(vi) In a type 1, second order system , the first undershoot occurs at a time
(a) $t_p=\pi/w_d$ (b) $t_p=2\pi/w_d$
(c) $t_p=\pi/2w_d$ (d) $t_p= w_d /2\pi$.

(vii) Derivative feedback control
(a) increases the rise time
(b) increases the overshoot
(c) increases the steady state error
(d) does not affect the steady state error.

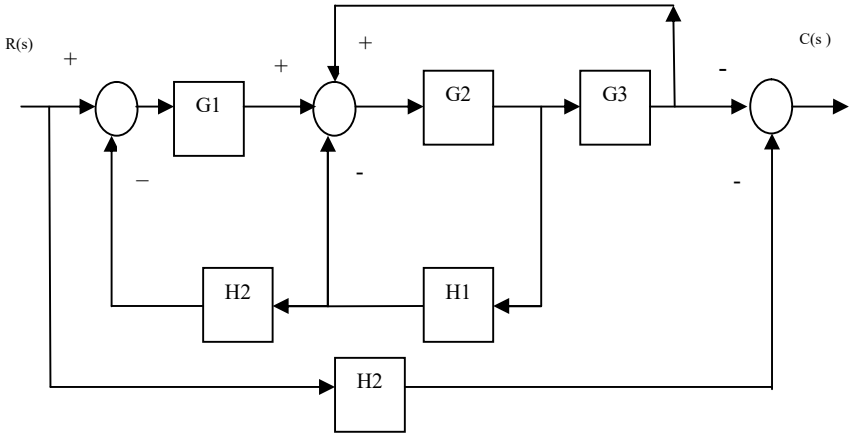
(viii) If a system has non repeated poles on the jw axis, using Routh-Hurwitz criteria, the system will be
(a) stable (b) unstable
(c) marginally stable (d) conditionally stable.

(ix) The unit step response of a control system is $c(t)= 1 – e^{-8t}$. The transfer function of the system is
(a) 8 / (S+1) (b) (8S)/(S+1)
(c) 8(8+S)/S (d) 8 / S(S+1)

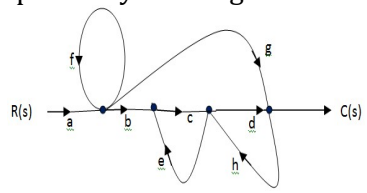
(x) The initial slope of Bode plot for a transfer function having simple zero at origin is
(a) -40db/dec (b) -20db/dec
(c) +20db/dec (d) +40db/dec.

Group – B

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



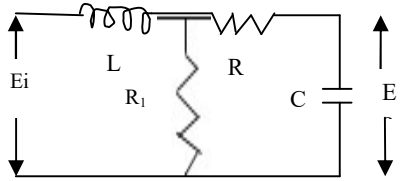
(b) The signal flow graph of a system is given below:



Find the overall tranfer function using MASON'S gain formula.

7 + 5 = 12

3. (a) Circuit diagram of an electrical system is given below:



(i) Find the transfer function of the given electrical system.
(ii) Draw the block diagram.

(b) What are the advantages of negative feedback?

(4 + 6) + 2 = 12

Group – C

4. (a) 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.

(b) For the unit step response of a unity feedback control system whose open loop transfer function is G(s) = 1/[s(s+1)], (i) find the rise time (t_r), peak time (t_p), percentage peak overshoot (%Mp) and settling time (t_s) on 2% basis. (ii) Also find the steady state errors (e_{ss}) when unit step and unit parabolic inputs are applied to it. Are both the given inputs acceptable for the given system? Explain with reason.

6 + 6 = 12

5. (a) The percentage peak overshoot and the peak time of a second order system are 15% and 0.25 secs respectively. Find the poles of the second order system.

(b) The output response c(t) of a system when subjected to a unit step input is given by, $c(t) = 1 + 0.2e^{-20t} - 1.2e^{-30t}$

(i) Obtain the closed loop transfer function of the system.
(ii) Determine the natural frequency and damping ratio of the system.

4 + (4 + 4) = 12

Group – D

6. (a) The characteristic equation of a feedback control system is given by $s^3 + 5s^2 + 7s + K = 0$. Determine the range of K for the system to be stable using Routh- Hurwitz criteria. Also find the frequency of sustained oscillations for the system to be marginally stable.

   (b) For a unity feedback system open loop transfer function is
   $G(s) = K(S+6) / (S+3)(S+5)$
   Find the breakaway point and break in point using root locus plot.

6 + 6 = 12

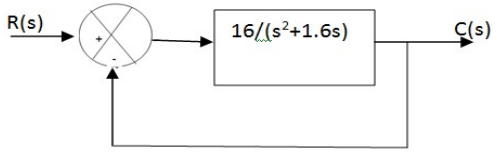
7. Construct the Bode plot for a unity feedback control system having open loop transfer function $G(s) = 10^7 / [S(S + 10)(S + 1000)]$.

   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.

12

Group – E

8. A unity feedback control system is shown in figure below. By using derivative control in the feedback path, the damping ration is to be made 0.8. Determine the value of T_d and compare the rise time, peak time and maximum overshoot.
   (i) without derivative control
   (ii) with derivative control



5 + 7 = 12

9. (a) Write a short note on field controlled D.C motor.

   (b) Design an electronic PID controller and find its transfer function.

6 + 6 = 12

CONTROL SYSTEMS AND APPLICATIONS
(AEIE 4282)

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

Figures out of the right margin indicate full marks.

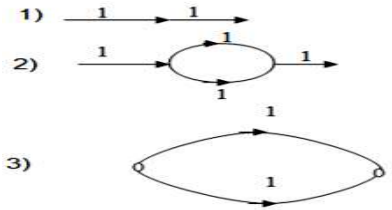
Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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) Consider the following graphs shown below. Which of the graph has the overall transfer function 2?



   (a) 1 (b) 2 (c) 2 and 3 (d) 1, 2 and 3.

   (ii) If the gain K of the system increases , the steady state error of the system
   (a) decreases (b) increases
   (c) may increases or decreases (d) remains unaltered.

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

   (iv) The transfer function is defined for
   (a) linear and time variant system
   (b) linear and time invariant system
   (c) nonlinear and time invariant system
   (d) all of these.

   (v) Signal flow graph is a
   (a) topological representation of asset of differential equation
   (b) bode plot
   (c) polar plot
   (d) none of these.