ME EN 534
Homework #1

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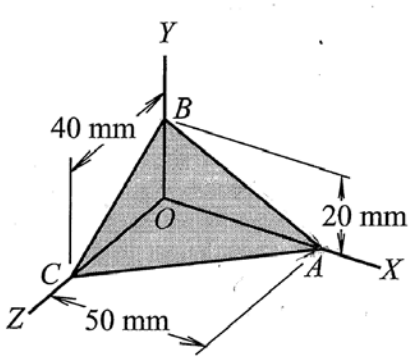
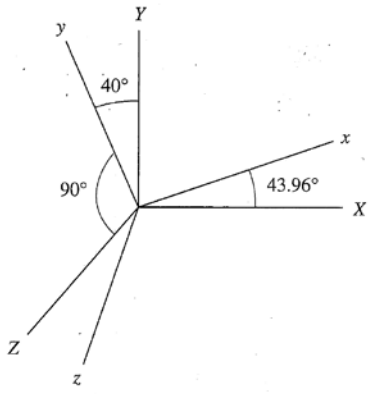
1. Complete Problem 2.20 from the text.

2. At a certain instant an inertial measurement unit (IMU) on an aircraft report that it is heading 40° west of north, climbing at 20° and that its wings are banked at an angle of 10° clockwise as viewed looking forward. At this instant, the aircraft's accelerometers indicate that the center of mass has acceleration components of 2g directed out of the belly of the aircraft and 0.5g directed out of the nose. What are the acceleration components in terms of a north-south, east-west, and vertical frame?

3. The corners of triangular plate *ABC* are situated along the axes of coordinate system *XYZ* as shown. Another coordinate system, *xyz*, whose origin is at corner *A*, is defined such that its *x* axis is aligned along *AB*, pointing from *A* to *B*, and its *z* axis is perpendicular to plane *ABC* with a positive component in the direction of *Y*. Determine the coordinate transformation matrix from *XYZ* to *xyz*. Then determine the coordinates of the origin *O* relative to *xyz* and expressed in *xyz*. Hint: Define a coordinate system parallel to *XYZ* with its origin at *A*, and then carry out the necessary rotations to align it with the plate as described above.



4. Two coordinate systems *XYZ* and *xyz* are related to each other as shown in the figure. Find the rotation matrix [*R*], where $\{x\ y\ z\}^T = [R]\{X\ Y\ Z\}^T$.



5. The rectangular box in Figure 2.39a of the text is rotated counterclockwise by 45˚ about a line passing through points *A* and *B* (viewed from *B*). Find the coordinates of point *C* (relative to and in terms of *XYZ*) after this rotation sequence. Hint: Create a new coordinate frame with its origin at point *A*, and then perform the rotations.