53 (IE 506) CNTH

2013

(December)

CONTROL THEORY

Paper : IE 506

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

*Answer **any five** questions out of **seven.***

1. *(a)* Explain Automatic Control System with suitable Example ? 10

(b) Write the differential Equation governing the Mechanical system shown in Fig: 1 and determine the Transfer Function. 10

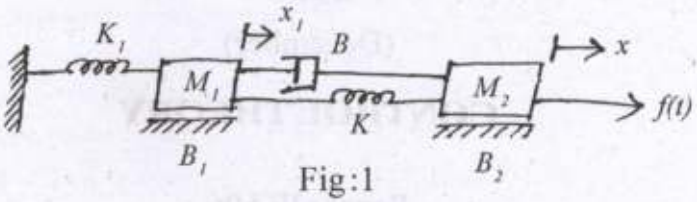

Fig:1

2. (a) Derive the Time Domain response of undamped Second order system for unit step input. 10

(b) The unity Feedback is characterized by an open loop Transfer Function $G(S)=K/S(S+10)$. Determine the gain K_1 so that the system will have a damping ratio of 0.5 for this value of K. Determine settling time, peak overshoot and time at peak overshoot for a unit step input. 10

3. (a) Find the overall gain $C(S)/R(S)$ for the signal flow graph shown in Fig: 2. 10

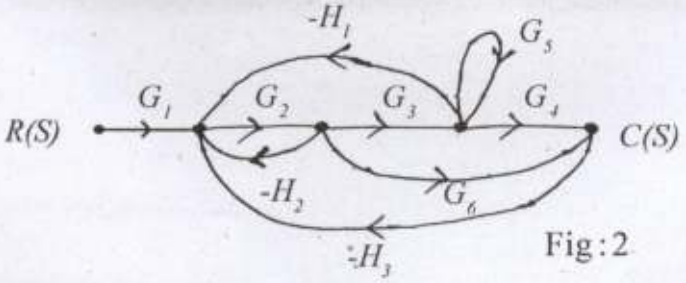

Fig: 2

(b) For the system represented by the block diagram shown in the Fig:3, determine C_2/R_1. 10

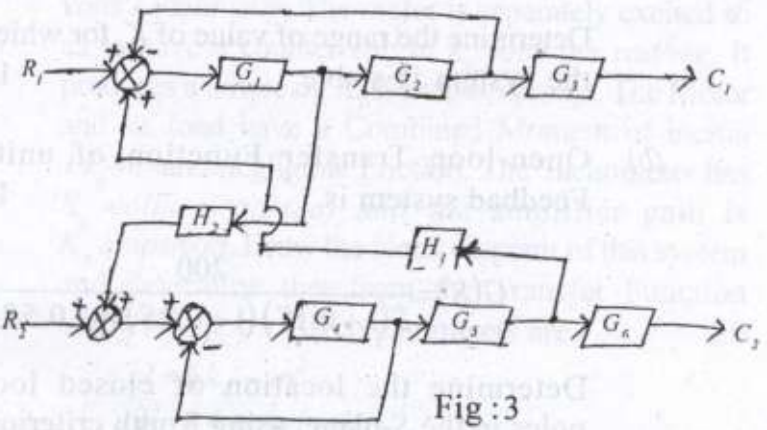

Fig:3

4. (a) For a unity Feedback Control System the open loop Transfer Function, $G(S)=10(S+2)/S^2(S+1)$. Find 10

(i) the position, velocity and acceleration Error Constants.

(ii) the Steady State Error when the input is $R(s)$, where $R(s)=\frac{3}{S}-\frac{2}{S^2}+\frac{1}{3S^3}$.

(b) Define the different types of controllers and give its transfer function, advantages and disadvantages. 10

5. *(a)* The characteristic equation of a Feedback Control system is

$$S^5 + S^4 + KS^3 + S^2 + S + 1 = 0$$

Determine the range of value of K, for which the system is stable 10

(b) Open-loop Transfer Function of unity Feedbad system is, 10

$$G(S) = \frac{200}{S(1+0.1S)(1+0.2S)(1+0.5S)}$$

Determine the location of closed loop poles in the S-plane, using Routh criterion. Comment on the stability of closed loop system.

6. *(a)* Sketch the bode plot of the open loop Transfer Function 15

$$G(S) = 100(1+0.1S)/S(1+0.2S)(1+0.5S)$$

From the plot determine the Phase Margin and Gain Margin.

(b) What are the rules for construction of Root Locus ? 5

7. In the speed control system shown in Fig : 3, the generator Field time Constant is negligible. It is driven at constant speed giving a generated voltage of k_g *volts / Field amp.* The motor is separately excited so as to have a counter *emf* of k_n *volts* per *rad/sec*. It produces a torque of K_T Newton-m/amp. The Motor and its load have a Combined Moment of inertia $J\ k_g\text{-}m^2$ and negligible Friction. 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 therefrom the Transfer Function $w(s)/E_i(s)$. Given parameters are : 20

$J = 6 k_g - m^2$

$K_A = 4\ amp/volt$

$K_T = 1.5\ Newton\ m/amp$

$K_b = 1.5\ Newton\ m/amp$

$k_g = 50\ volts/amp$

$k_t = 0.2\ volts/(rad/sec)$

$R_a = 1\ ohm$

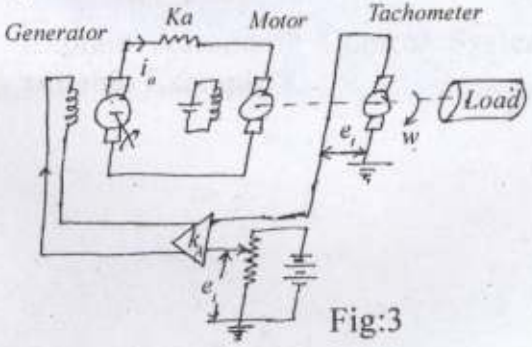

Fig:3