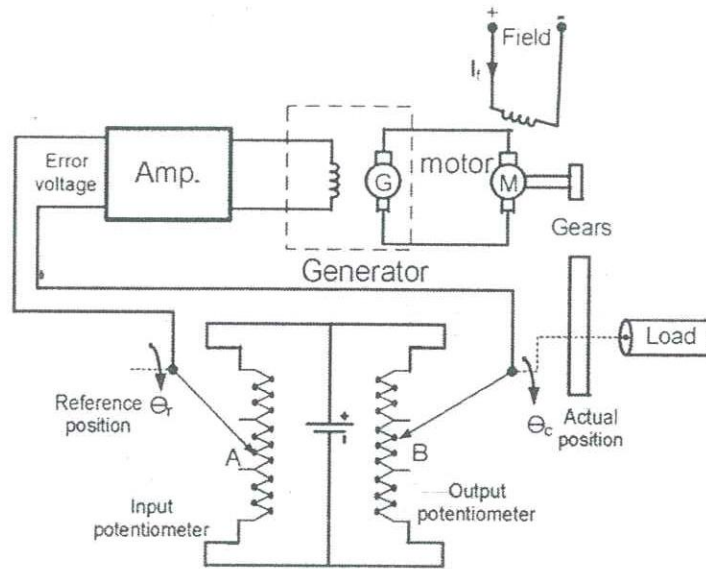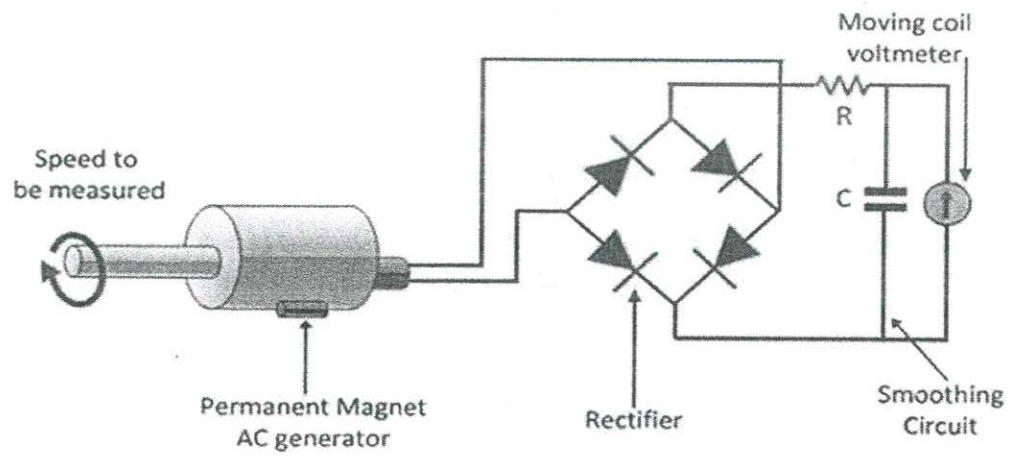
[04 Marks]

Figure Q2 – Position Control System

Figure Q5 – AC Tachogenerator