Reg. No.

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2016

SUBJECT: MODERN CONTROL THEORY [ELE 302]

REVISED CREDIT SYSTEM

Time: 3 Hours | 04 MAY 2016 | MAX. MARKS: 50

Instructions to Candidates:

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

1A. Consider a space vehicle control whose open loop transfer function is given by $G(s)H(s)=\frac{1}{s^2(0.1s+1)}$. Design a lead compensator such that the compensated system has a damping ratio of 0.5 and undamped natural frequency of oscillations 2 rad/s. Write the transfer function of overall compensated system and compute the overall gain of the compensated system. ***05***

1B. Consider the difference equation $y(k+2)-1.3679y(k+1)+0.3679y(k)=0.3679r(k+1)+0.2642r(k)$;

$y(k)=0\ for\ k\leq 0, r(k)=0\ for\ k<0, r(0)=1, r(1)=0.2142, r(2)=-0.2142\ and\ r(k)=0$

for other values of k. Determine the output y(k) using Z transform method. ***05***

2A. Obtain the transfer function Y(z)/R(z) of the closed loop system shown in Fig. 2A.

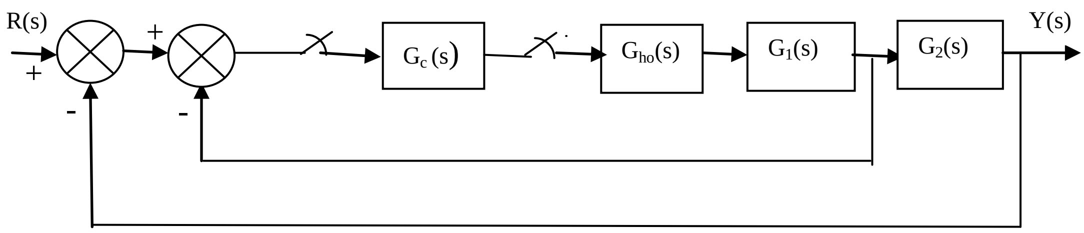

Fig. 2A ***04***

2B. A unity negative feedback system has the open loop transfer function $G(s)=\frac{5}{s(s+1)(s+2)}$ A sampler and ZOH are introduced in cascade with G(s). i)Obtain the closed loop transfer function of the discretized system ii) determine the stability of the system using Jury's stability test and hence find the number of poles inside the unit circle. Take T=1s. ***06***

3A. Given the pulse Transfer function $G(z)=\frac{z+8}{z^2+5z+3}$, obtain the state model in (i) parallel decomposition and (ii) controllable canonical form. ***03***

3B. Draw root locus in the z plane for the sampled data control system with open loop pulse transfer function $G_hG(z)=\frac{0.6321Kz}{(z-1)(z-0.3679)}$, T=1 sec. Also find the frequency of the sustained oscillations. ***04***

3C. Diagonalizable the system matrix $F=\begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix}$ using linear transformation. **03**

4A. For the sampled data system with open loop pulse transfer function $G_hG(z)=\dfrac{0.3935Kz}{(z-1)(z-0.6065)}$, Analyze the stability of the system using Nyquist / polar plot. T=0.5 sec. **05**

4B. Design a digital lag compensator for the system with $G_hG(z)=\dfrac{0.20334(z+0.7058)}{(z-1)(z-0.3486)}$, such that the compensated system satisfies the following specifications.
$K_V=6\sec^{-1}, \varsigma=0.517, \omega_n=1.5476 rad/\sec, T=0.52\sec.$ **05**

5A. A linear time invariant system represented by a state model $\dot{x}(t)=\begin{bmatrix} 0 & 1 \\ -8 & -6 \end{bmatrix}x(t)+\begin{bmatrix} 0 \\ 1 \end{bmatrix}r(t); y(t)=\begin{bmatrix} 0 \end{bmatrix}x(t)\, and\, x(0)=\begin{bmatrix} 1 \\ 0 \end{bmatrix}$. Determine the state transition matrix using Cayley Hamilton technique and determine unit step response. **04**

5B. The system matrix of a discrete time system is given by $G=\begin{bmatrix} 0 & 1 \\ -1/6 & 5/6 \end{bmatrix}$. Determine the state transition matrix using z-transform. **03**

5C. A linear time invariant system represented by a state model $\dot{x}(t)=\begin{bmatrix} -3 & 1 \\ 1 & -3 \end{bmatrix}x(t)+\begin{bmatrix} 1 \\ 0 \end{bmatrix}r(t); y(t)=\begin{bmatrix} -1 \end{bmatrix}x(t)$. Check for complete state observability using criterion-III (s-plane). **03**

6A. Design a state feedback controller for a satellite control system represented by a state model $\dot{x}(t)=\begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}x(t)+\begin{bmatrix} 0 \\ 1 \end{bmatrix}r(t)$. Choose the system poles to be placed that it has damping ratio 0f 0.707 with a settling time of 1 sec. Use Ackermann's formula. **03**

6B. Determine the stability of the non-linear system described by the equation $\ddot{x}+x^2\dot{x}+\dot{x}^3+x=0$ **02**

6C. A digital system in state space representation is given as

$$x_1(k+1)=x_1(k)+0.2x_2(k)+0.4$$
$$x_2(k+1)=0.5x_1(k)-0.5$$

Investigate the stability of the equilibrium state. Also verify the result by z-transform method. **05**