# 6.5 Advanced truss analysis: determinacy, rigidity, and redundancy

## Preparatory Problems

**6.5.1** Define these terms

a) statically determinate

b) rigid and non-rigid

c) redundant and non-redundant

**6.5.2** For each set of conditions below, find 2 trusses both of which fit the description

a) rigid and non-redundant

b) rigid and redundant

c) not rigid and not redundant

d) not rigid and redundant

**6.5.3** In 2D trusses we used the formula $b + r = 2j$. With what formula do we replace this for 3D trusses? Explain why.

**6.5.4** For the 3D method of joints, for a whole truss how many independent scalar equilibrium equations can one write?

**6.5.5** For one section cut in 3D how many bar tensions can you hope to find?

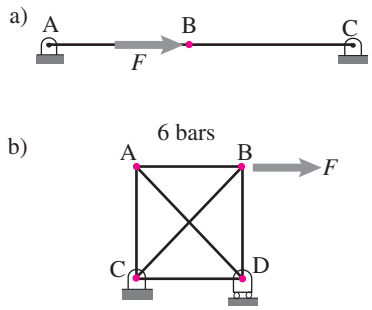
**6.5.6** For a 3D truss that is rigid when not grounded, how many independent reaction components do you need to make it a statically determinate structure for any loading?

## More-Involved Problems

**6.5.7** For the following structures find at least 2 different sets of bar forces that can equilibrate the applied load shown.

a) Two bars in a line with a force in the same line.

b) A square with two diagonal braces.



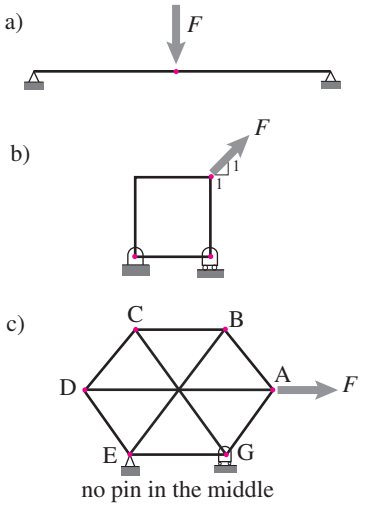

Problem 6.5.7

**6.5.8** For the structures and loading shown show that there is no set of bar forces for which equilibrium is possible (at least with the geometry shown). All of these structures are not rigid, they require either infinite bar forces or some (or a lot of) deformation to withstand the load applied

a) Two bars in a straight line.

b) A square without a diagonal.

c) A regular hexagon with three diameters. [This problem is hard and might best be answered using linear algebra methods on the matrix form of the system of equilibrium equations.]




Problem 6.5.8

**6.5.9** For each of the structures below and the shown loading answer these questions:
i) Does a set of equilibrium bar forces and ground reactions exist? ii) If so, find one such set. iii) Are the solutions, if they exist, unique? iv) If not find at least two solutions. v) Is the structure rigid? vi) If not, how can it deform?

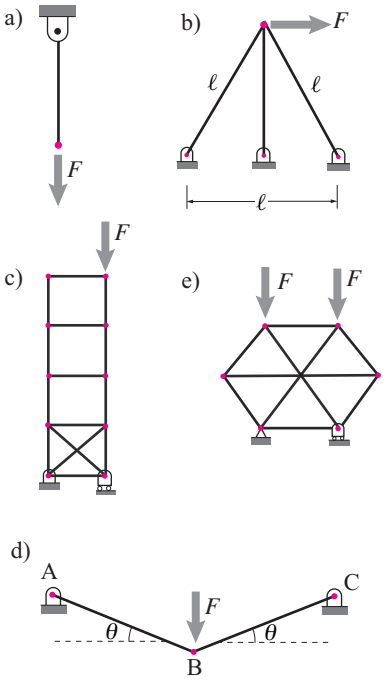
a) One hanging rod

b) A braced pole

c) A tower

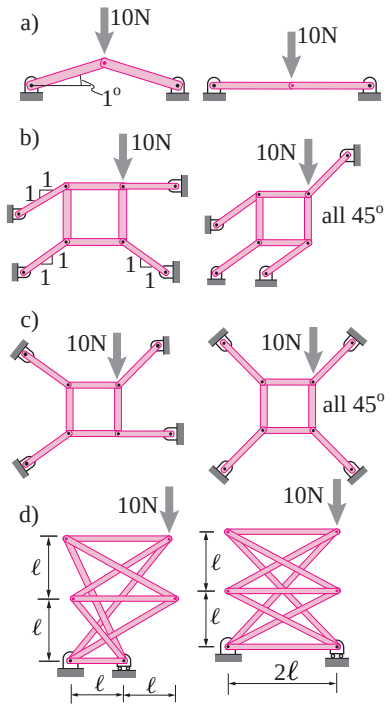
d) Two bars holding a vertical load. Comment in your answers how they change in the limit $\theta \to 0$.

e) A regular hexagon with three diagonals (this is a hard problem).




Problem 6.5.9

**6.5.10** Use your program from problem 6.3.4 to analyze each pair of structures shown. In each case the output of your program should be radically different for the right structure than for the superficially similar structure on the left. **i)** Describe the difference in your computer program behavior, **ii)** As well as you can, explain what it is about the structures that causes this difference in computer behavior.




Problem 6.5.10