Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKE UP EXAMINATIONS, JAN 2016

SUBJECT: MODERN CONTROL THEORY [ELE 302]

REVISED CREDIT SYSTEM

Time: 3 Hours | 11 January 2016 | MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitably assumed.

1A. For the system shown in Fig. Q1A i) find unit step response of the system for K=1 ii) find the range of K for stability of the system using Jury's stability test.

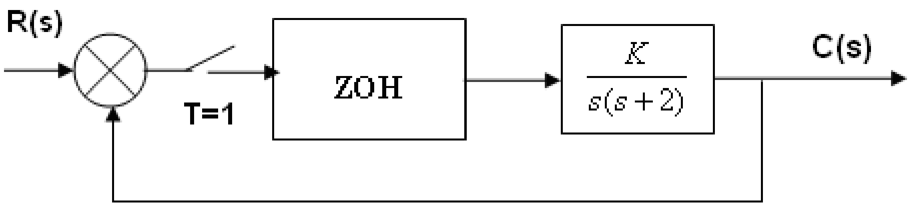

Fig. Q1A **(06)**

1B. Diagonalize using similarity transformations

$$\dot{x}(t)=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -2 & -5 & -4\end{bmatrix}x(t)+\begin{bmatrix}0\\0\\1\end{bmatrix}u(t)\,; \qquad y(t)=\begin{bmatrix}1 & 0 & 0\end{bmatrix}x(t)$$

(04)

2A. For the transfer function given $G(z)=\frac{0.3(z-0.5)}{(z-1)(z-0.5)}$ i) obtain controllable canonical form & observable canonical form. **(05)**

2B. For the system given $\dot{x}(t)=\begin{bmatrix}0 & 2\\ -2 & -5\end{bmatrix}x(t)+\begin{bmatrix}0\\1\end{bmatrix}e^{-2t}$; $y(t)=\begin{bmatrix}2 & 1\end{bmatrix}x(t)$ and $x(0)=\begin{bmatrix}1 & 2\end{bmatrix}^T$, find i) the state transition matrix ii) solution of state equation . **(05)**

3. For the sampled data system with open loop pulse transfer function $G_hG(z)=\frac{1.7788K(z+0.1153)}{(z-1)(z-0.1089)}$ i) draw root locus in the z plane ii) find the finite steady state error of the system iii) draw the Nyquist plot and find the limiting value of K for stability , T=0.5 sec. **(10)**

4. Design a linear state feedback controller to yield 20% overshoot and settling time of 2 sec for a plant $G(s)=\frac{(s+6)}{(s+9)(s+8)}$ when represented in controllable form, assume the third pole at $s=-6$. Draw the state diagram with controller. Design an observer which is 10% faster than the system with controller. **(10)**

5A. Design a digital lead compensator for the system shown in Fig.Q5A such that the compensated system satisfies the following specifications. Percentage overshoot 18% and a settling time of 2sec. Sampling Time T= 0.2sec. Also obtain static velocity error constant K_v of the compensated system. (verification & root locus not required, only transfer function & gain)

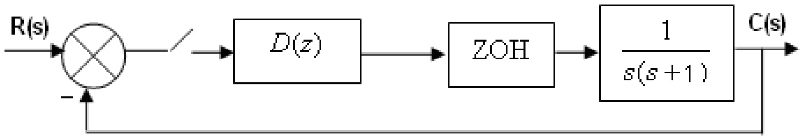

Fig.Q5A **(07)**

5B. Mention the design procedure of a lag compensator using frequency domain methods **(03)**

6A. Determine the stability of the equilibrium state of the system $x(k+1) = \begin{bmatrix} -0.5 & 0 \\ 0 & -0.5 \end{bmatrix} x(k)$ by choosing a Lyapunov function $x_1^{\,2}(k) + x_2^{\,2}(k)$. **(04)**

6B. Obtain the equivalent discrete time system for the continuous time system given below. Sampling time T = 0.1 sec. ii) Discuss the controllability and observability of the system before and after discretization.

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ 0 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; \quad y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

(04)

6C. Define with a neat sketch the conditions of boundedness with respect to Lyapunov stability. **(02)**