Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

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

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: ADVANCED CONTROL SYSTEMS [ICE 5102]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. How gain margin and phase margin are determined from frequency response plot. **2**

1B. Write down the design procedure of a lag compensator in frequency domain. **3**

1C. Consider a unity feedback system with open loop transfer function **5**

$G(s) = \dfrac{K}{s(s+10)}$. Design a Lead compensator in time domain to meet the following specifications (i) Percentage overshoot = 9.5% (ii) natural frequency of oscillation =12 rad/sec, (iii) velocity error constant Kv > 10.

2A. What are the natural choices of state variables for (i) Electrical systems (ii) Mechanical systems. **2**

2B. Diagonalize the matrix **3**

$$F = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix}$$

2C. The forward path transfer function of a certain unity feedback control system is given by $G(s) = \dfrac{k}{s(s+2)(s+10)}$. The system is to satisfy the following design specifications (i) Percentage overshoot $\leq 16\%$ for unit step input (ii) Steady state error for unit ramp input $\leq \dfrac{2}{15}\,rad$. Design a suitable lag compensator using root locus technique. **5**

3A. Find the Z transform of the function **2**

$F(s) = \dfrac{s}{(s+1)(s+2)}$

3B. A system is described by the difference equation **3**
y(k+3)+3y(k+2)+2y(k+1) + y(k) = u(k+2) +5u(k+1). Obtain the state model in

controllable canonical form

3C. A system is described by **5**

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u\ ;\ x(0)=\begin{bmatrix}1\\ 0\end{bmatrix}\quad y=\begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix};$$ find the step response of the system.

4A. Find the z inverse of the function **2**

$$F(z)=\frac{z^3+z^2+z+1}{(z+2)^2(z+1)}$$

4B. Derive an expression for discretization of continuous time systems. **3**

4C. Pulse transfer function of the discrete time system is given by **5**

$G(z)=\dfrac{z+2}{z(z+1)^2}$. Obtain the state models (i) Cascade form (ii) Jordan form.

5A. Check the sign definiteness of the following Quadratic form **2**

(i) $V(x)=6x_1^2+4x_2^2+x_3^2+2x_1x_2-2x_2x_3-4x_1x_3$

(ii) $V(x)=8x_1^2+4x_2^2+x_3^2-4x_1x_2-4x_2x_3+2x_1x_3$

5B. Determine the stability of the system by Lyapunov method. Given $\dot{x}=Ax(k)$, where $A=\begin{bmatrix}0 & 1\\ 1 & 1\end{bmatrix}$. **3**

5C. A system is described by **5**

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u\ ;\ y=\begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}.$$ Design a full order observer which has the poles at -1 and -2, Verify the same by using Ackerman's formula.

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