1. Re-examine Atwood’s machine in Example 2.9(a) in the textbook. Now assume the pulley is a disk with mass \( m \) and rotates without slipping between the string and the pulley’s edge. Find the acceleration of the masses \( m_1 \) and \( m_2 \), and the tension of the string (which is no longer constant everywhere).

2. A symmetric body moves without the influence of forces or torques. Let \( x_3 \) be the symmetry axis of the body and \( \mathbf{L} \) be along \( x_3' \). The angle between \( \mathbf{\omega} \) and \( x_3 \) is \( \alpha \). Let \( \mathbf{\omega} \) and \( \mathbf{L} \) initially be in the \( x_2 - x_3 \) plane. What is the angular velocity of the symmetry axis about \( \mathbf{L} \) in terms of \( I_1, I_3, \omega, \) and \( \alpha \) ?

3. Consider a thin disk composed of two homogeneous halves connected along a diameter of the disk. If one half has density \( \rho \) and the other has density \( 2\rho \), find the expression for the Lagrangian when the disk rolls without slipping along a horizontal surface. (The rotation takes place in the plane of the disk.)

4. Find the frequency of small oscillations for a thin homogenous plate if the motion takes place in the plane of the plate and if the plate has the shape of an equilateral triangle and is suspended (a) from the midpoint of one side and (b) from one apex.

5. A projectile is fired at an angle of 45° with initial kinetic energy \( E_0 \). At the top of its trajectory, the projectile explodes with additional energy \( E_0 \) into two fragments. One fragment of mass \( m_1 \) travels straight down. What is the velocity (magnitude and direction) of the second fragment of mass \( m_2 \) and the velocity of the first? What is the ratio of \( m_1/m_2 \) when \( m_1 \) is a maximum?