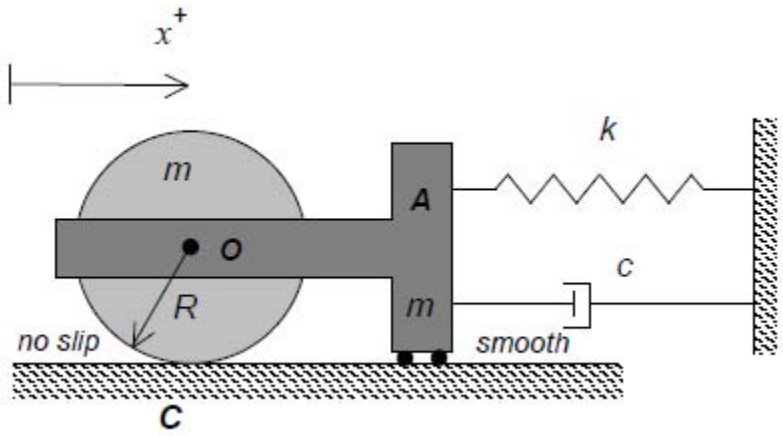
**Homework 6.B.6**

**Given:** A homogeneous wheel of mass $m$ and outer radius $R$ rolls without slipping on a horizontal surface. Block A (also having a mass of $m$) is pinned to the center O of the wheel and is able to slide without friction on the same horizontal surface. A spring (of stiffness $k$) and a dashpot (of damping constant $c$) are connected between block A and ground. Let $x$ represent the motion of block A measured positively to the right. When $x = 0$ m, the spring is unstretched.

**Find:** For this problem:
(a) Draw individual free body diagrams for block A and the wheel;
(b) Derive the single differential equation of motion for the system in terms of the coordinate $x$, its time derivatives, and the following parameters: $m$, $R$, $c$, and $k$;
(c) Determine numerical values for: the undamped natural frequency $\omega_n$, the damping ratio $\zeta$, and the damped natural frequency $\omega_d$; and
(d) Determine the response of the system $x(t)$ for $t > 0$, assuming the system is released when the springs are unstretched with $\dot{x}(0) = v_0$.




Use the following parameters in your analysis: $m = 4$ kg, $k = 2250$ N/m, $R = 0.1$ m, $c = 60$ kg/s, and $v_0 = 8$ m/s.