

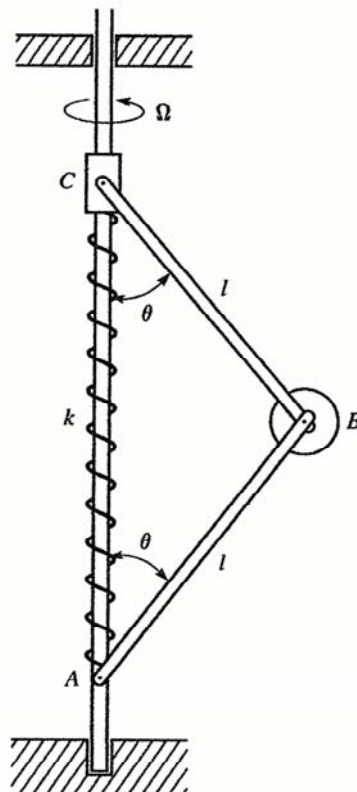
Problem Set No. 8

Out: Wednesday, October 28, 2009

The homework problems are for practice only. Solutions are posted in a separate file. Please work on the problems and be prepared to ask questions related to this homework in the recitation of Tuesday, November 3, 2009 (4:00–5:30pm in Room 1-379).

Problem 1 (Ginsberg, 7.38)

The linkage precesses about the vertical axis at the constant rate Ω . The small disk B and slider C each have mass m , and the mass of each link is negligible. The spring has stiffness k and its unstretched length is $2l$. Identify the two possible constant values of θ in the physically meaningful range $0 \leq \theta < \pi/2$ corresponding to steady precession with $\dot{\theta} = 0$. Prove that one of these possibilities is always unstable, while the other is a stable position that exists only if k is sufficiently large.



Problem 2 (adapted from Doctoral Qualifying Exam)

A cylinder has its center of gravity C at distance a from the geometric center O . The cylinder rolls without slipping on a plane inclined at an angle α relative to the horizontal.

(i) Derive a condition between a , the cylinder radius r and the angle α , ensuring that the cylinder will always roll down the plane and that it never can roll upward or be in equilibrium.

(ii) In the borderline situation in (i) above, describe the position of equilibrium of the cylinder and find whether that equilibrium is stable or unstable.

(iii) Let $a = r/4$, $\alpha = \pi/6$, $I_C = mr^2$ and let the cylinder start from rest from a position where OC is perpendicular to the incline. Calculate the velocity of point O for four subsequent positions, after rotations of the cylinder of 90, 180, 270 and 360 deg.

