Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY
BE SEM-IV Examination-Nov/Dec-2011

Subject code: 141701 **Date: 30/11/2011**

Subject Name: Control Theory

Time: 02.30 pm -5.00 pm **Total marks: 70**

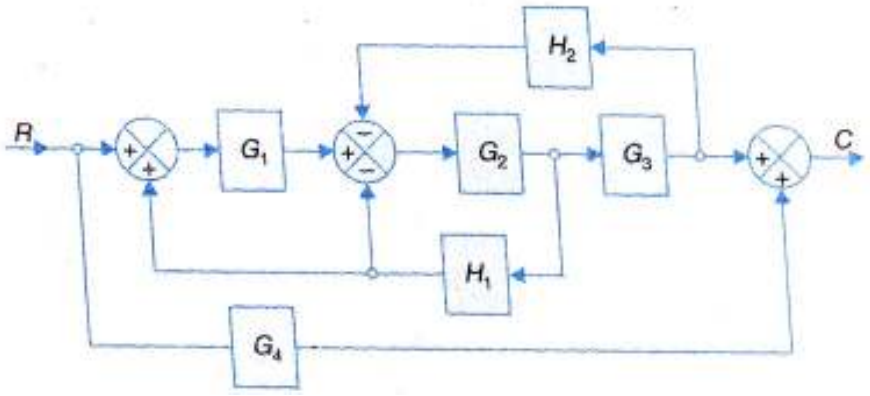
Instructions:

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

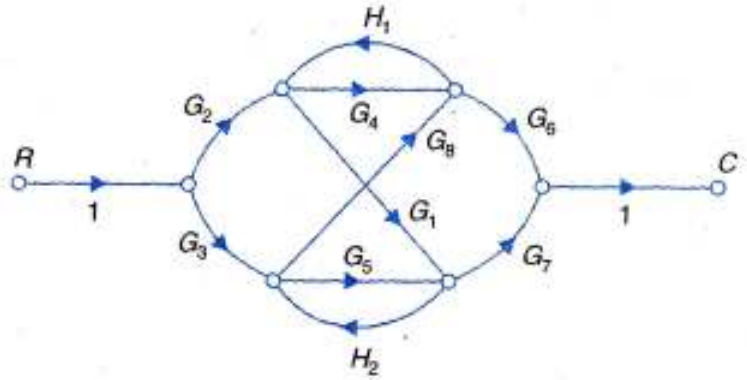
Q.1 **(a)** Explain the difference between Open loop and Close loop control system with examples. Compare their merits and demerits. **07**

(b) Determine the stability of the systems represented by the characteristic equation $s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$ by means of the Routh criterion. Determine the number of roots of the characteristic equation lying in the right half of s-plane. **07**

Q.2 **(a)** Using block diagram reduction technique find the closed loop transfer function of the system whose block diagram is given in figure below. **07**

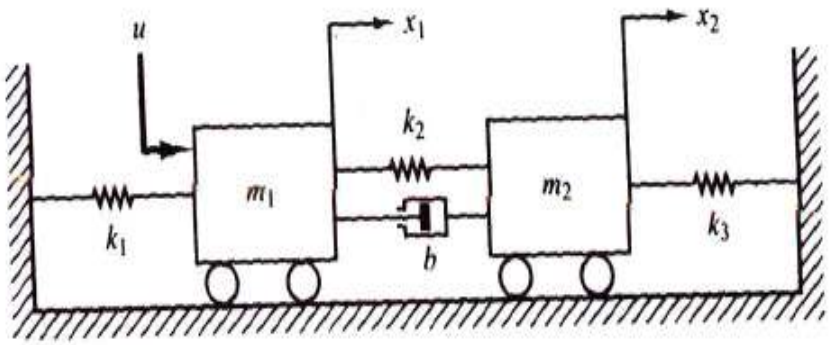


(b) Obtain the overall transfer function C/R of the system whose signal flow graph shown in figure below **07**



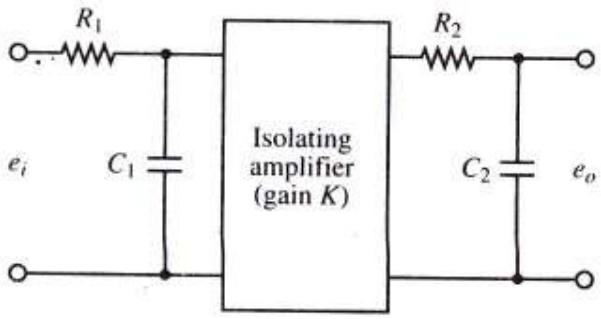
OR

(b) Obtain the transfer function $X_2(s)/U(s)$ of the mechanical system shown in figure. **07**



Q.3 **(a)** Write a note on gear train. **07**

(b) Find the transfer function of the given network **07**



OR

Q.3 **(a)** The open loop transfer function of a unity feed back system is given by $G(s)=\frac{k}{s(Ts+1)}$ where k and T are constants. By what factor should the amplifier gain be reduced so that the peak overshoot of the system is reduced from 75% to 25% ? **05**

(b) A unity feed back system is characterized by open loop transfer function $G(s)=\frac{k}{s(s+10)}$. Determine gain k so that the system will have a damping ratio of 0.5 **05**

(c) Give the names of the analogous quantities in thermal and liquid level systems analogous to charge, current, voltage and resistance in electrical systems? **04**

Q.4 **(a)** A feed back control system has an open loop transfer function $G(s)\,H(s)=\frac{K}{s(s+3)(s^2 2s+2)}$ sketch the root locus as K is varied from 0 to ∞. **14**

OR

Q.4 **(a)** Define the following terms with respect to root locus (I) Centroid (II) Asymptote (III) Angle of departure (IV) Angle of arrival (V) Break away point **05**

(b) The characteristic equation of the system is given by $s^4 + 2s^3 + (4 + k)\,s^2 + 9s + 25 = 0$. Determine the range of k for the system to be stable. **05**

(c) Write notes on "Phase Lag – Lead compensation" **04**

Q.5 **(a)** Explain : (I) Gain Margin (II) Phase Margin **04**
(III) Gain crossover frequency (IV) Phase crossover frequency

(b) Sketch the Bode plots showing the magnitude the decibels and phase angle in degrees as a function of log frequency for the transfer function given below. Determine the gain cross – over frequency ω_e. **10**

$$G(s)=\frac{10}{s(1+0.5s)(1+0.01s)}$$

OR

Q.5 **(a)** Sketch the polar plots of the transfer function given below. Determine whether these plots cross the real axis or not. If yes, determine the frequency and corresponding magnitude. **05**

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

(b) State and explain the Nyquist stability criterion use to determine system stability. **04**

(c) Determine the value of k for a unity feed back control system having open loop transfer function **05**

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

Such that (I) Gain margin 20 db (II) Phase margin 60 db

****