Problem 1 of 2) Solve for the reaction at C for the statically indeterminate structure shown. Dimensions are AB = 12 ft, BC = 5 ft, CD = 20 ft. Not to scale. W = 400 pounds/foot. EI = constant along the beam.

\[ W \]

\[ A \rightarrow B \rightarrow C \rightarrow D \]

\[ R_c - \text{Redundant} \]

\[ \text{COMP SIDE} \]

\[ \text{UNIT} \]

\[ A \rightarrow B \rightarrow C \rightarrow D \]

\[ W = 400 \]

\[ I \]

\[ I = 12 \left( \frac{1}{3} \right) \]

\[ M_0 \]

\[ A \rightarrow B \rightarrow C \rightarrow D \]

\[ 9600 \]

\[ 21600 \]

\[ 69600 \]

\[ H_0 \]

\[ R_0 \]

\[ \text{UNIT AB, BC} \]

\[ f \]

\[ \text{m} \]

\[ \text{m} = 0 \]

\[ \Delta_c = \int \frac{m_1 M_0}{EI} \, dx = \frac{L_c (a+2b)}{6EI} = \frac{20(20)(21600 + 2(69600))}{6EI} = \frac{-1072000}{EI} \]

\[ \delta_c = \int \frac{m_1 M_1}{EI} \, dx = \frac{\Delta_c}{3} = \frac{20(20)(20)}{3EI} = \frac{8000}{3EI} \]

\[ \Delta_c = 0 = \Delta_c + \delta_c R_c \]

\[ R_c = 4020 \text{ lbs} \uparrow \]
Problem 1 of 2) Solve for the reaction at C for the statically indeterminate structure shown. Dimensions are \( \Delta B = 12 \text{ ft}, \ BC = 5 \text{ ft}, \ CD = 20 \text{ ft}. \) Not to scale. \( W = 400 \text{ pounds/foot}. \) \( EI = \text{constant along the beam}. \)

\[
\Sigma M_{D} = 0 = M_{D} + (2400 \text{ lb})(29 \text{ ft}) \quad \Rightarrow \quad M_{D} = -69600 \text{ lb-ft}
\]

\[
\Sigma F_{y} = 0 = 0 + D_{y} \quad \Rightarrow \quad D_{y} = 2400 \text{ lb}
\]

(Sec AB)

\[
A
\]

\[
\Sigma M_{\text{cut}} = 0 = M + \frac{400}{12} x (x \left( \frac{x}{8} \right)) \quad \Rightarrow \quad M = -\frac{100}{9} x^{3}
\]

(Sec BC)

\[
A
\]

\[
\Sigma M_{\text{cut}} = 0 = M + 2400(x - 8) \quad \Rightarrow \quad M = -2400x + 19200
\]

(Sec CD)

\[
A
\]

\[
\Sigma M_{\text{cut}} = 0 = M + 2400(x - 5) \quad \Rightarrow \quad M = -2400x + 19200
\]

\[
\Sigma M_{D} = 0 = M_{D} - (1 \times 20) \quad \Rightarrow \quad M_{D} = 20 \text{ lb-ft}
\]

\[
\Sigma F_{y} = 0 = 1 + D_{y} \quad \Rightarrow \quad D_{y} = -1 \text{ lb}
\]

\[
\Sigma F_{x} = 0 = D_{x} \quad \Rightarrow \quad D_{x} = 0
\]
\[ \sum M_{tot} = 0 \implies M = 0 \]

[Diagram of AB with forces and moments]

\[ \sum M_{tot} = 0 \implies M = 0 \]

[Diagram of BC with forces and moments]

\[ \sum M_{tot} = 0 \implies M = (12)(x-17) \implies M = x - 17 \]

[Diagram of CD with forces and moments]

\[ \Delta_{co} = \frac{1}{EI} \left[ \int_{17}^{37} (-2400x^2 + 19200x + 192000x - 326400) \, dx \right] = \frac{1}{EI} \left[ \int_{17}^{37} (-2400x^2 + 19200x + 192000x - 326400) \, dx \right] \]

\[ \Delta_{co} = \frac{1}{EI} \left[ \int_{17}^{37} (-2400x^2 + 6000x - 326400) \, dx \right] = \frac{1}{EI} \left[ -2400x^3 + 30000x^2 - 326400x \right]_{17}^{37} \]

\[ \Delta_{co} = \frac{-10720000}{EI} \]

\[ \frac{f_{cc}}{EI} = \frac{1}{EI} \left[ \int_{17}^{37} (x-17)(x-17) \, dx \right] = \frac{1}{EI} \left[ \int_{17}^{37} (x^2 - 34x + 289) \, dx \right] = \frac{1}{EI} \left[ \frac{x^3}{3} - 17x^2 + 289x \right]_{17}^{37} \]

\[ f_{cc} = \frac{2666.67}{EI} \]

\[ \Delta_{co} + f_{cc}L_1 = 0 \implies \frac{10720000}{EI} = \frac{2666.67}{EI} L_1 \implies L_1 = 4020.16 \]
Problem 2 of 2) For the statically indeterminate frame, the reactions and reaction directions shown have been selected by the boss. Frame dimensions are \( AB = 14 \text{ feet} \), \( BC = 8 \text{ feet} \), \( CD = 12 \text{ feet} \), \( CE = 20 \text{ feet} \). Not to scale. The uniform load is 4 kips/foot. He has also decided that you will use \( R1 \), \( R2 \), and \( R3 \) as the redundant reactions. To get the final solution you would solve a set of equations similar to the following. I want you to get me two of the values.

\[
\Delta_1 = \Delta_{10} + \delta_{11} R_1 + \delta_{12} R_2 + \delta_{13} R_3 \\
\Delta_2 = \Delta_{20} + \delta_{21} R_1 + \delta_{22} R_2 + \delta_{23} R_3 \\
\Delta_3 = \Delta_{30} + \delta_{31} R_1 + \delta_{32} R_2 + \delta_{33} R_3
\]

Sketch the primary structure and solve for the values of \( \Delta_{30} \) and \( \delta_{33} \).
Problem 2 of 2) For the statically indeterminate frame, the reactions and reaction directions shown have been selected by the boss. Frame dimensions are AB = 14 feet, BC = 8.5 feet, CD = 12 feet, CE = 20 feet. Not to scale. The uniform load is 4 kips/foot. He has also decided that you will use $R_1$, $R_2$, and $R_3$ as the redundant reactions. To get the final solution you would solve a set of equations similar to the following. I want you to get me two of the values.

$$
\Delta_1 = \Delta_{10} + \delta_{11} R_1 + \delta_{12} R_2 + \delta_{13} R_3 \\
\Delta_2 = \Delta_{20} + \delta_{21} R_1 + \delta_{22} R_2 + \delta_{23} R_3 \\
\Delta_3 = \Delta_{30} + \delta_{31} R_1 + \delta_{32} R_2 + \delta_{33} R_3
$$

Sketch the primary structure and solve for the values of $\Delta_{30}$ and $\Delta_{33}$.

\[ \sum F_y = 0 \]
\[ A_y = 0 \]
\[ \sum M_A = 0 \]
\[ -(56k)(7.14) + Ey(144) = 0 \]
\[ Ey = 28k \]

\[ \sum F_y = 0 \]
\[ 28k + Ay - 56k = 0 \]
\[ Ay = 28k \]

\[ \Sigma M_A = 0 \]
\[ (1kA) - Ey(144) = 0 \]
\[ Ey = 0.07143k \]

\[ \Sigma F_y = 0 \]
\[ Ay = 0.07143k \]

\[ \Sigma F_x = 0 \]
\[ Ax = 0 \]

(Continue Back)
\[ \Delta_{30} = \sum \int_{AB} \frac{M_0 m_3}{EI} \, dx \]

\[ = \int_{0}^{14} \frac{28x - 2x^3}{EI} (0.07143x) \, dx \]

\[ = \frac{0.07143}{EI} \int_{0}^{14} 28x - 2x^3 \, dx = \frac{0.07143}{EI} \left[ \frac{28x^2}{3} - \frac{1}{2} x^4 \right]_{0}^{14} \]

\[ \Delta_{30} = \frac{457.333}{EI} \]

\[ \delta_{33} = \sum \int_{AB} \frac{m_3 m_3}{EI} \, dx = \int_{0}^{14} \frac{m_3^2}{EI} \, dx + \int_{8}^{14} \frac{m_3^2}{EI} \, dx + \int_{0}^{8} \frac{m_3^2}{EI} \, dx \]

\[ = \left( \frac{Lac}{3EI} \right)_{AB} + \left( \frac{Lac}{EI} \right)_{BC} + \left( \frac{Lac}{EI} \right)_{CD} \]

\[ = \frac{(14k)(1kA)^2}{3EI} + \frac{(8k)(-1kA)^2}{EI} + \frac{(12k)(1kA)^2}{EI} \]

\[ \delta_{33} = \frac{24.667}{EI} \]
Problem 1 of 2) For the statically indeterminate frame, the reactions and reaction directions shown have been selected by the boss. Frame dimensions are AB = 10 feet, BC = 8 feet, CD = 12 feet, BE = 16 feet. Not to scale. The uniform load is 2 kips/foot. She has also decided that you will use R1, R2, and R3 as the redundant reactions. To get the final solution you would solve a set of equations similar to the following. I want you to get me two of the values.

$$\Delta_1 = \Delta_{10} + \delta_{11} R_1 + \delta_{12} R_2 + \delta_{13} R_3$$
$$\Delta_2 = \Delta_{20} + \delta_{21} R_1 + \delta_{22} R_2 + \delta_{23} R_3$$
$$\Delta_3 = \Delta_{30} + \delta_{31} R_1 + \delta_{32} R_2 + \delta_{33} R_3$$

Sketch the primary structure and solve for the values of $\Delta_{20}$ and $\delta_{22}$. 

[Diagram of the frame with labeled reaction forces and moments]
\[ L_2 \alpha = \frac{1}{E_2} \int_0^L \left((12\alpha - x^2)(3.33\alpha)\right) dx \]

\[ L_2 \alpha = \frac{1440}{EI} \]

\[ \sigma_{zz} = \frac{1}{E_2} \left[ \int_0^L \sigma_{zz} \right] \alpha \left[ \int_0^\frac{L}{2} \sigma_{zz} \right] + \int_0^\frac{L}{2} \sigma_{zz} dx - \int_0^\frac{L}{2} (1.83\alpha) dx \]

\[ \delta_{zz} = \frac{1933.33}{E_2} \]
Problem 2 of 2) Solve for the reaction at B for the statically indeterminate structure shown. Dimensions are AB = 12 ft, BC = 5 ft, CD = 3 ft. Not to scale. W = 100 pounds/foot. EI = constant along the beam.

Primary:

\[ 150 \text{ lbs/ft} \]

\[ 100 \text{ lbs/ft} \]

\[ 18 \text{ ft} \]

\[ 17 \text{ ft} \]

\[ 3 \text{ ft} \]

\[ 5 \text{ ft} \]

\[ 12 \text{ ft} \]

M_{01}:

\[ \text{Moments} \quad 900 \quad 150 \quad 150 \]

Redundant:

\[ A_y = -1 \]

\[ M_A = -12 \]

Member CD:

\[ 100 = \frac{x^3}{3} \]

\[ x' = \frac{100}{3} \]

\[ E_m_{cut} = m = \frac{100x^3}{18} = \frac{50x^3}{9} \]

Member AC:

\[ 150 \uparrow \quad -150x + 2700 = m \]

Member BD:

\[ = \]

\[ m_{AB} = 1x - 12 = m \]

next page
To find reaction at By:

\[ By = -\frac{\Delta Bo}{dB} \]

\[ \Delta Bo = \int \frac{M_{\text{Mom}}}{EI} = \int_0^1 \frac{(-150x+2700)(x-12)}{EI} \, dx = -150^2 \]

\[ = -150x^2 + 1800x + 2700x - 32400 \]

\[ = \int_0^1 (-150x^2 + 4500x - 32400) \, dx = -\frac{150x^3}{3} + 4500x^2 - 32400x \int_0^1 \]

\[ = -86400 + 32400 - 988800 = -\frac{151200}{EI} \]

\[ dB = \frac{151200}{EI} \]

\[ By = \frac{151200}{576} \]

By = 262.5 lbs ↑

check with volume:

\[ \Delta Bo = \frac{LA(2c+d)}{b} = 12(\frac{12}{2})(2 \times 2700 + 900) \]

\[ = -\frac{151200}{EI} \] (same as above)
General examination rules:

1) Do not put your completed work anywhere that it can be seen. If any part of your work can be seen by others it will be confiscated and you will not be permitted to rework those problems. Place any pages of your work face down on your desk under your existing work, not on the floor next to you where it is visible.

2) Please remove your hat. If it is part of your head, turn it around backwards.

3) If your work is not legible, or if I cannot follow your logic at a glance, it will receive no credit. This paper must be written to acceptable engineering standards for credit. Please take this seriously as it will affect your grade.

4) You may work on the front or back of this paper. Just note if any work is on the back.

5) You can use your own paper or paper supplied at the front of the room.

6) You MUST specify what you are doing every step of the way. If I can follow where you got your numbers from, you will likely receive partial credit should you go off track.

7) Write big and use lots of paper, leaving me room to grade your paper. If there is no room to tell you why points were deducted, I will only show you the point deduction and let you try and figure out why.

8) You must present your work in a linear fashion, i.e. state what you are doing and then write down all necessary calculations you used in determining that value. Be sure to box your final answers.

I have read and understand all of the above instructions: _____________ (Initials)

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"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam."

____________________________
Signature of student

Please do not open this exam until you are told to do so.
VOLUME INTEGRALS

L is the total length of the member.

d is the central ordinate of the parabola.
The parabola values c, d, e, can be positive or negative.
The trapezoid a/c value can be greater or smaller than its b/d value.
The curves above ARE FOR PARABOLAS ONLY!
Problem 1 of 2) For the statically indeterminate frame, the reactions and reaction directions shown have been selected by the boss. Frame dimensions are $AB = 10$ feet, $BC = 8$ feet, $CD = 12$ feet, $BE = 16$ feet. Not to scale. The uniform load is 2 kips/foot. She has also decided that you will use $R_1$, $R_2$, and $R_3$ as the redundant reactions. To get the final solution you would solve a set of equations similar to the following. I want you to get me two of the values.

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$$\Delta_3 = \Delta_{30} + \delta_{31} R_1 + \delta_{32} R_2 + \delta_{33} R_3$$

Sketch the primary structure and solve for the values of $\Delta_{20}$ and $\delta_{22}$. 

\[ \Delta_2 = 0 \]

\[ \Delta_3 = 0 \]
\[ \sum M_E = 0 = -2^{k/ft}(12')(6') + Dv(12') \]
\[ Dv = 12k \]
\[ So \quad Ev = 12k \]

**Draw on Compressive Side**

\[ 12k \]
\[ (12)(6) - 12(3) = 36kft \]
\[ \Sigma M_D = 0 = -1 \times 22 + R_{Rev}(12') \]

\[ R_{Rev} = 1.833 \text{k} \]

\[ 16' \Rightarrow R_{Rev} = 0.833 \text{k} \] (\( \Sigma F_y = 0 \))

ON COMPRESSIVE SIDE

\[ 0.833 \text{k}(12') = 10 \text{kft} \]
\[ K \cdot \Delta_{20} = \int d = \frac{36 \text{ kft}}{3 \varepsilon I} \quad a = \frac{10 \text{ kft}}{121} \]

\[
= \frac{12 \text{ ft}}{3 \varepsilon I} \cdot (10 \text{ kft}) \cdot (36 \text{ kft}) \]

\[ \Delta_{20} = \frac{1440}{\varepsilon I} \]

\[ K \cdot \delta_{22} = \int \frac{a=10 \text{ kft}}{121} \quad c=10 \text{ kft} \]

\[
= \frac{L-a-c}{3} = \frac{(12') \cdot (10 \text{ kft}) \cdot (10 \text{ kft})}{3 \varepsilon I} \]

\[ = \frac{400}{\varepsilon I} \]
Problem 2 of 2) Solve for the reaction at B for the statically indeterminate structure shown. Dimensions are AB = 12 ft, BC = 5 ft, CD = 3 ft. Not to scale. W = 100 pounds/foot. EI = constant along the beam.
\[
\Delta_{10} = \sum \frac{m M dx}{EI} = \int \frac{12M}{12} \text{d}x = \frac{L}{6EI} (2a + b b) = \frac{(12)(12)(22700 + 900)}{6EI} = 151,200
\]
\[
S_{10} = \sum \frac{m M dx}{EI} = \int \left[ \frac{12}{12} - \frac{12}{12} \right] = \frac{Lac}{3}
\]
\[
\Delta_1 = 0 = \Delta_{10} + S_{11}R_1 = -151,200 + 576 R_1
\]
\[
R_1 = \frac{262,500}{576}
\]
\( M_0 \)

\( (150 \text{#})(18') \)

\( = 2700 \text{ ft#} \)

\( 12 \text{ KFT} \)
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7) Write big and use lots of paper, leaving me room to grade your paper. If there is no room to tell you why points were deducted, I will only show you the point deduction and let you try and figure out why.
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__________________________
Signature of student

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345Qb-2015c
Problem 1 of 2) Solve for the reaction at C for the statically indeterminate structure shown. Dimensions are AB = 12 ft, BC = 5 ft, CD = 20 ft. Not to scale. W = 400 pounds/foot. EI = constant along the beam.
\[ \Delta_{10} = \int_{c}^{d} m M dx = L a (2d + c) \left( \frac{1}{6EI} \right) \]

\[ = \frac{(20 \text{ ft})(20 \text{ ft} #)(-2 \cdot 69600 \text{ ft} #)}{6EI} = -21,600 \]

\[ = \frac{10,720,000}{EI} \]
\[ \delta_{11} = \frac{Lac}{3} = \frac{(20\text{ ft}) (20\text{ ft}) (20\text{ ft})}{3EI} \]

\[ = \frac{2666.67}{EI} \]

\[ \Delta_1 = 0 = \Delta_{10} + \delta_{11} R_1 \]

\[ = \frac{-10,720,000}{EI} + \frac{2,666.67 R_1}{EI} \]

\[ \Rightarrow R_1 = 4020 \]
Problem 2 of 2) For the statically indeterminate frame, the reactions and reaction directions shown have been selected by the boss. Frame dimensions are $AB = 14$ feet, $BC = 8$ feet, $CD = 12$ feet, $CE = 20$ feet. Not to scale. The uniform load is 4 kips/foot. He has also decided that you will use $R1$, $R2$, and $R3$ as the redundant reactions. To get the final solution you would solve a set of equations similar to the following. I want you to get me two of the values.

\[ \Delta_1 = \Delta_{10} + \delta_{11} R_1 + \delta_{12} R_2 + \delta_{13} R_3 \]
\[ \Delta_2 = \Delta_{20} + \delta_{21} R_1 + \delta_{22} R_2 + \delta_{23} R_3 \]
\[ \Delta_3 = \Delta_{30} + \delta_{31} R_1 + \delta_{32} R_2 + \delta_{33} R_3 \]

Sketch the primary structure and solve for the values of $\Delta_{30}$ and $\delta_{33}$. 

---

**Diagram:**

- $R4$ and $R5$
- $B$
- $C$
- $R1$ and $R2$
- $R3$
- $E$
- $R6$
\[ \sum M_A = 0 = + 1 - R_E (14') \]
\[ R_E = 0.071429 K \]
\[ \sum F_V = 0 = R_{AV} - 0.071429 \]
\[ R_{AV} = 0.071429 K \]

\[ R_{EV} = 0.071429 K \]
\[ 1 \text{kft} \cdot \Delta_{30} = \int \frac{d=98 \text{kft}}{141} \cdot \frac{\alpha=1 \text{kft}}{141} \]

\[ = \frac{Lad}{3EI} = \frac{(14') (1 \text{kft}) (98 \text{kft})}{3EI} \]

\[ \Delta_{30} = 457.3 \text{ radians} \]

\[ 1 \text{kft} \cdot \delta_{22} = \int \frac{1 \text{kft}}{14'} \cdot \frac{1 \text{kft}}{14'} \]

\[ = \frac{Lac}{3EI} = \frac{(14 \text{ft}) (1 \text{kft}) (1 \text{kft})}{3EI} \]

\[ = \frac{4.667}{EI} \]