UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: February 2024

Module Number: MN5303 **Module Name: Marine Engineering Instrumentation and Control Systems I**

[Three Hours]

[Answer **All** Questions, each question carries **14 marks**]

Instructions:

1. Start your answer to each question on a fresh page
2. This question paper contains **Five** (5) questions in **3** pages

Q1 Sensors play a major role in Control and Monitoring Systems used in many different applications. Irrespective of the application, suitable and most matching sensors and transducers are selected considering specific technical requirements.

a) Mention 4 types of different photoelectric transducers and briefly describe their functions (one sentence for each).

[4 Marks]

b) Draw a schematic diagram of a Hall Effect proximity sensor and briefly explain the operational principle.

[4 Marks]

c) Encoders are mainly in 2 types namely incremental and absolute. Explain the purpose and operation of an "Incremental Encoder" using a suitable sketch.

[3 Marks]

d) The seismic transducer works in two different modes. What are these modes and brief what parameters used to select each of these modes.

[3 Marks]

Q2 Control systems are designed in various ways to achieve the desired/ expected result. There are different test approaches to verify the results of the designed control system and Frequency Domain Analysis is one of that.

a) Briefly explain what is "Frequency response".

[2 Marks]

b) Sketch the graph of frequency domain response and mark and name essential points on it. Mention and briefly explain 6 specifications of frequency domain response.

[7 Marks]

c) Mention 5 advantages of use of frequency domain analysis in control system design.

[5 Marks]

Q3 Control system types are different and the uses are matched accordingly.

a) Sketch block diagrams and explain briefly what is a "Open-loop" control system and what is a "Closed-loop" control system.

[2 Marks]

b) Mention 4 functions of a control system and briefly explain each function.

[8 Marks]

c) Sketch block diagrams and briefly explain Feedforward control system and Feedback control system.

[2 Marks]

d) A mathematical model of a dynamic system is defined with basic elements of block diagrams. Sketch a sample block diagram and name the basic elements.

[2 Marks]

Q4 a) Briefly explain following terms

i. Dead time

ii. Gain

iii. Droop

iv. Hunting

[4 Marks]

b) What is a signal flow graph? Name the basic elements of Signal flow graph.

[2 Marks]

c) What is a Node? Briefly explain types of nodes.

[3 Marks]

d) Draw a signal flow graph for below algebraic equations and get the final graph accordingly,

[5 Marks]

$$y_2 = a_{12}y_1 + a_{42}y_4$$
$$y_3 = a_{23}y_2 + a_{53}y_5$$
$$y_4 = a_{34}y_3$$
$$y_5 = a_{45}y_4 + a_{35}y_3$$
$$y_6 = a_{56}y_5$$

Q5 Use of PID is utmost importance to maintain a system at pre-defined settings to provide desired output at a constant operating condition.

a) Sketch block diagram of a PI control and briefly explain how it works.
Use Error vs Time, Output vs Time graphs where necessary.

[4 Marks]

b) Briefly explain PD control.
Use error vs Time, output vs Time graphs in your explanation.

[4 Marks]

c) Sketch controlled variable vs time graphs and explain how PID controller is formed. Define how these variables make P, PI, PID control using the abovementioned graphs.

[6 Marks]