# ME 478 FINITE ELEMENT ANALYSIS

## Project #3

A hex key or Allen wrench has a hexagon cross-section. We wish to determine the maximum force that can be applied to an Allen wrench if its short end is inserted 2.5 mm into the head of a rusty bolt that does not want to turn, so thereby causing its short end to be fixed (Figure 1).

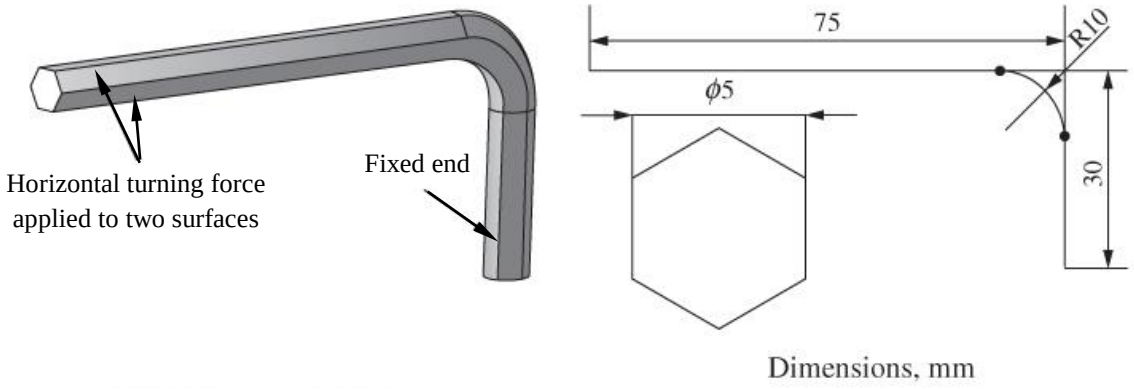


**Figure 1**. Allen wrench and its dimensions.

To model the fixed end of the Allen wrench, let the surface at the bottom of its short end and 2.5 mm along its sides be held fixed. The force to turn the wrench is applied uniformly over a length of 25 mm from the end of the horizontal section of the wrench and acts over two sides of its hexagonal surface. The wrench is made of steel with a modulus of elasticity of 200 GPa, Poisson's ratio of 0.29, and a yield strength of 615 MPa.

## Results

In your report, be sure to include the following (in any order):

1. What is the maximum force that can be applied before the von Mises stress exceeds the yield strength?
2. Where is the location of the maximum von Mises stress?
3. Plot the deformed (+ undeformed) shape the wrench at maximum force.
4. What is an analytical solution for the maximum force and maximum deflection? How do these calculation compare to your FEM model? Discuss why they would agree or disagree.
5. Do this model for different element types, e.g. tets vs. bricks. Does the change in element type affect the results? Why?