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

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Problem #1 (25)

Consider the four points \(A(1, -2, 1), B(-5, 1, -1), C(4, 0, -5), \) and \(D(1, -4, 7)\)

(a) Determine the magnitude and the direction of vector \(\mathbf{AB}\)  
(b) Determine the magnitude and the direction of vector \(\mathbf{CD}\)
(c) Determine the angle, \(\theta\), between vectors \(\mathbf{AB}\) and \(\mathbf{CD}\). Provide your result in degrees.
(d) Determine the vector component of \(\mathbf{AB}\) along \(\mathbf{CD}\)
(e) Determine the vector component of \(\mathbf{AB}\) orthogonal to \(\mathbf{CD}\)
Problem #2 (25)

Based on the figure below, answer the following:

1. Express Force $F_1$ in Cartesian coordinate vector form. (5)
2. Find the three coordinate direction angles for $F_1$ in degrees. (6)
3. Express the Force $F_2$ in Cartesian coordinate vector form. (6)
4. What is the magnitude of the resultant vector $R$ of the two forces $F_1$ and $F_2$? (4)
5. What is the unit vector pointing in the direction of $R$? (4)
Problem #3 (25)

A force of magnitude 300 lb. is applied at point C as shown. If angle $\alpha = 55^\circ$ and boom $AC$ exerts a force on pin $C$ along line $AC$:

a) Identify the particle to be analyzed (3)

b) Draw a complete and separate free body diagram for the identified particle (6)

c) Determine the magnitude of the tension in cable $CB$ and the force in boom $AC$. (12)

d) Determine the angle $\theta$ that the force 300 lb. should make with the vertical (currently it’s 20º) so that the tension in cable $CB$ becomes 0 ($0 < \theta < 180^\circ$). (4)

Note: You need to show work to receive credit.
Problem #4 (25)

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

\[
\begin{align*}
3x + 2y + 4z &= 9 \\
x + y + 2z &= 4 \\
-2x + 3y &= 4
\end{align*}
\]

a) Write out the augmented matrix corresponding to the system. (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.