Total No. of printed pages = 5

19/6th Sem/UIE 601

2022

PROCESS CONTROL

Full Marks – 100

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer any *five* questions.

1. (a) Differentiate servo and regulatory operation with the help of suitable example. 6

   (b) Derive the transfer function H(s)/Q(s) for the liquid level system as shown in Fig. 1. 8

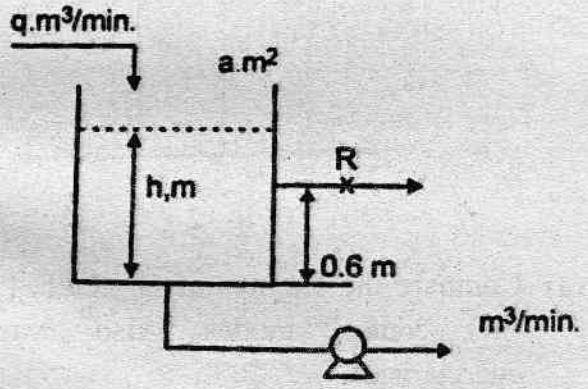

Fig. 1

[Turn over

(i) The tank operates above the steady state value of $h_s = 0.4$m.

(ii) The tank operates above the steady state value of $h_s = 1.2$m.

The pump removes water at a constant rate of 0.4 m^3/min, and is independent of head. The cross-sectional area of the tank is 0.2m^2 and the resistance R is 15 m^2/min.

(c) Derive the transfer function H(s)/Q(s) for the liquid level system shown in Fig. 2 [H and Q are the deviation variables in 'h' and 'q' respectively]. 6

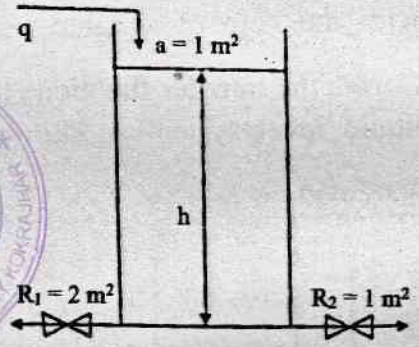

Fig. 2

2. (a) Compare the features of ON-OFF, P, PI and PID control modes. Also draw their charcteristics. 10

(b) Given the error values plot a graph of a proportional-integral control output as a function of time. $K_p = 5$, $K_i = 1.0$/sec and $P_i(0) = 20\%$.

From 0-1sec, e=t, From 1-3sec, e=1, From 3-5sec, e = 0. 10

3. (a) Discuss in detail the different performance criteria used to evaluate the performance of controller. 10

(b) Design and derive the gains of electronic and pneumatic proportional integral controller. 5+5=10

4. (a) Explain the function of I/P converter and pneumatic actuator (air to open) 5+5=10

(b) Explain the various steps involved in the tuning of controllers by closed-loop method. 5

(c) Analyse the feedforward-feedback control loop to show that the stability of feedback configuration is not disturbed by the addition of feedforward mode. 5

5. (a) Explain the occurrences of cavitation and flashing in the control valve. 10

(b) An equal percentage valve has a maximum flow of 50 m^3/s and a minimum of 1.8 m^3/s. if the full travel is 8cm, find the flow at a 4cm opening. 4

(c) Discuss on control valve sizing. Find the proper C_v for a valve that must pump 150 gallons of ethyl alcohol per minute with a specific gravity of 0.8 at maximum pressure of 50 psi and identify the required valve size. 6

6. (a) How does override control protect the drum boiler from overheating ? 10

(b) The transfer function for a cascade system are given as :

$Gp_1 = 2/(3s+1)(2s+1)$;

$Gp_2 = 4/(s+1)$;

$G_{l2} = 1/(2s+1)$;

G_{c1} is a proportional controller ;

$G_{c2} = 5$;

$G_{m1} = 0.06$;

$G_{m2} = 0.3$

(i) Calculate the ultimate value of Kp1 for primary controller for which simple feedback and cascade loop go into oscillations.

(ii) Compare the offset for simple feedback and cascade loop when Kp1 = 20. 10

7. For the given below process, draw the P&ID diagram with suitable control scheme and explain it. 5×4 = 20

(a) Heat Exchanger

(b) Mixing

(c) Evaporator

(d) Drying.