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

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Problem #1 (25)

Consider the following matrices

\[ A = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix}, \quad B = \begin{bmatrix} 1 \\ -1 \\ 2 \end{bmatrix}, \quad C = \begin{bmatrix} 2 & 1 & 0 \\ -1 & 0 & 2 \\ 2 & -2 & 3 \end{bmatrix}, \quad D = \begin{bmatrix} 3 & 3 \\ -1 & 2 \end{bmatrix} \]

Determine the following expressions. If an expression is not valid, STATE THE REASON.

(a) \( A(BB^T) \) \( ^T \) (7)
(b) \( \det(2I + C) \) using the duplicate column method (8)
(c) \( CD \) (2)
(d) \( B + DB \) (2)
(e) \( D - I \ ^{-1} \) (6)

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

If the bucket and its contents have a total weight of 20lb.
  a. Identify the particle in this problem (2)
  b. Draw a complete and separate FBD for that particle (4)
  c. Express all the forces acting on the particle in Cartesian Vector form (7)
  d. Write the equations of equilibrium for that particle (6)
  e. Determine the force in cables DA, DB, and DC (6)

**Note:** You can use the calculator to solve the equations needed for part d.
Problem #3 (25)

Consider the rigid body bracket shown above, with $F_A = 100\text{N}$ and $F_B = F_{Bx}i + F_{By}k\text{ N}$.

(a) If the total moment about point C is 0 N-m, find $F_B$ in Cartesian coordinates. (10)

(b) What is the total moment because of the two forces about point E? (7)

(c) Write the equivalent system as a resultant force and a couple, at the point A. (8)
Problem #4 (25)

A structural member is loaded as shown and supported at A by a smooth pin and at B by a smooth roller:

a. Draw a complete and separate FBD of that member (5)

b. Write the equations of equilibrium for that member (10)

c. Determine the reaction components at both supports. (10)