1. **Rack and pinion** (Modified from Williams, Problem 6-109)

A rack and pinion system is sketched in Figure P6-109. The axis of the pinion is fixed in frictionless bearings. A massless rocket is attached to the circular massless pulley of radius \( a \) at a point along its edge as shown in the figure. It exerts thrust \( F(t) \) which remains tangential to the pulley at all times. Assume that the pinion can be modeled as a uniform cylinder of mass \( m_2 \) and radius \( b \) and that the friction between the rack and the horizontal surface can be modeled as viscous damping having a dashpot constant \( c \). Derive the equation(s) of motion for the system using Lagrangian approach.

![Figure by MIT OpenCourseWare.](image-url)

2. **Problem 6-101 from Williams.**

3. **Problem 6-103 from Williams.**

4. **Problem 6-110 from Williams.**