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Question Paper Code: 41554

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2017

Fifth Semester

Electronics and Instrumentation Engineering

14UEI504 - PROCESS CONTROL INSTRUMENTATION

(Regulation 2014)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The variable used to maintain the controlled variable at its set point is called

   (a) controlled variable (b) manipulated variable
   (c) set point variable (d) process variable

2. Dead time is also called

   (a) pure delay (b) transport lag
   (c) distance-velocity lag (d) all of the above

3. Most commonly used controller for controlling the temperature is a _____ controller.

   (a) P (b) PI (c) PD (d) PID

4. The open loop response of two tank interacting system is _____ response.

   (a) over damped (b) under damped
   (c) undamped (d) critically damped

5. ITAE is used when

   (a) The error exists for a long time (b) The error exists for a short time
   (c) The error is small (d) The error is large

6. The time constant of a first order system is defined as time for the system to reach following a step input change _____ % of its final value.

   (a) 63.2 (b) 99.8 (c) 85.4 (d) 18.8

7. In boiler drum, swell effect occurs due to

(a) sudden load (steam demand) increase
(b) sudden load (steam demand) decrease
(c) feed water pressure variations
(d) level variations

8. Three element control means

(a) feedback (b) feedback + feedforward
(c) cascade (d) feedforward+cascade

9. After installation the equal percentage valve characteristics changes to

(a) Linear (b) Quick opening
(c) No changes (d) Non linear

10. The performance measure of Ziegler Nichols tuning is

(a) 1/4 decay ratio (b) ISE (c) IAE (d) Settling time

PART - B (5 x 2 = 10 Marks)

11. List the steps involved to obtain the mathematical model.

12. Why the derivative mode cannot be used as standalone controller?

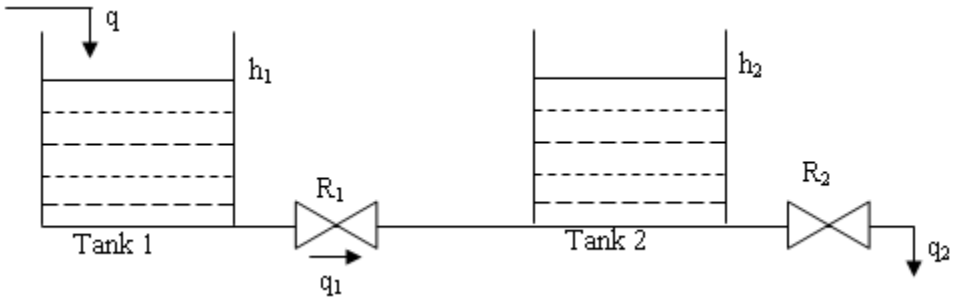
13. When IAE and ISE can be used as evaluation criteria for assessing the performance of a controller? Justify your answer with a suitable example?

14. An equal percentage has a maximum flow of 50 m^3/s and a minimum flow of $2m^3/s$. If the full travel is 3 cm, calculate the flow at a 1 cm opening.

15. Differentiate feedback control from feed forward control.

PART - C (5 x 16 = 80 Marks)

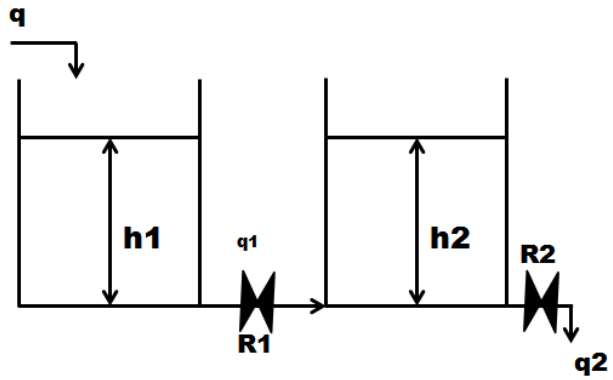
16. (a) Develop the transfer function model for the given interacting system shown in the figure below. (16)



Or

(b) (i) Illustrate servo and regulatory operation with an example for each. (8)

(ii) Consider the system shown in figure. Develop a mathematical model for the system. Assume that the effluent stream from a tank is proportional to the hydrostatic liquid pressure that causes the flow of liquid. Cross-sectional area of tank 1 is *A1 (ft^2)* and of tank 2 is *A2 (ft^2).* The flow rates q, q_1, q_2 are in ft^2/min. Take necessary assumptions. (8)



17. (a) A temperature control system inputs the controlled variable in a range of (0 - 4) V. The output is a heater requiring (0 - 8) V. A PID controller is to be designed with K_p = 2.4 % / %, Ki = 9 % / % min, and K_d = 0.7 % / % /min. The period of the fastest expected change is estimated to be 8 sec. Design an electronic PID circuit. Assume C_D =100 µF; R_1 = 10 KΩ ; C_I = 10 µF. (16)

Or

(b) (i) A water tank losses heat such that the temperature drops by 2K/min. when the heater is ON, the system gains temperature at 4K/min. An ON-OFF controller has a 0.5 min control lag and a Differential gap of +/-4% of the set point around 323 K. Plot the heater temperature Vs time and calculate the oscillation period. (8)

(ii) A second order process with transfer function of $\frac{5}{(10s+1)(3s+1)}$ is controlled by a proportional controller. What should be the value of proportional gain (k_c) so that the offset due to unit step change in set point is 0.05? (8)

18. (a) (i) Discuss the criteria to evaluate the performance of controller. (8)

(ii) Describe Ziegler-Nichols method of tuning PID Controller. (8)

Or

(b) Determine the optimal tuning parameters of P, PI, and PID controllers using Ziegler Nicholas (ZN) closed loop method for a given system below. Use frequency

response to calculate the ultimate gain and ultimate period. (16)

$$G(s) = \frac{5e^{-0.5s}}{2.5S+1}$$

19. (a) (i) Describe the function of an actuator. List the different types of actuators. (8)

(ii) Explain the working principle of pneumatic spring actuator with valve positioner with a help of neat sketch. Mention the drawback of control valve without positioner. (8)

Or

(b) (i) Describe the three types of flow lift characteristics with a help of neat valve plug diagrams. Why the installed characteristic of control valve is differ from its inherent characteristic. (8)

(ii) The liquid flow through a Diaphram type control valve has to be varied from 300 gpm to 1100 gpm. The pressure drop across the valve varies from 20 to 45 psig. Design the optimum size of the valve required, if the liquid density is 0.9. (8)

20. (a) Discuss the significance of three element control strategy in boiler drum level and illustrate how it can eliminate the Shrink/ Swell and feed water pressure variation effects. Explain with a help of neat P and I Diagram. (16)

Or

(b) Explain the cascade control scheme with example. (16)