Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

FIRST SEMESTER M.TECH. (AEROSPACE AND CONTROL SYSTEMS)

END SEMESTER EXAMINATIONS, NOV - 2017

ADVANCED CONTROL SYSTEMS [ICE 5102]

Duration: 3 Hour Max. Marks:50

Instructions to Candidates:

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

1A Compare Lag and Lead compensators in terms of frequency response, pole-zero map and performance. 4

1B The frequency response plot of an open loop system with steady state gain compensation is shown in Fig. Q1C. It is desired to design a Lead compensator to meet the specification of phase margin of at least 60^o. Design a cascade lead compensator and represent its transfer function. 6

Fig. Q1C

2A How is the stability criteria of discrete time system be developed from that of continuous time system. 4

2B Use the root locus concept to design a cascade lag compensator for the system with plant transfer function $G(s) = \dfrac{K}{s(s+1)(s+4)}$, to make the velocity error 0.2, overshoot < 20%. 6

3A Give an account of selecting sampling time. 2

3B Consider the plant transfer function $G_p(s) = \dfrac{e^{-2s}}{s+1}$ preceded by a ZOH. Obtain its pulse transfer 3 function and discrete time unit step response. Consider the sampling time as 0.2.

3C Transform the following continuous time state equation to a discrete time system, for a sampling time of 0.1 secs. 5

$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -3 & -4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u; \quad y=\begin{bmatrix}3 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$. Hence determine the pulse transfer function and the stability of discrete time system.

4A For the system shown in Fig. Q4A, obtain the closed loop pulse transfer function. 2

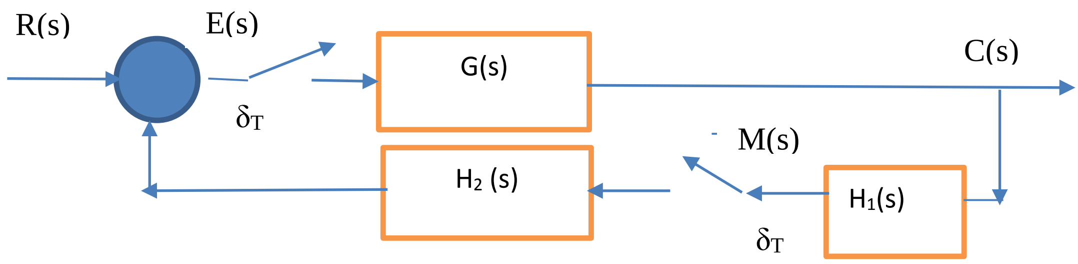

Fig. Q4A

4B For the pulse transfer function obtained in Q(3B), transform the transfer function to W-plane. In which parameters the W-transformed transfer function and original s-domain transfer function are similar? What are the features of the W-transformation function used? Also mention the significance of W-transfer function. 3

4C For the following state equations, determine i) state transition matrix by both the methods ii) Hence determine the time domain output of the system for a unit step input, with zero initial conditions. 5

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-8 & 6\\ -6 & 4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}4\\ -6\end{bmatrix}u; \quad y=\begin{bmatrix}1 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

5A Obtain the state space representation of the following system in 2

Diagonal form

$$\frac{Y(s)}{U(s)}=\frac{2(s+3)}{(s+1)(s+2)}$$

5B 3

For the matrix $A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -24 & -26 & -9\end{bmatrix}$ determine

i) Eigen Values

ii) Transformation matrix which transforms it into diagonal form

iii) Obtain the diagonal form of A

5C Define controllability and observability. Find a suitable transformation matrix which transforms given system into controllable canonical form. Also determine the feedback gain matrix which places the closed loop poles of the system at s=-5±j5. Verify the result by Ackerman's formula. 5

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