Department of Mechanical Engineering
Massachusetts Institute of Technology
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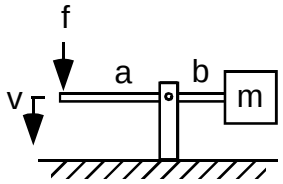
2.003 Modeling, Dynamics and Control I
Homework 5

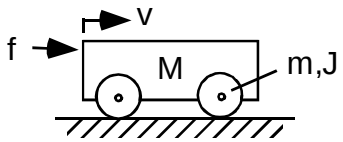
Assigned: Wednesday March 13, 2002
Due: Wednesday March 20, 2002

Problem 1

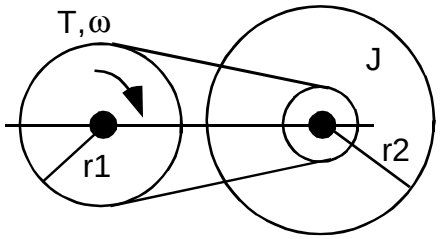
(a) Derive an expression for the equivalent mass at the point of application of the force.



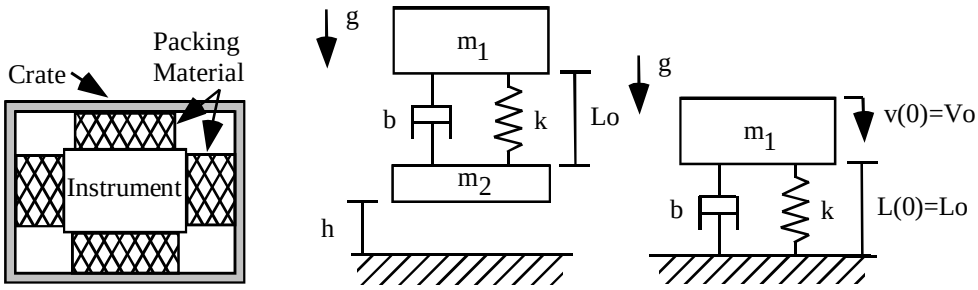
(b) Derive an expression for the equivalent mass at the point of application of the force. Assume that each wheel has a mass, m , and a rotational inertia of J . Assume there is no energy loss due to bearings and that the wheels do not slip.



(c) Derive an expression for the equivalent rotational inertia. Assume that the two pulleys have negligible inertia, there are no losses due to bearings and that the flywheel has inertia, J .



Problem 2
A packing crate was designed to protect a fragile instrument during shipment. Assuming that the packing material can be modeled as an ideal linear spring of stiffness, k , in parallel with an ideal linear damper, b , and that the instrument and crate are of mass, m_1 and m_2 , respectively, the system can be modeled as shown in the middle figure below



The packing crate (with instrument inside) is dropped from a height, h , as shown in the middle figure. The height is sufficiently large that by the time the crate hits the ground, the spring is fully extended to its unloaded length, Lo , as shown in the figure on the right. Note that the crate hits the ground with velocity, V_o , and in the presence of gravity.

(a) Derive the differential equation for the system. Clearly indicate the initial conditions, and any inputs present.
(b) For what values of, b , will the instrument oscillate?
(c) Assuming that the instrument does oscillate, derive an analytical expression for the complete solution.

Problem 3
Palm 3.4

Problem 4
Palm 3.5

Problem 5
Palm 3.6