# SFD & BMD CALCULATOR

# DECLARATION

We hereby declare that the project work entitled "Computation of Shear Force and Bending Moment Diagrams" submitted in partial fulfillment of the requirements for Course ME-101 at NIT Hamirpur is our original work.
This project is developed under the guidance of Prof. Dr. Anshul and is based on the principles of structural analysis. The program implemented for the calculation of SFD and BMD has been developed using HTML, CSS, Python, Flask for micro web framework, and Python libraries NumPy and Matplotlib that create the graph for the required function and tested for accuracy.
We confirm that this project does not contain any material copied from any published or unpublished work, except where due acknowledgment is given. The results and findings presented in this report are solely for academic purposes.


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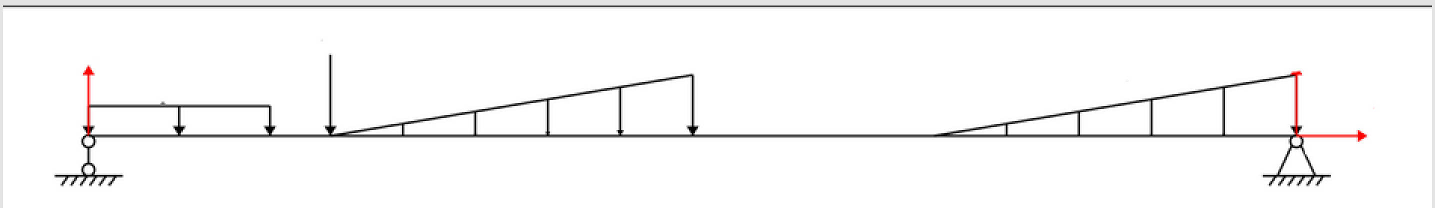
# INTRODUCTION

Structural analysis is a fundamental aspect of civil and mechanical engineering that deals with determining the effects of loads on physical structures and their components. Beams, being one of the most basic structural elements, are commonly used in various constructions such as buildings, bridges, and mechanical systems. Analyzing the behavior of beams under different types of loads is essential for ensuring the safety, stability, and performance of a structure.

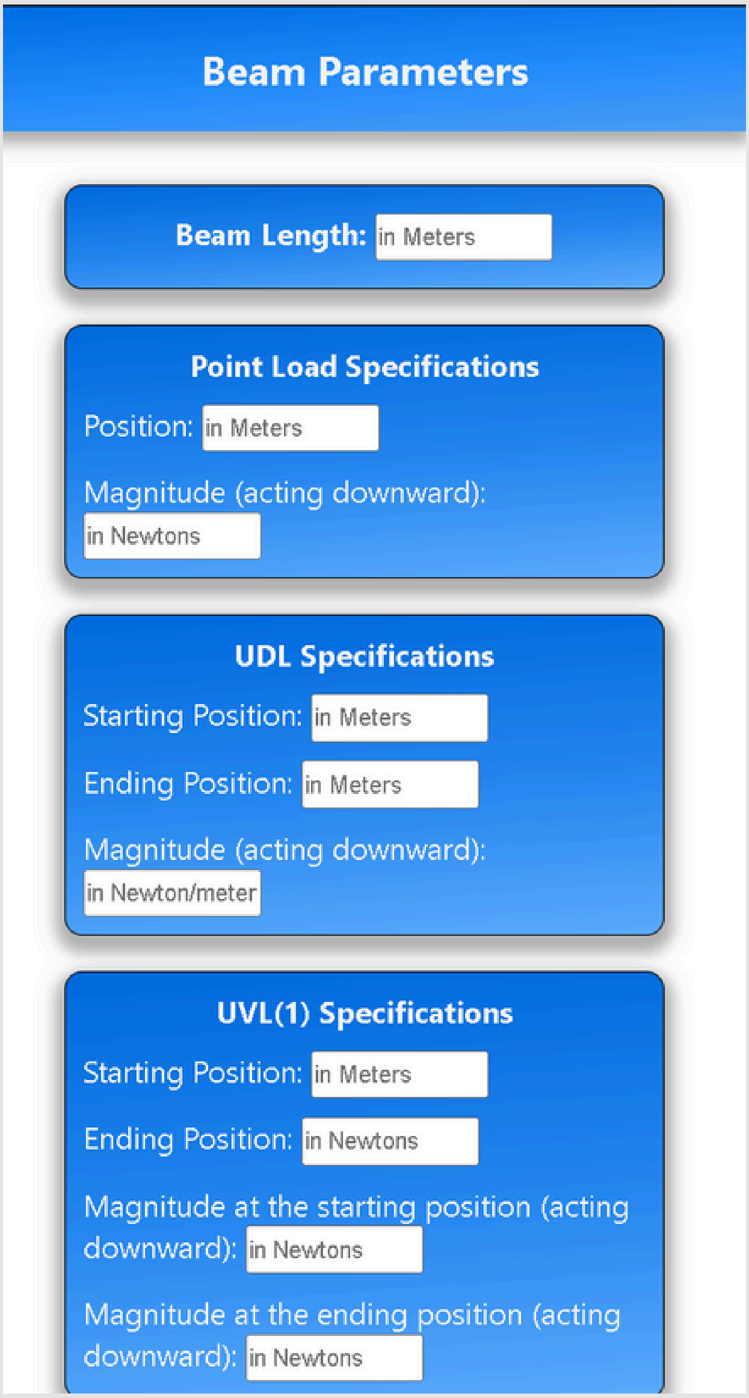
This project focuses on the development of a generalized Python program to analyze a simply supported beam subjected to a combination of different loading types. The beam is considered to be subjected to one concentrated point load, one uniformly distributed load (UDL), and 2 uniformly varying loads (UVLs), each with different start and end intensities along specified segments of the beam. The goal of this program is to compute the support reactions at the two ends of the simply supported beam, and then generate the corresponding Shear Force Diagram (SFD) and Bending Moment Diagram (BMD).

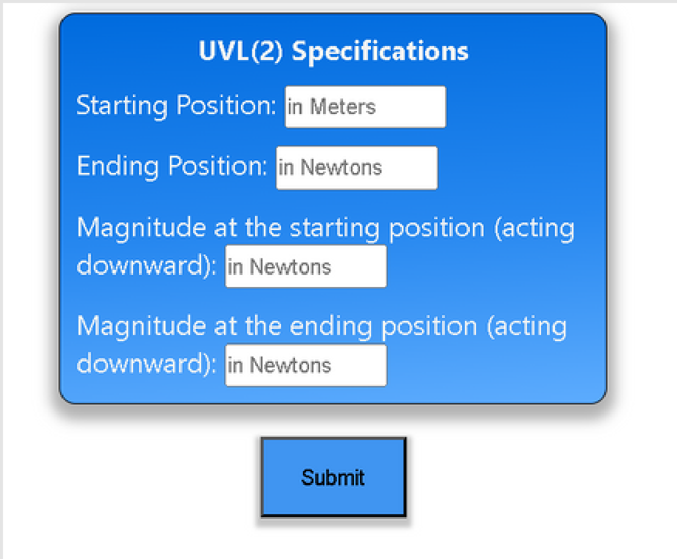
The program uses fundamental principles of static equilibrium to determine the vertical reactions at the supports. It then evaluates shear forces and bending moments at discrete points along the length of the beam, considering the cumulative effects of all load types. The results are visualized graphically using Matplotlib, providing clear insights into how the beam responds to the applied loading.

This computational tool serves as an educational and practical resource for engineering students and professionals, simplifying complex beam analysis tasks and offering a flexible approach to simulate real-world loading conditions

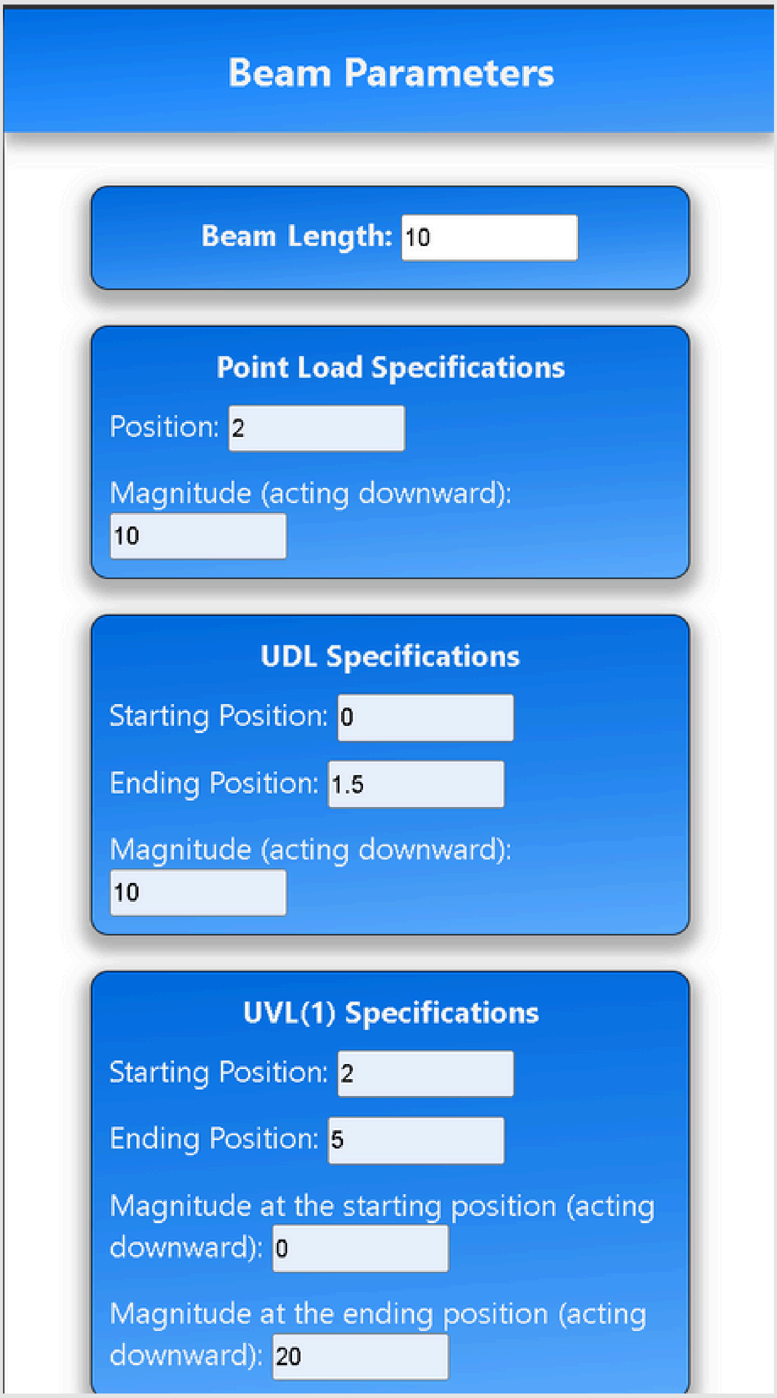


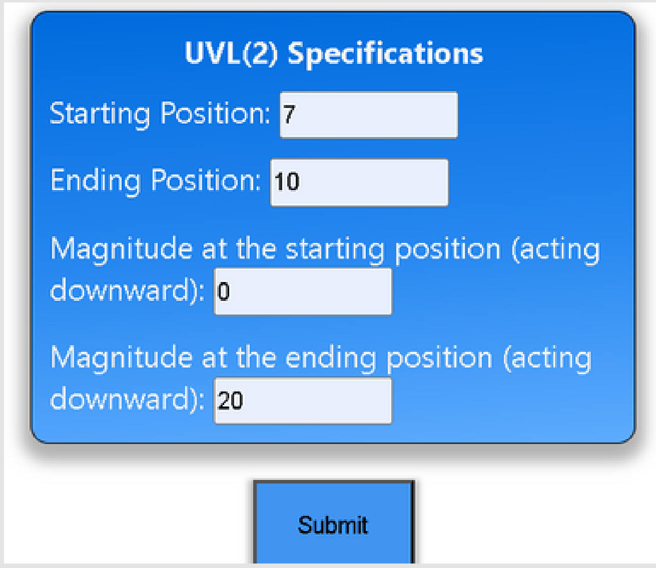
# Working Computer Program



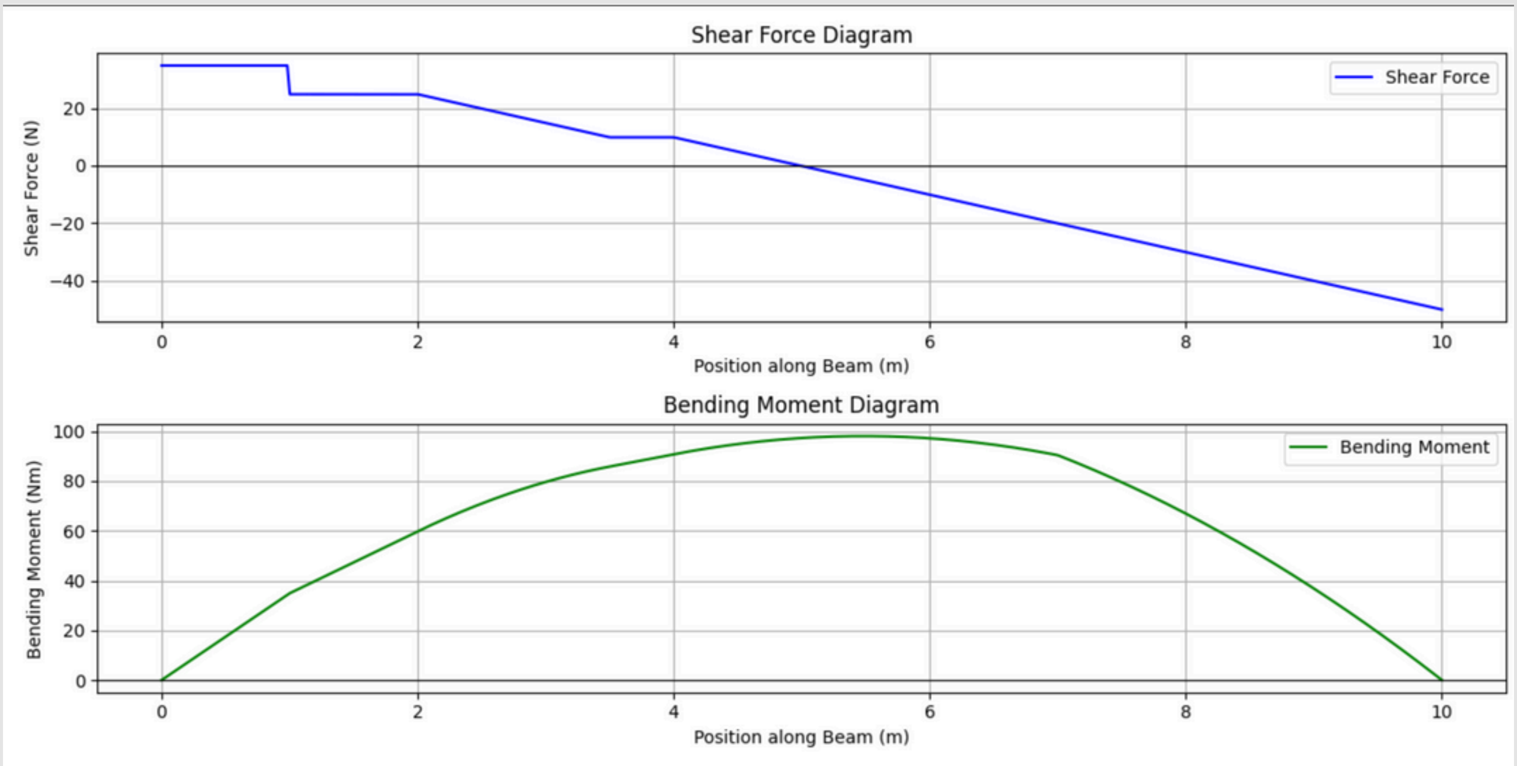



# Step 1 : Entering Values and Submit



# Computed Output in form of Graph



# INSTRUCTIONS

Case Study: Analysis of a Simply Supported Beam Under Combined Loading Conditions
Objective
The goal of this case study is to analyze a simply supported beam subjected to:

A uniformly distributed load (UDL) on the left span ($q_1$ = 10 N/m),
A point load ($P_1$ = 10 N) at a defined location,
Two uniformly varying loads ($U_1$ and $U_2$) applied over separate spans, increasing linearly from 0 to a maximum intensity.

The purpose is to calculate:

Support Reactions at points A and B,
Shear Force Diagram (SFD),
Bending Moment Diagram (BMD).

Problem Description
Beam Type: Simply Supported Beam
Supports:

- Left end (A): Pinned support → vertical reaction RAR_ARA
- Right end (B): Roller support → vertical reaction RBR_BRB and horizontal reaction HBH_BHB

Loads:

- UDL ($q_1$ = 10 N/m) applied from point A over a specific segment
- Point Load ($P_1$ = 10 N) applied at a known point
- UVL $U_1$: Varies from 0 to 20 N/m linearly over a span starting after the point load
- UVL $U_2$: Varies from 0 to 20 N/m linearly up to the support B

Methodology

Support Reaction Calculation:

- Apply the conditions of static equilibrium:
  - ΣFy=0: Sum of vertical forces must be zero.
  - ΣMA=0: Sum of moments about point A must be zero.
  - ΣH=0: Sum of horizontal forces is zero (used if horizontal forces are involved).

Equivalent Load Conversion:

- UDL: Replaced with a point load at the centroid of the distribution.
- UVL: Replaced with a triangular load's equivalent point load located at 1/3 distance from the higher end.
- Point Load: Directly considered with moment arms.

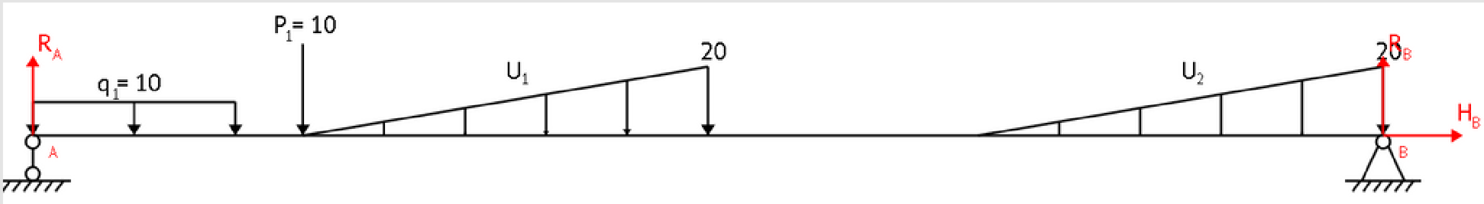
Shear Force and Bending Moment Analysis:

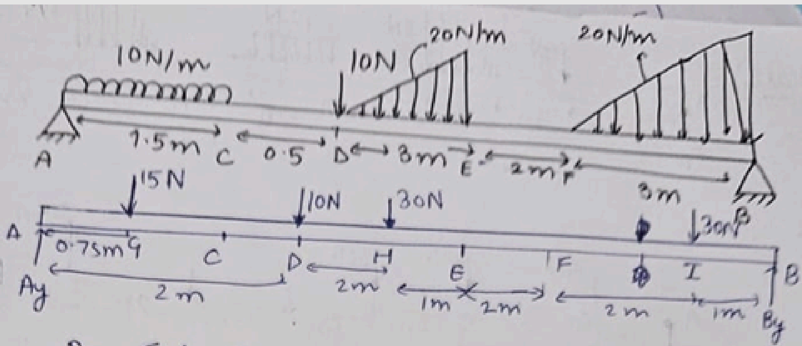
- Divide the beam into segments based on load changes.
- Use equations of equilibrium in each segment.
- Plot Shear Force and Bending Moment across the span.

- Results Overview
- Support Reactions:
  - RAR_ARA: Vertical reaction at left support (calculated using moment equilibrium)
  - RBR_BRB: Vertical reaction at right support
  - HBH_BHB: If any horizontal force exists (in this case, often zero)
- SFD:
  - Shear force varies linearly under UDL
  - Shear force curve under UVL is parabolic
  - Sharp drop at point load location
- BMD:
  - Parabolic variation under UDL
  - Cubic variation under UVL
  - Linear change under point loads

# MANUAL SOLUTIONS

## CASE 1:




By $\Sigma f_y = 0$

$$A_y - 15 - 10 - 30 - 30 + B_y = 0$$

$$A_y + B_y - 85 = 0$$

$$A_y + B_y = 85 \quad \text{— (1)}$$

$$\Sigma M_A = 0$$

$$(15\times 0.75) + (10\times 2) + (30\times 4) + (30\times 9) - (B_y \times 5) = 0$$

$B_y = 42.125$ N (upward)

By (1)

$A_y = 42.875$ N (downward)

⇝ Calculation of Shear force Across point load

(*) SF at point A = 0

(*) SF after point A ⇒ 42.875

(*) SF at point C ⇒ 42.875 − 15 ⇒ 27.875N

(*) SF at point D ⇒ 42.875 − 15 = 27.875

(*) SF at point H = 42.875 − 15 − 10 = 17.875

(*) SF at point E = 42.875 − 15 − 10 − 30 = − 12.125 (downwar

(*) SF at point I = −72.125 (downward)

(*) SF after I = 42.125 N

(*) SF at point B = 0

Observing from Right side

B.M about A = $42.125 \times 10 - 30 \times 9 - 30 \times 4 - 10 \times 2 - 15 \times 0.75$

$= 421.25 - 270 - 120 - 20 - 11.25$

$= 0$ Nm.

B.M about D = $-(30 \times 2) - (30 \times 7) + 42.125 \times 8$

$= -60 - 210 + 337$

$= 67$ Nm

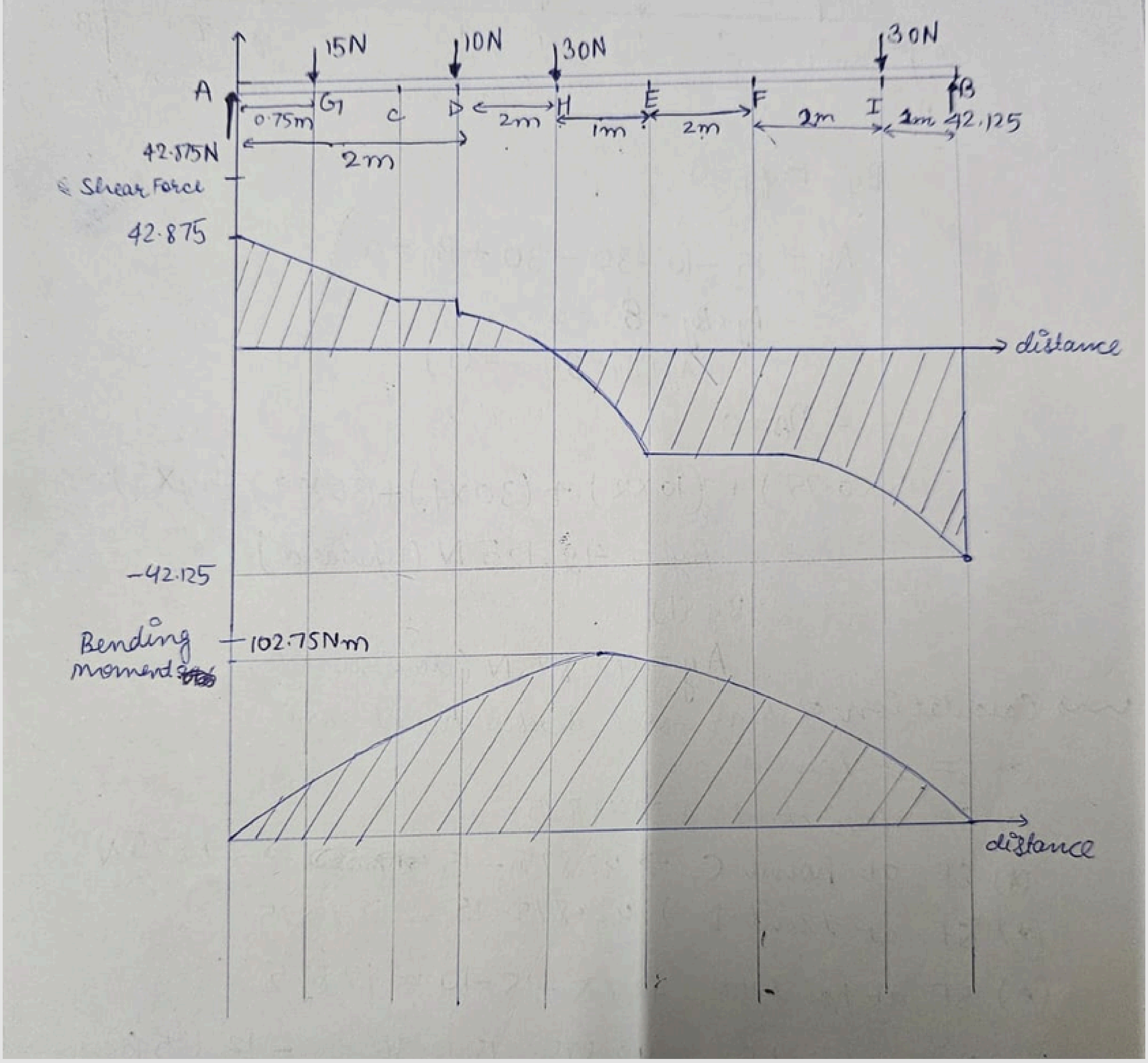
B.M. about H = $-30 \times 5 + 42.125 \times 6$

$= -150 + 252.75$

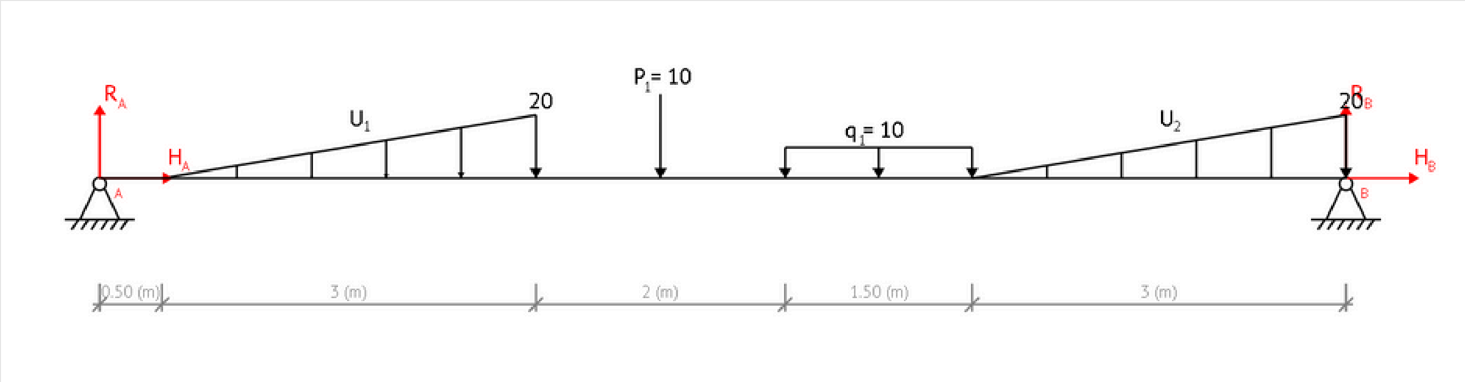
$= 102.75$ Nm

B.M. about I = $42.125 \times 1 = 42.125$ Nm

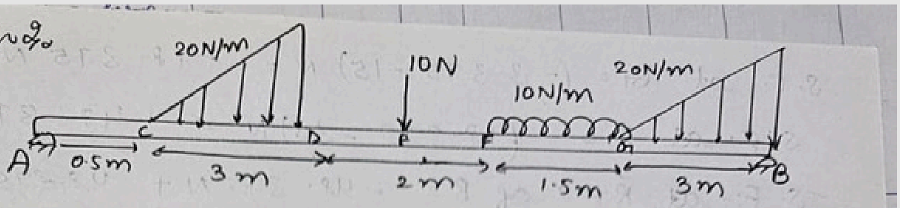
B.M. about B = $42.125 \times 0 = 0$ Nm

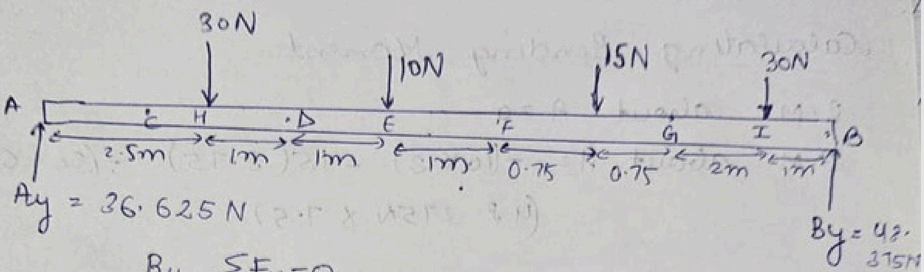


# Case Study: 2




Question 2




By $\Sigma F_y = 0$

$Ay - 30 - 10 - 15 - 30 + By = 0$

$Ay + By = 85 \quad \text{---(1)}$

$\Sigma M_A = -(30 \times 2.5) - (10 \times 4.5) - (15 \times 6.25)$
$\quad - (30 \times 9) + (By \times 10)$

$= -75 - 45 - 93.75 - 270 + 10By$

$= -483.75 + 10By$

$\Sigma M_A = 0$

$10By = 483.75$

$\boxed{By = 48.375 \text{ N}}$

$Ay = (85 - 48.375) \text{ N}$

$\boxed{Ay = 36.625 \text{ N}}$

Calculating Shear Force $\quad \downarrow +ve \quad \uparrow -ve$

Shear force at R.H.S of A = 36.625 N

S.F. at H = 36.625 N

S.F at E = (36.625 - 30) N = 6.625 N

S.F. at F = 6.625 - 10 = -3.375 N

S. F. at G = $(-3.375 - 15)\ N = -18.375\ N$

S. F. at B = $(-18.375 - 30)\ N = -48.375\ N$

S. F. at R.H.S of B = $-48.375\ N + 48.375\ N = 0\ N$

Calculating Bending Moment

B.M. about A = 0

B.M about H = $-(10 \times 2) - 15(3.75) - (30 \times 6.5) + (48.375N \times 7.5)$

B.M. about E = $(-15 \times 1.75) - (30 \times 4.5) + (48.375 \times 5.5)$

$\Rightarrow -26.25 - 135 + 266.0625$

$\Rightarrow 104.8125$

B.M. about F = $(-15 \times 0.75) - (30 \times 3.5) + (48.375 \times 4.5)$

$\Rightarrow -11.25 - 105 + 217.6875 \Rightarrow 101.4375$

B.M. about G = $-(30 \times 2) + (48.375 \times 3)$

$= -60 + 145.125$

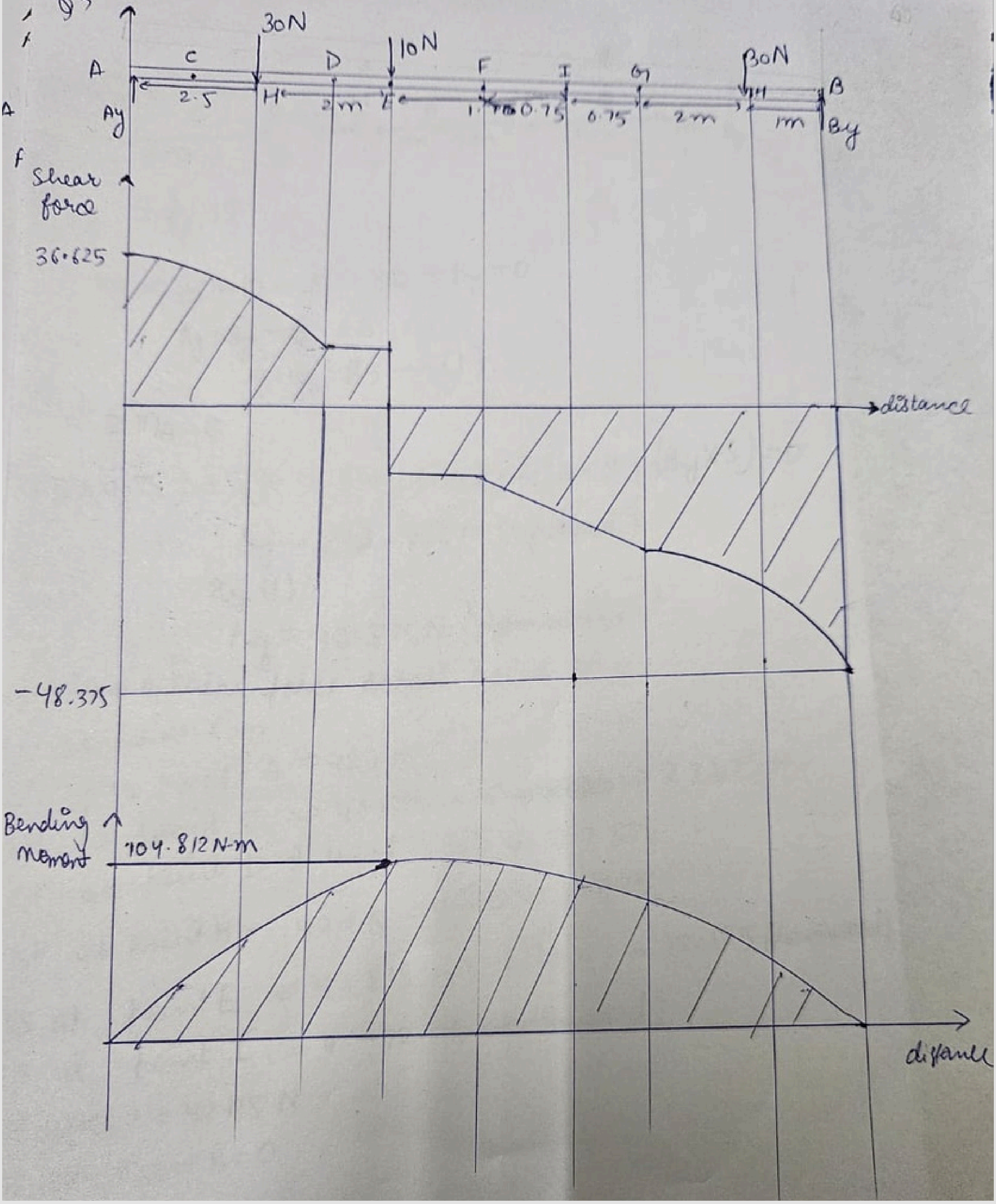
$= 85.125$

B.M. about I = $(48.375 \times 1) = 48.375$ Nm

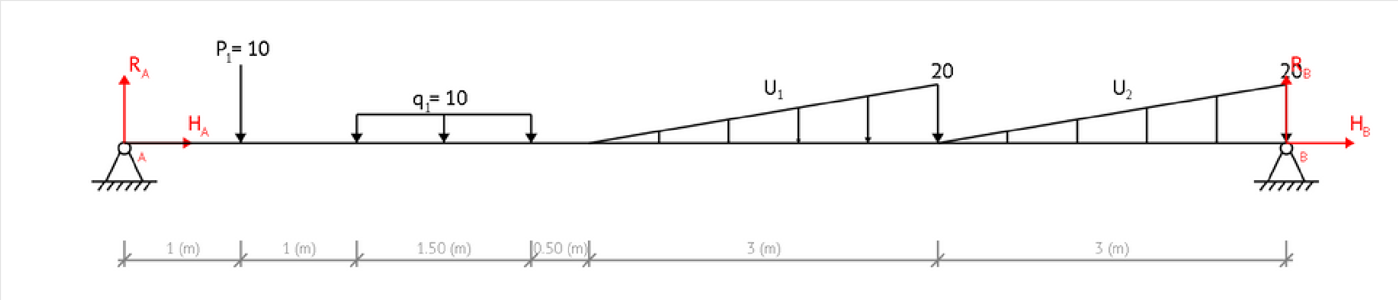
$\Rightarrow 48.375$ Nm

B.M. about B = $48.375 \times 0 = 0$ Nm

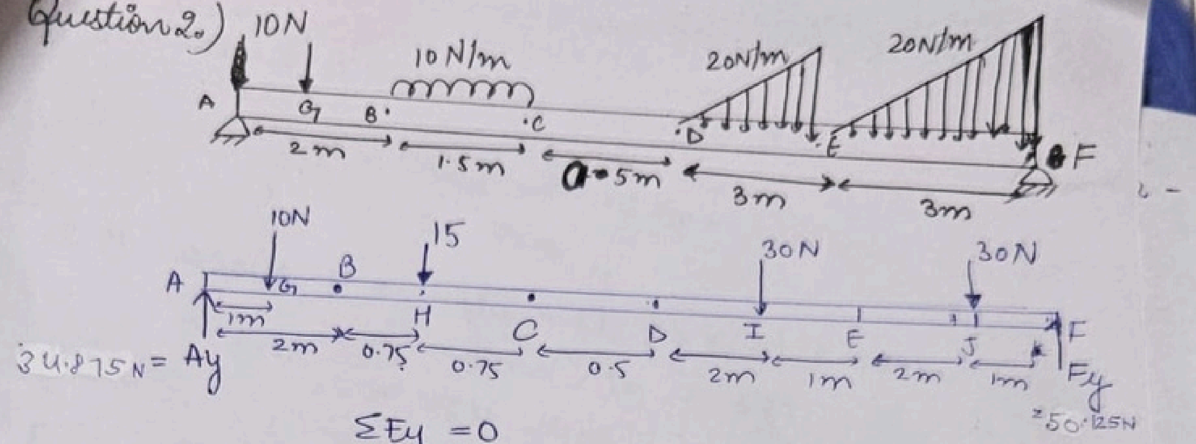
Q3


30N
10N
30N
A
C
D
F
I
G
B
H
E
2.5
2m
0.75
0.75
2m
1m
Ay
By
Shear force
36.625
distance
-48.375
Bending moment
704.812 N-m
distance

# Case Study: 3




Question 2.)




$$\Sigma F_y = 0$$

$$A_y - 10 - 15 - 30 - 30 + F_y = 0$$

$$A_y + F_y = 85 \quad -(1)$$

$$\Sigma M_A = 0$$

$$(2) - (10\times 1) + (15\times(2.75)) + (30\times 6) + (30\times 9) - (F_y\times 10) = 0$$

By equation (1) and (2)

$$F_y = 50.125\,N$$

$$A_y = 34.875\,N$$

Calculation of shear forces

(*) Shear force at point A = 0

(*) Shear force after point A = 34.875 N

(*) Shear force at point B = 34.875 − 10 = 24.875 N

(*) Shear force at point C = 24.875 − 15 = 9.875 N

(*) Shear force at point I = 9.875 N

(*) Shear force at point J = − 20.125 N

(*) Shear force at point K = − 50.125

(*) Shear force at R.H.S of K = − 50.125 + 50.125 = 0

Que 2). Calculation of Bending Moment.

B.M. about A = $(-10 \times 1) - (15 \times 2.75) - (30 \times 6) - (30 \times 9) + (50.125 \times 10)$

$= -10 - 41.25 - 180 - 270 + 501.25$

$= 0$ Nm

B.M about G = $-(15 \times 1.75) - (30 \times 5) - (30 \times 8) + (50.125 \times 9)$

$= -26.25 - 150 - 240 + 451.125$

$= 34.875$ Nm

B.M. about H = $-(30 \times 3.25) - (30 \times 6.25) + (50.125 \times 7)$

$= -97.5 - 187.5 + 350.875$

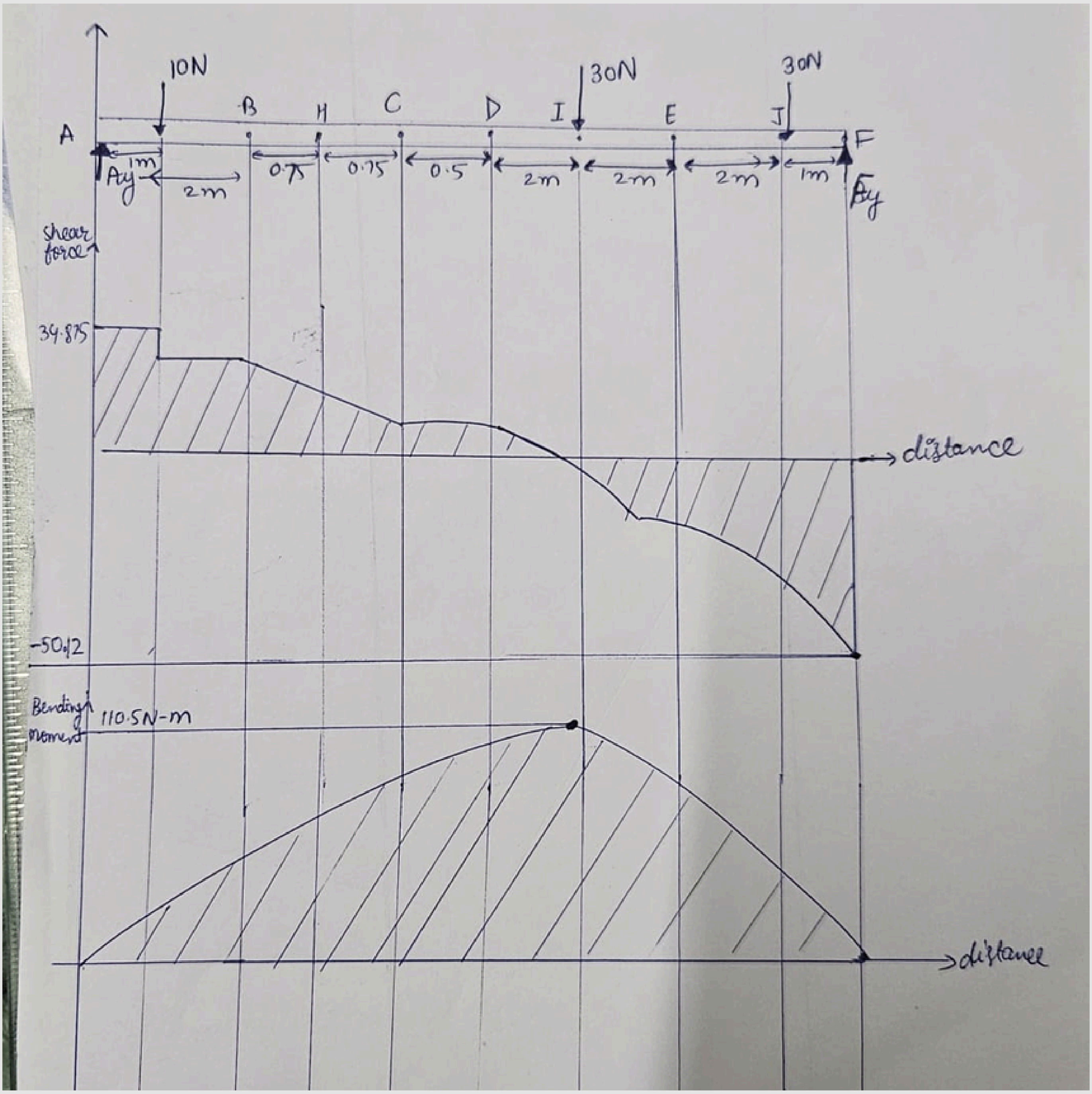
$= 65.875$ Nm

B.M. about I = $-30 \times 3 + 50.125 \times 4$

$= -90 + 200.5$

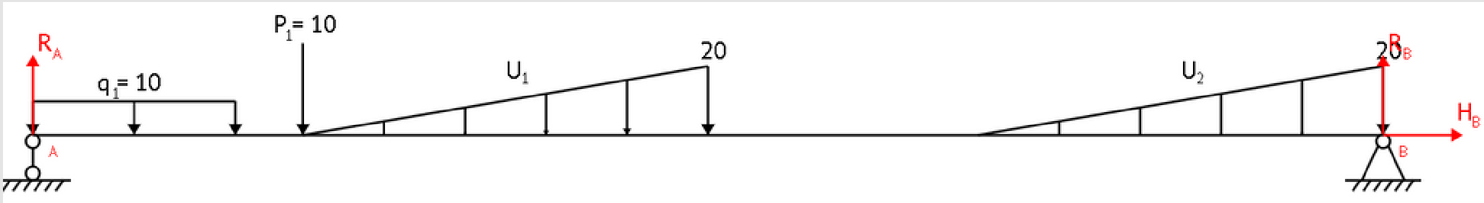
$= 110.5$ Nm

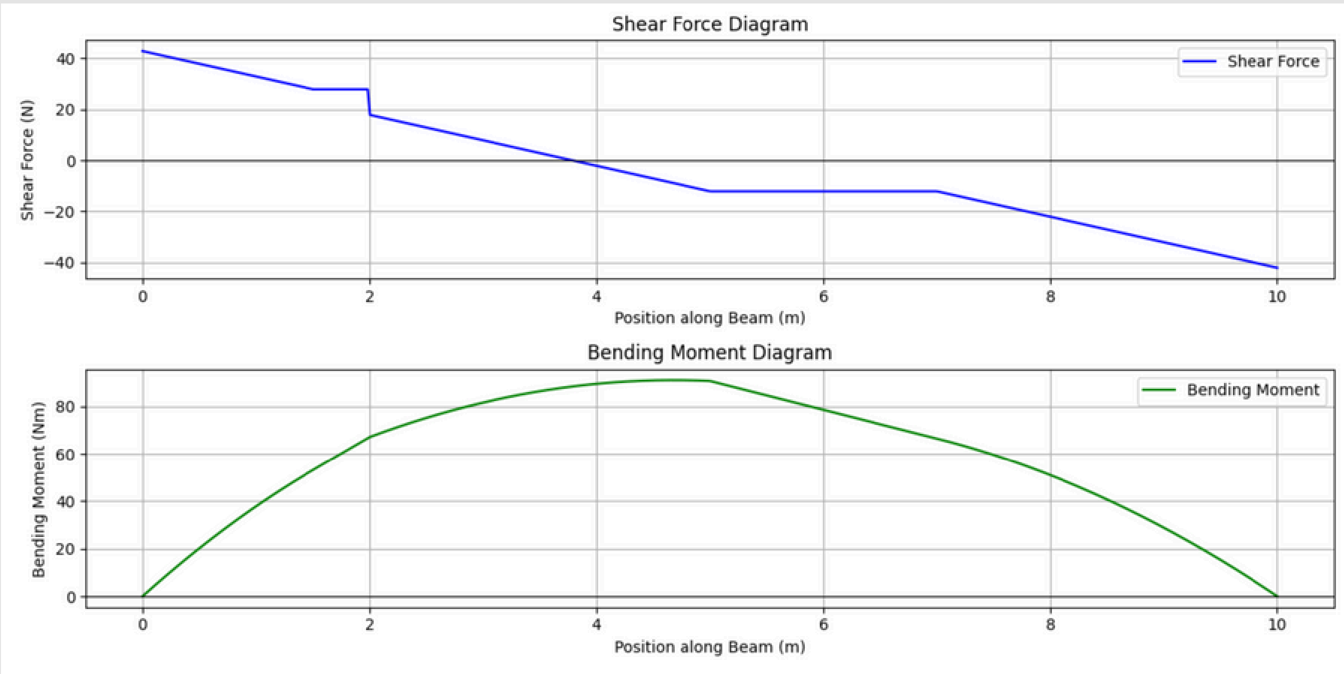
B.M. about K = $50.125 \times 0 = 0$ Nm


10N
30N
30N
A
B
H
C
D
I
E
J
F
Ay
Fy
1m
2m
0.75
0.75
0.5
2m
2m
2m
1m
shear force
34.875
-50.12
distance
Bending moment
110.5N-m
distance

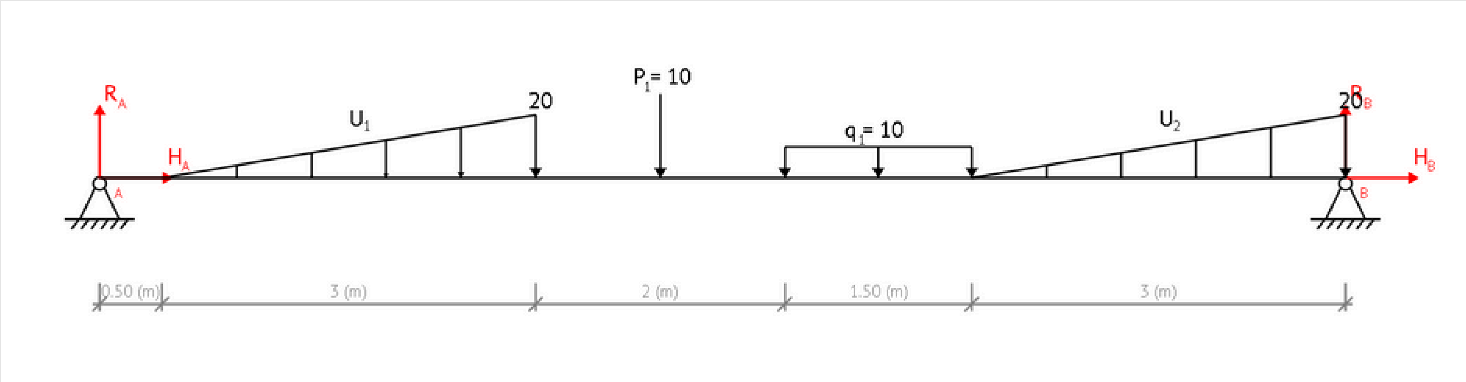
# Program Outputs

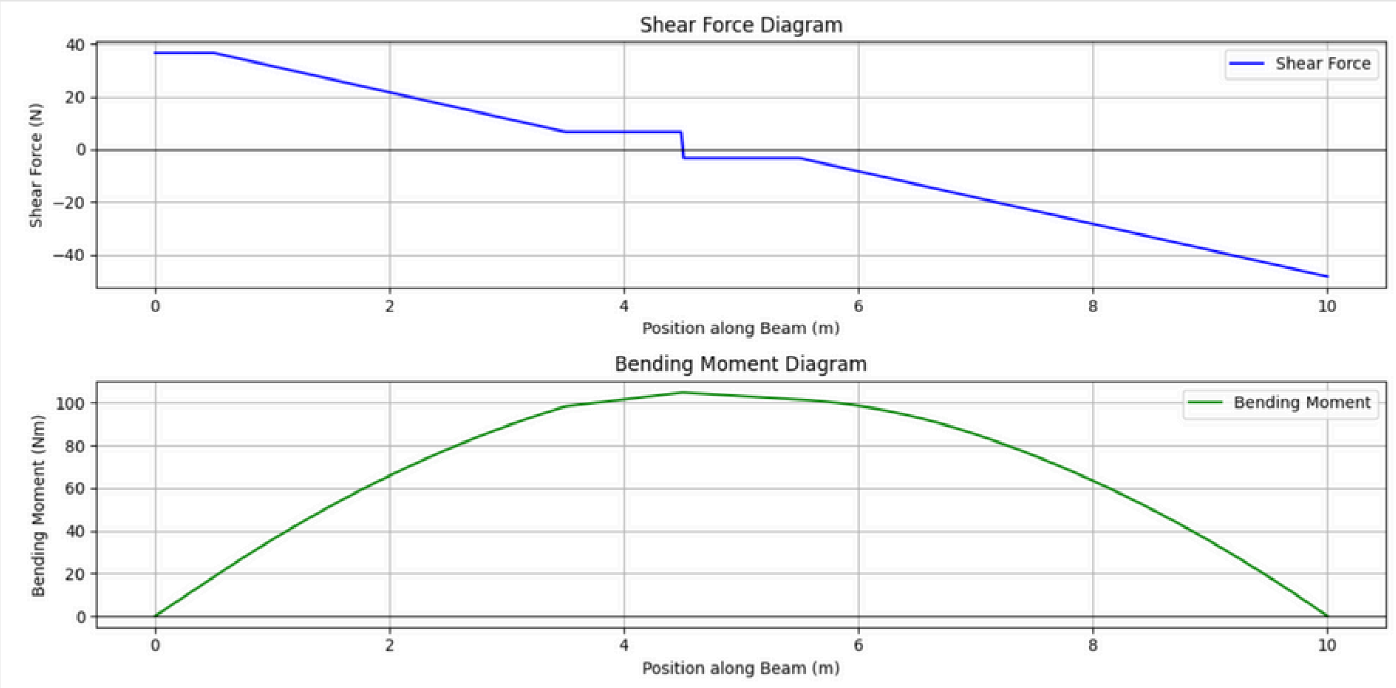
## Case 1:



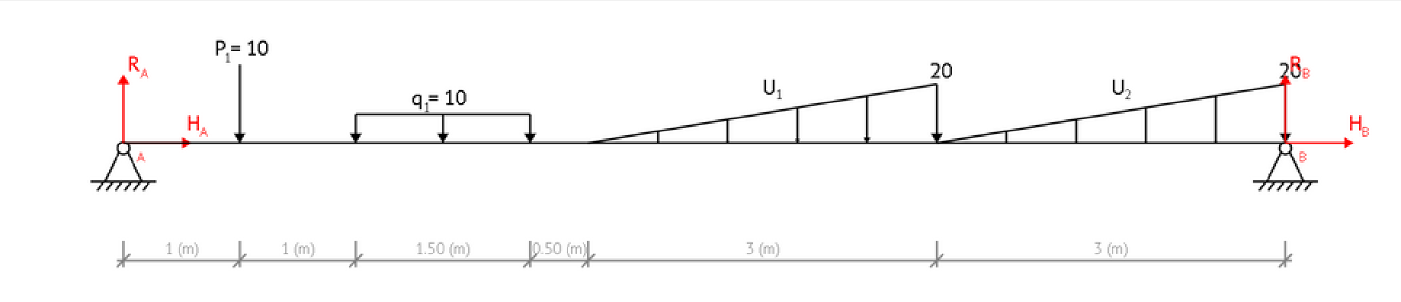



# Case 2:

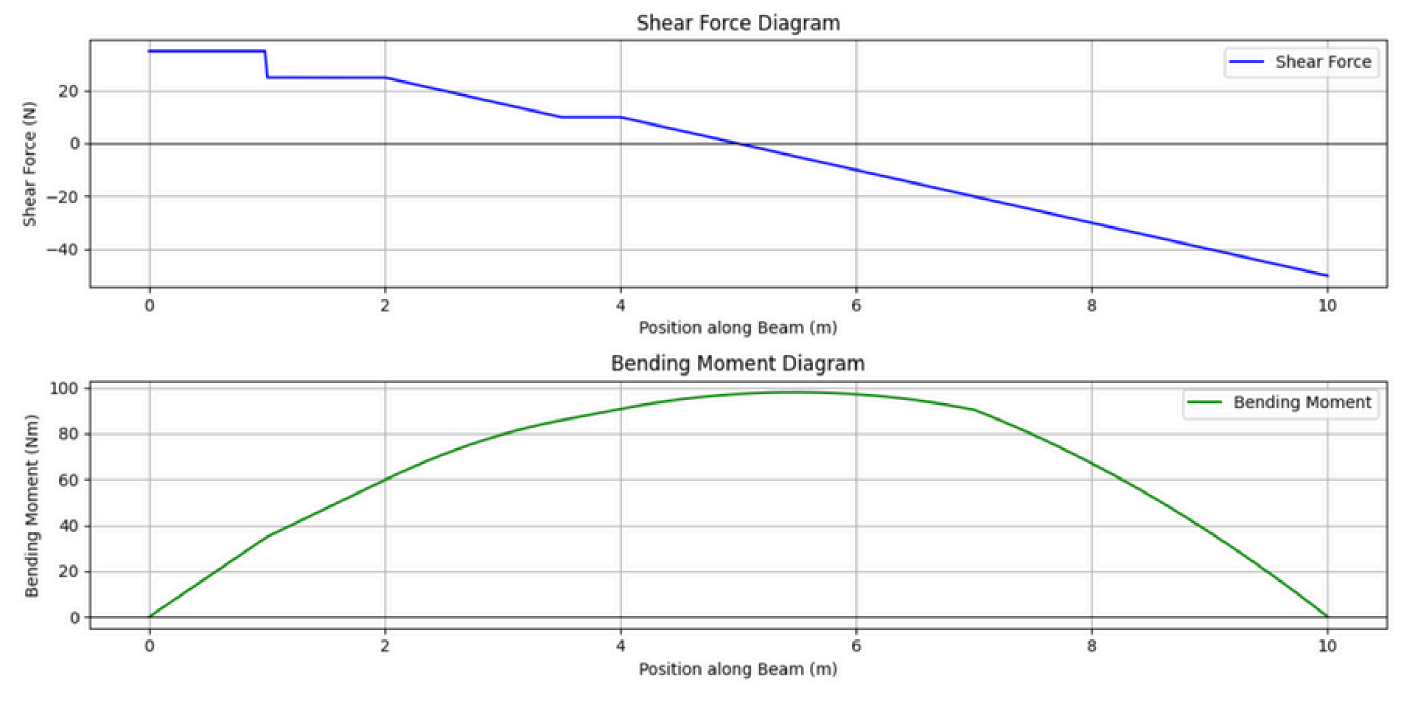

R_A
H_A
U_1
20
P_1= 10
q_1= 10
U_2
20
R_B
H_B
A
B
0.50 (m)
3 (m)
2 (m)
1.50 (m)
3 (m)


Shear Force Diagram
Shear Force
Shear Force (N)
Position along Beam (m)
Bending Moment Diagram
Bending Moment
Bending Moment (Nm)
Position along Beam (m)

# Case 3:



P1= 10
q1= 10
U1
U2
20
20
RA
HA
RB
HB
A
B
1 (m)
1 (m)
1.50 (m)
0.50 (m)
3 (m)
3 (m)

Shear Force Diagram
Shear Force
Shear Force (N)
Position along Beam (m)
Bending Moment Diagram
Bending Moment
Bending Moment (Nm)
Position along Beam (m)

# CONTRIBUTIONS

| CONTRIBUTION AREAS | MEMBER NAME |
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| Report Writing and Documentation | 1) Yash Verma<br>2) Suhanee Thakur<br>3) Pintu Saini |
| UI, Design and Illustration | 1) Vanya Sharma<br>2) Vyom Pant<br>3) Priya |
| Python Code Development , Diagram Creation | 1) Vanni Chauhan<br>2) Vyom Pant<br>3) Yash Verma |
| Manual Calculations | 1) Omanshi Rajpurohit<br>2) Puneet<br>3) Karthik Byju |

# References


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4. Engineering Intro. (n.d.). Shear force and bending moment diagrams. Retrieved April 1, 2025, from http://www.engineeringintro.com
5. LearnEngineering. (n.d.). Shear force and bending moment diagrams. Retrieved April 1, 2025, from http://www.learnengineering.org
6. StructuralAcademy. (n.d.). Shear force and bending moment calculator. Retrieved April 1, 2025, from http://www.structuralacademy.com