Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent institution of MAHE, Manipal)

VII SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV 2018

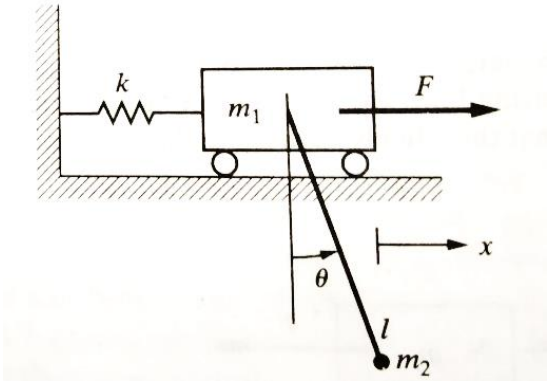
SUBJECT: Robot Dynamics and Control [MTE 4007]

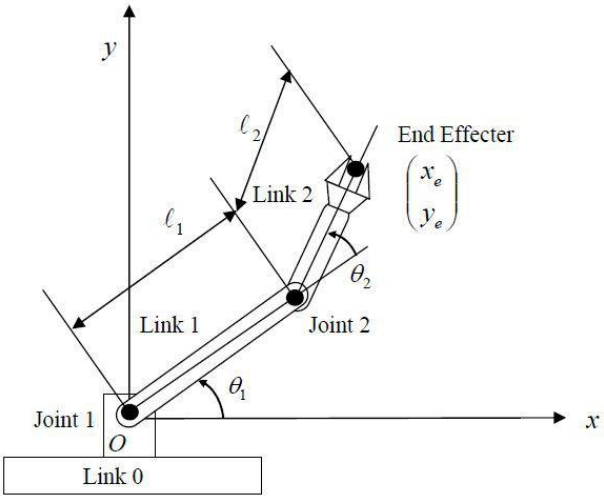
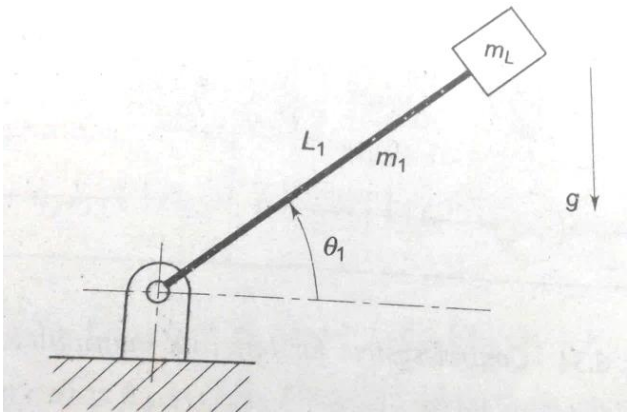
REVISED CREDIT SYSTEM
(29/11/2018)

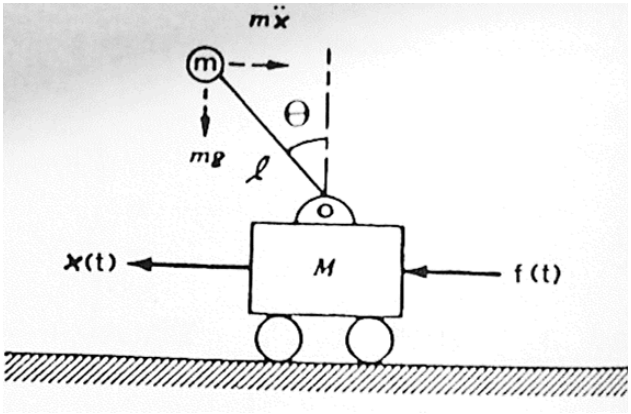
Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A.	Explain the features of any one of the controllers used in robotic systems for a suitable application.	**03**
1B.	State Lagrangian equation of motion for a robotic system and explain each parameters in detail with their properties and dimensions.	**05**
1C.	Define degree of freedom? Calculate degrees of freedom of a rolling coin on a flat surface.	**02**
2.	Formulate equation of motion for a two-degree-of-freedom system shown in Fig.Q.2A using energy method. Linearize the system and propose the best suitable controller for it. (Where F and τ are external force and torque corresponding to generalized variables x and Θ respectively.)  Fig.Q.2A	**10**
3A.	Calculate linear and angular velocities of a 2 wheeled planar mobile robot, if wheel angular velocities are w_l and w_r. Assume distance between wheels is 2b and dimensions of the robot platform are L x L.	**02**

3B.	Apply an impedance control law for the manipulator shown in Fig.Q.3B.Assume no gravity loading and draw a block diagram of a controlled system. Where, $Kp=diag[kp_1\ kp_2]$, $Kd=diag[kd_1\ kd_2]$ and Error vector = $[e_1\ e_2]^T$.  Fig.Q.3B	**06**
3C.	Define workspace and singularity of a manipulator?	**02**
4A.	Derive dynamic equation for the following system shown in Fig.Q.4A. The load carried by the link is modeled as a point mass m_L at the distal end of the link.  Fig.Q.4A	**04**
4B.	Define coriolis and centripetal forces in robot dynamics.	**02**
4C.	Design a model-based controller for the system shown in Fig.Q.4A	**04**
5A.	Explain Newton's method for modelling dynamic equation of multi body systems and design dynamics of a spring mass damper system as well.	**04**
5B.	Formulate dynamics of the system shown in Fig.Q.5B using energy method such that the cart must be moved so that mass m is always in an upright position.	**06**

	Obtain the state variable representation for the system and show that the system is unstable. Where, $f(t)$ is the force on the cart.  Fig.Q.5B Assume that the rod between the pendulum and the cart is stiff and does not bend or expand, M >> m and the angle of rotation Θ is small.	