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

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Problem #1 (25)

Let \( A = \begin{pmatrix} 4 & 1 & -6 \end{pmatrix} \), \( B = \begin{pmatrix} -2 & 4 \\ 1 & -5 \end{pmatrix} \), \( C = \begin{pmatrix} 2 & -3 & 5 \\ 1 & 2 & 4 \end{pmatrix} \) and \( D = \begin{pmatrix} 3 & -1 & 2 \\ 2 & 9 & -3 \\ -2 & 1 & -4 \end{pmatrix} \).

Determine the following expressions (if not possible, explain why):

1. \( CD \) (5pts)
2. \( A^T A - 3D \) (5pts)
3. \( B^{-1} \) (5pts)
4. \( |D| \) (5pts)
5. \( B + 6BB^{-1} \) (5pts)
Problem #2 (25)

A 3000 lb cylinder is supported by a system of cables as shown in figure below.

1. Identify the particle that needs to be analyzed to determine the tensions in the cables (1 Pt)

2. Draw a complete and separate FBD showing the particle and all the forces acting on the particle. (Note: Include ALL relevant coordinates as part of this FBD) (6 Pts)

3. Express all forces in a Cartesian vector form (6 Pts)

4. Write the (scalar) equilibrium equations. (9 Pts)

5. Determine the magnitude of the forces in the cables OA, OB and OC . (a calculator may be used for question 5). (3 Pts)
Problem #3 (25)

A force, a moment of couple (pure moment) and a weight act on a tunnel assembly as shown in the figure. The magnitude of the force acting at point B is 20 kN, that of the moment of couple is 50 kN m, acting parallel to section BA and that of the weight is \( W \) kN acting at point D. Section AB lies on \( y-z \) plane with a slope of 2 \((z \text{ to } y)\) and section BCD lies on \( x-y \) plane.

1. Find the moment of \( F \) about point O. Express the result as a Cartesian vector. (5pts)

2. Express the moment of couple in a Cartesian vector form. (Note: \( M_c = |M_c| u_{BA} \)). (5pts)

3. Determine the moment of \( W \) about point O using \( W \) kN. Express the result as a Cartesian vector. (5pts)

4. Find the resultant force and moment about point O. Express the results as a Cartesian vector. (5pts)

5. Determine the value of \( W \) (>0 kN) when the magnitude of the resultant moment about OA axis is minimum. (5pts)
**Problem #4 (25)**

A lever is loaded as shown below.

1. Draw a complete and separate FBD of lever. (5 Pts)
2. Write the equations of equilibrium for the lever (10 Pts)
3. Determine the reaction components at the pin A and the roller support B. (10 Pts)