Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

V SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS,DEC 2016/JAN 2017

SUBJECT: DYNAMICS AND CONTROL OF MECHATRONICS SYSTEMS [MTE 4105]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** questions.
- Missing data may be suitable assumed.

1A. Design an observer based controller to control the robot tennis player system given by **10**

$$\begin{bmatrix}\dot{x}\\ \ddot{x}\end{bmatrix} = \begin{bmatrix}0 & 1\\ 4 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$$

$$Y = [1\ 0]\ X$$

Where is the position Θ_1 is desired to be maintained with 1.67 sec settling time and damping factor 1.2.

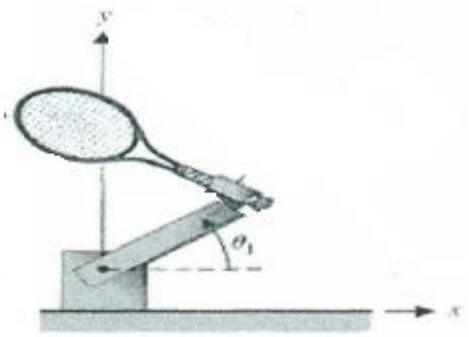

Fig 1.

2A. Obtain the diagonalized form for the following system **6**

$$\dot{X} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}X + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}U; Y = [1\ 0\ 0] + [0]U$$

2B. Check for the controllability and observability of the system in 2A. **4**

3A. Obtain the linearized form of the system $\ddot{x} + 2x^2 + (1 - 7x)\dot{x} = u$. **4**

3B. Check whether the following Lyapunov function is a valid candidate function for the system in 3A. **4**

$$V(x) = 2x_1^2 + x_2^2 + 4x_1x_2, \text{ for } x_1 \geq 0 \text{ , } x_2 \text{ is unconstrained.}$$

3C. Write a matlab function to take up the A, B,C, D matrices of a state space model in 3A and obtain the observer based controlled plot of states for a step input. Assume that the controller poles be at -4 ± 2j. **2**

4A. The slosh dynamics of a fuel tank in a motor bike is causing the unnecessary motions while riding. The test bench at R&D has identified the dynamics as H(s) = $\frac{s+1}{s^2+3s+2}$. Obtain the state space model of the slosh dynamics **4**

4B. Mention atleast four advantages of state space modeling over transfer function. **2**

4C. Brief about ratio control, feed forward control and PI controllers. **4**

5A. Obtain the state space model of geared armature controlled DC motor for speed control The motor is having J_m = 0.1 kgm^2 , B_m = 1 Nms and gear ratio 1:1. The electrical parameters are R_a = 2ohms. L_a = 1 H and K_b = 3 v/rad/s = K_t. **5**

5B. The automatic active cruise control system is responding to the cruise command changes as shown in the figure. The customer want an improved performance and the design engineer is given a task of improving the performance with 20% overshoot and less than 4 sec settling time with minimal error possible. Design the feedback controller using ZN algorithm. **5**

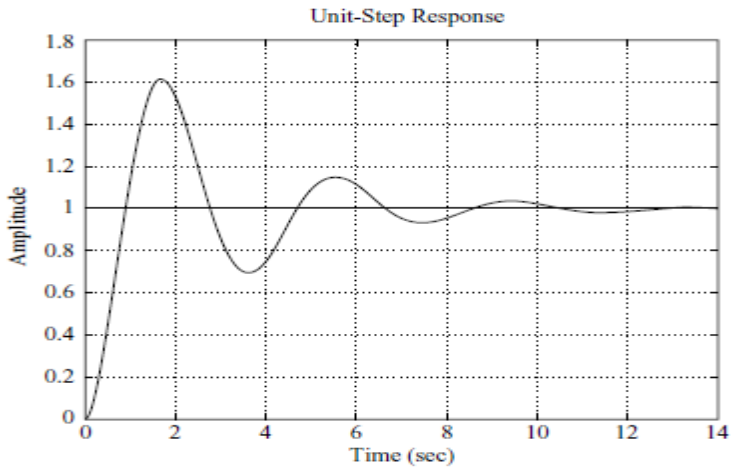

Fig.2