53 (IE 601) PRCN

2018

PROCESS CONTROL

Paper : IE 601

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* Why process control is needed in industry and its advantages? 10

   (b) Explain the mathematical system of thermal systems and derive its transfer function. 10

2. In a speed control system shown in *Fig.*1, the generator field time constant is negligible. It is driven at constant speed giving a generated voltage of *kg volts/field amp*. The motor is separately excited so as to have a counter *emf* of K_b *volts/(rad/sec)*. It produces a torque of K_T *N-m/amp*. The motor inertia and friction is negligible where its load has a moment of inertia J_L *kg-m*^{2} and B_L *N-m/(rad/sec)*. The tachometer has K_t *volts/(rad/sec)* and the amplifier gain is K_A *amps/volt*. Draw the block diagram of this system and determine the transfer function $\omega(s)/E_i(s)$; $J_1 = 5kg - m^2$;
$B_L = 0{\cdot}02\ N - m/(rad/sec)$; $K_A = 5amps/volt$;
$K_T = 1{\cdot}7N - m/amp$; $kg = 40volts/field\ amp$;
$K_t = 0{\cdot}3\ volts/(rad/sec)$; $R_a = 2ohm$;
$K_b = 0{\cdot}5\ volts/(rad/sec)$ 20

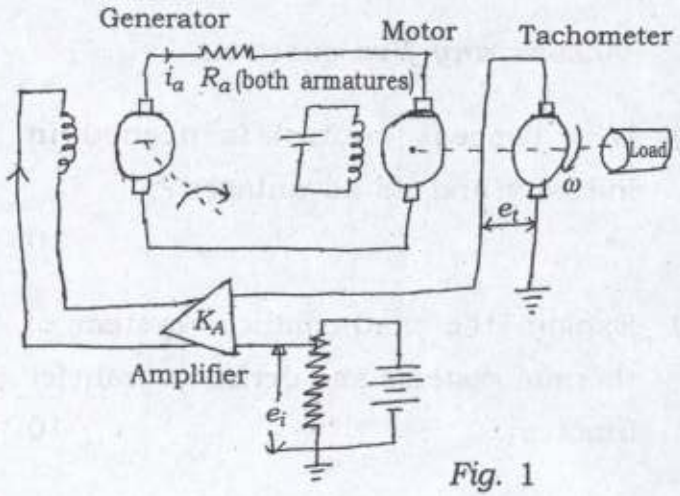

Fig. 1

3. *(a)* Explain about performance characteristics in evaluation criteria and its type in brief. 14

(b) Compare Ziegler-Nichol's method and Cohen-Coon method of tuning the controller ? 6

4. *(a)* What is degree of freedom and give *one* example ? 8

(b) Determine the transfer function $H_4(s)/Q_i(s)$ for the liquid level system shown in *Fig.* 2.
[Resistances R_1, R_2 and R_3 are linear. The flow rate from tank 4 is maintained constant at '*a*' by means of a pump] 12

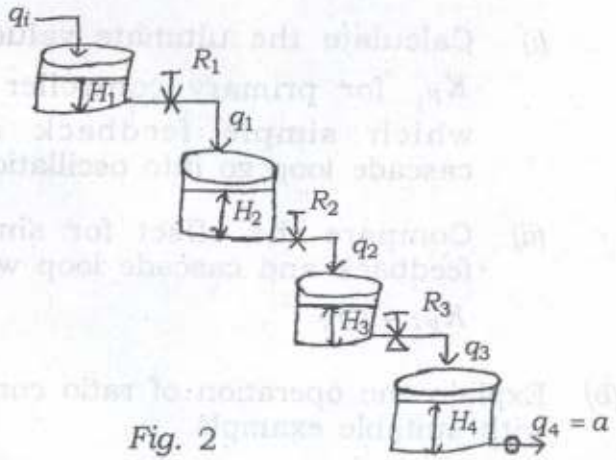

Fig. 2

5. *(a)* Design and derive the gains of Electronic PID controller? 10

(b) Explain the inherent characteristics of control valves and valve sizing? 10

6. *(a)* The transfer function of a cascade system are given as :

$$G_{P_1} = \frac{3}{(4s+1)(3s+1)}; \; G_{P_2} = \frac{3}{s+1}$$

$$G_{12} = \frac{1}{3s+1}; \; G_{C_1} \text{ is a proportional controller's}$$

$$G_{C_2} = 4; \; G_{m_1} = 0{\cdot}05; \; G_{m_2} = 0{\cdot}4$$

(i) Calculate the ultimate value of K_{P_1} for primary controller for which simple feedback and cascade loop go into oscillations.

(ii) Compare the offset for simple feedback and cascade loop when $K_{P_1} = 15$. 12

(b) Explain the operation of ratio control with suitable example. 8

7. Write short notes on the following with *one* example of each : 4×5=20

(a) I/P converter

(b) Heat exchanger

(c) Evaporator

(d) Dryer.
