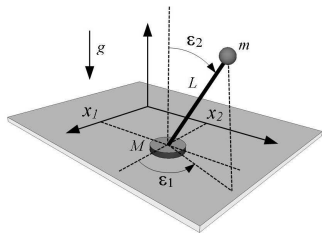


## Exercise 4



The system has four generalized coordinates:  $(x_1, x_2)$  are variables for representing the position of the puck on a plane;  $(\epsilon_1, \epsilon_2)$  are two angles (precession and nutation) for representing the status of the pendulum.

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The dynamics of the system are

$$\begin{aligned} \frac{d}{dt} \left[ \frac{\partial \mathcal{L}}{\partial \dot{\epsilon}_1} \right] - \frac{\partial \mathcal{L}}{\partial \epsilon_1} &= 0 & \frac{d}{dt} \left[ \frac{\partial \mathcal{L}}{\partial \dot{\epsilon}_2} \right] - \frac{\partial \mathcal{L}}{\partial \epsilon_2} &= 0 \\ \frac{d}{dt} \left[ \frac{\partial \mathcal{L}}{\partial \dot{x}_1} \right] - \frac{\partial \mathcal{L}}{\partial x_1} &= F_1 & \frac{d}{dt} \left[ \frac{\partial \mathcal{L}}{\partial \dot{x}_2} \right] - \frac{\partial \mathcal{L}}{\partial x_2} &= F_2 \end{aligned}$$

with  $F_1, F_2$  being external forces acting on the puck along  $x_1, x_2$  axes

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**The task:** to find an induced behavior of the system when the puck is forced to move along of a circle of a radius  $R$  while the pendulum stays above the horizontal for all the time.