(b) From the plot obtain the gain margin, phase margin, gain cross-over frequency and phase cross-over frequency.

(c) Analyze the above parameters to conclude on the stability of the system.

6 + 4 + 2 = 12

Group – E

8. (a) A unity feedback control system having open loop gain $G(S) = \frac{20}{(S+1)(s+5)}$. Make a comparative study of the system performance with and without derivative feedback control for the following parameters:
   (i) rise time
   (ii) percentage overshoot (%OS) and
   (iii) steady state error (for unit ramp input)

   (b) A process is inherently oscillatory in nature. Suggest a suitable controller for the system with proper explanation.

10 + 2 = 12

9. (a) Explain the working principle of an armature controlled D.C motor with block diagram and derive the transfer function.

   (b) Design a PI controller using electronic components like resistance and capacitance.

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)

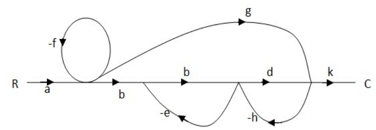
1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) A system is stable
(a) if bounded inputs produce bounded outputs
(b) if bounded inputs produce unbounded outputs
(c) if bounded inputs produce unbounded outputs
(d) if all bounded inputs produce bounded outputs.

(ii) The characteristics of a second order system is $S^2 + 6S + 25 = 0$, the system is
(a) underdamped (b) overdamped
(c) undamped (d) critically damped.

(iii) The type of a transfer function denotes the number of
(a) zeros at origin (b) poles at infinity
(c) poles at origin (d) finite poles.

(iv) Find the Δ using Mason's gain formula for the above signal flow graph



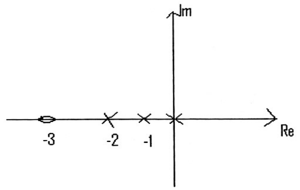
(a) Δ = -f – ce - dh (b) Δ = 1 - f – ce - dh
(c) Δ = 1 + f + ce + dh + fce + fdh (d) Δ = 1 - f – ce – dh - fce - fdh.

(v) Repeated roots on the imaginary axis makes the system
(a) absolutely stable (b) unstable
(c) marginally stable (d) stable.

(vi) In case of Bode Plot, the system is stable if
(a) PM = GM (b) PM & GM both are positive
(c) PM & GM both are negative (d) PM negative but GM positive.

(vii) The unit step response of 2nd order underdamped system exhibits the peak overshoot of 15%. If the magnitude of the input is doubled, the peak overshoot will be
(a) 30% (b) 15% (c) 7.5% (d) none of these.

(viii) The forward path gain is 5, pole-zero configuration of a overall transfer function is shown in above figure. So the overall transfer function will be



(a) $\frac{5(S+3)}{S(S+1)(S+2)}$ (b) $\frac{5(S+1)(S+2)}{S(S+3)}$
(c) $\frac{5(S+3)}{(S+2)(S+1)}$ (d) $\frac{5S(S+3)}{(S+1)(S+2)}$.

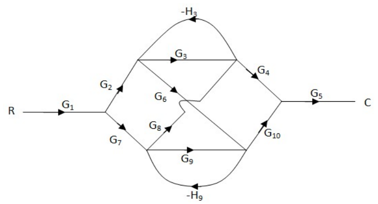
(ix) The initial slope of Bode plot for a transfer function having single pole at origin is
(a) -40db/dec (b) -20db/dec
(c) +20db/dec (d) +40db/dec.

(x) The term 'reset control' refers to
(a) integral control (b) proportional control
(c) derivative control (d) on-off control.

Group – B

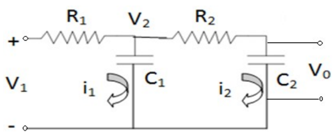
2. (a) What is 'Analogous system'? Explain 'Force-Voltage Analogy', and 'force current analogy' in brief with the example of mass damper spring system.

(b) Find the overall tranfer function (C/R) of the above signal flow graph using MASON'S gain formula.



5 + 7 = 12

3. In the above RC circuit, V_1 and Vo are the input and output voltage respectively.



(i) Draw the block diagram of the above RC circuit.
(ii) Derive the transfer function, $\frac{V_o(s)}{V_1(s)}$ from the block diagram.

(iii) Also find the overall transfer function using MASON'S gain formula.

(3 + 4 + 5) = 12

Group – C

4. (a) Derive the expression for the unit step response of a second order unity gain negative feedback system having open loop transfer function $G(S) = \frac{W_n^2}{S(S+2\zeta W_n)}$.
Where ζ 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

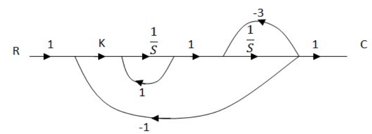
5. (a) $G(S) = \frac{K}{S(TS+1)}$
The open loop transfer function of a unity feedback control system is given by the above G(S). By what factor the amplifier gain K should be multiplied so that the damping ratio is increased from 0.3 to 0.9.

(b) The closed loop transfer function of a unity negative feedback control system is given by $\frac{C(S)}{R(S)} = \frac{Ks+b}{s(s+a)+b}$. Determine the open loop transfer function of the system. Show that the steady state error (e_{ss}) with unit ramp input will be $e_{ss} = \frac{a-k}{b}$.

8 + 4 = 12

Group – D

6. (a) From the above signal flow graph, find the value of k for which the system will be stable.



(b) Draw the root locus plot of the given system having open loop transfer function is $G(S) = \frac{k}{S(S+2)(s+4)}$.

4 + 8 = 12

7. (a) Construct the Bode plot for a unity feedback control system having open loop transfer function, $G(S) = \frac{30}{S(0.5S+1)(0.08s+1)}$.