Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

Manipal University

SIXTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION – APRIL / MAY 2017

SUBJECT: LINEAR AND DIGITAL CONTROL SYSTEMS (ECE - 306)

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

Instructions to candidates

- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.
- Graph sheets will be supplied.

1A. For the mechanical system shown in Figure Q1A, obtain the equations of motion for masses M_1 and M_2. Find the transfer function $X_2(s) / F(s)$.

1B. For the block diagram shown in Figure Q1B, find the overall transfer function using block diagram reduction techniques.

1C. Find the step response for the system described by $G(s) = \frac{4}{s+4}$.

(5+3+2)

2A. For the second order systems, obtain the expression for underdamped step response.

2B. Refer the characteristic equation given by $s^4+25s^3+15s^2+20s+K=0$, determine

(i) The range of value of K so that the system is asymptotically stable.

(ii) The value of K so that the system is marginally stable and the frequencies for sustained oscillations, if applicable.

2C. The characteristic equation 1+G(s)H(s)=0 of a system is given by $s^4+8s^3+12s^2+8s=0$. For the system to remain stable, the value of gain K should be

a) Zero b) 0<K<11 c) > 11 d) positive.

(5+3+2)

3A. Obtain the state transition matrix for the state model whose A matrix is given by $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

3B. Obtain the Bode plot of the factor $\frac{1}{1+j\omega T}$ (a simple pole).

3C. A control system is represented in a block schematic as shown in Figure Q3C. What is the type number?

(5+3+2)

4A. Draw the Bode plot for a unity feedback control system having $G(s) = \frac{200}{(s+1)(s+100)}$ and determine

(i) Gain crossover frequency.

(ii) Phase margin

(iii) Gain margin

(iv) Stability of the system.

4B. Discuss the effects and limitations of phase lead compensation.

4C. If the open loop transfer function of a system is $G(s)H(s) = \frac{K(s+4)}{s(s+2)}$, the break points are

a) – 1.18 and – 6.82. b) - 2 and – 4 c) – 1.82 and 6.82 d) 1.18 and – 6.82.

(5+3+2)

5A. Draw the root locus plot of a feedback control system whose open loop transfer function $G(s)H(s) = \frac{K(s+2)}{s^2}$.

5B. For a unity feedback system with $G(s) = \frac{1}{S(S+1)}$ followed by a sampler and ZOH design a controller D(z) so that the response to the unit step is c(n)=0,0.5,1,1,1 ………. Given sampling period T= 1 second.

5C. Discuss why transportation lag are important in control systems? How it is modelled mathematically?

(5+3+2)

6A. Test the controllability and observability of the system described by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ -3 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, \qquad y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

6B. The system state matrix is given by

$$A = \begin{bmatrix} -1 & 2 & -8 \\ 0 & -2 & 4 \\ 0 & 0 & -4 \end{bmatrix}$$

Evaluate the Eigen values of the system.

6C. Write detailed note on feedforward and cascade controls with example

(5+3+2)

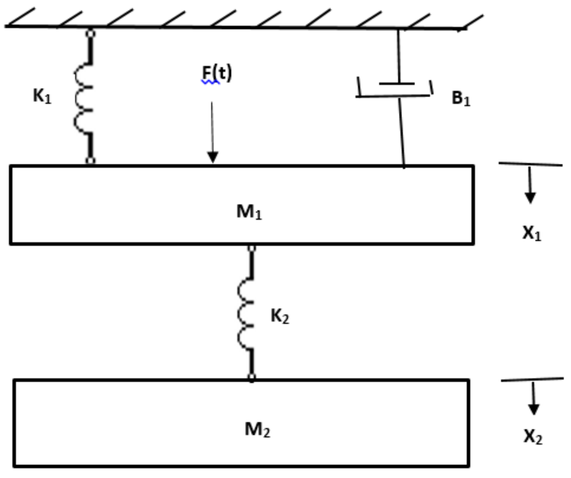

Figure Q1A

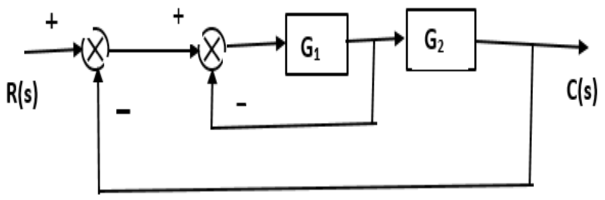

Figure Q1B

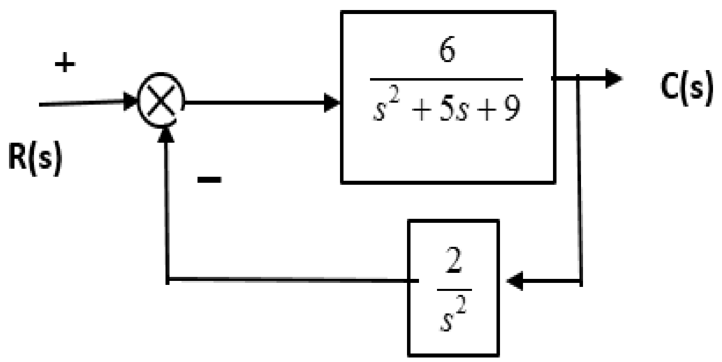

Figure Q3C