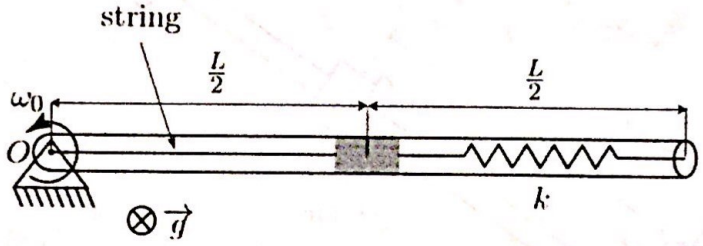
ME 104
Midterm 1
February 28, 2022

[1] (50%) A tube of length L rotates with constant angular speed ω_0 about the fixed end O and in the horizontal plane. Gravity $\vec{g}$ points perpendicular to the plane as shown. A particle of mass m is held at the mid-point of the tube by a string attached to the end O and a spring attached to the outer end. The spring has stiffness k and a free length of zero. The tube is frictionless.



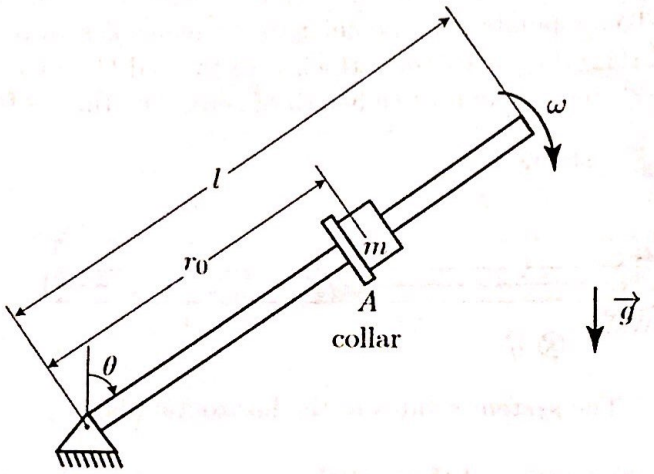
The system rotates in the horizontal plane.

(a) (10 pts) Compute the acceleration of the particle.

(b) (20 pts) Determine the ~~tesion~~ tension in the string.

(c) (20 pts) Now assume the string is cut at time $t = 0$ and determine the acceleration of the particle the instant *after* the string is cut.

[2] (50%) The rod of length l shown below rotates in the *vertical* plane with constant angular speed ω. A slider of mass m is initially seated against the collar A at a fixed distance r_0 from the pivot. The slider is like a bead with a hole it allowing it to slide along the rod. The coefficient of friction (static kinetic) between the rod and the slider is μ.



(a) (20 pts) At the same arbitrary position θ where the slider is in contact with the collar, write a vector for the absolute acceleration of the slider in terms of the variables given.

(b) (20 pts) Determine the angular speed ω needed for the slider to begin to slide at any prescribed angle $\theta = \theta_0$ where $\theta \leq \theta_0 \leq 90^0$.

(c) (10 pts) The slider then slides outwards for $\theta > \theta_0$. The slider is observed to reach the end of the rod of length l when $\theta = 90^0$ and with speed v. You may consider both l to v to be known. At this instant, compute the reaction force(s) acting on the slider by the rod.