

Moment Visualization Assignment

A visual understanding of moments is especially important for machine design, since this will allow one to troubleshoot and optimize a design. For this assignment review the Moment Visualization handout. Then visually represent the moments for each figure. In each problem:

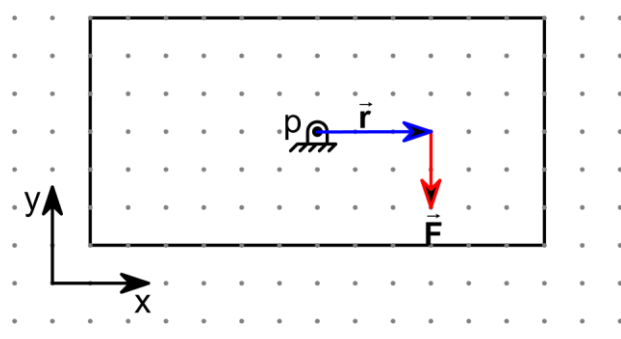
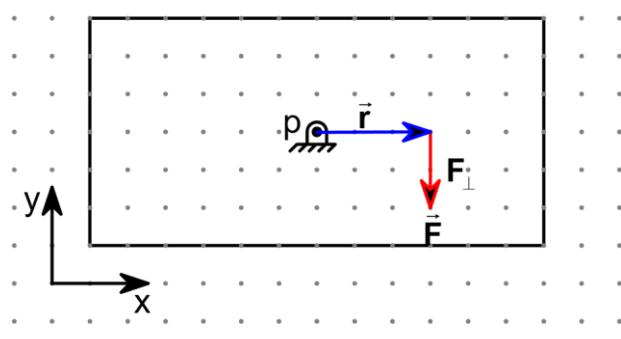
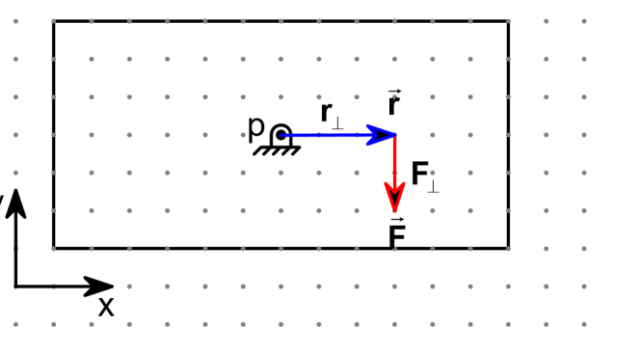
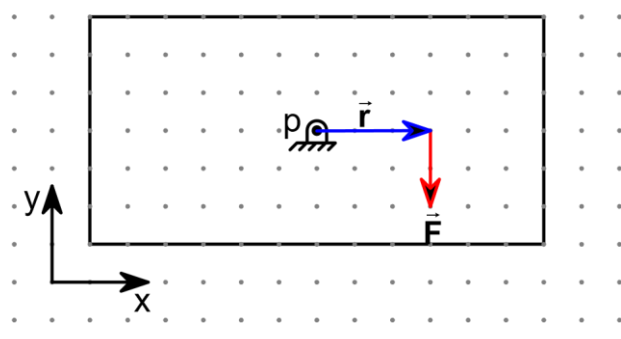
1. Review the Moments Visualization handout (see Guides section of MAE3 webpage for electronic version)
2. Draw the relevant vector components, \mathbf{r} , \mathbf{r}_\perp , \mathbf{r}_\parallel , \mathbf{F}_\perp , \mathbf{F}_\parallel , F_x , F_y , r_x , r_y
Use a ruler to draw the vectors properly and measure their length. Make sure perpendicular lines are indeed drawn at 90 degrees.
3. On the drawing measure the length of the vectors, and convert to distance and force values using the scale of:
1 mm on drawing = Distance of 0.1m
1 mm on drawing = Force of 2N
4. Calculate the moments about point p using the:
 - Perpendicular Force Representation
 - Moment Arm Representation
 - Cartesian (XY) Representation

For this assignment you will need:

- A ruler with millimeter markings
- An angle to draw perpendicular lines

Due to errors in length measurements, one may expect up to 10% discrepancy in results from different visual methods of calculations.

Example: (This is a very easy example; for harder problems see the Moments Visualization handout)

 <p>Vector magnitudes $F = 10 \text{ grid mm} = 20\text{N}$ $r = 15 \text{ grid mm} = 1.5\text{m}$</p>	 <p>$10 \text{ grid mm} = 20\text{N}$ $M_p = \mathbf{F}_\perp r = -20\text{N} \times 1.5\text{m} = -30\text{Nm}$</p>
<p>Problem Definition</p>	<p>Perpendicular Force Representation</p>
 <p>$r_\perp = 15 \text{ grid mm} = 1.5\text{m}$ $M_p = F r_\perp = -20\text{N} \times 1.5\text{m} = -30\text{Nm}$</p>	 <p>grid = 0N $F_y = -10 \text{ grid mm} = -20\text{N}$ $r_x = 15 \text{ grid mm} = 1.5\text{m}$ $r_y = 0 \text{ grid} = 0\text{m}$ $M_p = F_y r_x - F_x r_y$ $M_p = -20\text{N} \times 1.5\text{m} - 0\text{N} \times 0\text{m} = -30\text{Nm}$</p>
<p>Moment Arm Representation</p>	<p>Cartesian (XY) Representation</p>

Scale: On the drawing, each millimeter corresponds to (the grid marks are at 5mm steps)

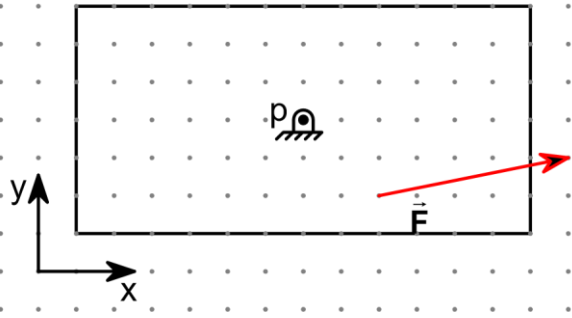
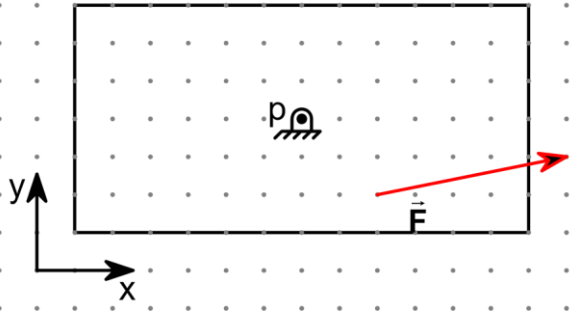
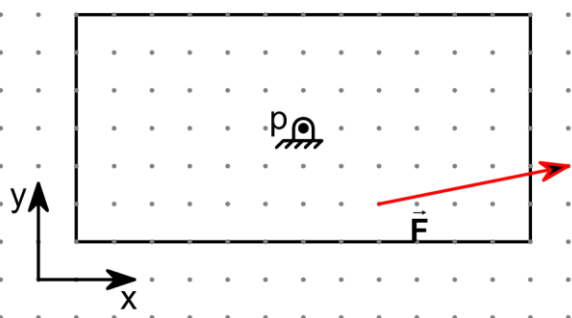
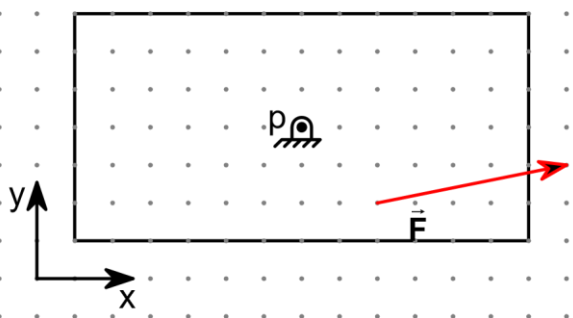
1 mm on drawing = Distance of 0.1m

1 mm on drawing = Force of 2N

Right Hand Rule: counterclockwise moments are positive

In Cartesian representation the signs in the equations as shown are correct, as long as one represents the signs of the vectors properly.

Problem 1

 <p>A diagram on a grid showing a rectangular body with a pivot point 'p' at the center. A force vector \vec{F} is applied at the bottom-right corner, pointing up and to the right. A Cartesian coordinate system with x and y axes is shown at the bottom-left corner.</p>	 <p>A diagram on a grid showing the same rectangular body and pivot point 'p'. The force vector \vec{F} is decomposed into two perpendicular components: a red vector pointing up and to the right, and a black vector pointing up and to the left. A Cartesian coordinate system with x and y axes is shown at the bottom-left corner.</p>
Problem Definition	Perpendicular Force Representation
 <p>A diagram on a grid showing the same rectangular body and pivot point 'p'. A red line segment, representing the moment arm, is drawn from the pivot point 'p' perpendicular to the force vector \vec{F}. A Cartesian coordinate system with x and y axes is shown at the bottom-left corner.</p>	 <p>A diagram on a grid showing the same rectangular body and pivot point 'p'. The force vector \vec{F} is decomposed into its x and y components. A Cartesian coordinate system with x and y axes is shown at the bottom-left corner.</p>
Moment Arm Representation	Cartesian (XY) Representation

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Problem 2

<p>A rectangular body is shown on a grid. A pin support is located at point P, which is at the center of the body. A force vector \vec{F} is applied to the body, pointing upwards and to the right. A Cartesian coordinate system (x, y) is shown at the bottom left corner of the body.</p>	<p>A rectangular body is shown on a grid. A pin support is located at point P, which is at the center of the body. A force vector \vec{F} is applied to the body, pointing upwards and to the right. A second force vector, perpendicular to \vec{F}, is applied to the body, pointing upwards and to the left. A Cartesian coordinate system (x, y) is shown at the bottom left corner of the body.</p>
<p>Problem Definition</p>	<p>Perpendicular Force Representation</p>
<p>A rectangular body is shown on a grid. A pin support is located at point P, which is at the center of the body. A force vector \vec{F} is applied to the body, pointing upwards and to the right. A Cartesian coordinate system (x, y) is shown at the bottom left corner of the body.</p>	<p>A rectangular body is shown on a grid. A pin support is located at point P, which is at the center of the body. A force vector \vec{F} is applied to the body, pointing upwards and to the right. A Cartesian coordinate system (x, y) is shown at the bottom left corner of the body.</p>
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