(3 + 4) + 5 = 12

Group – D

6. (a) The overall transfer function of a system is given by,
$T(s) = (s^2 + 5s - 6) / (s^4 + 4s^3 + 8s^2 + 20s + 15)$.
Find the number of poles on RHP, LHP and on jw axis using Routh- Hurwitz criteria. Hence comment on the stability of the system.

(b) The open loop transfer function of a unity feedback system is given by, $G(s)H(s) = k / s(sT_1 + 1)(sT_2 + 1)$. Find the range of k for the system to be stable.

7 + 5 = 12

7. For a unity feedback system having open loop transfer function $G(s) = k/[s(s + 2)(s^2 + 2s + 10)]$, sketch the root locus plot on the graph paper by finding the required parameters. Hence comment on the stability of the system.

10 + 2 =12

Group – E

8. (a) Construct the Bode plot for a unity feedback control system having open loop transfer function $G(s) = k(s + 20) / (s + 1)(s + 2)(s + 10)$.

(b) From the above plot find the gain margin, phase margin, gain cross-over frequency and phase cross-over frequency. Assess the stability of the system from the findings.

7 + 5 = 12

9. (a) Sketch the Nyquist plot for a unity feedback system having open loop transfer function $G(s) = k (s + 2) / s^2(s + 1)$.

(b) Analyze the plot to check the closed loop stability of the given open loop system.

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) If the number of open loop poles and zeros of a system are 4 and 1 respectively, the number of root locus branches terminating at infinity is
(a) 5 (b) 0 (c) 4 (d) 3.

(ii) A unity feedback system has open loop transfer function
$G(s) = s / [(s^2 + 4)(s+2)]$. The breakaway point of the root locus plot is at
(a) s= -1 (b) s = 0 (c) no breakaway point (d) -0.5.

(iii) For a system gain margin is positive and at gain crossover frequency 6 rad/sec phase angle is - 150°. The system is
(a) stable (b) unstable
(c) marginally stable (d) cannot be predicted.

(iv) For a system, gain crossover frequency and phase crossover frequency are equal. The system is
(a) stable (b) unstable
(c) marginally stable (d) no conclusion can be made.

(v) A unity feedback system has open loop transfer function
$G(s) = k(1+2s) / s(1+s)(1 + s + s^2)$. The polar plot of this system starts with
(a) magnitude 0, phase -270 deg
(b) magnitude infinity, phase -90 deg
(c) magnitude 0, phase -90 deg
(d) magnitude infinity, phase -180 deg.

(vi) 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.

(vii) If T be the time constant of a system, on 5% basis settling time is expressed as
(a) 2T (b) 4T (c) 3T (d) 6T.

(viii) A system has a pole at s= - 2. The unit impulse response of it
(a) linearly increases with time
(b) exponentially increases with time
(c) exponentially decreases with time
(d) linearly decreases with time.

(ix) If the roots of the characteristic equation are given by s = -3 ± j2, the value of damping ratio is
(a) 0.55 (b) 0.27 (c)1.11 (d) 0.83.

(x) The unit step response of a control system is $c(t)= t\, e^{-t}$. The transfer function of the system is
(a) $1/ (s+1)^2$ (b) $1/ s(s+1)^2$ (c) $s /(s+1)^2$ (d) $1 / s(s+1)$.

Group – B

2. (a)

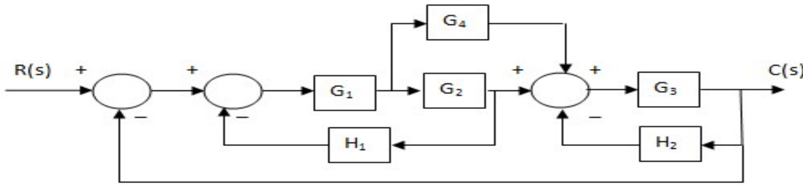

Fig. 1

Find the overall transfer function of the system for the block diagram shown in Fig. 1 using block reduction technique.

(b) For the block diagram shown in Fig.1, draw the signal flow graph and hence find the overall transmittance using Mason's gain formula.

(c) Find the transfer function of the system given in Fig. 2 below.

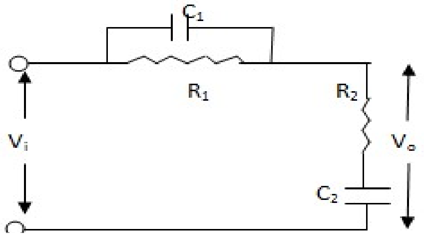

Fig. 2

B.TECH/AEIE /5TH SEM/AEIE 3104/2019

6 + 4 + 2= 12

3. (a) In the state variable model of a linear time invariant system, matrix
$A = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}; C = [1 \quad 2]; D = 0$
Check the controllability and observability of the system.

(b)

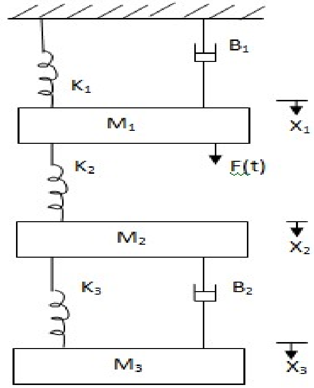

Fig. 3

Write the differential equations of the given in Fig. 3, mechanical system showing the necessary free body diagrams.

7 + 5 = 12

Group – C

4. (a) For the unit step response of the second order system having transfer function $C(s)/ R(s) = w_n^2 / (s^2 + 2d\, w_n\, s + w_n^2)$, find the expression of peak time and percentage peak overshoot where d is the damping ratio and w_n is the natural frequency of oscillation.

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

(3 + 3) + 6 = 12

5. (a) A feedback system has forward path transfer function 25 / s(s+1) and feedback path transfer function (2+bs). For the unit step input of the system find the value of 'b' such that damping ratio is 0.25. Also find the rise time, peak time, percentage peak overshoot and settling time of the system.

(b) The unit step response of a unity feedback system is $c(t) = e^{-0.5t} - 0.25te^{-0.5t}$. Find the open loop transfer function of the system.