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

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Problem #1 (25)

\[
A = \begin{pmatrix}
1 & 2 & 3 \\
4 & 5 & 6
\end{pmatrix},
B = \begin{pmatrix}
1 & 2 & 3 \\
4 & 5 & 6
\end{pmatrix},
C = \begin{pmatrix}
1 & 2 \\
3 & 4
\end{pmatrix} \\
7 & 8 & 9
\]

Determine (if possible) and if not state the reason:

(a) \(BC\)  
(b) \((BC)^{-1}\)  
(c) \(A + BC\) and \(A + CB\)  
(d) Determinant of \(A\) using any method  
(e) If \(B I = B\), what is the dimension of \(I\)? Write explicitly this identity matrix.

Note: To receive full credit, all intermediate work should be shown.)

\[
\]
Problem #2 (30)

A 100-kg cylinder is supported by two cables AC and BC, which are attached to the top of vertical posts. A force \( \mathbf{P} \), parallel to the x-y plane and making an angle \( \theta = 30^\circ \) with the x axis, holds the cylinder in the position shown in the figure below.

1. Identify the particle that needs to be analyzed to determine the tensions in the cables and the force \( \mathbf{P} \). (1)
2. Draw a complete and separate FBD showing the particle and all the forces acting on it. (8)
3. Express all forces in a Cartesian vector form. (6)
4. Write the (scalar) equilibrium equations. (9)
5. Determine the magnitude of the force \( \mathbf{P} \). (2)
6. Determine the magnitude of the forces in the cables CA and CB. (4)

(a calculator may be used for questions 5 and 6).
Problem #3 (30)

A ball and a rod \(ABC\) are connected through a T junction. The ball and the rod weigh 20 lb. each as shown in the figure. The length of the rod \(AC\) is 2 ft. The point \(B\) is in the middle of the rod. Two 50-lb forces acting at points \(A\) and \(C\), and a 50-lb-ft couple about the z-axis shown above point \(O\) are also exerted on the system. If \(b = 3\) ft. and \(\beta = 60^\circ\), find:

(a) The moment of the weight of the ball about point \(C\) (5)  
(b) The moment of the weight of the ball about axis \(AC\) in Cartesian vector form (5)  
(c) The resultant of just the two 50 lb. forces (5)  
(d) The equivalent of the four forces and the 50-lb-ft couple at point \(O\) (10)  
(e) Is it possible to find a point at which the equivalent of the four forces and the 50-lb-ft couple is just a single force? If yes, find the point(s). If not, explain why. (5)

![Diagram of the T junction system with forces and moments indicated.]

**Note:** You need to show details of your work to receive credit.
Problem #4 (15)

Draw a separate and complete free body diagram for the following:

1) A bent bar of negligible mass is supported by a pin at A and a roller at B (the angle $\alpha = 50^\circ$)

![Diagram 1](image1)

2) A bar of negligible mass is supported by rollers at A and B and a rope AD.

![Diagram 2](image2)