Please state clearly all assumptions made in order for full credit to be given.

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Problem #1 (25)

Use the following 3 vectors, given in a 3D Cartesian coordinate system, for the questions below.

\[ \mathbf{P}_1 = (1, -6, 2), \quad \mathbf{P}_2 = (-2, -1, 4), \quad \mathbf{B} = \frac{1}{2}, -\frac{1}{2}, \frac{1}{\sqrt{2}} \]

(a) Determine vector \( \mathbf{A} \) with initial point \( \mathbf{P}_1 \) and terminal point \( \mathbf{P}_2 \). (3)
(b) Find the length of \( \mathbf{A} \) and \( \mathbf{B} \). (2)
(c) What kind of vector is \( \mathbf{B} \)? (1)
(d) Find the angle between \( \mathbf{B} \) and \( \mathbf{A} \). (5)
(e) Determine \( 3\mathbf{A} - 5\mathbf{B} \). (3)
(f) Determine the orthogonal projection of \( \mathbf{A} \) on \( \mathbf{B} \). (5)
(g) Determine \( \mathbf{C} = \mathbf{A} - \text{proj}_\mathbf{B} \mathbf{A} \). (4)
(h) Find \( \mathbf{C} \cdot \mathbf{B} \) and explain the geometric relationship between \( \mathbf{C} \) and \( \mathbf{B} \). (2)

Note: show all steps.
Problem #2 (25)

Knowing that the tension is 425 Lb. in Cable AB and 510 lb. in Cable AC:

1. Express the tension in cable AB in vector form, (Units: lb.). (8)
2. Express the tension in cable AC in vector form, (Units: lb.). (8)
3. Using your response to (1) and (2), determine the vector form of the resultant force acting at A, (Units: lb.) (3)
4. Using your response to (3), determine the magnitude of the resultant force acting at A, (Units: lb.)? (3)
5. Using your response to (3) and (4), determine the direction of the resultant force (i.e., angles $\theta_x$, $\theta_y$ and $\theta_z$ made with the X, Y and Z axis). (Units: Degrees) (3)
Problem #3 (25)

A boom BC, which is supported by a cable AC, is loaded as shown by two forces having magnitudes of 50 lb. and 75 lb., respectively. It is also known that the resultant of the three forces exerted at Point C must be directed along the boom BC.

1. Draw the free body diagram for the point C.  
   (8)

2. Using your response to (1), Write the equilibrium equations for Point C  
   (10)

3. Using your response to (2), determine the magnitude of the tension in Cable AC (Units: lb.)  
   (3.5)

4. Using your responses to (2) and (3), determine the magnitude of the resultant directed along the boom BC (Units: lb.)  
   (3.5)
Problem #4 (25)

Solve the following system of linear equations using Gauss-Jordan elimination method:

\[-2x + 7y - 8z = 39\]
\[x - 3y + 4z = -17\]
\[-x + 3y - 3z = 16\]

a) Show the augmented matrix. (3)

b) Use elementary row operations to obtain the reduced row echelon form. (19)

c) Write the solution for the three variables x, y, and z. (3)

Note: To receive full credit, all intermediate work (e.g. elementary row operations) should be shown.