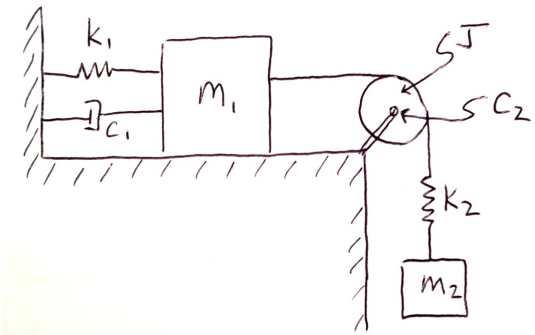
Find state-space models for each of the following systems:

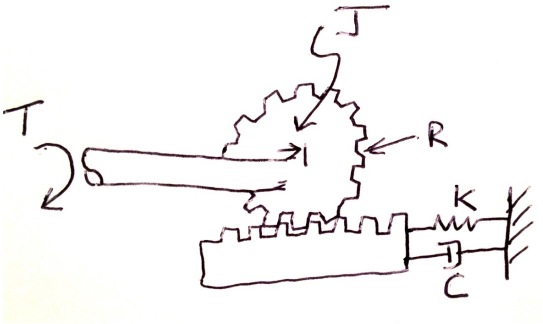
1.



Mass m_1 is connected to the wall through spring k_1 and damper c_1. It slides on the floor without friction. An inextensible cord connects mass 1, over the pulley with inertia J, to spring k_2. The cord does NOT slide relative to the pulley. The hub of the pulley has rotational damping c_2. Gravity acts downward as usual.

The system's input is gravity; the outputs are (i) the tension in the cord connected to m_1, and (ii) the force in spring k_2.

2.



The diagram shows an idealized rack-and-pinion steering mechanism. The driver creates input torque (moment) T on the shaft of the pinion gear, which has inertia J and radius R. The rotation of the pinion gear slides the rack, which has mass m. Assume that all motion of the pinion gear is pure rotation, and all motion of the rack is pure translation. The resistance of the tires is modeled by a spring k and dashpot c, shown connected to ground.

The system's input is T; the output is the force on the tires (through k and c).