Reg. No.									

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKEUP EXAMINATIONS JUNE 2016

SUBJECT: MODERN CONTROL THEORY [ELE 302]

REVISED CREDIT SYSTEM

Time: 3 Hours | 27 JUNE 2016 | MAX. MARKS: 50

Instructions to Candidates:

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

1A. Consider a unity feedback control system whose open loop transfer function is given by G(s) = $\frac{4k}{s(s+2)}$. Design a lag compensator such that the compensated system has a damping ratio of 0.5 and a reduction of finite steady state error by a factor of 10. ***03***

1B. With neat sketches, explain the mapping of primary strip of s-plane onto z-plane. ***02***

1C. Consider the difference equation
$y(k+2) - 1.5327y(k+1) + 0.6607y(k) = 0.4673r(k+1) - 0.3393r(k)$ and
$y(k) = 0\ for\ k < 0, r(k) = 2\ for\ k = 0, and\ r(k) = 0\ for\ other\ values\ of\ k.$
Determine the output y(k) using Z transform method. ***05***

2A. For the sampled data system shown in Fig Q2A, obtain the pulse transfer function and hence find the unit step response of the system. Take sampling time T=0.5s.

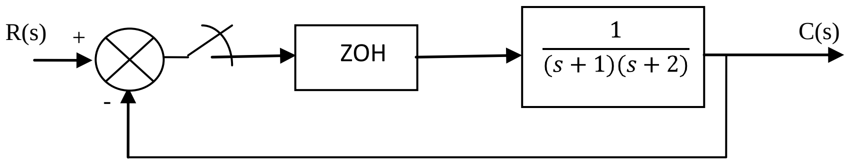

Fig Q2A ***05***

2B. Consider a discrete time system whose characteristic equation is given by
$z^3 - 1.3z^2 - 0.08z + 0.25 = 0$. Determine the stability of the system using Jury's test and hence find the number of closed loop poles inside the unit circle. Also verify the result by using bilinear transformation. ***05***

3A. Given the pulse Transfer function $G(z) = \frac{z+2}{z^3 + 5z^2 + 7z + 3}$, obtain the state model in controllable canonical form. Draw the state diagram ***03***

3B. Draw root locus in the z plane for the sampled data control system with open loop pulse transfer function $G_hG(z) = \frac{0.3935Kz}{(z-1)(z-0.6065)}$, T=0.5 sec. Also find the frequency of the sustained oscillations. ***04***

3C. Diagonalizable the system matrix $F = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -3 & -3 \end{bmatrix}$ using linear transformation. ***03***

4A. For the sampled data system with open loop pulse transfer function $G_hG(z) = \dfrac{0.0952Kz}{(z-1)(z-0.905)}$, Analyze the stability of the system using Nyquist / polar plot. T=1 sec. ***04***

4B. Design a digital lead compensator for the system with $G_hG(z) = \dfrac{0.0126(z+0.9735)}{(z-1)(z-0.9226)}$, such that the compensated system satisfies the following specifications. $K_V = 3.536\sec^{-1}, \varsigma = 0.5, \omega_n = 5\,rad/\sec, T = 0.16\sec$. ***06***

5A. The state model for a control system represented by $\dot{x}(t) = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 10 \end{bmatrix} r(t);$ Determine the state transition matrix using Laplace-transform method. ***02***

5B. A linear time invariant system represented by a state model $\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r(t);$ Check for complete state controllability using criterion-II (Kalman's test). ***02***

5C. The state model for a discrete control system represented by $x(k+1) = \begin{bmatrix} 0.25 & 0.25 \\ 0 & 0.5 \end{bmatrix} x(k) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} r(k); y(k) = [\blacksquare\ \ 2]\,\underline{x}(k)$. Determine the state transition matrix and response of the system to an input of unit step response given that $x_1(0)=0$ and $x_2(0)=1$ using z-transform method. ***06***

6A. Design an observer for a satellite control system represented by a state model $\dot{x}(t) = \begin{bmatrix} -1 & 1 \\ 0 & 0 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} r(t); y(t) = [\blacksquare\ \ 0]\,\underline{x}(t)$. Choose the system poles to be placed at s = -8, -8 by coefficients matching method. ***03***

6B. The system is described by the equations $\dot{x}_1 = x_2$ and $\dot{x}_2 = -x_1 - 3x_2$. Determine the stability of the system. ***02***

6C. For the system given below, find a Liapunov function and investigate its stability.

$$\dot{x}(t) = \begin{bmatrix} -1 & 1 \\ 2 & -3 \end{bmatrix} x(t)$$

05