06/10/2020 19:00-20:10hrs

Exam: 1-2 Segment

E1.1. Write down the equations of constraints in Cartesian coordinates for the following dynamical systems and categorize them according to the classification of the constraints:

a) A pair of cartwheels of radius R, the center of which are connected by a rigid shaft of length l is allowed to roll without slipping down an incline that makes an angle α with the horizontal.

b) Motion of a carrom striker (disk) of radius R on a square carrom board, where length of each side is l.

E1.2. A mass point moves on the outside surface of the upper hemisphere of a globe. Let its initial position $\boldsymbol{r}$ and initial velocity $\mathbf{v}$ be arbitrary, except that the latter is to be tangential to the surface of the sphere. The motion is to be frictionless, occurring solely under the influence of gravity. Investigate the problem in terms of cartesian coordinates only and find at what height from the center the particle should jump off the sphere.

E1.3. Find the equation of motion of a solid sphere rolling down on an incline using the Lagrange multipliers for the rolling constraints.

E1.4. A small plumb bob of mass m is free to swing back and forth in a vertical x-z plane at the end of a string of length R. What is the number of degrees of freedom? What is the generalized coordinate for this system? Write down the Lagrangian of the bob and use that to write the Euler-Lagrange equation and final equation of motion.