Q.P. Code: 40741

(3 HOURS) **TOTAL MARKS : 80**

N.B. :
(1) Attempt any **four** questions.
(2) Assumptions made should be **clearly** stated.
(3) Use log/semi-log paper is permitted.

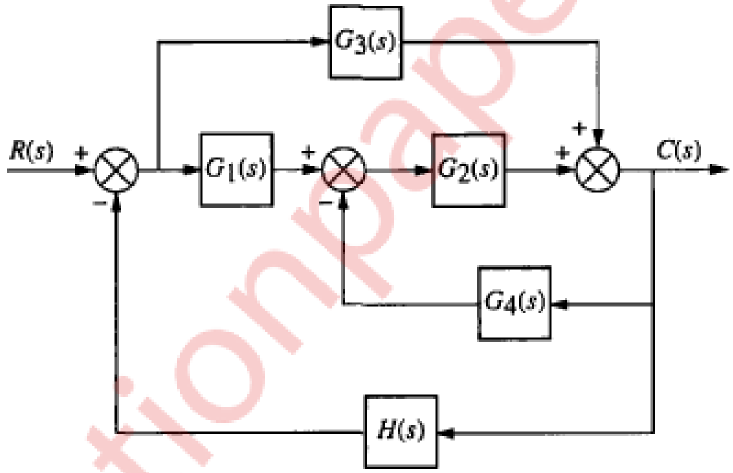
Q.1) (a) The characteristic equation of a system is given by (10)

$$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$$

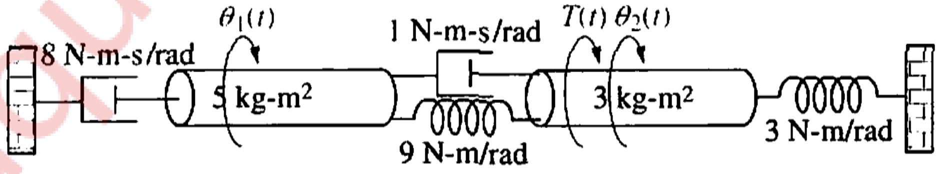
Comment on stability of the system using Routh's rule.

(b) Define and explain with the help of neat diagram, specifications of transient response, such as delay time, rise time, peak time, maximum overshoot and settling time. (10)

Q.2) (a) Simplify the block diagram shown in Figure below and obtain the closed-loop transfer function C(s)/R(s). (10)



(b) Write the differential equations governing the mechanical rotational system shown in figure and determine possible transfer functions. Moment of inertia of rotors are 5 kg m^2 and 3 kg m^2. (10)

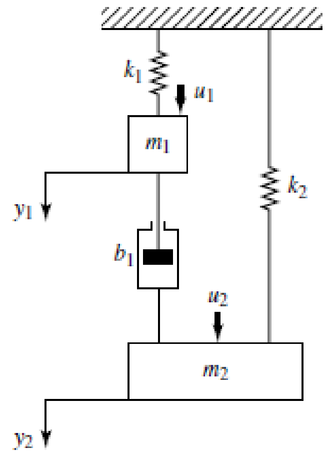


Q.3) (a) In case of the closed loop system whose transfer function is, (10)

$$\frac{G(S)}{R(S)} = \frac{K}{JS^2 + KpS + K}$$

Determine the values of K and p for the 25% maximum overshoot in unit step response and the peak time is 2 sec. Assume J = 1 Kg-m^2.

(b) Obtain a state-space representation of the mechanical system shown in figure below, where u_1 and u_2 are the inputs and y_1 and y_2 are the outputs. (10)



Q.4) (a) Find the transfer function for the following systems represented in state space. (10)

$$[\dot{x}] = \begin{bmatrix} 2 & -3 & -8 \\ 0 & 5 & 3 \\ -3 & -5 & -4 \end{bmatrix}[x] + \begin{bmatrix} 1 \\ 4 \\ 6 \end{bmatrix}[u]$$

$$[y] = [1 \quad 3 \quad 6][x]$$

(b) Sketch the root locus for an open loop transfer function of a control system. (10)

$$G(s)H(s) = \frac{k}{s(s+4)(s^2+4s+10)}$$

Q.5) (a) Sketch the bode plot and determine the gain margin, phase margin, gain crossover frequency and phase crossover frequency for the transfer function. (10)

$$G(s) = \frac{75(1+0.2s)}{s(s^2+16s+100)}$$

(b) For a certain control system $G(s)H(s) = \frac{10}{s(s+6)(s-4)}$. Sketch the Nyquist plot and discuss the stabilty of given system. (10)

Q.6) (a) Linearize the nonlinear equation (10)

$$z = x^2 + 4xy + 6y^2$$

in the region $8 \le x \le 10$, $2 \le y \le 4$. Find the error if the linearized equation is used to calculate the value of z when $x = 9$ and $y = 4$.

(b) (i) Explain Lyapunov stability theory and common nonlinearities in control systems. (05)

(ii) Distinguish between Transfer function and state space representation (05)

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