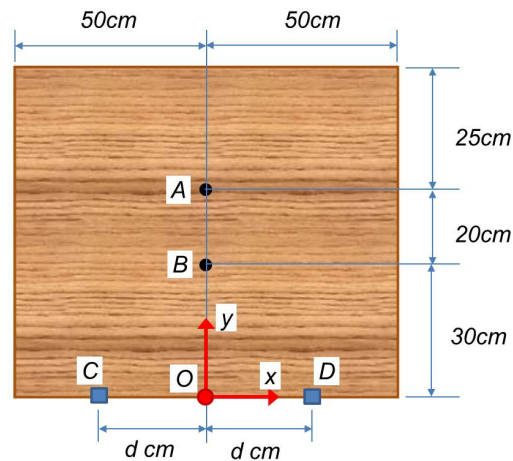


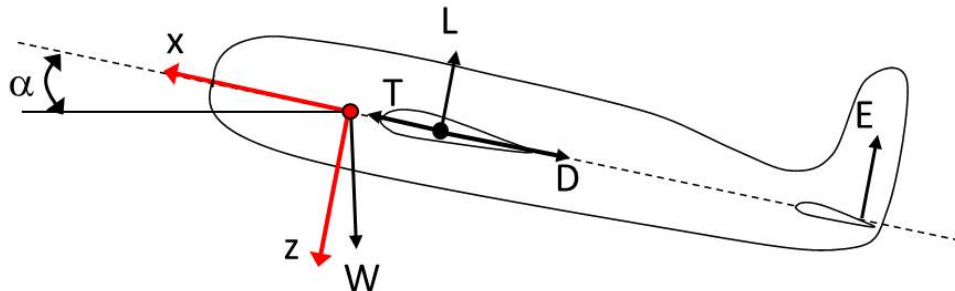
Unless otherwise mentioned, these problems should be solvable using a basic calculator. Practice clear communication by showing all work (free body diagrams, algebra, etc). This will be required to receive full credit on any graded problems.

1. A researcher is building a mount to experimentally test a motor for an uninhabited aerial vehicle (UAV). To build the mount she must insert a screw in a plank of wood at point A as shown in the diagram below. The plank is secured to the workbench at points C and D by clamps. Each clamp is capable of providing a force up to 50N tangential to the plank. Assume that the forces provided by the clamps act along the y-direction.
 - (a) The researcher first places the clamps at $d = 20\text{cm}$. She uses a power screw-driver which exerts a clockwise torque of 30 N-m on the plank. What is the value of the force couple and the corresponding force that has to be provided by the clamps so that the plank remains in equilibrium?
 - (b) Will the clamps give way (yield) in this situation? In other words, is the force calculated in (a) greater than the 50N limit? If so, calculate the minimum value of distance d so that the clamps will not give way.
 - (c) Would your answers change if she inserts the screw at point B instead of point A. Explain briefly.



Top-down view of experimental motor mount

2. Consider the coordinate system (red lines) attached to the aircraft center of gravity (red dot) depicted in the diagram below. The positive y -axis, not shown, points into the page (to the right-side of the pilot). The aircraft weight W acts downward at the center of gravity. The lift L and drag D forces are generated by the airflow over the wing and act at the center of pressure (black dot) in the negative z and negative x directions, respectively. The center of pressure is located at $\bar{r}_{CP} = -d\mathbf{i}$. The engine thrust T is also assumed to act at the center of pressure in the positive x direction.
- Assume that all forces balance along the x direction. What lift force L is required to ensure that all forces balance along the z direction? Your answer should be expressed in terms of W and α . Assume $E = 0$.
 - Replace the lift force L computed in the previous part with a force-couple system at the center of gravity. Your answer should be expressed in terms of W , α , and d . Assume $E = 0$.
 - The tail surface on an aircraft is needed to prevent the aircraft from rotating about the y -axis. E is the force generated by the flow over the tail surface of the aircraft. This force acts in the negative z direction at $\bar{r}_E = -11d\mathbf{i}$. What forces L and E are required to ensure that the system is equivalent to zero force and zero moment about the center of gravity?



3. Book problems:

- (a) 3.81
- (b) 3.92
- (c) 3.96
- (d) 3.116
- (e) 3.124

Additional Practice Problems: 3.73, 3.83, 3.98, 3.105, 3.114, 3.126

The quiz problem will not be selected from these additional practice problems. However, these exercises contain important elements of the course and similar problems may appear on the exam.