Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIFTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
JANUARY/FEBRAURY 2021
SUBJECT: LINEAR CONTROL THEORY (ECE-3152)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. Write the differential equations governing the mechanical behaviour of the system shown in **Fig. 1A**. Draw the FI and FV analogous circuits and verify by writing mesh and node equations.

1B. Find the state transition matrix of a system represented by the state equation $\dot{X}$=AX whose response is X(t)= $\begin{bmatrix} e^{-2t} \\ -4e^{-2t} \end{bmatrix}$ when X(0)= $\begin{bmatrix} 2 \\ -1 \end{bmatrix}$& X(t)= $\begin{bmatrix} e^{-t} \\ -2e^{-t} \end{bmatrix}$ when X(0)= $\begin{bmatrix} 1 \\ -2 \end{bmatrix}$

(5+5)

2A. OLTF of a system is given by G(S)H(S) = $\frac{K}{S(1+T_1S)(1+T_2S)}$. Calculate the gain margin of the system when T_1 , T_2 , K >0 (Plotting not necessary)

2B. For a negative UFB system with forward path gain of G(s), find the 3rd order OLTF so that steady state error due to ramp input is 1.5 and the characteristics equation has roots at -1$\pm$j1.

(5+5)

3A. Test whether the system characterized by the differential equation $\dddot{Y} + 7\ddot{Y} + 12\dot{Y} + 6Y + U = 0$ is controllable and observable using Kalman's method. Write the block diagram representation of the state model.

3B. For the SFG shown in **Fig. 3B**, find forward paths, loops and non-touching loop gains.

(6+4)

4A. The OLTF of a system is given by G(S)H(S) = $\frac{KS^2}{(1+0.2S)(1+0.02S)}$ Sketch the Bode plot of the given system indicating gain and phase margin. Also determine a) K such that gain crossover frequency is 5 rad/sec b) K such that phase lag at ω_{gcf} is 180^0

4B. Obtain the state space representation of a system shown in **Fig. 4B**.

(6+4)

5A. Sketch the Root Locus of the system whose OLTF is given by G(S)H(S) = $\frac{K(S+2)}{S^2+2S+3}$ Determine

i. The value of damped frequency of oscillation when system gain is 1.33
ii. The location of poles when damping ratio is 0.707

iii. The range of system gain for which unit step response is overdamped.

5B. OLTF of a unity feedback system is given by $G(S)=\frac{K(S+1)}{S^3+aS^2+2S+1}$ Determine the value of K and a such that the system oscillates at a frequency of 3 rad/sec

(6+4)

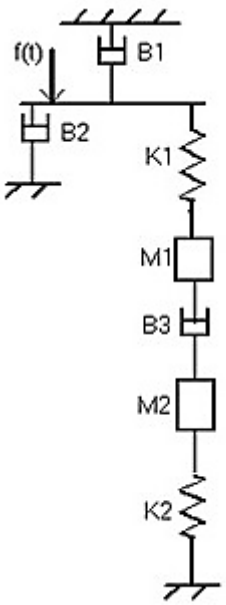

Fig. 1A

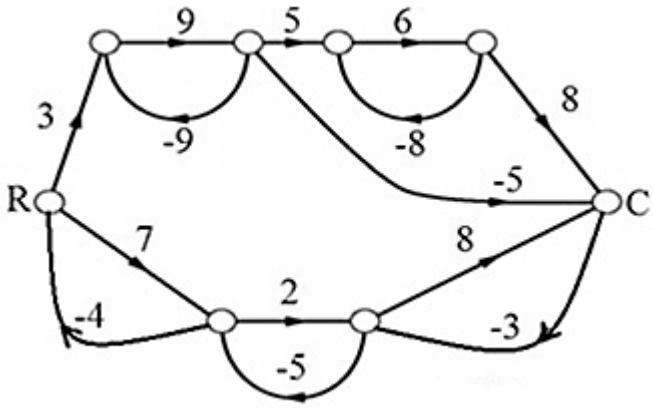

Fig. 3B

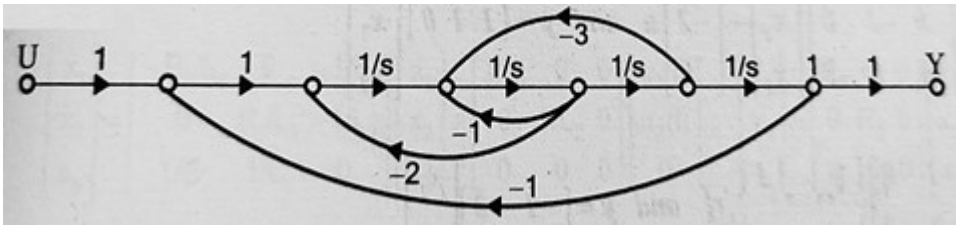

Fig. 4B