6.5.1 Define these terms

a) statically determinate

b) rigid and non-rigid

c) redundant and non-redundant

a) A truss that yields a single unique solution is a statically determinate truss.

b) A non-rigid truss is one that cannot carry arbitrary loads at its joints.

c) A redundant truss is one that contains more unknown tensions than equations which can be derived.

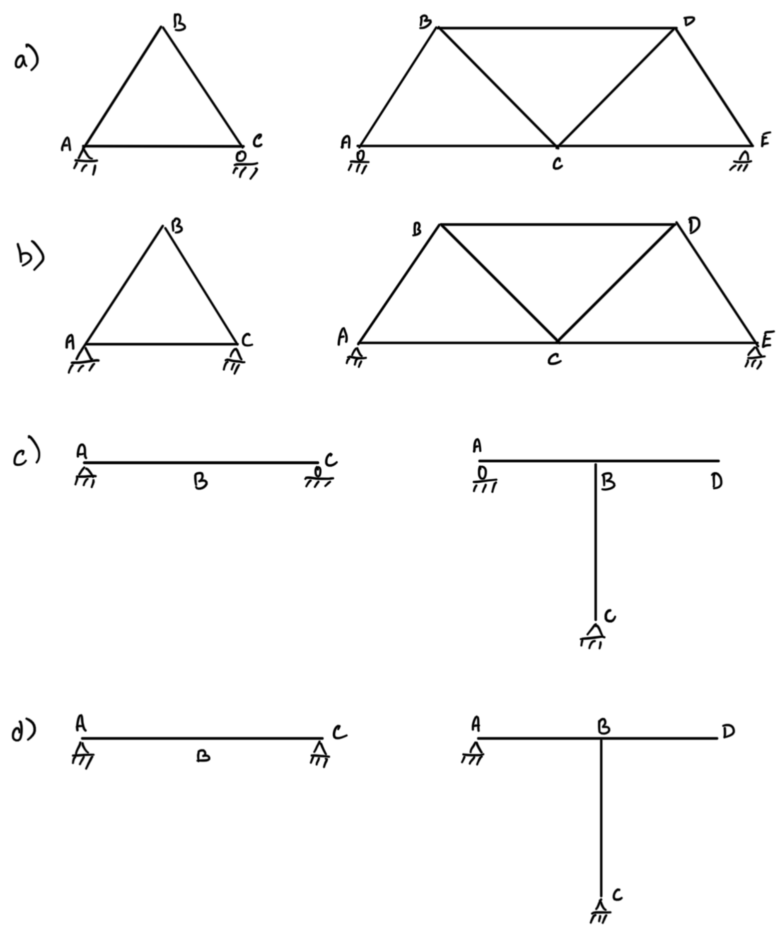
6.5.2 For each set of conditions below, find 2 trusses both of which fit the description

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.

$3j = b + r$

The number of unknowns = no. of bars + no. of reactions

This is because the truss is a two-force body

The number of equations = 3 x no. of joints

There will be 3 force balance equations of the joint.

Hence the formula for a 3-D truss is:

$3j = b + r$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

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

At each joint of a 3-D truss, 3 scalar force-balance equations can be applied:

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum F_z = 0$$

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

From one section of a 3-D truss 6 scalar balance equations are obtained:

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum F_z = 0$$

$$\sum \vec{M}_{/x} = \vec{0}$$

$$\sum \vec{M}_{/y} = \vec{0}$$

$$\sum \vec{M}_{/z} = \vec{0}$$

Hence, 6 tensions can be found from a single section of a 3-D Truss.

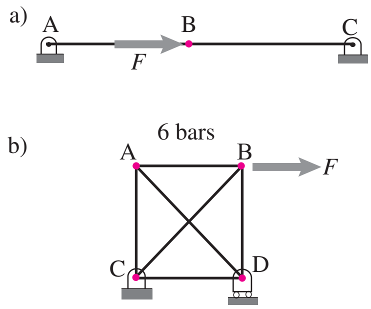
6.5.6 For a 3D truss that is rigid when not grounded, how many independent reaction components do you need to make it a statically determinate structure for any loading?

For a 3-D truss, 6 reaction components are required to make it statically determinate.

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.

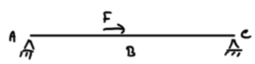
b) A square with two diagonal braces.



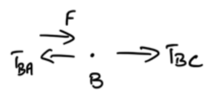
Problem 6.7

a)

Sketch:



FBD (Joint):



$\Sigma F_x = 0$

$\Rightarrow T_{BC} + T_{BA} + F = 0$

$\Rightarrow T_{BC} + T_{BA} = -F$

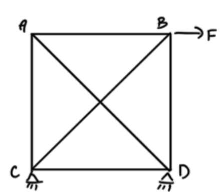
$\Rightarrow T_{BC} = -1/3\ F\ ,\ T_{BA} = -2/3\ F$

or

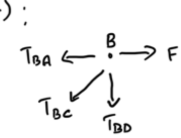
$T_{BC} = -4/3\ F\ ,\ T_{BA} = 1/3\ F$

b)

Sketch:



FBD (Joint):



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$\Sigma F_x = T_{BA} - T_{BC}\cos 45 + F = 0$

$\Rightarrow T_{BA} - T_{BC}\cos 45 = -F$

$\Rightarrow T_{BA} = T_{BC}\cos 45 - F$

$\Sigma F_y = -T_{BC}\sin 45 - T_{BD} = 0$

$\Rightarrow T_{BD} = -T_{BC}\sin 45$

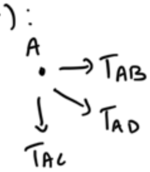
$\Sigma F_x = T_{AB} + T_{AD}\cos 45 = 0$

$\Rightarrow -T_{BA} + T_{AD}\cos 45 = 0$

$\Rightarrow T_{AD} = T_{BA}$

$= T_{BC} - F\sec 45$

FBD(Joint):

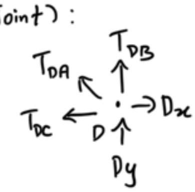


$\Sigma F_y = -T_{AD}\sin 45 - T_{AC} = 0$

$\Rightarrow T_{AC} = -T_{AD}\sin 45$

$= -T_{BC}\sin 45 + F\tan 45$

FBD (Joint):



$\Sigma F_x = D_x - T_{DC} - T_{DA}\cos 45 = 0$

$\Rightarrow D_x - T_{DC} = T_{DA}\cos 45$

$\Rightarrow D_x - T_{DC} = F - T_{BC}\cos 45 \quad -(i)$

$\Sigma F_y = D_y + T_{DB} + T_{DA}\sin 45 = 0$

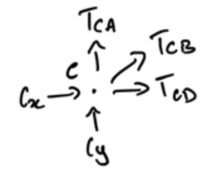
$\Rightarrow D_y + T_{DB} = F\tan 45 - T_{BC}\sin 45$

$\Rightarrow D_y = F\tan 45 - 2T_{BC}\sin 45$

$\Sigma F_x = C_x + T_{CD} + T_{CB}\cos 45 = 0$

$\Rightarrow C_x + T_{CD} = T_{BC}\cos 45 \quad - (ii)$

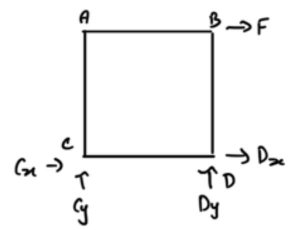
FBD (Joint):



$\Sigma F_x = C_x + D_x = F$

$\Rightarrow D_x = F - C_x$

FBD (Whole Structure):



Substite in (i)

$F - C_x - T_{DC} = F - T_{BC}\cos 45 \quad - (iii)$

$C_x - T_{DC} = T_{BC}\cos 45 \quad - (iv)$

$(iii) + (iv)$

$\cancel{F} - 2T_{DC} = \cancel{F}$

$T_{DC} = 0$