

# MECH463 -- Tutorial 1

For each of these one-degree-of-freedom vibrating systems, draw a free body diagram and use it to determine the equation of motion. Hence, find the natural frequency of vibration.

1. A mass  $m$  hanging from a pulley that is supported on a cable and a spring of stiffness  $k$ .
2. A wheeled cart of mass  $m$  on a plane inclined at an angle of  $30^\circ$ , supported by a pulley system and a spring of stiffness  $k$ . (You may ignore the mass of the pulleys).
3. A circular gear of mass  $m$ , moment of inertia  $I$ , radius  $r$ , and supported on four strings of length  $h$ . (The gear vibrates by rotation in the  $x$ - $y$  plane).
4. A solid hemisphere of radius  $r$  and mass  $m$ , rolling on a horizontal plane without slipping.
5. A testing machine for measuring dynamic friction coefficient  $\mu$ . A rod of length  $L$ , mass  $m$ , rests on two counter-rotating pulleys with centres  $H$  apart.
6. A thin circular ring of radius  $r$ , mass density  $\rho$ , Young's modulus  $E$ , and cross section area  $A$ , vibrates radially. (Hint: consider a small segment with infinitesimal angle  $d\theta$ ).

