PAPER ID-410843

Subject Code: NIC501

Roll No: | | | | | | | | | | | | | |

B.TECH
(SEM-V) THEORY EXAMINATION 2021-22
CONTROL SYSTEM-I

Time: 3 Hours ***Total Marks: 100***

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

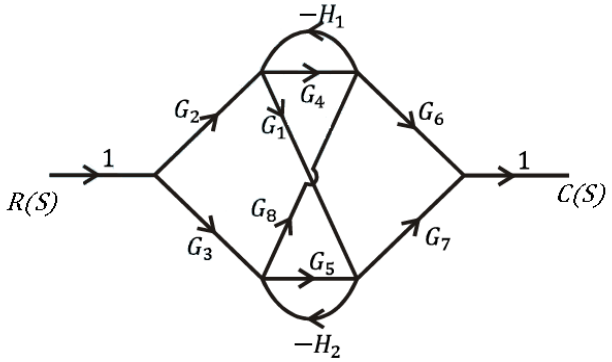
SECTION A

1. Attempt *all* questions in brief. 2 x 10 = 20

Q no.	Question	Marks
a.	What are the standard test signals used in control system?	2
b.	Why Laplace transform is used to find the transfer function of a system in linear control system?	2
c.	Write the analogous electrical elements in force voltage analogy for the elements of mechanical translational system.	2
d.	Write the Mason's Gain Formula.	2
e.	What is Centroid in root locus?	2
f.	Distinguish between open loop and closed loop control system.	2
g.	Define gain cross over frequency and phase margin?	2
h.	Distinguish between type and order of the system.	2
i.	What is the effect of feedback on the time constant of a control system?	2
j.	Define controllability and observability of the system.	2

SECTION B

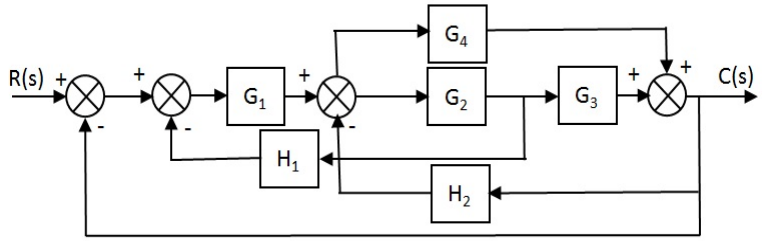
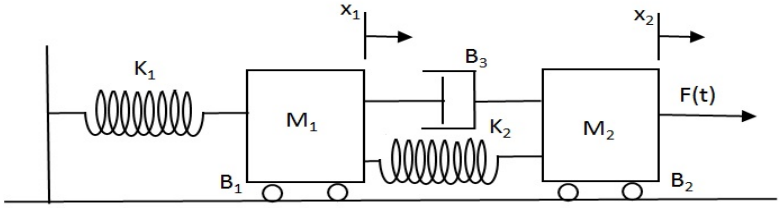
2. Attempt any *three* of the following: 10x3 = 30

Q no.	Question	Marks
a.	Consider the Signal Flow Graph. Find C(s)/R(s) by Mason's gain formula as shown in fig. 	10
b.	Derive the expressions and draw the response of first order system for unit step input.	10
c.	Calculate the transfer function and State transition matrix of the system represented in the state space model as $$X' = \begin{bmatrix} x_1' \\ x_2' \end{bmatrix} = \begin{bmatrix} -1 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} [u]$$ $$Y = [0 \quad 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$	10

d.	Plot the Bode diagram for the following transfer function and obtain the gain and phase cross over frequencies $$G(s) = \frac{Ks^2}{(1+0.2s)(1+0.02s)}$$ Determine the value of K for a gain cross over frequency of 20 rad/sec.	10
e.	Determine the stability of the system by using Routh Hurwitz stability criterion having following characteristic equation. $$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$$	10

SECTION C

3. Attempt any *one* part of the following: 10x1 = 10

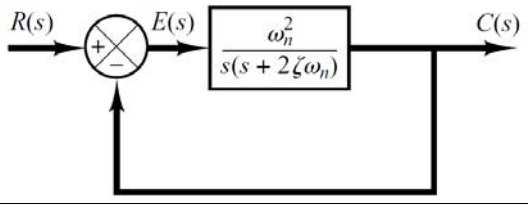
Q no.	Question	Marks
a.	Derive the transfer function C(s)/R(s) of the system by block diagram reduction techniques. 	10
b.	Obtain the transfer function of the translational mechanical system as shown in fig. 	10

4. Attempt any *one* part of the following: 10x1 = 10

Q no.	Question	Marks
a.	Examine the controllability and observability of a control system which is represented in the state space model as, $$X' = \begin{bmatrix} x_1' \\ x_2' \end{bmatrix} = \begin{bmatrix} -1 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} [u]$$ $$Y = [0 \quad 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$	10
b.	Find the solution of non-homogeneous state equation of the system described by the equation. $$x'(t) = \begin{bmatrix} -1 & 1 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ -1 \end{bmatrix} u(t)$$	10

	$x(0) = \begin{bmatrix} -1 \\ 0 \end{bmatrix}, u(t) = 1, t > 0$	

5. Attempt any *one* part of the following: 10x1 = 10

Q no.	Question	Marks
a.	Impulse response of a 1st order system is given below. $$c(t) = 3e^{-0.5t}$$ Find out: Time constant T, D.C Gain K, Transfer Function, Step Response.	10
b.	Consider the system shown in following figure, where damping ratio is 0.6 and natural undamped frequency is 5 rad/sec. Obtain the rise time t_r, peak time t_p, maximum overshoot M_p, and settling time 2% and 5% criterion t_s when the system is subjected to a unit-step input. 	10

6. Attempt any *one* part of the following: 10x1 = 10

Q no.	Question	Marks
a.	Sketch the root locus for the transfer function $$G(s)H(s) = \frac{K}{s(s+6)(s^2+4s+13)}$$ Determine the breakaway point, angle of departure and stability criterion.	10
b.	Determine the stability of the system having a characteristic equation given below $$s^5 + 6s^4 + 3s^3 + 2s^2 + s + 1 = 0$$	10

7. Attempt any *one* part of the following: 10x1 = 10

Q no.	Question	Marks
a.	Draw Nyquist plot for the open loop transfer function of a system $$G(s).H(s) = \frac{1}{s(s+2)}$$ Find whether the system is stable or unstable?	10
b.	Draw the bode plot for the transfer function $$G(s) = \frac{16(1+0.5s)}{s^2(1+0.125s)(1+0.1s)}$$ From the graph determine Phase cross over frequency, gain cross over frequency, Phase margin, gain margin and Stability of the system.	10