(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.

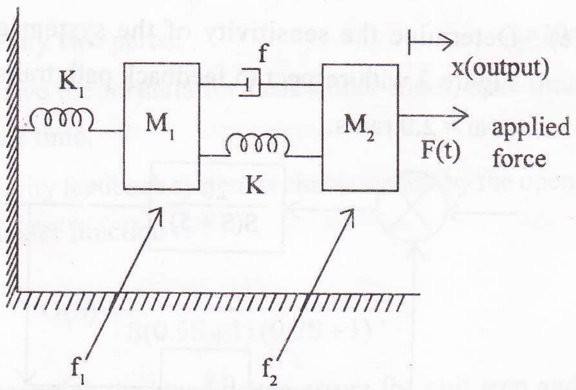

Figure 1

(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.

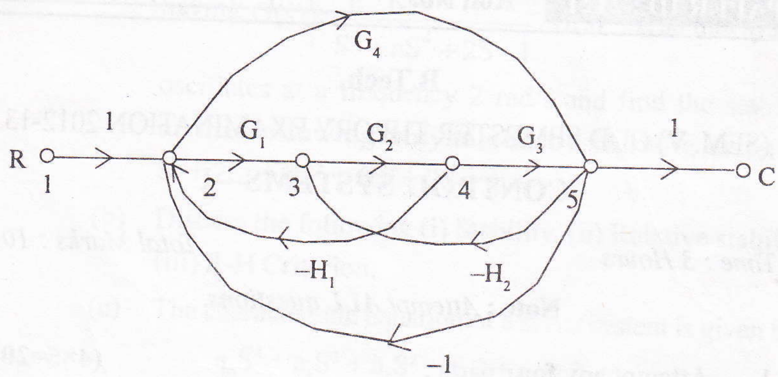

Figure 2

(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.

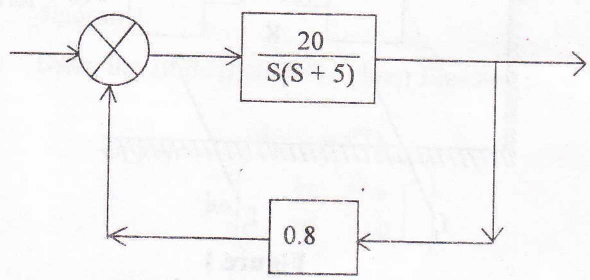

Figure 3

(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 :

$$T(s) = \frac{b_o}{s^3 + a_2 s^2 + a_1 s + a_o}$$

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, τ > 0.