Reg. No. | | | | | | | | | | |

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

FIRST SEMESTER M.TECH (ASTRONOMY AND SPACE ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: CONTROL SYSTEM DESIGN TECHNIQUES [ICE 509]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Consider a two input single output system described by **04**

$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 1 \\ 0 & -2 \end{bmatrix} u(t)$; $y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} \underline{x}(t)$. Obtain minimal realization of the system.

1B. Solve the following state equation for a unit step function scalar input **04**

$\dot{x}(t) = \begin{bmatrix} 0 & 6 \\ -1 & -5 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$ considering initial conditions $\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix}$.

1C. Explain P-I controller characteristics. What are the design considerations in determining the P I controller parameters? **02**

2A. A general state variable equation contain the matrices **06**

$A_p = \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ -4 & -2 & -1 \end{bmatrix}$ and $B_{p=} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$.

Find suitable transformation matrices to transform the system into i) Diagonal/Jordan form ii) Controllable canonical form

2B. Define i) Eigen values ii) Eigen vectors iii) Nullity iv) Generalized eigen vector. What is their significance? **04**

3A. What is an observer? Describe with relevant diagram estimation of state variables using Luenberger observer. Comment on separation principle. **05**

3B. How PID controllers are tuned using Ziegler-Nichols method? **03**

3C. State and prove Lyapunov's stability theorem for continuous time linear systems. **02**

4A. Obtain the pulse transfer function from the following state models **02**

$F = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix}; G = \begin{bmatrix} 0 \\ 1 \end{bmatrix}; C = \begin{bmatrix} 1 & 0 \end{bmatrix}; D = [1];$

4B. For the discrete time system shown in figure Q4B, Determine the range of K for stability. Also sketch the root locus plot for the system and find the frequency of oscillation. **03**

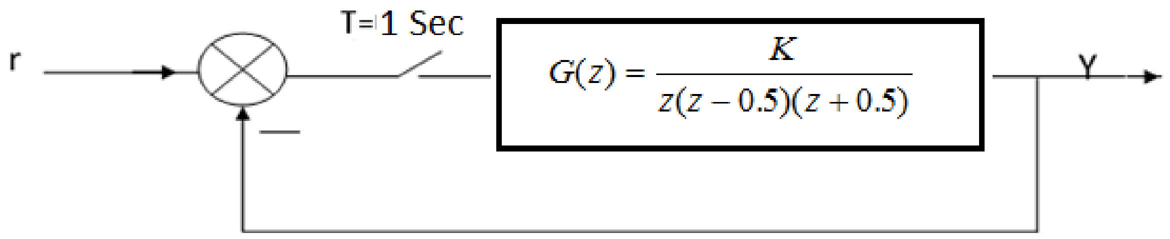

Figure Q4B

4C. Discretize the continuous time system, **05**

$G(s) = \frac{1}{s(s+3)}$ when T=1 Sec.

5A. Explain the concept of (i) Controllability (ii) Observability **02**

5B. Consider a unity feedback discrete time control system derive K_p, K_v, and K_a **03**

5C. A discrete time system is described by the state model **05**

$x(k+1) = \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ -4 & -2 & -1 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(k)$; $y(k) = [1 \quad 0 \quad 0]\underline{x}(k)$ Is the system controllable, observable? Also design a state feedback controller which will place the closed loop poles at s = -0.6$\pm$j 0.5, and s = 0 verify the result by applying Ackermann's formula.

6A. With sketches explain the terms (i) stability, (ii) instability **02**

6B. Determine the stability of the system described by the following equation x(k+1)=Fx(k), where **03**

$F = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix}$

6C. Derive the optimal control law for a discrete time linear state regulator **05**