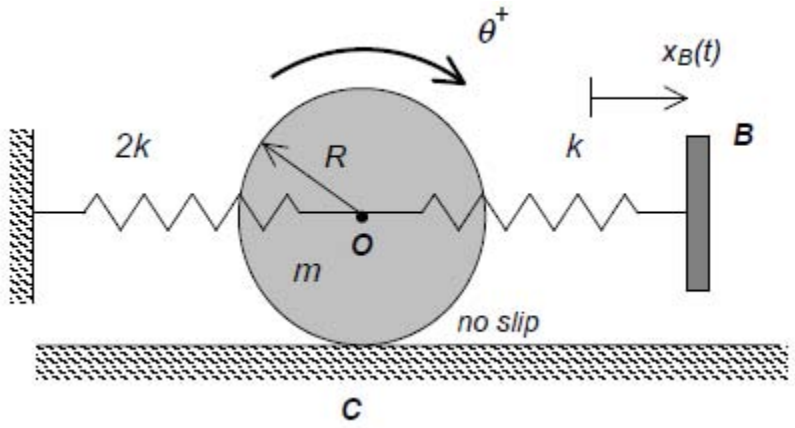
Homework H.6.K

Given: A homogeneous disk, having a mass of m and outer radius of R, rolls without slipping on a rough, horizontal surface. A spring of stiffness $2k$ is connected between the center O of the disk and ground on the left side of the disk. A second spring, having a stiffness of k, is connected between O and the moveable base B. Base B is given a prescribed horizontal motion of $x_B(t) = b \sin \omega t$. Let θ represent the rotation of the disk measure positive clockwise, and let $\theta = 0$ rad and $x_B = 0$ m describe the state at which the springs are unstretched.

Find: For this problem:
(a) Draw a free body diagram of the disk;
(b) Derive the differential equation of motion for the system in terms of the coordinate θ;
(c) Derive the particular solution $\theta_p(t) = A \sin \omega t$ for the previously-obtained equation of motion; and
(d) Make a plot of the amplitude of θ_p (i.e. $|A|$) versus the excitation frequency ω.



Use the following parameters in your analysis: $m = 24$ kg, $k = 108$ N/m, $R = 0.2$ m, and $b = 0.03$ m.