Reg. No.										

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

VII SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV 2018

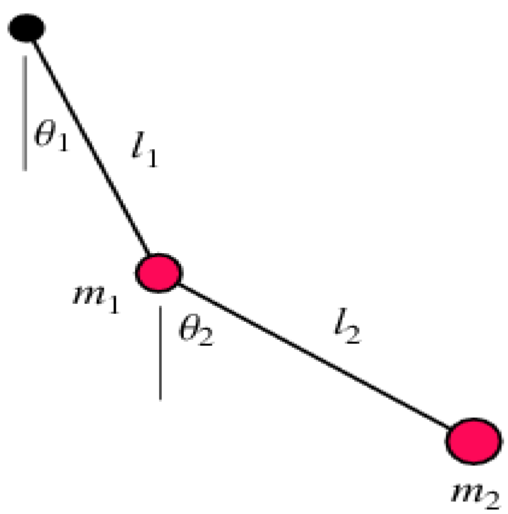
SUBJECT: Robot Dynamics and Control [MTE 4007]

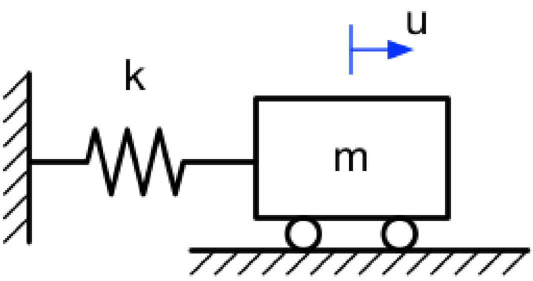
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A.	Derive the equation of motion for the manipulator shown in Fig.Q.1A using Euler-Lagrange formulation. Consider rods are massless and earth fixed frame is at the hinge joint.  Fig.Q.1A	**05**
1B.	Define the following with relevant plots. a. Rise time b. Maximum overshoot c. Settling time	**03**
1C	Define coriolis and centripetal forces in robot dynamics.	**02**

2A.	Explain equilibrium conditions in simple pendulum using its dynamic model.	**03**
2B.	Obtain solutions for forward and inverse kinematics of 2R planar serial manipulator.	**07**
3A.	Derive the force-acceleration relationship for the one-degree-of-freedom system shown in Fig.Q.3A using both energy and force methods. Assume that the wheels have negligible inertia. Compare both the results. (u is an applied force).  Fig.Q.3A	**06**
3B.	Explain computed torque control for a serial manipulator with a neat labelled block diagram.	**04**
4A.	Linearize the given nonlinear system at an equilibrium point $x_1 = 0 \; and \; x_2 = 0$. $$\frac{dx_1}{dt} = x_2^2 + x_1 \cos(x_2)$$ $$\frac{dx_2}{dt} = x_2 + (x_1 + 1)x_1 + x_1 \sin(x_2)$$	**04**
4B.	Explain Lyapunov stability criteria and prove that spring-mass-friction system will eventually come to rest even when it starts with an arbitrary initial condition.	**06**
5A.	Formulate an equation of motion for a 2R manipulator. Given mass m_i, length l_i and moment of inertia I_i for link i.	**06**
5B.	With the data given in 5A, compute linear velocities of centre of mass of links. Express the kinetic energy of the system in terms of mass matrix and generalized coordinates.	**04**