Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – WINTER • 2014

Subject Code: 160304 Date: 05-12-2014

Subject Name: Bio Medical Control Theory

Time: 02:30 pm - 05:00 pm Total Marks: 70

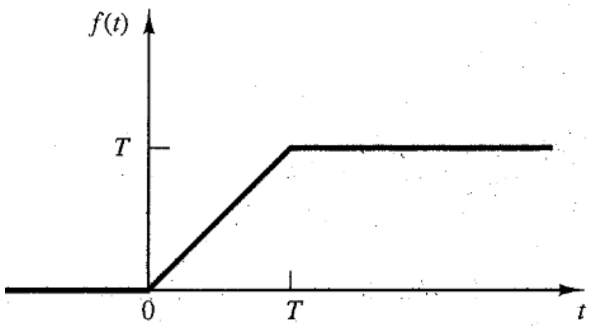
Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

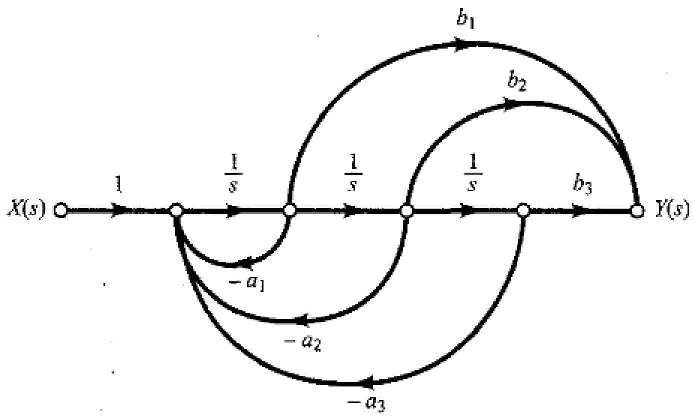
Q.1 **(a)** Find the inverse Laplace transform of F(s), where **07**

$$F(s) = \frac{5(s+2)}{s^2(s+1)(s+3)}$$

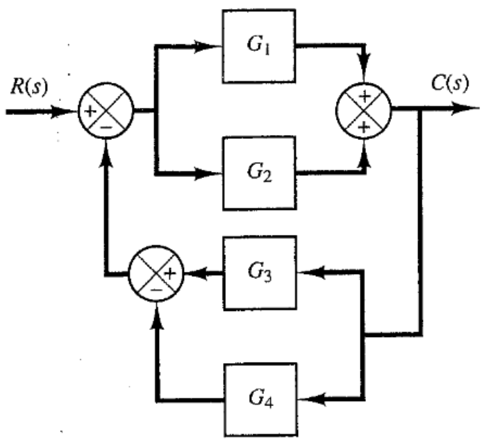
(b) Obtain the Laplace transform of function *f(t)* as shown in below figure. **07**



Q.2 **(a)** Obtain the transfer function Y(s)/X(s) of below given system. **07**



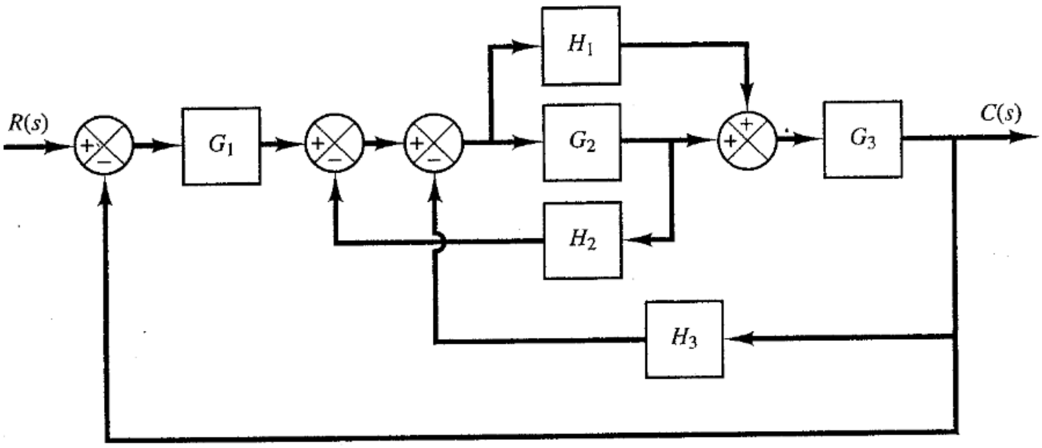
(b) Obtain the close-loop transfer function C(s)/R(s) of given block diagram by reduction technique. **07**



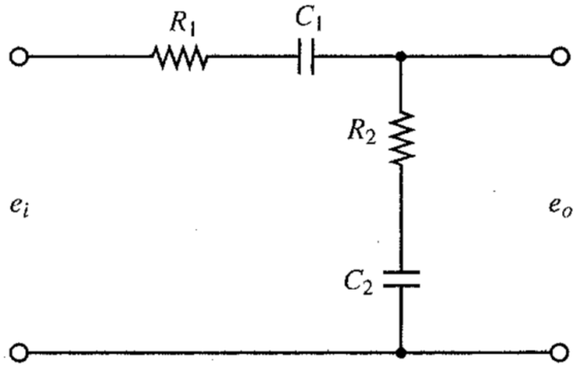
OR

(b) Obtain the close-loop transfer function C(s)/R(s) of given block diagram by **07**

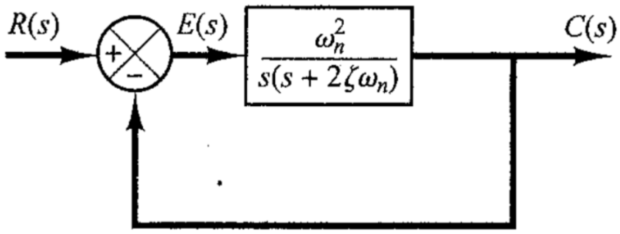
reduction technique.



Q.3 (a) Draw a schematic diagram of an analogous mechanical system and derive the transfer function of below given electrical system. **07**

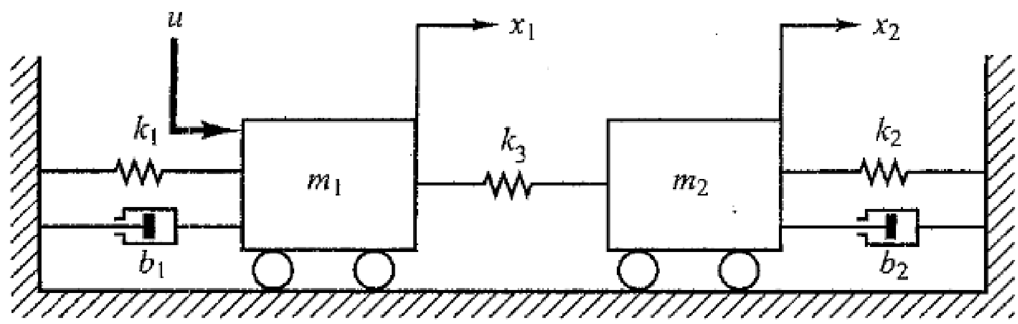


(b) If ζ=0.6 and ω_n = 5 rad/sec, then find the rise time t_r, peak time tp, maximum overshoot M_p, and settling time t_s, when the system is subjected to a unit-step input. **07**

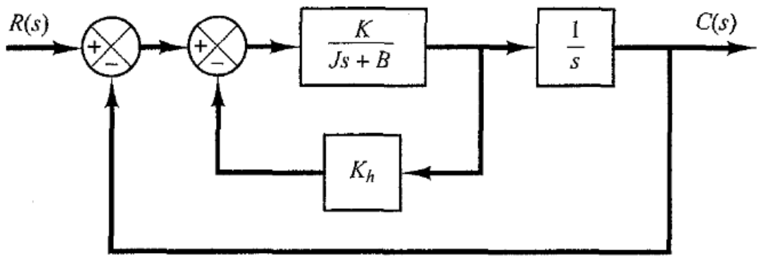


OR

Q.3 (a) Obtain the transfer function $X_1(s)/U(s)$ and $X_2(s)/U(s)$ of the mechanical system. **07**



(b) For below given system, determine the values of gain K and velocity feedback constant K_h, so that the maximum overshoot in the unit-step response is 0.2 and the peak time is 1 sec. With these values of K and K_h, obtain the rise time and settling time. Assume that J = 1 kg-m^2 and B = 1 $\frac{\text{N-m}}{\text{rad/sec}}$. **07**



Q.4 **(a)** Plot root-loci of the unity-feedback control system with the following feed forward transfer function: **07**

$$G(s) = \frac{K}{s(s^2 + 4s + 5)}$$

Also determine closed-loop poles that have the damping ratio of 0.5. Find the gain value K at this point.

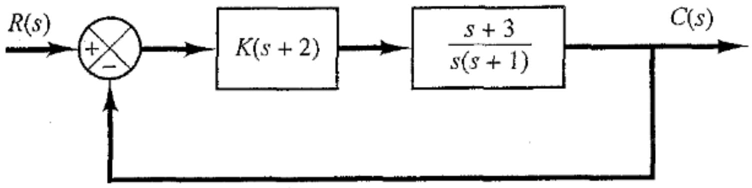
(b) Consider the unity-feedback control system with the following open-loop transfer function: **07**

$$G(s) = \frac{10}{s(s-1)(2s+3)}$$

Comment on stability of the system.

OR

Q.4 **(a)** Sketch the root loci for the below system. (The gain K is assumed to be positive.) Observe that for small or large values of K the system is overdamped and for medium values of K it is underdamped. **07**



(b) Consider the characteristic equation **07**

$$s^4 + 2s^3 + (4+K)s^2 + 9s + 25 = 0$$

Using the Hurwitz stability criterion, determine the range of K for stability.

Q.5 **(a)** Draw a bode plot of the system. **07**

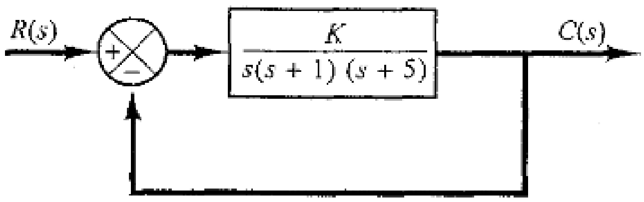
$$G(s) = \frac{10(s^2 + 0.4s + 1)}{s(s^2 + 0.8s + 9)}$$

(b) Draw the Nyquist plot of below given open-loop transfer function. **07**

$$G(s) = \frac{1}{s^2 + 0.8s + 1}$$

OR

Q.5 **(a)** Obtain the phase and gain margins of the system for the two cases where K = 10 and K = 100. **07**



(b) Draw the polar plot and investigate the stability of a closed-loop system with the following open-loop transfer function: **07**

$$G(s)H(s) = \frac{K(s+3)}{s(s-1)} \qquad (K > 1)$$

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