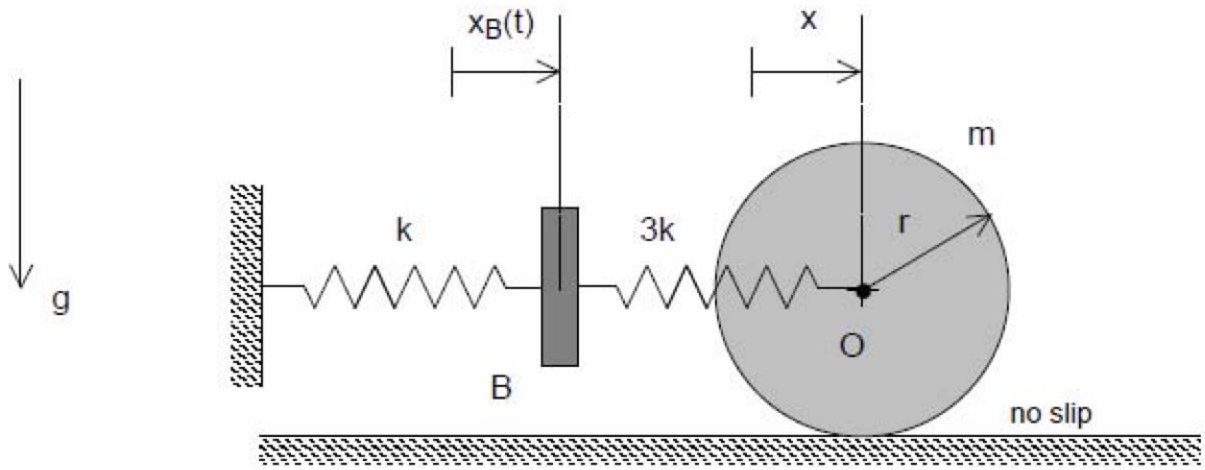
Homework H6.M

Given: A homogeneous disk (of mass m and outer radius R) rolls without slipping on a rough, horizontal surface. A spring (of stiffness $3k$) is attached between the center O of the disk and a moveable base B. A second spring (of stiffness k) is attached between point B and ground. Base B is given a prescribed motion of $x_B(t) = b \sin \Omega t$. The coordinates x and x_B are both zero when the springs are unstretched.

Find: For this problem:
(a) Derive the differential equation of motion for the disk in terms of the coordinate x;
(b) Determine the numerical value for the natural frequency of this system;
(c) Determine the numerical value of X, if the particular solution of the system is written as $x_p(t) = X \sin \Omega t$; and
(d) Determine if the disk is moving in-phase or out-of-phase with the base B.



Use the following parameters in your analysis: $m = 80$ kg, $k = 640$ N/m, $r = 0.25$ m, $b = 0.16$ m, and $\Omega = 10$ rad/s.