**SET-B** AKGEC/IAP/FM/03

# Ajay Kumar Garg Engineering College, Ghaziabad

## Department of ECE

### Pre-University Test

Course: B.Tech
Session: 2019-20
Subject: Control System
Max Marks: 70

Semester: VI
Section: EC-1, 2, 3, EI
Sub. Code: RIC-603
Time: 3Hrs.

***OBE Remarks:***

| Q.No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO No. | CO1 | CO2 | CO3 | CO3 | CO5 | CO4 | CO5 | CO2 | CO1 | CO3 | CO3 | CO1 | CO4 | CO4 | CO5 | CO5 | CO2 |

***Note*** : Answer **all** the sections.

**Section-A**

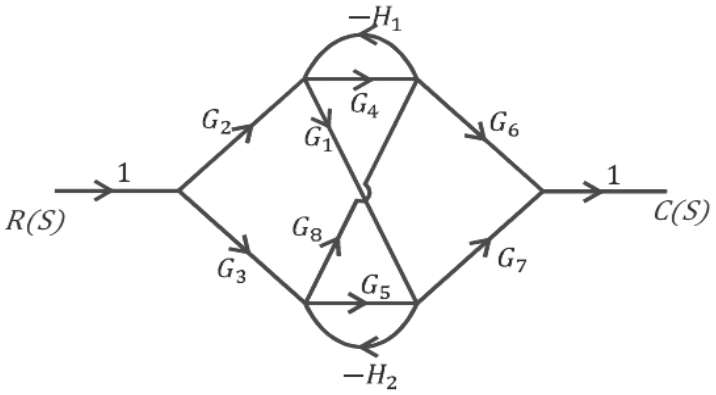
A. Attempt **all** the parts. **(7x2 =14)**

1. Name the analogous electrical elements in Torque – Current analogy for the elements of mechanical rotational systems?
2. Explain Eigen value and Eigen vector.
3. The closed loop transfer function of a system is given by $T(s)=\frac{K(s+6)}{s(s+2)(s+5)(s+7)}$
   Determine i) Poles ii) Zeroes iii) Characteristic Equation
4. What is meant by time response of a control system?
5. Draw the polar plot for $G(s)=s+2$
6. Explain relative and absolute stability.
7. Explain gain margin and phase margin.

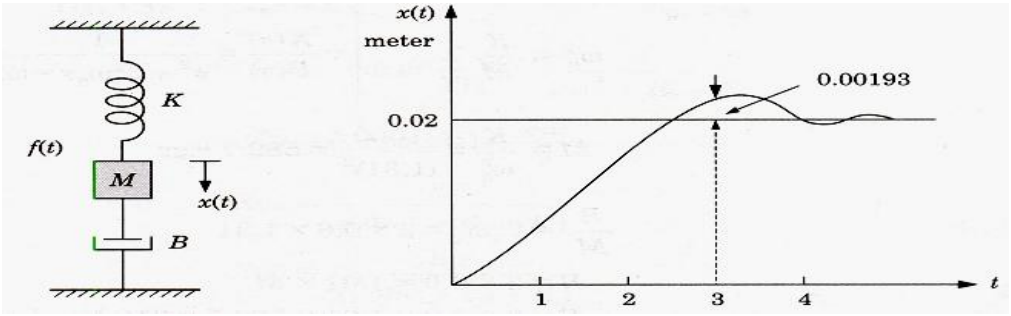
**Section-B**

B. Attempt **Any three**. **(3x7 = 21)**

8. What are the advantages of state space techniques? For the given transfer function obtain the dynamic equations.
   $$G(s)=\frac{y(s)}{u(s)}=\frac{K}{s^3+a_3s^2+a_2s+a_1}$$
9. Define the following SFG terms-
   (a) Forward Path (b) Loop (c) Self loop (d) Non-touching loops
   Find the closed loop transfer function of the given signal flow graph using mason's gain formula.




10. Figure below shows mechanical system and its response when 20N of force is applied to the system. Calculate the value of M and B.




11. Derive the expressions for rise time, peak time and peak overshoot, for a second order system applying to a unit step input? The closed loop transfer function of a second order system is given by $\frac{C(s)}{R(s)} = \frac{25}{(s^2+6s+25)}$ .Determine the output response of given second order system subjected to unit step input
12. Give short note on the following-
    (i) Potentiometer (ii) Tachometer (iii) Field Control DC Motor

**Section-C**

C. Attempt **all** the parts. **(5x7 = 35)**

**13. Attempt any one.**

**a)** Show that the root locii for a control system with $G(s) = K\frac{s^2+6s+10}{s^2+2s+10}, H(s) = 1$ are the arcs of the circle centered at the origin with radius equal to $\sqrt{10}$ .

**b)**The open loop transfer function of a unity feedback control system is given as $G(s) = \frac{K}{s(1+Ts)}$

It is desired that all the roots of the characteristic equation must lie in the region to the left of the line $s = -a$ . Determine the value of K and T required so that there are no roots to right of the line $s = -a$ .

**14. Attempt any one.**

**a)** What are the necessary and sufficient conditions of Routh Hurwitz criterion? Determine the ranges of K such that the characteristics equation $s^3 + 3(K+1)s^2 + (7K+5)s + 4K + 7 = 0$ has roots more negative than s = - 1.

**b)**Sketch the root locus for the open loop transfer function given below and comment on stability:

$$G(s)\,\mathrm{H}(s) = \frac{K}{s(s+3)(s^2+3s+11.25)}$$

15. **Attempt any one.**

**a)** Give frequency domain specifications. Determine the expression for resonant peak and resonant frequency for a second order system.

**b)** Define Nyquist Stability Criterion in detail? Investigate the stability of a closed loop system with open loop transfer function given by $G(s)\,\mathrm{H}(s) = \frac{K}{s(s-1)}$ using Nyquist plot analysis. Also determine the value of Gain margin.

**16. Attempt any one.**

**a)** Draw the bode plot of the unity feedback control system having open loop transfer function $G(s) = \frac{10}{s(1+0.02s)(1+0.2s)}$. Also, determine Gain Margin and Phase Margin and discuss the stability of closed loop system.

**b)** Sketch the polar plot for $G(s) = \frac{100}{s(s^2+10s+100)}$.Also, calculate Gain Margin and Phase Margin of the system.

**17. Attempt any one.**

**a)** A single input single output system is given as

$$\dot{x}(t) = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u$$

$$y = [1 \quad 0 \quad 2]x(t)$$

Test for controllability and observability.

**b)** Give the solution of non-homogeneous state equations. Find the time response of the system described by the equation

$$\dot{x}(t) = \begin{bmatrix} -1 & 1 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$x(0) = \begin{bmatrix} -1 \\ 0 \end{bmatrix}, \quad u(t) = 1, \quad t > 0$$