Venue: LHC 316 | Odd Semester 2018-2019 | 24 August 2018

Department of Mechanical Engineering
Indian Institute of Technology Delhi
MCL731: Analytical Dynamics

Time: 9.30 am-10.30 am | Minor Test - I | Maximum Marks: 20

Instructions

Use of any electronic devices not permitted; Do not share pencil,eraser,ruler; Assume appropriately any missing data

Section A

1. A particle of mass m can slide down on a smooth rigid wire having the form $x^2 = 4ay$, where gravity acts in the direction of negative y axis. Using D'Alemberts's principle and the equation of constraint, show that $2a\ddot{x} + x\ddot{y} + gx = 0$ [05]

2. In Fig. 1, two particles having masses m and $2m$ are connected by a massless rod of length $\sqrt{2}r$ to form a dumbbell. It can slide without friction in a circular bowl of radius r. Use the principle of virtual work to obtain the value of θ at the position of static equilibrium. [05]

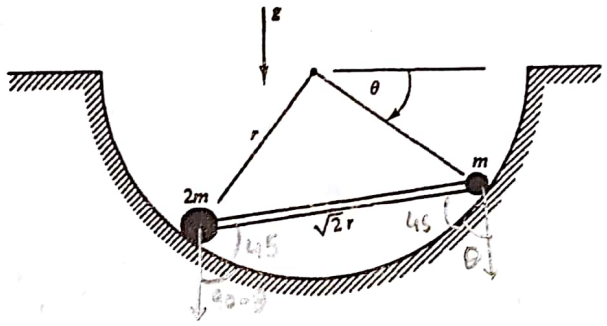

Fig. 1: Question 2

3. A vector $\overline{P}(t) = 6t\hat{e}_1 - 3t^2\hat{e}_2 + 6\hat{e}_3$ units is referred to a reference frame $B = \{O'; \hat{e}_1\hat{e}_2\hat{e}_3\}$ which has a constant angular velocity $\overline{\omega} = 3\hat{e}_1 + 2\hat{e}_2 + 6\hat{e}_3$ units relative to another frame $A = \{O; \hat{i}\hat{j}\hat{k}\}$. Find the time rate of change of $\overline{P}(t)$ apparent to observers in the two frames, and referred to $\hat{e}_1\hat{e}_2\hat{e}_3$ basis of B. [03]

Section B

4. Write the expression for Coriolis acceleration in vector form and give the kinematic meaning of the vectors used in your expression. [02]

5. Explain why obtaining the equations of motion (in Cartesian coordinates) of a spherical pendulum using D'Alembert's principle together with the constraint equation is relatively easier than using Lagrange's equations of motion of the first-kind together with the same constraint equation. [01]

6. Give an example of a workless constraint with a neat sketch and reasoning. [02]

7. Is the kinematic constraint between two gears holonomic or nonholonomic? Give reasons. [02]