Question Paper

Exam Date & Time: 04-Jan-2023 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

Vth semester Make up examination January 2023

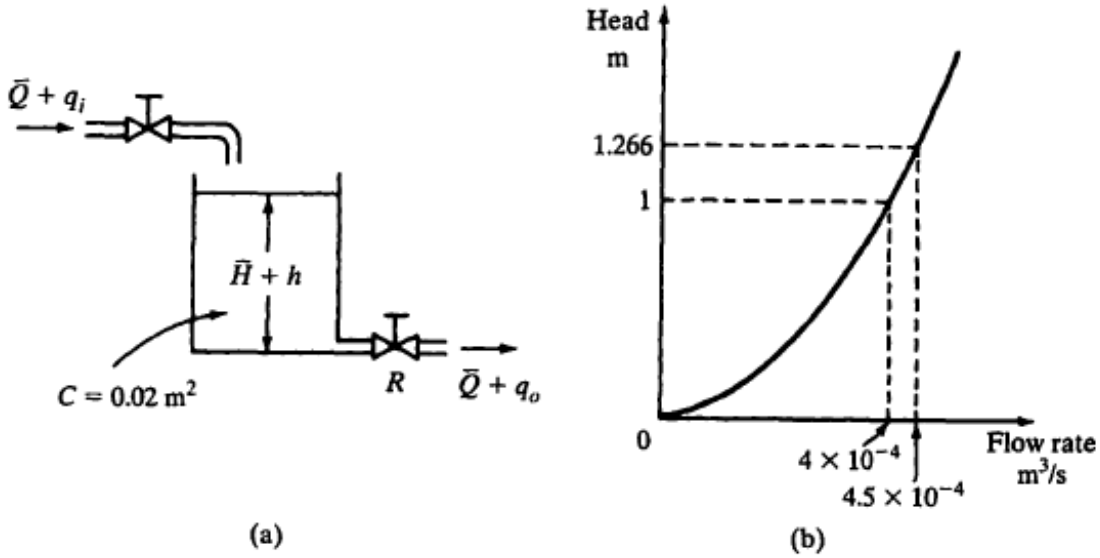
PROCESS INSTRUMENTATION AND CONTROL [ICE 3154]

Marks: 50 **Duration: 180 mins.**

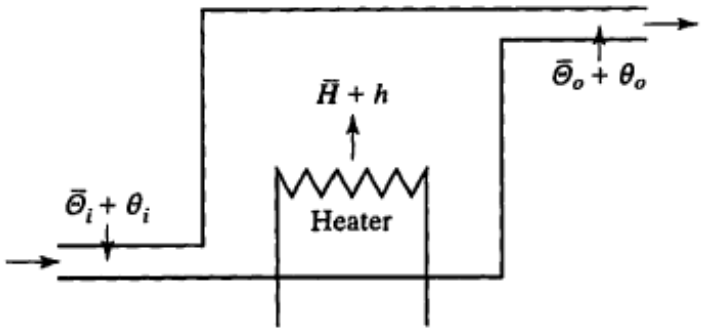
Descriptive Questions

Answer all the questions. Section Duration: 180 mins

1) Consider the liquid-level system of Figure (a). The curve of head versus flow rate is shown in Figure (b). Assume that at steady state the liquid flow rate is 4 X 10^{-4} m^3/s and the steady-state head is 1 m. At t = 0, the inflow valve is opened further, and the inflow rate is changed to 4.5 X 10^{-4} m^3/s. Determine the average resistance R of the outflow valve. Also, determine the change in head as a function of time. The capacitance C of the tank is 0.02 m^2. (Consider the flow rate through outflow valve as Q=√(K). [CO1, PO1, PO2, BL3] (5)



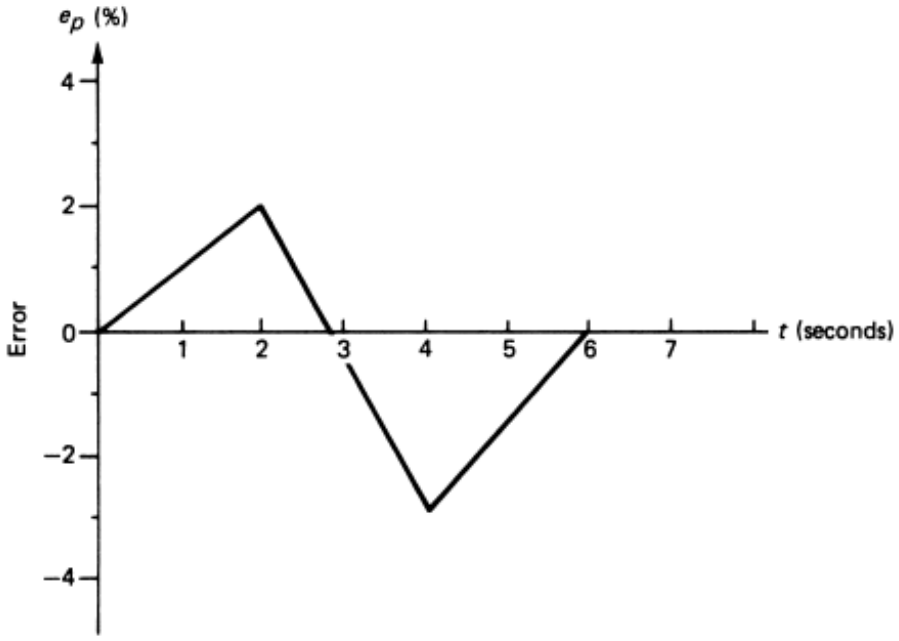
2) Consider the air-heating system shown in Figure. Assume small deviations from steady-state operation and derive a mathematical model for the system. Assume that the heat loss to the surroundings and the heat capacitance of the metal parts of the heater are negligible. [CO1, PO1, PO2, BL4] (3)



3) Define capacitance and resistance of a liquid level system with their units. [CO1, PO1, PO2, BL1] (2)

4) A PID controller has K_p=2, K_I=2.2 s^{-1}, K_D=2 s and $p_I(0)$=40% . Plot the controller output for an error graph shown in figure. (5)

[CO2, PO3, PO4, BL3]



5) Describe single speed floating controller mode with necessary diagrams. (3)

[CO2, PO3, PO4, BL1]

6) A liquid-level control system linearly converts a displacement of 2 to 3 m into a 4- to 20-mA control signal. A relay serves as the two-position controller to open or close an inlet valve. The relay closes at 12 mA and opens at 10 mA. Obtain the relation between displacement level and current, and the neutral zone or displacement gap in meters. [CO2, PO3, PO4, BL3] (2)

7) Design a PD controller with a 140% PB and a 0.2-min derivative time. The fastest signal speed is 1 min. Measurement range is 0.4 to 2 V, and the output is 0 to 10 V. [CO3, PO3, PO5, BL4] (5)

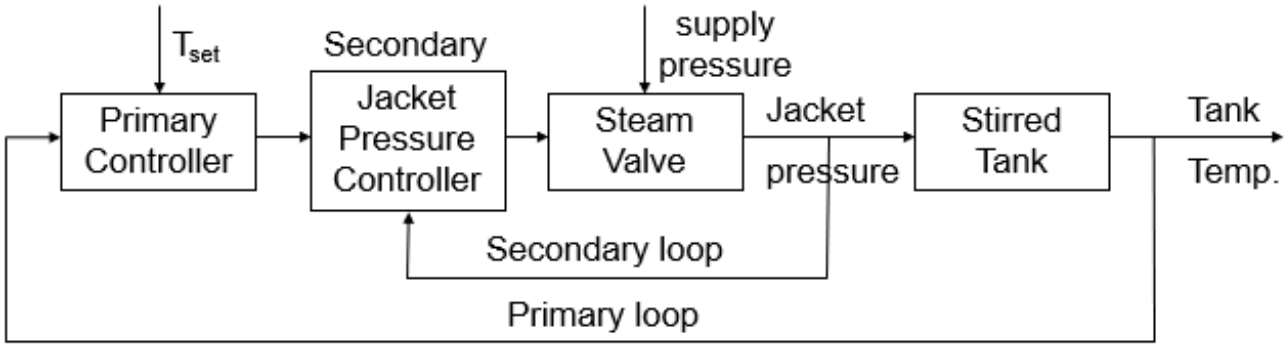
8) Design a two-position controller that turns a 5-V light relay ON when a silicon photocell (3)

output drops to 0.22 V and OFF when the cell voltage reaches 0.78 V.

[CO3, PO3, PO5, BL4]

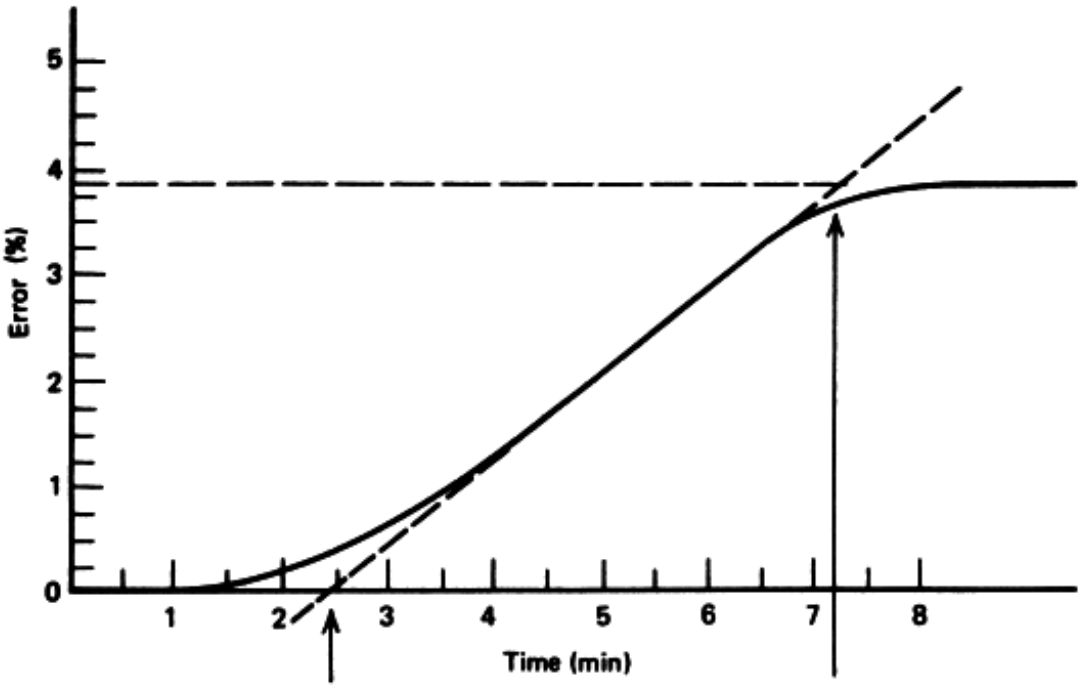
9) Obtain the transfer function model $\theta(s)/T_{set}(s)$, of the cascade control system shown in the figure, assuming suitable transfer functions to individual blocks. How this model can be converted to a simple feedback control system? (2)

Note: $\theta(s)$ and $T_{set}(s)$ corresponds to tank temperature and setpoint respectively.



[CO5, PO1, PO2, PO3, PO4, PO5, BL3]

10) A transient disturbance test is run on a process loop. The results of a 9% controlling variable change give a process-reaction graph as shown in Figure. Find settings of P, PI and PID control actions. (5)

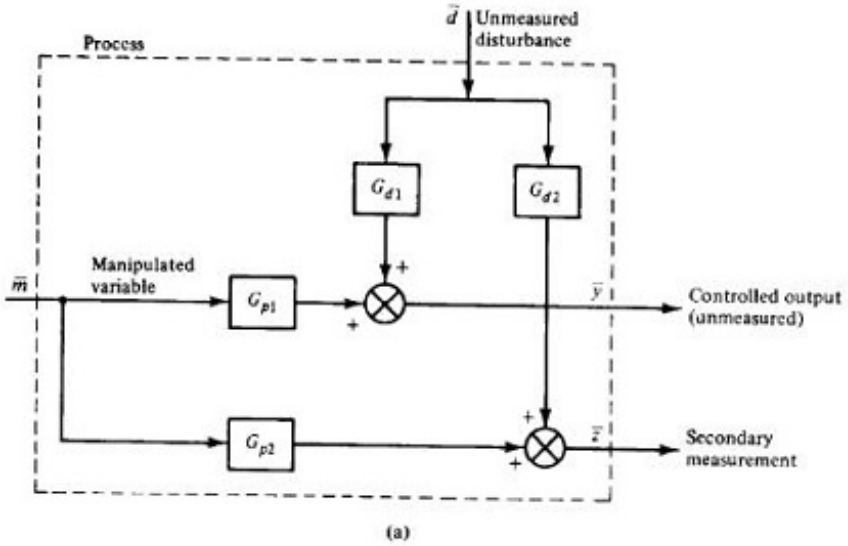


[CO4, PO1, PO2, PO6, BL3]

11) Explain the time integral criterions for controller performance evaluation. What are the considerations to be taken care while choosing them, for evaluating a control action? (3)

[CO4, PO1, PO2, PO6, BL2]

12) Identify the control algorithm in the figure. Write its importance. (2)



[CO5, PO1, PO2, PO3, PO4, PO5, BL1]

13) With a block diagram, explain feedforward- feedback control system. Discuss on its advantage compared to a feedforward control. (5)

[CO5, PO1, PO2, PO3, PO4, PO5, BL2]

14) What is self-tuning regulator? How does it differ from model reference adaptive controller? (3)

[CO5, PO1, PO2, PO3, PO4, PO5, BL2]

15) 3 boilers supply steam to a steam header. Discuss how can a split range control action be implemented for to control the pressure in the stem header. (2)

[CO5, PO1, PO2, PO3, PO4, PO5, BL2]

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