7. (a) A unity feedback system having open loop transfer function $G(s) = k/\left[s(s^2+8s+32)\right]$, Calculate all the parameters required to sketch the root locus plot.

   (b) From the plot, find the stable and unstable region.

10 + 2 = 12

Group - E

8. (a) Construct the Bode plot for a unity feedback control system having open loop transfer function G(s) = 640(s+2) / [s^2(s+8)(s+10)].

   (b) From the above plot find 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. (a) Sketch the Nyquist plot for a unity feedback system having open loop transfer function $G(s) = k/\left[s(Ts+1)\right]$.

   (b) Is it possible to find the condition of stability form the above Nyquist plot? Justify your answer.

10 + 2 = 12

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 steady state error for a type 2 system subjected to a unit ramp input is
   (a) 2 (b) 0 (c)infinity (d) 1.

   (ii) A unity feedback system has open loop transfer function G(s) =k /[s(s+1)(s+3)]. The breakaway point of the root locus plot is -0.45. The open loop gain k of the system at the breakaway point is
   (a) 1 (b) 0.63 (c)0.82 (d) 3.

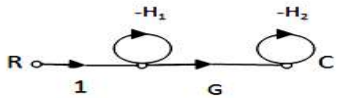
   (iii) The initial slope of Bode plot for a transfer function having simple pole at origin is
   (a) -40db/dec (b) -20db/dec (c)+20db/dec (d) +40db/dec.

   (iv) A system has a pole at s=0. The unit step response of it
   (a) linearly increases with time
   (b) exponentially increases with time
   (c) exponentially decreases with time
   (d) linearly decreases with time.

   (v) A unity feedback system has open loop transfer function G(s) = 5/[(s +2)(s+3)]. The intercept of the polar plot of this system with the negative real axis is
   (a) 5 (b) 0.5 (c) 0 (d) 1.5.

   (vi) If for a system gain margin = 5.5 dB and phase margin = 30°, the system is
   (a) unstable (b) stable
   (c) marginally stable (d) none of these.

(vii)



The overall transmittance C/R of the above system is

(a) G (b) $G/(1+H_2)$

(c) $G/[(1+H_1)(1+H_2)]$ (d) $G/(1+H_1+H_2)$.

(viii) A unity feedback system has open loop transfer function $G(s) = 5 / [s^2(s+3)]$. The polar plot of this system terminates with

(a) magnitude 5, phase -180^o (b) magnitude 0, phase -180^o

(c) magnitude 0, phase -270^o (d) magnitude 5, phase -270^o.

(ix) The phase margin of a system is used to specify

(a) frequency response (b) relative stability

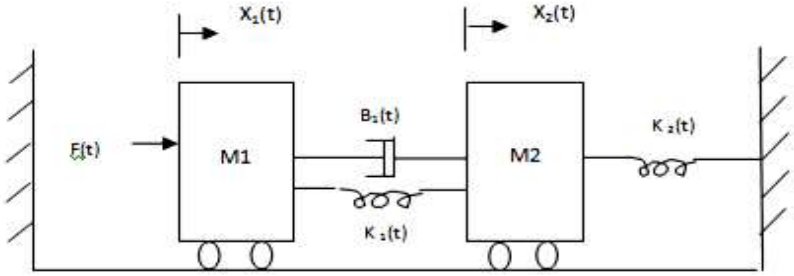
(c) absolute stability (d) time response.

(x) The unit step response of a control system is $c(t)= 1- e^{-10t}$. The transfer function of the system is

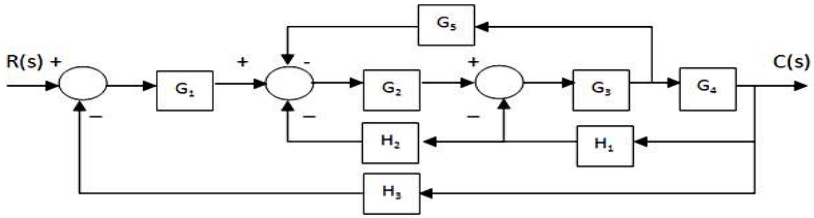
(a) 10/(S+10) (b) (S-10)/(S+1) (c) (1-S)/(S+10) (d) 10/[S(S+10)].

Group - B

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



(b)



Find the overall transfer function of the system for the given block diagram using block reduction technique.

6 + 6 = 12

3. (a) In the state space model of a system, matrix $A=\begin{bmatrix} -1.1680 & -0.0886 \\ 2.0030 & -0.2443 \end{bmatrix}$

Find the stability of the system.

(b) In the state variable model of a linear time invariant system, matrix

$A=\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$; $B=\begin{bmatrix} 0 \\ 1 \end{bmatrix}$; $C=[1 \quad 0]$; D=0

Check the controllability and observability of the system.

5 + 7 = 12

Group - C

4. (a) Find out the overall transfer function of armature controlled dc servo motor considering angular shift of the shaft as output and applied voltage to the armature as input.

(b) Derive the expression for the unit step response of a second order negative feedback system having open loop transfer function

$$G(s) = \frac{Wn^2}{s(s + 2d\,Wn\ )}$$

Where d is the damping ratio & w_n is the natural frequency of oscillations.

6 + 6 = 12

5. (a) A second order system has damping ratio 1.25, natural frequency of oscillation 200 rad/sec and dc gain k=1. Find the unit step response of the system. Also find the settling time of the system.

(b) A second order system is defined by the differential equation,

$4\frac{d^2c(t)}{dt^2}+8\frac{dc(t)}{dt}+25c(t)=25r(t)$. Find the rise time, peak time, percentage peak overshoot and settling time for the unit step input to the system.

(5 + 2) + 5 = 12

Group - D

6. (a) A negative feedback control system has forward path transfer function ,G(s) = k/[s(s+5) +T] and feedback path transfer function H(s) = 1/s . Using Routh Hurwitz criteria determine the relation between k and T so that the system is stable.

(b) For a unity feedback system the forward path transfer function is given by $k(s+2) / (s^3 + as^2 + 4s +1)$. Determine the value of k & a so that the given system oscillates at a frequency of 3 rad/sec.

6 + 6 = 12