Registration No. : [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

Total number of printed pages – 4

B. Tech
PCEI 4303

Sixth Semester Regular / Back Examination – 2015

CONTROL SYSTEMS

BRANCH(S) : AEIE, IEE

QUESTION CODE : J 135

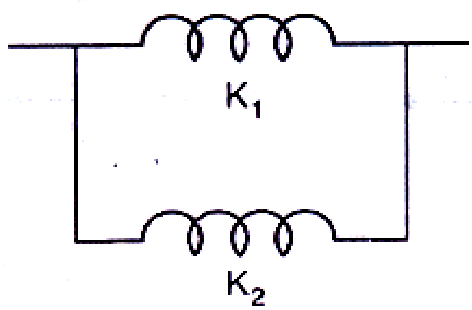
Full Marks – 70

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) Determine the equivalent spring constant for the given system.



(b) What is the sinusoidal transfer function of a system whose response y(t) to an input x(t) is given by the differential equation

$$\frac{d^2y}{dt^2}+5\frac{dy}{dt}+25y=25x$$

(c) What are K_p, K_v and K_a ? Write expressions for them.

(d) Differentiate between 'Type' and 'Order' of a system. What are the advantages and disadvantages of increasing the 'type' of a system ?

(e) Draw a figure to show the 'Electrical zero' positions of a synchro transmitter and a synchro control transformer. What is the function of a synchro transmitter-control transformer pair in an ac Position Control system ?

P.T.O.

(f) The transfer function of a system is given as

$$T(s) = \frac{s+5}{s^2+10s+50}$$

Determine its impulse response.

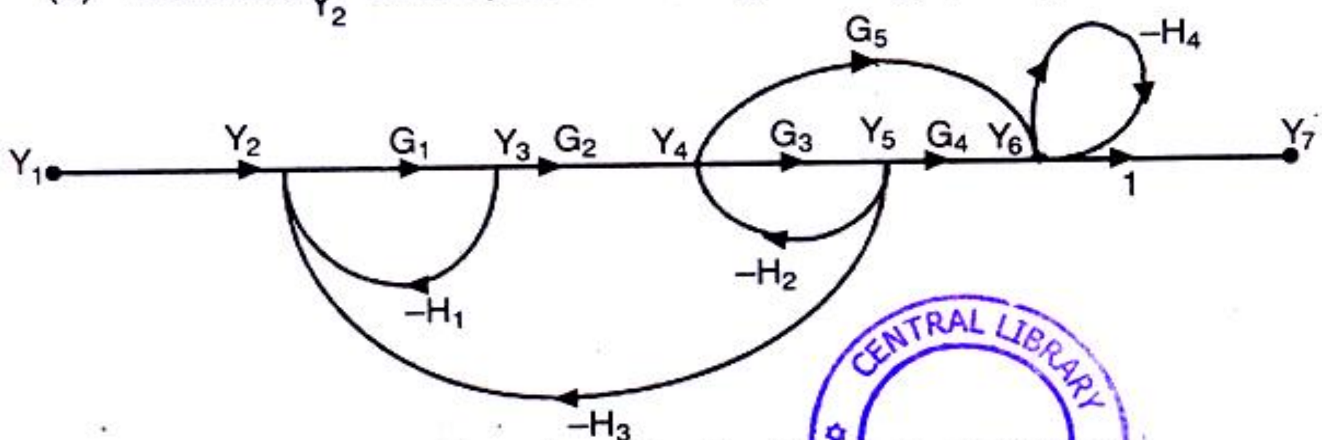
(g) Define the octave and decade frequency ranges. For a first order system, what corrections do you apply to the asymptotic Bode Plot at the corner frequency and the frequencies at one octave above and below the corner frequency ?

(h) What do you mean by dominant closed loop poles ? Why are they named so ? Why do the complex poles and zeroes of a control system always occur in conjugate pairs ?

(i) What are the measures of relative stability in frequency domain? At what frequencies are they determined and why ?

(j) What do you mean by 'State Transition Matrix' ?

2. (a) Calculate $\frac{Y_7}{Y_2}$ of the system whose signal flow graph is given below. 6



(b) (i) The Laplace Transform of a circuit to some excitation is

$$I(s) = \frac{s+3}{(s+1)^2+4}$$

Determine the time domain current i(t). 2

(ii) Write down the expression for Laplace Transform of a transportation lag of 5 sec. 2

3. The open loop transfer function of a unity feedback system is

$$G(s) = \frac{100}{s(s+10)}$$

(a) Find the static error constants and the steady state error of the system when subjected to the polynomial input $r(t) = a_0 + a_1 t + a_2 t^2$ 5

(b) Find the dynamic error using dynamic error coefficients. 5

4. The open loop transfer function of a unity feedback system is given by

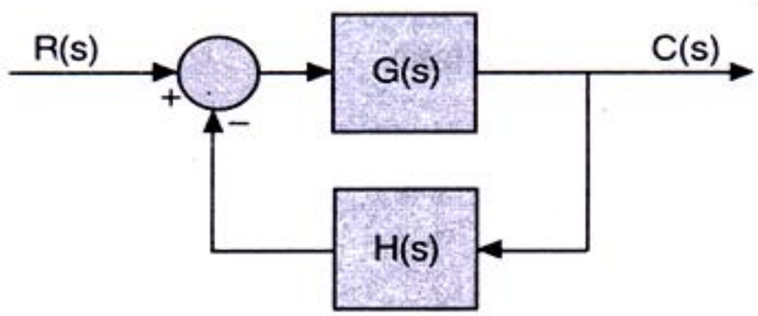
$$G(s) = \frac{K}{s(1 + sT)}$$

Where T and K are constants having positive values. By what factor the amplifier gain be reduced so that,

(a) the peak overshoot of the unit step response of the system is reduced from 75% to 25% ? 5

(b) the damping ration increases from 0.1 to 0.6 ? 5

5. Consider the system shown below. G(s) is given by $(S) = \frac{K}{S^2 (S + 2)}$. 10



Show that the system is unstable for all positive values of the gain K. This system can be stabilized by adding a zero on the negative real axis to modify G(s) to $G_1(s)$ given by $G_1(s) = \frac{K(s+a)}{s^2(s+2)}$. Find the limits on a for stability. Plot root locus of the stabilized system.

6. Sketch the polar plot of the open loop transfer function given below : 10

$$G(s) = \frac{10}{(s+1)(s+3)}$$

Find the frequency at which the plot crosses the negative real axis and the magnitude of $G(j\omega)$ at this frequency.

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

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

$$y = [1 \quad 0 \quad 0] \begin{bmatrix} x_1 \\ x_2 \\ x_2 \end{bmatrix}$$

(b) Find $f(A) = A^4 + 2A^2$, where $A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$ using Cayley Hamilton Technique. 5

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

(a) Sensitivity of Control System

(b) Nyquist Stability Criterion

(c) Stepper Motor

(d) Routh- Hurwitz Stability Criteria.
