B.TECH/AEIE/5TH SEM/AEIE 3104/2016

CONTROL SYSTEMS
(AEIE 3104)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The damping ratio of the second order system $2d^2y/dt^2 + 4dy/dt + 8y = 8x$ is
(a) 0.1 (b) 0.25 (c) 1 (d) 0.5.

(ii) If the characteristic equation of a system is $(s^2 + s + 16) = 0$, the system is
(a) undamped (b) underdamped
(c) critically damped (d) overdamped.

(iii) The type of a transfer function denotes the number of
(a) zeros at origin (b) poles at infinity
(c) poles at origin (d) none of these.

(iv) A system has a simple pole at origin. Its unit impulse response will be
(a) ramp (b) decaying exponentially
(c) oscillatory (d) constant.

(v) A closed loop system is stable if
(a) GM = -ve & PM=+ve (b) GM= +ve & PM= +ve
(c) GM= -ve & PM= -ve (d) GM= +ve & PM= -ve.

(vi) A second order system exhibits 100% overshoot. Its damping ratio is
(a) 1 (b) less than 1 (c) greater than 1 (d) 0.

(vii) For the unit step response of a system having closed loop transfer function $4 / (s^2 + 8s + 4)$, the settling time on 2% basis is
(a) 1.86 sec (b) 4 sec (c) 1 sec (d) 2.86 sec.

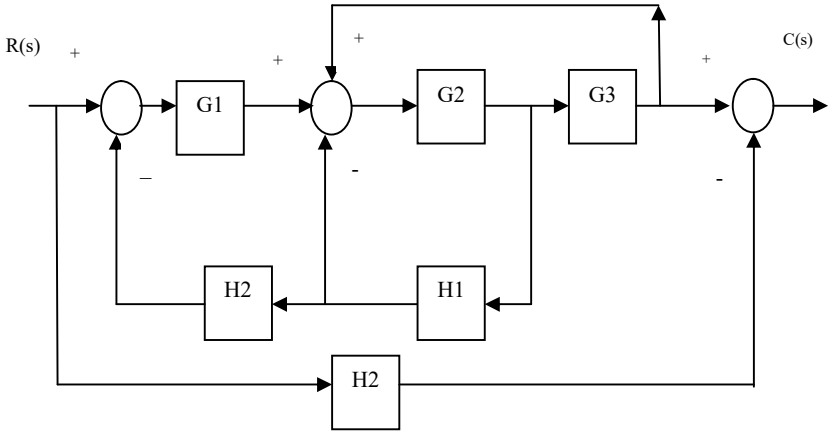
(viii) The root locus of a system has three asymptotes. The system can have
(a) 5 poles and 2 zeros (b) 3 poles and 1 zero
(c) 4 poles and 2 zeros (d) 6 poles and 2 zeros.

(ix) The Routh-Hurwitz criteria gives
(a) absolute stability (b) gain margin
(c) phase margin (d) none of these.

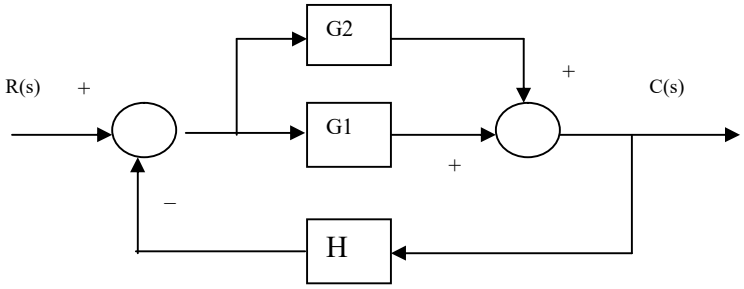
(x) The phase margin of a system is used to specify
(a) frequency response (b) absolute stability
(c) time response (d) relative stability.

Group – B

2. (a) Find the overall transfer function of a system having the following block diagram using block reduction technique.



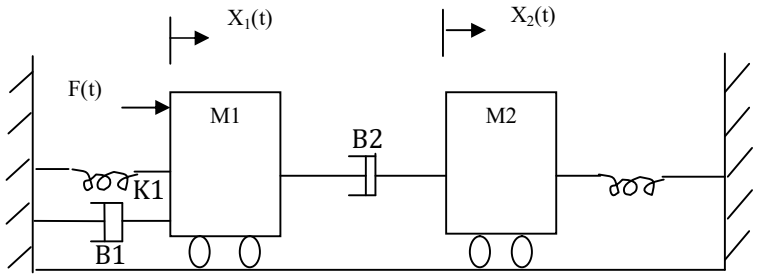
(b)



Draw the signal flow graph of the above block diagram and find the overall transfer function of the system using Mason's gain formula.

7 + 5 = 12

3. (a)



For the above mechanical system find out $X_2(s)$ / $F(s)$ considering fc_1 and fc_2 as the frictional coefficients for the mass M1 and M2.

(b) A system matrix A is given by $A = \begin{bmatrix} -1.8124 & -0.2324 \\ 9.6837 & 1.4697 \end{bmatrix}$

Find the stability of the system.

7 + 5 = 12

Group – C

4. (a) Write a short note on field controlled dc servomotor.

(b) Derive the expression for the unit step response of a first order negative unity feedback system having open loop transfer function G(s) = 1 / sT, where T is the time constant of the system. Hence draw the response and find the steady state value.

7 + 5 = 12

5. (a) Derive the expression for the unit step response of a second order negative feedback system having open loop transfer function $G(s) = \frac{W_n^2}{s(s+2d\,W_n)}$, where d is the damping ratio & W_n is the natural frequency of oscillations.

(b) For the above system find the expression for peak time and maximum percentage peak overshoot.

7 + 5 = 12

Group – D

6. (a) For a unity negative feedback system having open loop transfer function $G(s) = K(s + 1) / [s^3 + as^2 + 2s + 1]$, determine the values of K and 'a' so that the given system oscillates at a frequency of 4 rad/sec.

(b) The open loop transfer function of a unity feedback control system is given by $G(s) = K / [s (sT_1 + 1)(sT_2 + 1)]$. Find the value of K in terms of T_1 & T_2 so that the system is stable.

7 + 5 = 12

7. For the system having open loop transfer function $G(s) = K / [s (s + 4) (s^2 + 4s + 13)]$, sketch the root locus plot by finding out the required parameters. Hence comment on the stability of the above system.

(10 + 2) =12

Group – E

8. (a) Construct the Bode plot for a unity feedback control system having open loop transfer function $G(s) = 10^7 / [s (s + 10) (s + 1000)]$.

(b) From the plot obtain the gain margin, phase margin, gain cross-over frequency and phase cross-over frequency. Hence comment on the stability of the system.

7 + 5 = 12

9. Sketch the Nyquist plot for a unity feedback system having open loop transfer function $G(s) = 5 /[s(s + 1) (s + 2)]$. Hence comment on the closed loop stability of the system.

(10 + 2) = 12