Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

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A Constituent Institution of Manipal University

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKEUP EXAMINATIONS, DEC 2016 - JAN 2017

SUBJECT: LINEAR CONTROL THEROY [ELE 3101]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 27 December 2016** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. For the translation mechanical system shown in Figure Fig. Q 1A

(i) Draw mechanical network. (ii) Write down the dynamic equations that describe the system (iii) determine the transfer function considering f (t) as the input and x_2 as the output. ***(04)***

1B. Using block reduction technique reduce the given block diagram shown in Fig.Q1B in its simple form and obtain the equivalent transfer function $\frac{C(s)}{R(s)}$ ***(02)***

1C. Obtain the transfer function $\frac{Y_2(s)}{Y_1(s)}$ of a closed loop system represented by the signal flow graph shown in Fig. Q.1C using mason's gain formula. ***(04)***

2A. The characteristic equation for a feedback control system is $s^7 + 3s^6 + 7s^5 + 10s^4 + 11s^3 + 11s^2 + 2s + 6 = 0$. Using Routh-Hurwitz criterion determine how many poles of closed loop system that lie (i) in RH plane (ii) in LH plane (iii) on $j\omega$ axis. Also comment on stability of system. ***(04)***

2B. The open loop transfer function of a unity feedback system is, $G(s)=\frac{K}{s(s+15)}$. If K=225, what change must be made in the system to reduce the peak overshoot by 50%, keeping the settling time same. Also find the new transfer function. ***(03)***

2C. A unity feedback system with open loop transfer function, $G(s)=\frac{K(s+a)}{s(s+b)}$ is designed to meet the following requirements:

(i) The steady-state position error for a unit ramp input equals 1/10;

(ii) The closed-loop poles will be located at $-1 \pm j1$.

(iii) Find the values of "K", "a", and "b" in order to meet the specifications given in (i) and (ii) ***(03)***

3A. Select the Nyquist contour and obtain the Nyquist diagram by mapping each section of contour to a $G(s)H(s)$ plane showing step by step procedure for a negative feedback system with open loop transfer function, $G(s)H(s) = \frac{k}{s(s+1)(s+2)}$.

Find the value of K for which (i) system is stable (ii) system is marginally stable **(04)**

3B. The open loop transfer function of a negative feedback system is, $G(s)H(s) = \frac{k(s+1)}{s^2(s+9)}$. By step by step procedure draw the root locus plot for $k > 0$. Also determine the value of K for a damping ratio of 0.707 due to a pair of complex conjugate poles. **(06)**

4A. The log magnitude plot for an open loop transfer function G(s) H(s) is shown in Fig. Q4A

Determine (i) G(s) H(s) (ii) Gain at ω = 10 rad/s and ω= 100 rad/s (iii) the gain cross over frequency (iv) the phase margin. **(05)**

4B. Given a state model

$$\dot{x}(t) = \begin{bmatrix} -3 & 2 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t); \;\; y(t) = [1 \;\; 0]; \;\; x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

Where the state variables chosen are: $x_1(t)$ and $x_2(t)$. Find (i) state transition matrix using Sylvesters Interpolation Formula (ii) Find the unit step response y(t) of the system **(05)**

5A. An LTI single input single output system is described by the transfer function

$\frac{Y(s)}{R(s)} = \frac{3s^2 + s + 2}{s^3 + 7s^2 + 14s + 8}$, develop a state model in observable canonical form. **(03)**

5B. Design a suitable controller for a unity feedback system with forward path transfer function $G(s) = \frac{K}{s^3 + 10s^2 + 24s}$ to yield an overshoot of 16% with a three-fold reduction in settling time. **(04)**

5C. A linear system is described by following state equation

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u(t);$$

Find the state feedback gain matrix by Ackermann's formula if the system poles are placed at s=-3 and s=-4. **(03)**

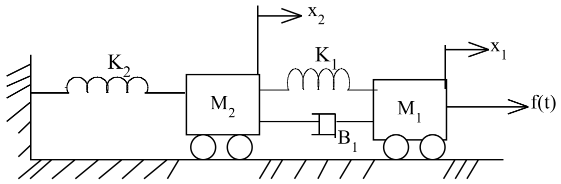

Fig.Q1A

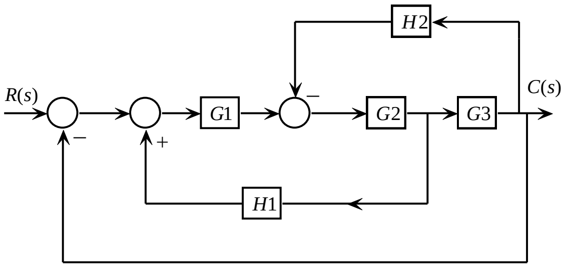

Fig. Q1B

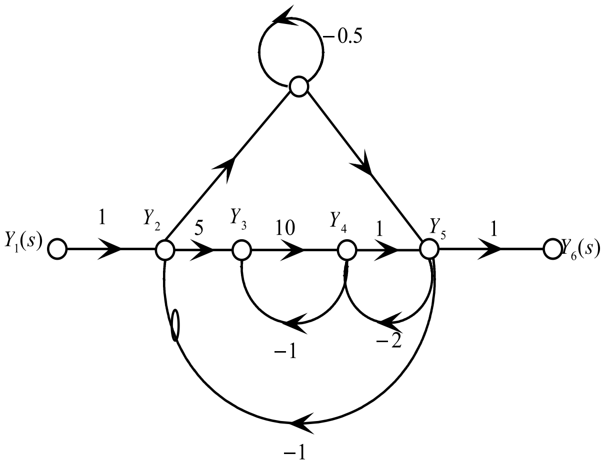

Fig.Q1C

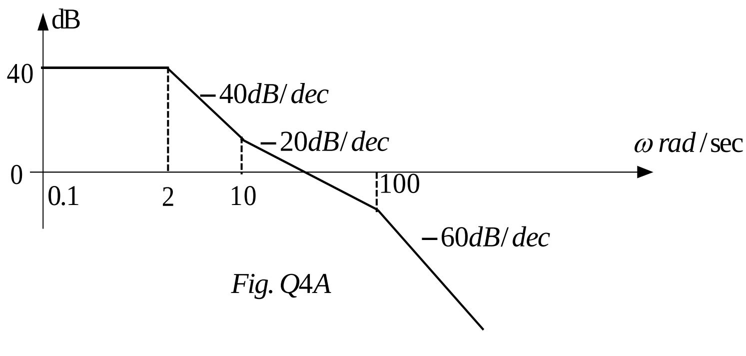

Fig. Q4A