

Department of Mechanical Engineering
Cleveland State University

MCE 503: Modeling and Simulation of Mechatronic Systems
Homework 1- Part 2 Spring 2010

OUT: 09-14-10. DUE*: 09-22-10 during class. No homework will be accepted past the due date and time.

2. (80 pts) The hand-sketch of Fig. 1 represents a bolt with preloading spring. In the position shown, the bolt is compressed by h units from its natural length. The variables θ and x are zero at this position and are positive when the screw goes down. They are related by the screw pitch l (in units of x per unit of θ). The torque T_f required to turn the screw is proportional to the tension on the bolt, with proportionality constant c . Assume quasi-static operation, so T is always equal to T_f .

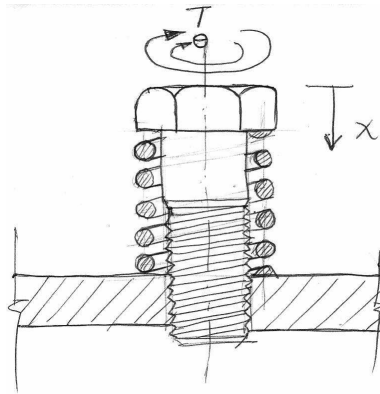


Figure 1: Bolt with Preloading Spring

1. Assume first that the ends of the spring are not attached to the bolt or the plate. Draw a graph of T vs. θ and the inverse graph, θ vs. T .
2. Now assume that the lower end of the spring is welded to the plate and the upper end is welded to the bolt's head (welding took place at the preloaded position). Repeat the graphs of the previous part.
3. Taking the device as a 1-port with T as effort and $\dot{\theta}$ as flow, is this an R , C or I ? Is energy conserved?