Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, DEC 2017

SUBJECT: ROBOT DYNAMICS AND CONTROL [MTE 4007]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Data not provided may be suitably assumed

1A.	What do you mean by Degree of Freedom (DoF) of a rigid body? What is the DoF of a rigid body which is constrained to move in a plane? Considering ${}^{A}_{B}R$ represents the orientation of frame {B} with respect to {A}, write down some properties of the rotation matrix.	**05**
1B.	Write down newton's and Euler's equation of motion. What does Lagrangian(L) stands for. Write down the Lagragian formulation employed to derive Equation of Motion for multi link planar manipulator.	**05**
2A.	Write down the general form of EoM(Equation of Motion) for a multi-link manipulator. Illustrate the method for finding out the individual components in the equation.	**03**
2B.	Find the inertia tensor for the rectangular body of uniform density ρ with respect to the coordinate system shown in Figure Q2B.(l=1;w=.5,h=2)	**03**

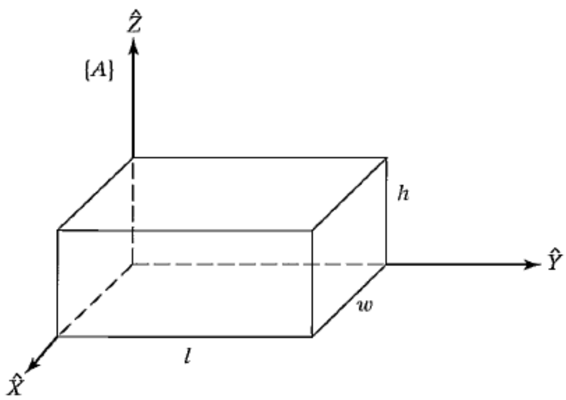

Figure .Q2B

2C. Derive the equation of motion for the simple inverted pendulum problem as shown below by Lagrangian formulation (Fig. Q2C). **04**

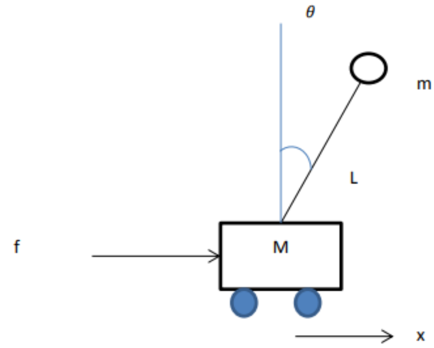

Figure .Q2C

3A. Write down the forward kinematic equation for a three link planar manipulator and derive its complete Jacobian matrix. **02**

3B. Illustrate an inverse kinematics scheme (flow-chart/algorithm/pseudo code) employing Jacobian of the manipulator. **04**

3C. Derive the equation of Motion for the 2 DoF freedom manipulator as shown in Fig. Q3C. **04**

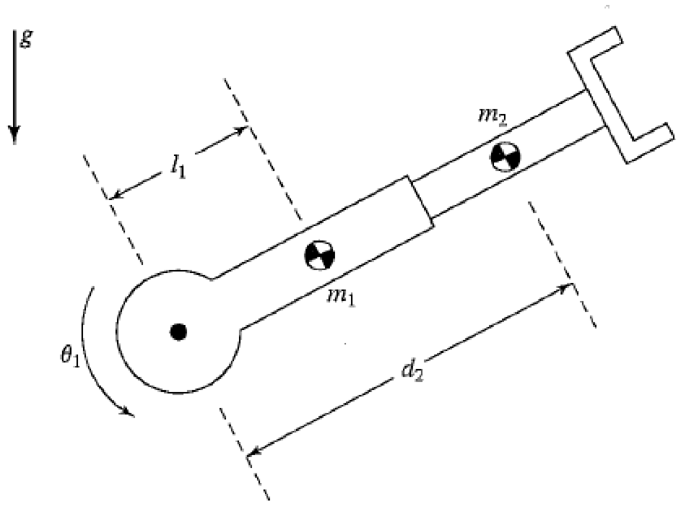

Figure.Q3C.

4A. Consider the nonlinear spring characteristic shown in Figure Q4A., Rather than the usual linear spring relationship, $f = kx$, this spring is described by $f = kx^3$. Construct a control law to keep the system critically damped with a stiffness of K_{CL}. **05**

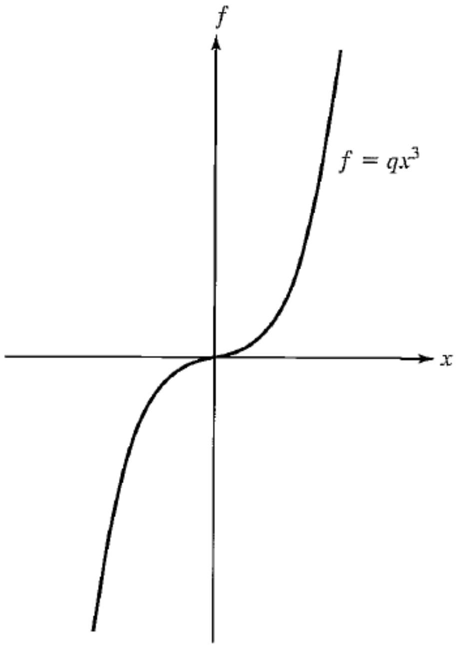

Figure Q4A.

4B. Consider the single-link manipulator shown in Figure Q4B. It has one rotational joint. The mass is considered to be located at a point at the distal end of the link, and so the moment of inertia is ml^2. There is Coulomb and viscous friction acting at the joint, and there is a load due to gravity. Illustrate the control law based on partioning. **05**

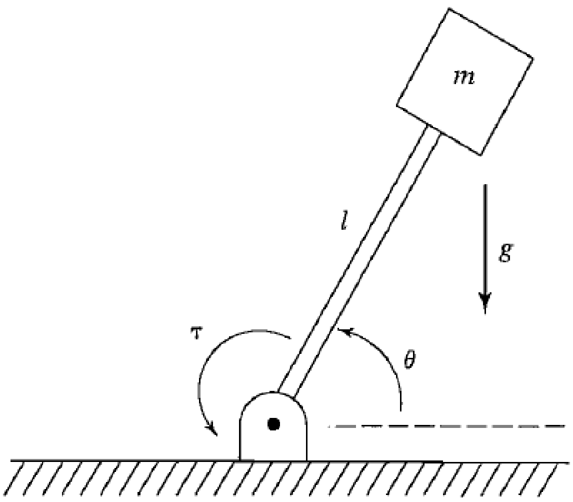

Figure.Q4B.

5A. Determine the motion of the system in Figure.Q5A. if parameter values are in m= 1, b = 2, and k = 3 and the block (initially at rest) is released from the position x = —1. **04**

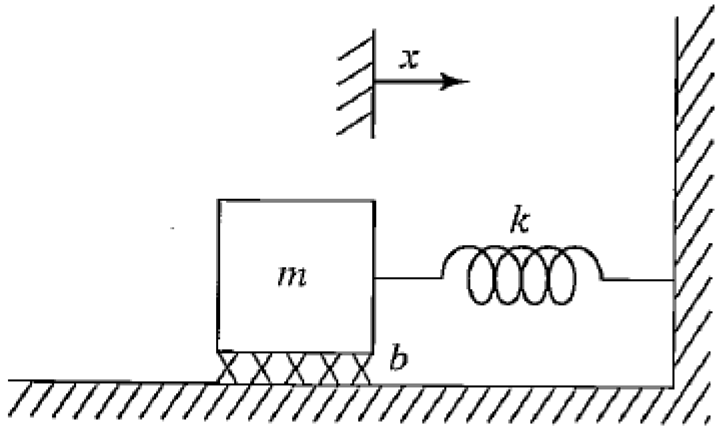

Figure Q5A.

5B. If the parameters of the system in Fig.Q5A. are in m= 2, b = .4, and k = .8, find gains k_p, k_v for a position-regulation control law that results in the system's being critically damped with a closed-loop stiffness of 12.0. **04**

5C. Draw a block diagram for a position regulator system. **02**