

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2121

Roll No.

--	--	--	--	--	--	--	--	--	--

**B.Tech.**

(SEM. V) ODD SEMESTER THEORY EXAMINATION 2012-13

**CONTROL SYSTEMS—I**

Time : 3 Hours

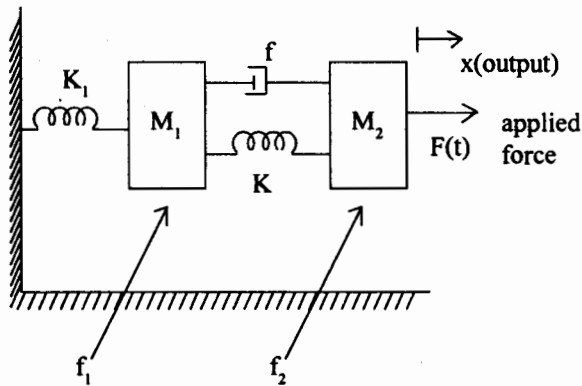
Total Marks : 100

**Note : Attempt ALL questions.**

1. Attempt any four parts :

(4×5=20)

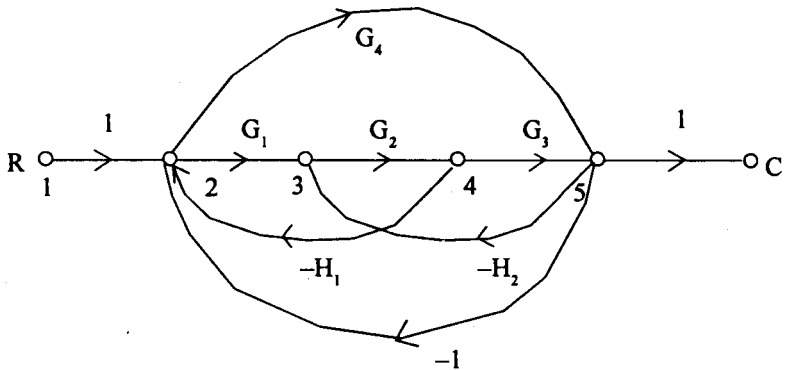
- (a) Obtain the transfer functions of the mechanical systems shown in Figure 1.

**Figure 1**

- (b) Discuss the effect of feedback on the following :

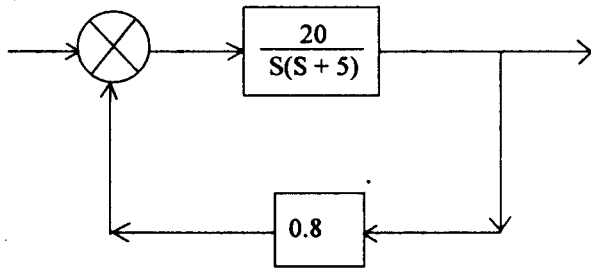
- (i) Sensitivity
- (ii) Stability
- (iii) Error.

- (c) Find the transfer function of the system shown in the Figure 2 using Mason's gain formula.



**Figure 2**

- (d) Compare the open loop control system and closed loop control system.
- (e) Determine the sensitivity of the system given in the Figure 3 with respect to feedback path transfer function at  $\omega = 2.0$  rad/s.



**Figure 3**

- (f) What is the role of sensors and encoders in control system ? Explain the construction and principle of operation of a potentiometer.

2. Attempt any two parts :

(2×10=20)

(a) State equation of a control system is given by :

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix};$$

find the state transition matrix.

(b) For a given transfer function :

$$T(s) = \frac{b_0}{s^3 + a_2s^2 + a_1s + a_0}$$

Obtain the signal flow graph and hence deduce the state model.

(c) Define the following terminology :

(i) State Variables, (ii) State Space.

3. Attempt any two parts :

(2×10=20)

(a) Derive the formula for Peak under shoot, Rise time and Peak time.

(b) A unity feedback system is characterized by the open loop transfer function :

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

Determine the steady state errors for unit step and unit ramp input. Also determine the damping ratio and natural frequency of the dominant roots.

(c) For a general second order systems find the  $c(t)$ , when input is unit step.

4. Attempt any **two** parts : (2×10=20)

- (a) Determine the values of  $K > 0$  and  $a > 0$ , so that system

having  $G(s) = \frac{K(S+1)}{S^3 + aS^2 + 2S + 1}$ ,  $H(s) = 1$ , so that system

oscillates at a frequency 2 rad/s and find the stability of the following polynomial by Hurwitz criterion  $S^5 + 2S^4 + 3S^3 + 6S^2 + 2S + 1$ .

- (b) Discuss the following (i) Stability, (ii) Relative stability, (iii) R-H Criterion.

- (c) The characteristic equation of a servo system is given by :

$$a_0S^4 + a_1S^3 + a_2S^2 + a_3S + a_4 = 0$$

Determine the conditions which must be satisfied by the coefficients of the characteristic equation for the system to be stable.

5. Attempt any **two** parts : (2×10=20)

- (a) Establish the correlation between time response and frequency response analysis and suitably explain with diagrams.

- (b) Draw the Bode plot of the given function :

$$G(j\omega) = \frac{4(1 + j\omega/2)}{j\omega \left( 1 + \frac{j\omega}{10} - \left( \frac{\omega}{10} \right)^2 \right)}$$

- (c) Sketch the Nyquist plot for the following transfer function :

$$G(S) H(S) = \frac{K}{S^2(1 + \tau S)}$$

for  $K > 0$ ,  $\tau > 0$ .