BACHELOR OF INSTRUMENTATION AND ELECTRONICS ENGINEERING EXAMINATION, 2024

(3ed Year, 1st Semester)

PROCESS DYNAMICS AND CONTROL

Time : Three hours | Full Marks : 100

List of Course Outcomes (CO):

CO1: Develop mathematical models of typical processes (K3, A2-model)
CO2: Explain and analyse the performance of different controllers and their tuning methods(K4,A2-examine)
CO3: Differentiate between various control schemes and interpret their necessity (K4,A3)
CO4: Explain the role of final control elements in process control systems (K2, A1)

Instructions to the Examinees:

- Each module in the question paper matches up with the corresponding CO
- **Attempt questions for the attainment of all the COs**
- Alternative questions (if any) exist within a module, not across the modules
- Different parts of same question should be answered together

Attempt ALL Questions

Q1A. **8+7+5**

a) Outflow(q_0)from a tank is equal to $2h^{3/2}$, Inflow is m, Steady state level in tank is 4m, and area of the tank is $2m^2$.Find [*H(s)/M(s)*] and characterizing parameters of the transfer function.

b) Describe a simple thermal system in which incoming liquid is heated by the heater in the tank and going out with higher temperature. Develop first order transfer function of the thermal process.

c) For a liquid tank having uncontrolled inflow and controlled outflow, set the mathematical model with process resistance and capacitance.

OR

Q1B. **8+7+5**

a) Establish a dynamic model of stirred tank heating process with constant holdup.

b) For a tank having area=0.1 m^2, at steady state the liquid level height is 1m and the discharge is $0.16 \times 10^{-3} m^3$/sec, find the height of the tank after 10 min.

c) With an example of Heat Exchanger define various process variables.

Q2A. **6+6+6+6 +6**

a) What is meant by offset of a proportional controller?

b) Establish the relation between proportional gain and proportional band. Draw the response characteristic of PID control action for a step input.

c) Explain the advantages of using velocity algorithm over position algorithm.

d) An integral controller with a value of K_I =0.1/s, has an output of 40% PB at the SP. What will be the output after 2S if there is a sudden change to a constant error of 20%.

e) Why the offset cannot be fully eliminated using proportional controller? How the offset can be nullified in a control loop.

OR

Q2B. **6+6+6+6+6**

a) A proportional type pneumatic controller is used to control the temperature of a furnace at 750^{0}C. The range of the instrument is 0-1000^{0}C & PB is set at 15%.The controller is a direct action type. Find the temp corresponding to max and min position of the control valve & the output pressure of the controller corresponding to 15^{0}C downscale from the SP. What will be these values for reverse action type controller?

b) Write down the position algorithm for control action.

c) What are the basic criteria to be satisfied in order to obtain tuning of a controller?

d) Give any one method for obtaining controller tuning parameters.

e) How the integral wind up can be prevented using programmable controller?

Q3A. **6+6+6+6+6**

a) What is process reaction Rate?

b) What are the advantages & disadvantages of feedback control system?

c) Why FF control is used along with FB control? Explain with the transfer function.

d) Explain the override control system with an example.

e) Explain the operation of ratio control system.

OR

Q3B. **6+6+6+7+5**

a) Explain the operation of a pneumatic level transmitter.

b) What are the advantages of smart transmitter over conventional transmitter?

c) In a cascade control system the inner loop must be faster than outer one—Explain.

d) Explain the operation of relay based annunciator.

e) Explain the working principle of split-range controller.

Q4A. **6+5+6+3**

a) Draw and explain the ideal flow characteristics of three different types of control valves.

b) Define the term rangeability of a control valve and its importance.

c) 'An equal percentage valve gives a better linear response than linear characteristic valve in actual case'—justify.

d) Explain the purpose of using valve positioner.

OR

Q4B. **5+6+6+3**

a) With a neat diagram explain the operation of springless actuator.

b) Write the advantages and disadvantages of double seated valve.

c) Explain the steps of selection of valve size.

d) Write the working principles of I/P converter.