Lecture 4: Frames and Machines

Previously, we looked at frameworks where each member is carrying either compression or tension. Here, we will consider the cases where at least one individual member is a _____. When this is the case, such a structure is called a _____.

Let us define the terms frames and machines as follows

- Frames _____
  _____
- Machines _____
  _____

Example of an interconnected body with multiforce members

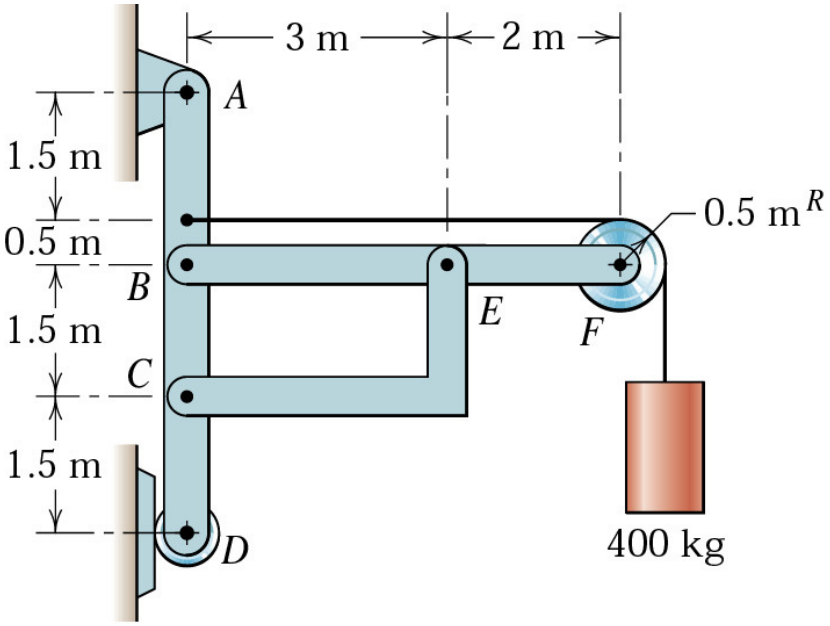

Figure 1

Suppose that we are required to compute the forces acing on each member of the frame. The steps needed to compute the forces are given below.

1. First, always include the _____ and determine the _____. This is achieved by using the free body diagram of the entire structure. (See figure 2) Note that the forces A_x, A_y, and D are the reaction forces which the supports are acting _____ the structure.

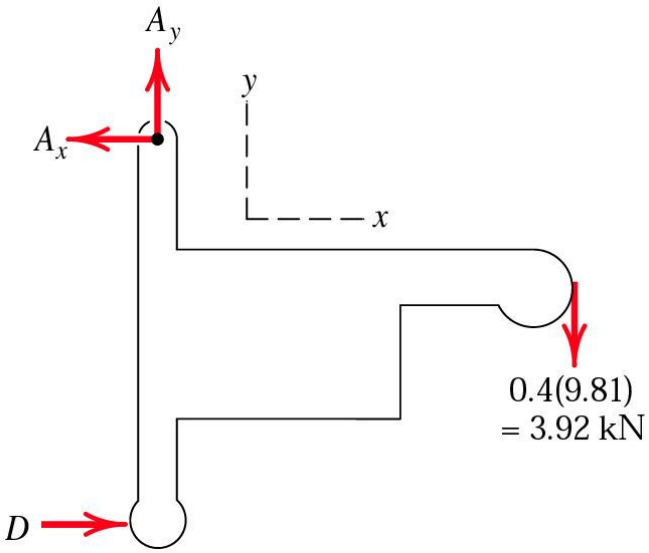

Figure 2.

From the free body diagram in figure 2, we can determine the reaction forces using the equilibrium equations. Hence,

$$\sum M_A = 0 \qquad 5.5(0.4)(9.81) - 5D = 0 \qquad D = 4.32kN$$

$$\sum F_X = 0 \qquad A_X - 4.32 = 0 \qquad A_X = 4.32kN$$

$$\sum F_Y = 0 \qquad A_Y - 3.92 = 0 \qquad A_Y = 3.92kN$$

2. Next, we will dismember the frame and consider the equilibrium conditions of each member individually. Each member will have its own free body diagram

Figure 3

Recall the Newton's third law motion which states that the reaction force is always equal and opposite to the action force. In this case, the force acting on connected members must be _____ _____.

For example, the members AD and BF are pin jointed at point B. Recall that there must be _____ forces acting at a _____. These forces are unknown so they are named B_x and B_y, for the horizontal and vertical components, respectively. Each of these two forces acts on the members AD and BF. The magnitude of the force B_x acting on both members must be the same and their directions must be opposite. This also applies to the force B_y.

Note also that the cable can only support _____. The 400kg weight produces a 3.92kN cable tension, which is transmitted to the vertical member AD at 0.5m above point B and also to the roller. The cable tension produces horizontal force acting on the member AD whose direction is towards the

right hand side, while it also produces a horizontal force towards the left on the roller.

We now have six unknowns in the system, namely B_x, B_y, C_x, C_y, E_x and E_y.

By considering the moment equilibrium of the member CE, we can reduce the number of unknowns using the following relationships.

_____

_____

_____

Finally, all other member forces can be found using the equilibrium conditions on appropriate members. In this case, we will use member BF.

_____

_____

_____