Indian Institute of Technology Guwahati

Department of Physics

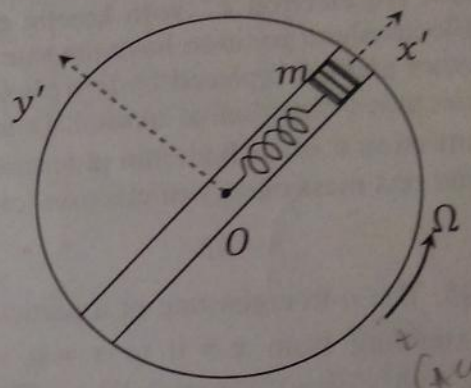
End-Semester Examination: Physics-I (PH101)

Total Marks: 48 **Date: 24.11.2013** **Duration: 3hrs**

$6 \times 8 = 48$

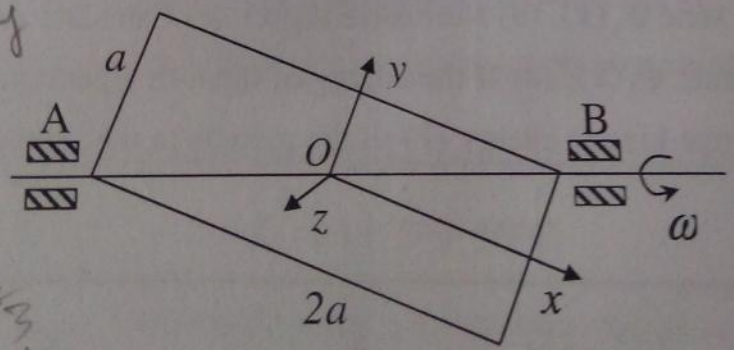
Answer all six questions:

Q1. A flat, circular turntable with a straight groove passing through the center O, is rotating in a horizontal plane with a constant angular speed Ω, as shown in the figure. A block of mass m, which is snugly fitted and constrained to move along the groove, is connected to a spring whose other end is fixed at O. Assume that the natural length of the spring is negligible, and its spring constant k is $\leq m\Omega^2$. The groove is of rectangular cross section having a frictionless floor but rough side walls with coefficient of kinetic friction $\mu = 1/2$. Consider a rotating frame S' attached to the turntable with x' axis along the groove, y' axis is on the plane of the turntable and the origin $O' = O$. At $t = 0$, the block is released from the origin $x'(0) = 0$ with an initial velocity $\dot{x}'(0) = v_0$ in the positive x'-direction. (Assume that the block remains on the turntable and the spring does not break.)



(a) What are the forces (ignoring gravity) acting on the block in the rotating frame S' at any later time? (b) Write the equations of motion of the block. (c) If the spring constant k is taken to be $m\Omega^2$, what are the instantaneous velocity $\dot{x}'(t)$ and position $x'(t)$ of the block? [3+2+3=8]

Q2. A thin rectangular plate of mass m with sides a and $2a$, rotates with constant angular velocity ω about an axle passing through two diagonal corners, as shown in figure. The axle is supported at the corners of the plate by bearings A and B which can exert forces only on the axle. xyz represents the body fixed frame with origin O at the center of mass of the plate, xy plane is the plane of the plate and x-axis is parallel to the side $2a$. (a) What is the moment of inertia tensor of the plate in the given body frame? (b) Find the torque about O required to maintain the motion. (c) Find the components of forces exerted by each bearing on the axle in the given body frame. (Ignore gravitational and frictional forces.) [2+3+3=8]



NEXT PART IN ENDSEM-2