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

PAPER ID : 2112 Roll No.

B.Tech.

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

CONTROL SYSTEM

Time : 3 Hours *Total Marks : 100*

Note : *Attempt **all** the questions.*

1. Attempt any **four** of the following : **(4×5=20)**

   (a) Find the transfer function for armature controlled d.c. motor by mathematical modelling.

   (b) For the system represented by the following equations, find the transfer function X(s)/U(s) by signal flow graph technique :

   $x = x_1 + \beta_3 u,\ x'_1 = -\alpha_1 x_1 + x_2 + \beta_2 u,\ x'_2 = -\alpha_2 x_1 + \beta_1 u$

   (c) Find the sensitivity of the overall transfer function of the system shown in Figure 1 with respect to (i) forward path transfer function, (ii) feedback path transfer function. The value of ω is 1.2 rad/sec.

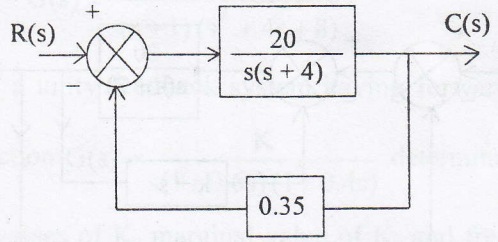

Figure 1

(d) Briefly write about the historical development of control system as a branch of Engineering. Also compare open loop and closed loop control system.

(e) Obtain the transfer function C/R for the block diagram shown in Figure 2.

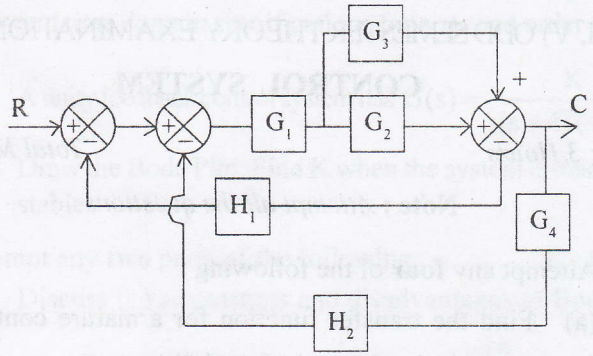

Figure 2

2. Attempt any **four** parts of the following : **(4×5=20)**

(a) Derive the expressions for the rise time (t_r) and peak time for the second order control system.

(b) For a system having $\frac{C(s)}{R(s)} = \frac{20}{s^2 + 7s + 25}$ find its time response specifications and expression for output.

(c) Determine K_t so that $\xi = 0.6$. Find the corresponding time domain specification for system shown in Figure 3.

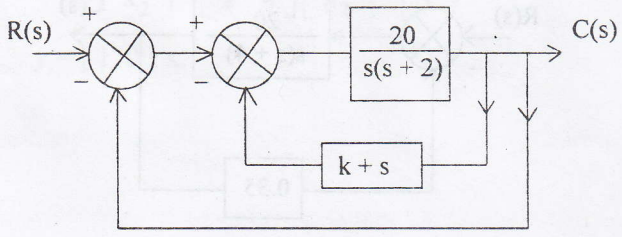

Figure 3

(d) Define the following :

(i) Delay time

(ii) Rise time

(iii) Peak time

(iv) Peak overshoot

(v) Settling time (t_s)

(e) For a system having :

$$G(s)\,H(s) = \frac{k(s+4)}{s(s^3+5s^2+6s)}$$

find :

(i) type of the system

(ii) static error constants

(iii) error due to input $\frac{A}{2}t^2$.

3. Attempt any **two** parts of the following : **(2×10=20)**

(a) Describe the working principle of ac servomotors. Also express its transfer function and draw its characteristics curve.

(b) Sketch the root locus diagram for the feedback control system having following open loop transfer function. Assume K > 0 from 0 to ∞ :

$$G(s) = \frac{K(s+2)}{s(s+1)(s^2+4s+8)}.$$

(c) For a unity feedback system having forward transfer function $G(s) = \frac{K}{s(1+0.6s)(1+0.4s)}$ determine the range of values of K, marginal value of K, and frequency of sustained oscillation.

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

(a) Determine the frequency domain specifications for a second-order system with unity feedback and $G(s)=\frac{225}{s(s+6)}$.

(b) Establish the correlation between the frequency domain and time domain specifications for a second order system.

(c) A unity feedback control system has $G(s)=\frac{K}{s(s+4)(s+10)}$.

Draw the Bode Plot. Find K when the system is marginally stable.

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

(a) Discuss the advantages and disadvantages of Bode Plot.

Also find the polar plot of $G(s)=\frac{14}{s(s+1)(s+2)}$.

(b) Discuss the effects of lead compensation with its limitations. Find the maximum phase shift that can be obtained from lead compensator :

$$G_c(s)=\frac{1+0.12s}{1+0.04s}.$$

(c) Find the controllability and observability of the system described by the state equation :

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}3 & 0\\ 2 & 4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u$$

$y=[\,1\ \ 0\,]\,x.$