Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIFTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
DECEMBER 2020/JANUARY 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. Draw the SFG of the network given in Fig. Q1A and determine the transfer function of the system.

1B. Using block diagram reduction techniques, find the closed loop transfer function of the system shown in Fig. Q1B.

1C. Derive the expression for maximum overshoot of the unit step response of a second order under damped system.

(5+3+2)

2A. Write the differential equations governing the mechanical behaviour of the system shown in Fig.Q2A. Draw the FI and FV analogous circuits and verify by writing mesh and node equations.

2B. Unity feedback system with G(S) = $\frac{K(S+\alpha)}{(S+\beta)^2}$ is to be designed to meet the following specifications. Damping ratio=0.5; Natural frequency= $\sqrt{10}$ rad/sec; e_{ss} due to unit ramp input =0.1. Find the value of K, α, β

2C. The OLTF of a system is given by G(S)H(S) = $\frac{500}{S(S+6)(S+9)}$. Find the magnitude and phase angle of the system at the starting and end point of the corresponding polar plot.

(5+3+2)

3A. The characteristic polynomial of a system is given by:
$S^7+9S^6+24S^5+24S^4+24S^3+24S^2+23S+15=0$.
Determine the location of the roots on S-plane and hence the stability of the system using Routh-Hurwitz criteria.

3B. What is an observable system? Find if the following system is i) controllable ii) observable.

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -2 & 1 \\ 1 & -1 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \qquad y = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} x$$

3C. Determine the state transition matrix of the system described by $\dot{x} = \begin{bmatrix} -1 & 3 & 0 \\ 0 & -1 & 2 \\ 0 & 0 & -1 \end{bmatrix} x$

(4+3+3)

4A. Sketch the Root Locus for a unity feedback system with OLTF G(S) = $\frac{K(S+0.5)}{S^2(S+4.5)}$ and comment on stability.

4B. Derive an expression for resonant peak and resonant frequency of a second order system in terms of ζ.

(5+5)

5A. Open loop transfer function of a system is given by G(S)=$\frac{5K}{S(S+2)}$ Design a lead compensator so that static velocity error constant is $20sec^{-1}$; Phase margin of atleast 55^0; Gain margin of atleast 12dB

5B. Obtain the state space representation of the system shown in Fig.Q5B.

(6+4)

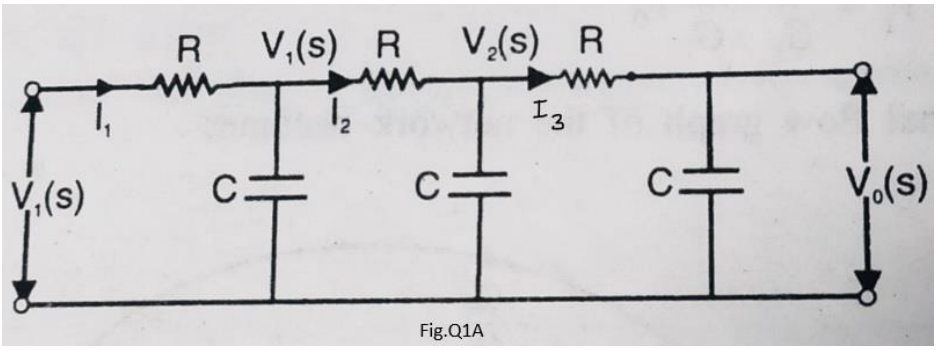

Fig.Q1A

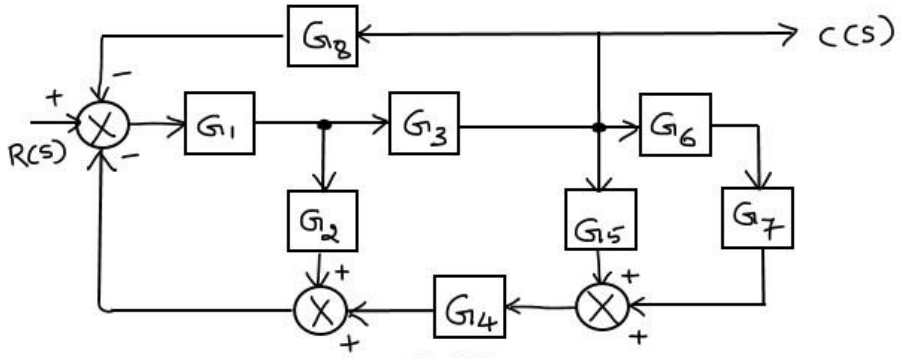

Fig.Q1B

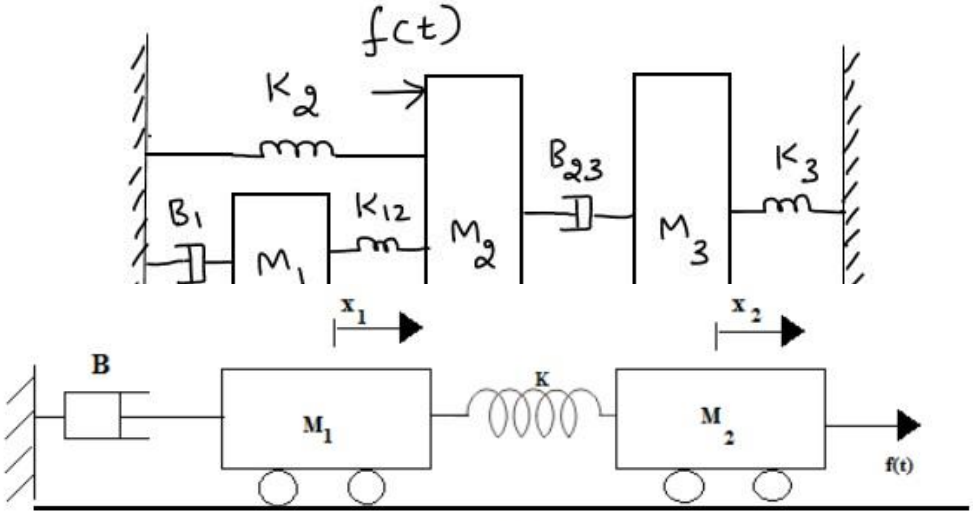

Fig.Q5B