53 (IE 601) PRCN

2014

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 out of* ***seven.***

1. *(a)* Obtain the block diagram representation of the system for the process shown in *Fig. 1* 8

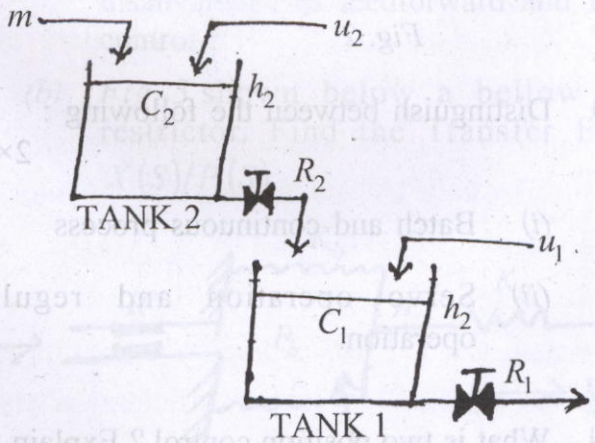

Fig. 1

(b) Find the process variables for the thermal system shown below. 4

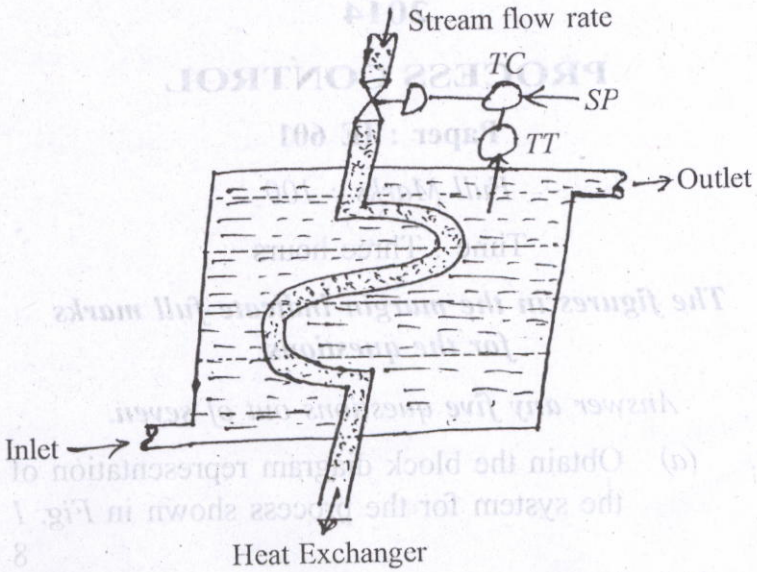

Fig. 2

(c) Distinguish between the following : 2×4=8

(i) Batch and continuous process

(ii) Servo operation and regulator operation.

2. (a) What is two position control ? Explain with suitable example. 5

(b) Give the needs of process control. 3

(c) Derive the Transfer function for PD controller in both electronic and pneumatic system. 12

3. Write short notes on the following : ***(any four)*** 4×5=20

(a) Evaporating

(b) Mixing

(c) Drying

(d) Heat Exchanger

(e) Reactor

(f) Binary distillation column.

4. (a) What are the relative advantage and disadvantage of feedforward and feedback control ? 6

(b) *Fig. 3* shown below a bellow with a restrictor. Find the Transfer Function $X(S)/P_i(S)$ 5

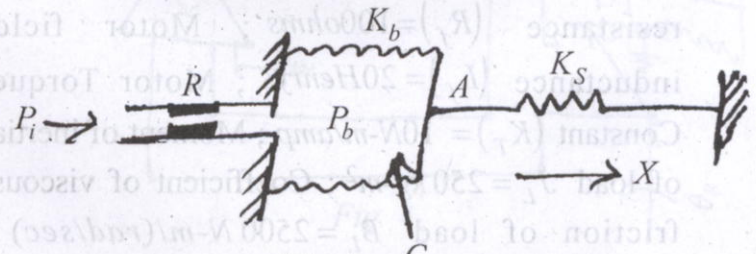

Fig. 3

(c) In an application of the Zieglar-Nichols Method, a process begins oscillation with a 30% proportional band in an 11·5-Min period. Find the nominal three-mode controller settings. 3

(d) Describe the evaluation criteria of Integrals of the square error (ISE), absolute value of the error (IAE) and time-weighted absolute error (ITAE) of the controller settings. 6

5. Consider the positional servomechanism shown in *Fig. 4*. Assume that the input to the system is reference shaft position θ_R and the system output is the load shaft position θ_L. Draw a block diagram of the system indicating the transfer function of each block. Simplify the block diagram to obtain $\theta_L(S)/\theta_R(S)$. The parameters of the system are given below : 20

Sensitivity of error detector $(K_P) = 10\,volts/rad$; Amplifier gain $(K_A) = 50\,volts/amp$; Motor field resistance $(R_f) = 100 ohms$; Motor field inductance $(L_f) = 20 Henrys$; Motor Torque Constant $(K_T) = 10 N\text{-}m/amp$; Moment of inertia of load $J_L = 250\,kg\text{-}m^2$; Coefficient of viscous friction of load $B_L = 2500\,N\text{-}m/(rad/sec)$;

Motor to load gear ratio $\dot{\theta}_L / \dot{\theta}_M = 1/25$; Load to potentiometer gear ratio $\dot{\theta}_P / \dot{\theta}_L = 1$.

Motor inertia and friction are negligible.

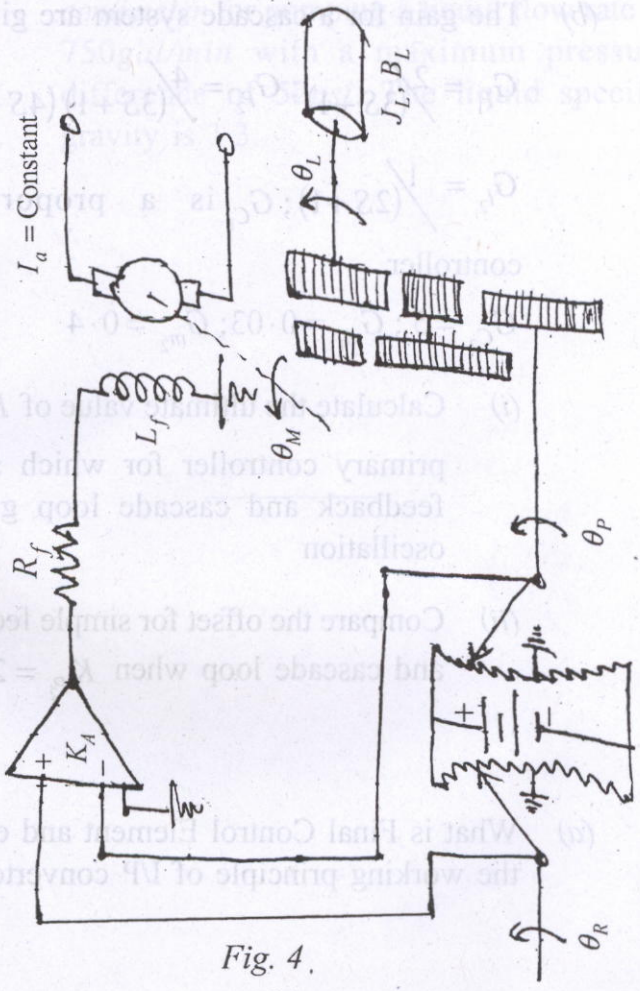

Fig. 4.

6. *(a)* Give the analysis of feed Forward Feedback control loop for its generalized block diagram. 10

(b) The gain for a cascade system are given as

$G_{P_1} = 2/(3S+1)$; $G_{P_2} = 4/(3S+1)(4S+1)$;

$G_{l_2} = 1/(2S+1)$; G_{C_1} is a proportional controller

$G_{C_2} = 5$; $G_{m_1} = 0 \cdot 03$; $G_{m_2} = 0 \cdot 4$

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

(ii) Compare the offset for simple feedback and cascade loop when $K_{P_2} = 20$.

10

7. *(a)* What is Final Control Element and explain the working principle of I/P converter ?

8

(b) Define control valve and give its different characteristics. 8

(c) Find the proper valve size in *inches* or *centimeter* for pumping a liquid flow rate of 750*gal/min* with a maximum pressure difference of 52*psi*. The liquid specific gravity is 1·3. 4