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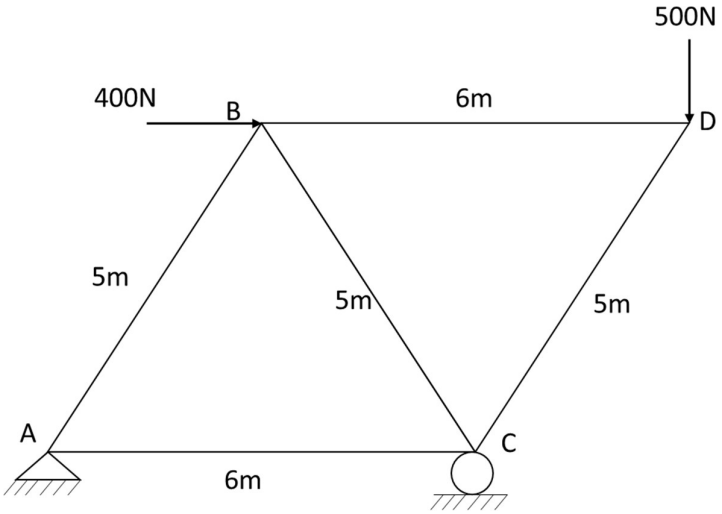
DEPARTMENT OF MATHEMATICS

3-sem-Linear Algebra- Lab Assessment No. 2

Name: Srushti G Joshi SRN:01FE24BAR014 Date:24/10/2025	
Question	Determine the member forces for the truss shown in the figure and give the physical interpretation 
Solution	i) Identify the parameters and mathematical concept

Category	Parameter	Value/Description
Mathematical Concept	**System of Linear Equations**	Used to solve for the unknown forces by enforcing static equilibrium ($\Sigma F_x = 0, \Sigma F_y = 0$) at every joint.
Solution Method	**Matrix Algebra**	Used to solve the resulting 8×8 system of linear equations (Forces $\times$ Unknowns).
Governing Principle	**Static Equilibrium**	The sum of forces (vector sum) on any body (joint) at rest must be zero.
:---	:---	:---
Geometrical	**Member Dimensions**	Side lengths ($5\ \text{m}, 6\ \text{m}$), determining the angles.
Geometrical	**Angles** (θ)	$\cos(\theta) = 0.6, \sin(\theta) = 0.8$ (for the 3-4-5 triangles).
Loading	**External Loads**	$400\ \text{N}$ (Horizontal at B), $500\ \text{N}$ (Vertical at D).
Boundary Conditions	**Supports**	Pin at A (R_{Ax}, R_{Ay}), Roller at C (R_{Cy}).

ii) Solve analytically

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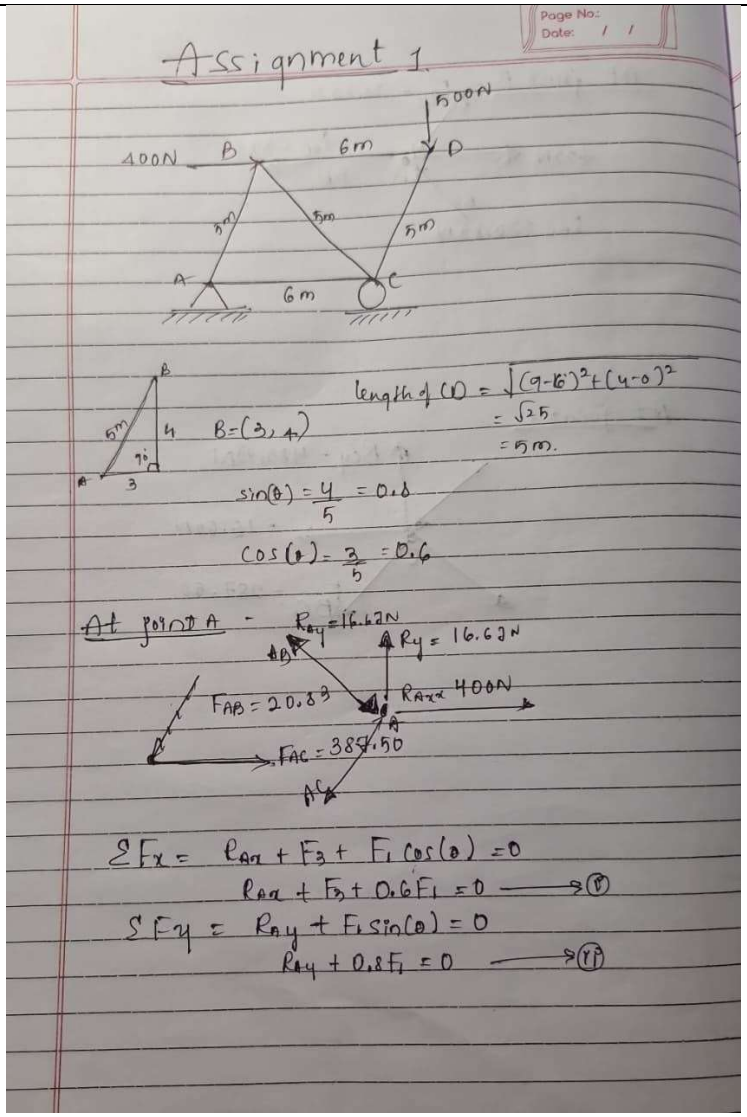

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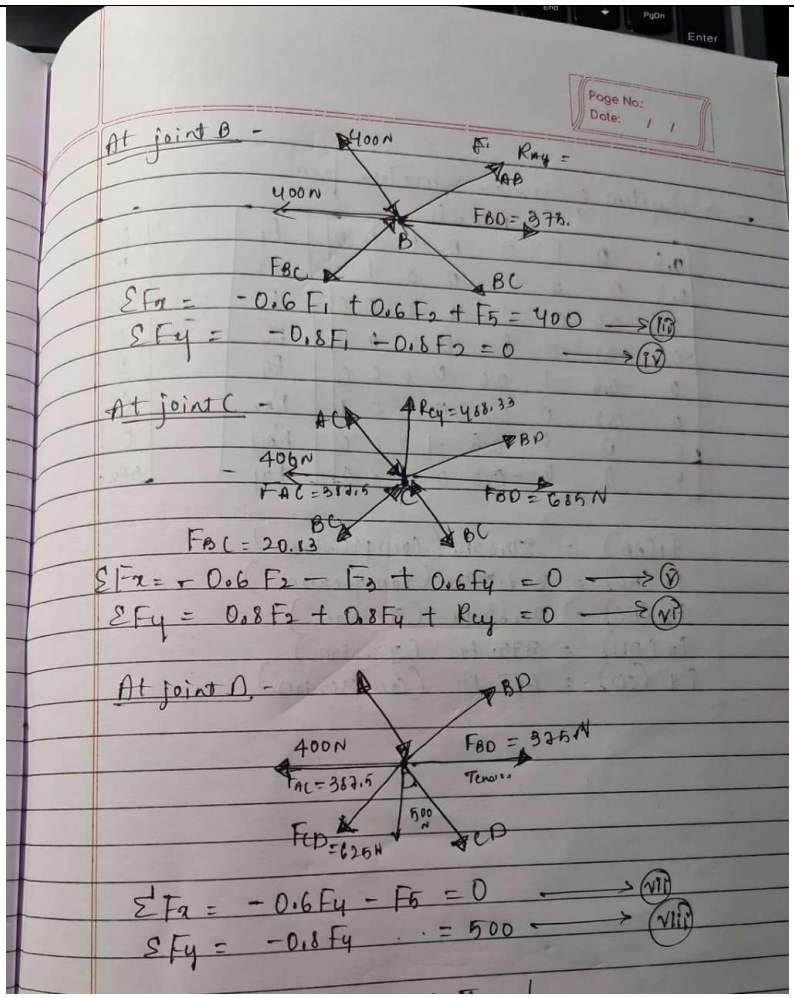

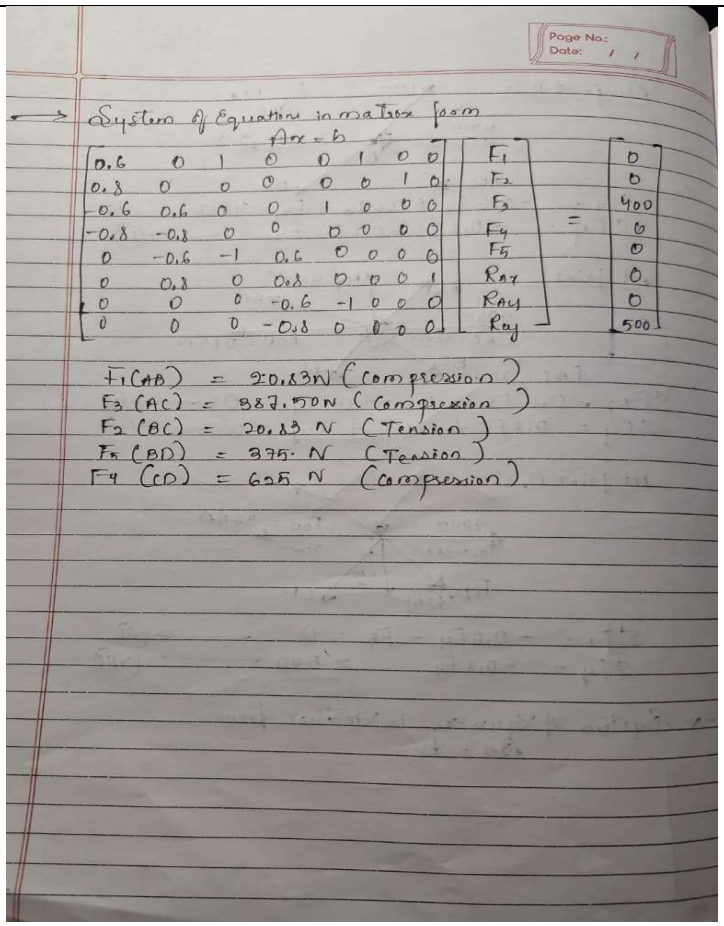

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→ System of Equation in matrix form

$$Ax = b$$

$$\begin{bmatrix} 0.6 & 0 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0.8 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ -0.6 & 0.6 & 0 & 0 & 1 & 0 & 0 & 0 \\ -0.8 & -0.8 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -0.6 & -1 & 0.6 & 0 & 0 & 0 & 0 \\ 0 & 0.8 & 0 & 0.8 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & -0.6 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -0.8 & 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ F_4 \\ F_5 \\ R_{AX} \\ R_{AY} \\ R_{BY} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 400 \\ 0 \\ 0 \\ 0 \\ 0 \\ 500 \end{bmatrix}$$

F_1(AB) = 20.83N (compression)
F_3 (AC) = 387.50N (compression)
F_2 (BC) = 20.83 N (Tension)
F_5 (BD) = 375. N (Tension)
F_4 (CD) = 625 N (compression)

iii) Program Execution Screen shot

```
[18]: #ASSIGNMENT PROBLEM 1
import numpy as np
A= np.array([
    [0.6, 0.0, 1.0, 0.0, 0.0, 1.0, 0.0, 0.0],
    [0.8, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0],
    [-0.6, 0.6, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0],
    [-0.8, -0.8, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0],
    [0.0, -0.6, -1.0, 0.6, 0.0, 0.0, 0.0, 0.0],
    [0.0, 0.8, 0.0, 0.8, 0.0, 0.0, 0.0, 1.0],
    [0.0, 0.0, 0.0, -0.6, -1.0, 0.0, 0.0, 0.0],
    [0.0, 0.0, 0.0, -0.8, 0.0, 0.0, 0.0, 0.0]
])
B = np.array([0, 0, 400, 0, 0, 0, 0, 500])
Results = np.linalg.solve(A, B)
F_members = Results[:5]
print(F_members)

[ -20.83333333   20.83333333 -387.5        -625.         375.        ]

[16]: members = ["F_AB", "F_BC", "F_AC", "F_CD", "F_BD"]
print("--- CORRECTED RESULTS ---")
for name, val in zip(members, F_members):
    print(f"{name} = {val:0.2f} N")

--- CORRECTED RESULTS ---
F_AB = -20.83 N
F_BC = 20.83 N
F_AC = -387.50 N
F_CD = -625.00 N
F_BD = 375.00 N
```

iv) Physical Interpretation

Member	Force (N)	Physical State	Interpretation
AC (F_3)	387.50 (C)	**Compression**	The bottom chord of the truss is primarily being **pushed inward** by the horizontal resistance at A and the forces from the diagonal members. This member is stiff and prevents the bottom of the truss from buckling.
CD (F_4)	625.00 (C)	**Compression**	This diagonal member is the **most heavily loaded** component. It is bearing the 500 N vertical load at D and transmitting it downward and inward toward the base.
BD (F_5)	375.00 (T)	**Tension**	The top chord is under **tension**, being stretched horizontally. This prevents the top part of the truss from collapsing inward under the compression in CD and the horizontal load at B.
AB (F_1)	20.83 (C)	**Compression**	This member is lightly loaded in **compression**. It helps stabilize joint B against the horizontal 400 N force and transmits a small vertical component to the support at A.
BC (F_2)	20.83 (T)	**Tension**	This diagonal member is lightly loaded in **tension**. It helps hold the bottom chord up and counteracts the upward pull from the 400 N force's reaction at A.