Registration No. : | | | | | | | | | | |

Total number of printed pages – 3

B. Tech

PCEI 4303

Sixth Semester Regular Examination – 2014

CONTROL SYSTEMS

BRANCH(S) : AEIE, EIE, IEE

QUESTION CODE : F 216

Full Marks – 70

Time : 3 Hours

Answer Question No. 1 which is compulsory and any ***five*** *from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

(a) Differentiate between linear time-invariant and non-linear time-variant systems.

(b) Define transfer function and impulse response of a system.

(c) The response c (t) of a system is described by the differential equation

$$\frac{d^2c(t)}{dt^2} + 4\frac{dc(t)}{dt} + 5c(t) = 0$$

Determine whether the system response is undamped, underdamped, overdamped, or critically damped.

(d) First column elements of the Routh's tabulation are 3, 5, –3/4, 1/2, 2. How many roots of the characteristic equation lie on the right hand side of the s-plane ?

(e) Define the various static error constants.

(f) What is the slope of the log-magnitude curve in the low-frequency region of a type ')' system ?

(g) Define gain cross over frequency and phase cross over frequency.

P.T.O.

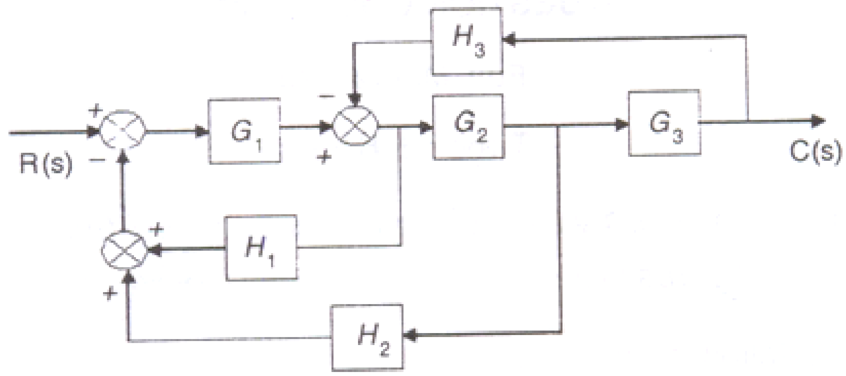
(h) State Nyquist Stability criteria for a system which is both closed-loop and open-loop stable. Is it possible to stabilize an open-loop unstable system by closing the loop ?

(i) What is the utility of an integral controller ?

(j) What is the State Transition Matrix? Enumerate its properties.

2. (a) Draw the block diagram of an armature-controlled d.c. servomotor and determine its transfer function. 5

(b) Determine R(s)/C(s) for the system shown in figure. 5



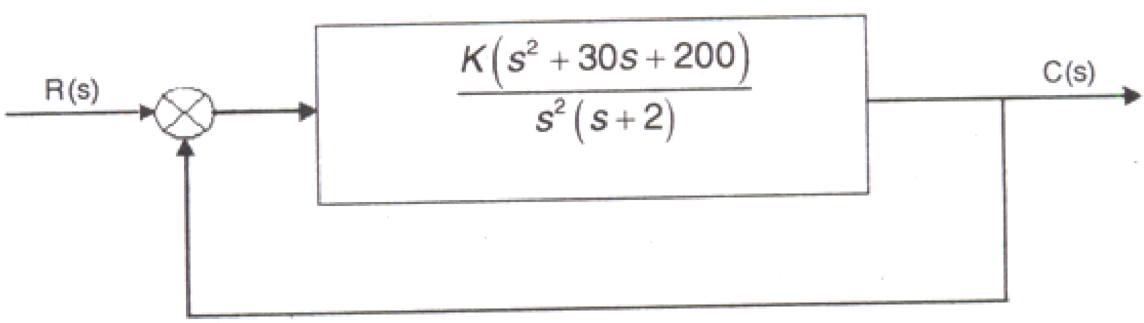
3. (a) Derive the expressions for rise time, peak time and peak overshoot of the response of a second order system to unit step input. 5

(b) Determine the value of gain K for the system whose closed-loop transfer function is

$$T(s) = \frac{K}{s^2 + 5s + K}$$

The response of the system for a unit step input will have 10% overshoot. 5

4. Consider the closed-loop feedback system shown in the figure below. 10



Using Routh-Hurwitz criterion, determine the range of K for which the system is stable. Find also the number of roots of the characteristic equation that are in the right half of the s-plane for K = 0.5.

5. (a) A closed-loop system is described by

$$G(s)H(s) = \frac{K}{s(1+sT_1)(1+sT_2)}$$

Determine the gain margin of the system for $K = 1$, $T_1 = 1$, $T_2 = 1/3$. 5

(b) Sketch the Polar plot for the system having open-loop transfer function

$$G(s) = \frac{1}{s(Ts+1)}$$

How is a polar plot modified when a pole at the origin is added to the original transfer function ? 5

6. (a) Using Nyquist plot, examine the stability of the closed-loop system with 5

$$G(s)H(s) = \frac{s+2}{(s+1)(s-1)}$$

(b) Consider a feedback system with characteristic equation

$$1 + K\frac{1}{s(s+1)(s+2)} = 0$$

How many branches of the root locus move to infinity and in which direction ? Determine the centroid of the asymptotes. 5

7. (a) Obtain the transfer function for the system 5

$$\dot{X} = \begin{bmatrix} 1 & 2 \\ -4 & -3 \end{bmatrix} X + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u$$

(b) Consider the system 5

$$\dddot{y} + 6\ddot{y} + 11\dot{y} + 6y = 6u$$

Obtain a state-space representation of the system in diagonal canonical form.

8. Write short notes on any **two** : 5×2

(a) Stepper Motor

(b) M-circle

(c) Generalised error series

(d) Effects of degenerative feedback on control systems.