53 (IE 702) INSC

2013

(December)

INSTRUMENTATION SYSTEM COMPONENTS

Paper : IE 702

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* What is Synchro and explain its construction and working principle ? 10

   (b) Give *any two* applications of Synchro with neat diagram. 10

2. *(a)* Derive the Transfer Function for AC Servomotor. 10

   (b) What are the different types of controllers ? Derive its Transfer Function and discuss its advantages and disadvantages. 10

Contd.

3. *(a)* Write short note on Tachogenerator with suitable application. 10

(b) Explain the operating principle of Stepper Motor and draw the driver circuit and logic Translator. 10

4. *(a)* What is the effect of negative Feedback in the performance of closed loop system and explain the Feedback pneumatic load cell. 10

(b) Write the construction and principle of operation of pitot valve and two stage valve in Hydraulic system. 10

5. *Fig : 1* shows a positional control system for controlling the position of a shaft. The potentiometer error detector measures the deviation of the output. Shaft w.r.t reference position θ_r. The error is amplified by means of an amplifier, the output of which is fed to an armature controlled *dc* motor of an amplifier, the output of which is fed to an armature controlled *dc* motor. The motor shaft is coupled to the load shaft through a gear.

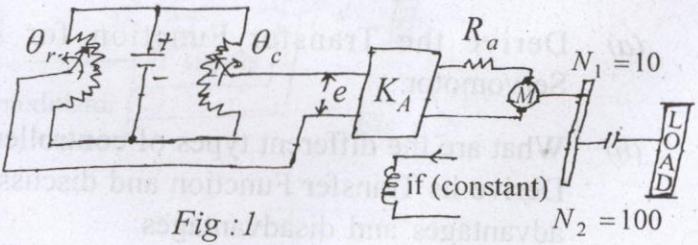

Fig : 1

The system parameters are as follow :

Error detector gain $K_C = 2V/rad$

Amplifier gain $K_A = 10V/V$, $R_a = 0.5\,ohm$; L_a = negligible

Motor Torque constant $K_T = 10 \times 10^{-5}\ Nm/A$

Motor back *emf* constant

$$K_b = 10 \times 10^{-5}\ V/(rad/sec)$$

Equivalent moment of inertia referred to motor side, $J_M = 15 \times 10^{-5}\ K_g - m^2$

Equivalent coefficient of Viscous Friction referred to motor side $F_M = 20 \times 10^{-5}\ NM/(rad/sec)$

Draw the block diagram Function relating the output and input.

6. *(a)* Derive the T. F for PID in pneumatic system and explain it (T.F. = Transfer function) 8

   (b) Explain and draw the equivalent circuit of an two Hydraulic valves. 12

7. An *ac-dc* servo system is shown in *Fig : 2*. The sensitivity of the synchro error detector is $K_S\ Volt/rad$ and the gain of the generator is $K_g\ Volts/Field\ amp$. The *dc* motor is separately excited and has a back *emf* constant of

K_b *Volts / (rad / sec)* and a torque constant of K_T *N–m/amp.* Motor inertia and Friction are negligible. Draw the block diagram of the system indicating the Transfer Function of each block. Obtain $\theta_L(S)/\theta_R(S)$. 20

The system parameters are given below :

$K_S = 30\ volts/rad$; $K_A = 5\ volts/volts$

$R_f = 200\ ohms$; $L_f = 2\ Henrys$

$K_g = 150\ volts/Field\ amp$; $R_a = 2\,ohm$

$K_b = 1 volt/(rad/sec)$; $J_L = 0.5\ kg-m^2$

$B_L = 1\ N-m/(rad/sec)$; $\dot{\theta}_L/\dot{\theta}_M = \dot{\theta}_S/\dot{\theta}_M = 1$

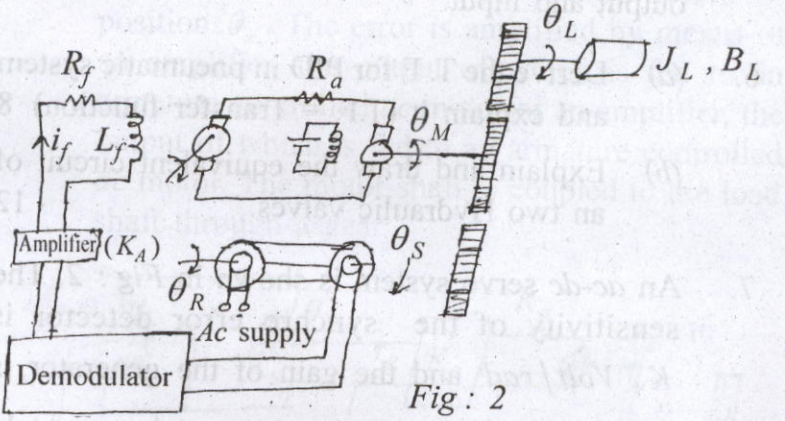

Fig : 2