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

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Problem #1 (25)

The assembly shown below is used to control the tension $T$ in a tape that passes around a frictionless spool at $E$. Collar $C$ is welded to rods $ABC$ and $CDE$. The collar can rotate about shaft $FG$, but its motion along the shaft is prevented by a washer $S$.

(a) Draw a free-body diagram (FBD) for the assembly, under the loading shown. (7)
(b) Write down equilibrium equations for the rod: detailed force and moment calculations, if needed, should be included here. (12)
(c) For the loading shown, determine the tension in the tape and the reaction at $C$. (6)

*Note: you need to show your work to receive full credit.*
Problem #2 (25)

A beam weighing 400 N is supported at A and is subject to a distributed load as shown. As seen, the distributed load increases between A and C, according to the function $w = 100x^2$ N/m, and then tapers to zero, for the portion CB of the beam (i.e., at B, distributed load is 0 N/m)

1) Determine the magnitude of the distributed load at C (Units N/m). (2)
2) Determine the resultant force of the distributed load for the beam AB. (6)
3) Determine the location of the resultant force of the distributed load, with respect to the fixed support at A. (10)
4) Use results above to draw free body diagram of the beam (3)
5) Determine the reactions at support A (Note: Both force and moment reactions (if any) need to be clearly identified) (4)
Problem #3 (25)

The above truss is supported at A by a smooth pin and at G by a smooth roller supports.

a) Determine the reactions at the two supports (5)

b) Using the method of joints determine the force in members AB and AL and state whether they are under tension or compression (8)

c) Using the method of sections determine the force in members DK and JK and state whether they are under tension or compression (10)

d) Identify all zero force members in the truss. **Note:** You will lose credit for identifying wrong members (2)

**Note:** You need to draw all required FBD’s and show solution steps
Problem #4 (25)

Given the following system of equations:

\[
\begin{align*}
    x + y + z &= 1 \\
    2x + y + 3z &= -3 \\
    3x + 3y + 2z &= 4
\end{align*}
\]

(a) Write this system of equations as \(AX = B\) and identify the matrices \(A\), \(X\), and \(B\). (3)

(b) Determine the inverse of \(A\) using row operations (as done in the class). (9)

(c) Solve for \(x\), \(y\), and \(z\) using \(X = A^{-1}B\). (6)

(d) Find the determinant of matrix \(A\) by cofactor expansion along the 3rd column. (7)

Show all work.