READ THE FOLLOWING GENERAL EXAMINATION RULES:

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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. Box your final answers.

9) Each problem is of equal credit unless noted otherwise.

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

Signature of student

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VOLUME INTEGRALS

- \( \frac{L_1 c}{2} \)
- \( \frac{L_2 c}{3} \)
- \( \frac{L_3 c}{6} \)
- \( \frac{L_1 (a + b)}{2} \)
- \( \frac{L_2 (a + b)}{2} \)
- \( \frac{L_3 (a + b)}{2} \)
- \( \frac{L_1 (a + 2b)}{6} \)
- \( \frac{L_2 (a + 2b)}{6} \)
- \( \frac{L_3 (a + 2b)}{6} \)
- \( \frac{L_1 (c-d)}{2} \)
- \( \frac{L_2 (c-d)}{6} \)
- \( \frac{L_3 (c-d)}{6} \)
- \( \frac{L_1 (2c+d)}{6} \)
- \( \frac{L_2 (2c+d)}{6} \)
- \( \frac{L_3 (2c+d)}{6} \)
- \( \frac{L_1 (2d+c)}{6} \)
- \( \frac{L_2 (2d+c)}{6} \)
- \( \frac{L_3 (2d+c)}{6} \)
- \( \frac{ac(L - L_1) + ad(L + L_3)}{6} \)
- \( \frac{(L + L_1)ac}{6} \)
- \( \frac{(L + L_2)ac}{6} \)
- \( \frac{ac(L + L_3) + bc(L + L_3)}{6} \)
- \( \frac{ac(L - (L_2 / L_3)^2 / L_1)}{6} \)

For \( L_3 < L_1 \) ONLY:

- \( \frac{L_1 c}{3} \)
- \( \frac{L_2 c}{4} \)
- \( \frac{L_3 c}{12} \)
- \( \frac{ac(a + 3b)}{12} \)
- \( \frac{ac(3L_1 L_1^2 / L)}{12} \)

- \( \frac{2L_1 d}{3} \)
- \( \frac{L_2 d}{3} \)
- \( \frac{L_3 d}{3} \)
- \( \frac{L_1 (a + b)}{3} \)
- \( \frac{L_2 (a + b)}{3} \)
- \( \frac{L_3 (a + b)}{3} \)
- \( \frac{ad(L - (L_1 L_2) / L)}{3} \)

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) An influence line for moment at c in a beam is shown below. Use a wheel spacing L = 15 ft, P = 30 k, Wlive = 10 k/ft, Wdead = 2 k/ft, with the height “h” of the influence line at c = 10 ft. Solve for the maximum possible positive moment at c.

\[ M_{\text{LIVE}} = (10 \text{ k})(45') \cdot (\frac{1}{2})(10 \text{ k}/\text{ft}) + (\frac{5}{2} \text{ ft})(10')(\frac{1}{2})(10 \text{ k}/\text{ft}) = 2333 \]

\[ M_{\text{DEAD}} = 2 \text{ k/ft} \left[ (10)(45')(\frac{1}{2}) + \frac{5}{3}(10)(\frac{1}{2}) - (\frac{40}{3})(20')(\frac{1}{2}) - (\frac{10}{3})(30')(\frac{1}{2}) \right] = 100 \]

\[ M_{30^k} = 30^k \cdot (104') = 300 \]

\[ M_{10^k} = 10^k \cdot \left( \frac{104'}{30^k'} \cdot 154' \right) = 50 \]

\[ = 2783 \text{ kft} \]

\[ \delta_{67} \]
Problem 1) An influence line for moment at c in a beam is shown below. Use a wheel spacing L = 15 ft, P = 30 k, Wlive = 10 k/ft, Wdead = 2 k/ft, with the height "h" of the influence line at c = 10 ft. Solve for the maximum possible positive moment at c.

\[ \frac{10}{20} = \frac{10}{15} \quad ? = 13.33 \]

\[ \frac{10}{20} = \frac{7}{10} \quad ? = 2.22 \]

\[ \frac{10}{20} = \frac{2}{10} \quad ? = 1.66 \]

\[ M_e = (30)(10) + (10)(5) \quad \text{wheel} \]

\[ + (10)(15)(10)(0.5) + (10)(30)(10)(0.5) + (10)(15)(1.667)(0.5) \quad \text{line} \]

\[ + (2)(20)(-13.333)(0.5) + (2)(15)(10)(0.5) + (2)(30)(10)(0.5) + (2)(10)(-3.333)(0.5) \]

\[ + (2)(20)(-3.333)(0.5) + (2)(10)(1.667)(0.5) \]

\[ M_e = 350 + 2173.333 + 106.017 \]

\[ M_{e, \max} = 2783.35 \text{ k-ft} \]

\[ \text{Good} \]
Problem 1) An influence line for moment at c in a beam is shown below. Use a wheel spacing L = 15 ft, P = 30 k, Wlive = 10 k/ft, Wdead = 2 k/ft, with the height “h” of the influence line at c = 10 ft. Solve for the maximum possible positive moment at c.

\[
\begin{align*}
&\text{Find } M_{\text{Max}} \\
&\frac{10}{30} = \frac{x}{10} \\
&+ \frac{3.333}{10} = \frac{x}{10} \\
&W_{\text{live}} = 10 \text{k/ft} \\
&W_{\text{dead}} = 2 \text{k/ft}
\end{align*}
\]

\[
M \rightarrow DL = 2 \frac{\text{k}\cdot\text{ft}}{\text{ft}} \left[ \left( \frac{-13.333 \cdot 20}{2} \right) + \left( \frac{10 \cdot 45}{2} \right) - \left( \frac{30 \cdot 3.333}{2} \right) + \left( \frac{10 \cdot 1.467}{2} \right) \right] = 100.017 \text{kft}
\]

\[
M \rightarrow LL = 10 \frac{\text{k}\cdot\text{ft}}{\text{ft}} \left[ \left( \frac{10 \cdot 45}{2} \right) + \left( \frac{10 \cdot 1.467}{2} \right) \right] = 2333.35 \text{kft}
\]

\[
M \rightarrow \text{wheels} = (30 \text{k} \cdot 10') + (10 \text{k} \cdot 5') = 350 \text{kft}
\]

\[
\begin{align*}
M^{(4)}_{\text{Max}} &= \left( \sum M_{DL \cdot LL \cdot \text{wheels}} \right) \\
M^{(4)}_{\text{Max}} &= 2783.37 \text{kft}
\end{align*}
\]
Problem 2) Draw influence lines, including values, for the cases listed below. Note the pins at C and F in the beam.

\[ \frac{2.5}{5} = \frac{3}{8} \quad \theta = 4.0 \]

\[ \frac{1.0}{10} = \frac{2}{18} \quad \theta = 1.8 \]

\[ \frac{1.0}{16} = \frac{3}{18} \quad \theta = \frac{5}{8} = 0.625 \]

\[ 1.0 - 0.625 = 0.375 \]
Problem 2) Draw influence lines, including values, for the cases listed below. Note the pins at C and F in the beam.

\[
\begin{align*}
\frac{1}{10} &= \frac{h}{8}, \quad h = 0.8 \\
0.3 &= \frac{h}{8} \quad G = 0.3 \\
\frac{5}{10} &= \frac{h}{5}, \quad h = 2.5 \\
\frac{2.5}{5} &= \frac{h}{5}, \quad h = 4 \\
\frac{1}{10} &= \frac{h}{16}, \quad h = 1.6 \\
\frac{h}{6} &= \frac{(1-h)}{10} \Rightarrow h = 0.375 \\
0.375 &= 0.0625 \\
\end{align*}
\]
Problem 2) Draw influence lines, including values, for the cases listed below. Note the pins at C and F in the beam.
Problem 2) Draw influence lines, including values, for the cases listed below. Note the pins at C and F in the beam.

\[
\frac{y}{8} = \frac{1}{10}, \quad y = 0.8
\]

\[
\frac{5}{10} = \frac{y}{5}, \quad y = 2.5
\]

\[
\frac{y}{8} = \frac{2.5}{5}, \quad y = 4
\]

\[
\frac{y}{18} = \frac{1}{10}, \quad y = 1.8
\]
Problem 3) The frame shown originally had 9 reactions, 6 of which have been removed as redundants, as shown. Solve for $\delta_{16}$ for use in the solution for the reactions. Note that the figure is NOT TO SCALE. Blank sheets follow the problems for your work. USE THEM.
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\[
\begin{align*}
\Sigma F_x &= 0 \\
A_x &= 1 \text{k}
\end{align*}
\]

\[
\begin{align*}
\Sigma F_y &= 0, \quad A_y = 0 \\
2F_y &= 0, \quad A_y = 0
\end{align*}
\]

\[
\begin{align*}
2M_A &= 0 \\
1(25) - M_A &= 0
\end{align*}
\]

\[
M_A = 25 \text{ ft-cw}
\]

\[
\delta_{16} = \frac{2300}{EI}
\]

\[
\delta_{16} = \frac{2300}{EI}
\]
Problem 3) The frame shown originally had 9 reactions, 6 of which have been removed as redundants, as shown. Solve for δ16 for use in the solution for the reactions. Note that the figure is NOT TO SCALE. Blank sheets follow the problems for your work. USE THEM.

\[ \delta_{16} = \int \frac{m_i m_6}{E_1} \, dx \]

need \( m_i, m_6 \)

for \( m_1 \)

\[ 52 M_A = M_B + 1(10) + 1(15) = 0 \]

\[ M_B = -75 \text{ kft} \]

\( \delta_{16} = \int \frac{m_i m_6}{E_1} \, dx \)

\( M_1 \) compression side for both

\[ \delta_{16} = \left( \frac{55 \text{ kft}}{20 \text{ ft}} \right) + \left( \frac{55 \text{ kft}}{20 \text{ ft}} \right) \]

\( M_{cut} = 55 \text{ kft} \)

\( M_{cut} = 55 \text{ kft} \)

\( P = (55 + 1) \text{ kft} \)

\( M_{cut} = 55 \text{ kft} \)

\[ \delta_{16} = \frac{L a c}{E_1} + \frac{L a (c + d)}{2E_1} \]
\[ \delta_{16} = \frac{La}{E_1} + \frac{La(c+d)}{2E_1} \]

\[ \delta_{16} = \frac{70 \text{ ft} \times (55 \text{ ft}) \times (1 \text{ ft})}{E_1} + \frac{30 \text{ ft} \times (12 \text{ ft}) \times (25 + 55)}{2E_1} \]

\[ \delta_{16} = \frac{1100}{E_1} + \frac{1700}{E_1} \]

\[ \delta_{16} = \frac{2300}{E_1} \text{ ft} \]

\[ \delta_e = \frac{2300}{E_1} \text{ ft} \]

[Signature]
Problem 3) The frame shown originally had 9 reactions, 6 of which have been removed as redundants, as shown. Solve for $816$ for use in the solution for the reactions. Note that the figure is NOT TO SCALE. Blank sheets follow the problems for your work. USE THEM.
\[ L_a c + L a \frac{(b + c)}{2} \]

\[ \delta 16 = \frac{(20')(55)(1.0)}{E I} + \frac{(30')(55 + 25)(1.0)}{2} \]
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Problem 1) The frame shown originally had 9 reactions, 6 of which have been removed as redundants, as shown. Solve for δ43 for use in the solution for the reactions. Note that the figure is NOT TO SCALE. Blank sheets follow the problems for your work. USE THEM.

\[ \delta_{43} = \int \frac{m_4 m_3 dx}{EI} = \int \frac{45 \text{kft}}{20'} + \int \frac{1 \text{kft}}{15} \]

[Diagram of the frame with reactions and forces labeled]
Problem 1) The frame shown originally had 9 reactions, 6 of which have been removed as redundants, as shown. Solve for $\delta_{43}$ for use in the solution for the reactions. Note that the figure is NOT TO SCALE. Blank sheets follow the problems for your work. USE THEM.

Using volume integrals

$$\delta_{43} = \left[ 0 + 0 + L a c + \frac{LC(a+b)}{2} \right] \frac{1}{EI}$$

$$= \left[ 20 \text{ ft} \right] \left[ 45 \text{ kips} \right] \left[ 1 \right] + \frac{30 \left[ 15 \right] (45)}{2}$$

$$= \frac{1800}{EI}$$
Problem 1) The frame shown originally had 9 reactions, 6 of which have been removed as redundants, as shown. Solve for $\delta_{43}$ for use in the solution for the reactions. Note that the figure is NOT TO SCALE. Blank sheets follow the problems for your work. USE THEM.

$$M_A = -1$$

$$\delta_{45} = \int \frac{m_4 m_3 \, dy}{EI}$$

$$\Sigma F_y = 2 \text{ kips/ft} \times 20 \text{ ft} + A_y = 0$$

$$A_y = 40 \text{ kips}$$

$$\Rightarrow \Sigma F_x = 0 = A_x$$

$$\Sigma F_y = 2 \text{ kips/ft} \times 20 \text{ ft} + 2 \Sigma M_A = -2 \times 20 \text{ kips} \times 10 \text{ ft} + M_4$$

$$M_4 = 400$$

<table>
<thead>
<tr>
<th>Member</th>
<th>Limit</th>
<th>$m_4$</th>
<th>$m_3$</th>
<th>$\delta_{43}$</th>
</tr>
</thead>
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<tr>
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<td>0-55</td>
<td>0</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>0-20</td>
<td>0</td>
<td>0</td>
<td></td>
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<tr>
<td>43</td>
<td>0-45</td>
<td>-1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>0-30</td>
<td>0</td>
<td>1</td>
<td>(15x + x^2) / 2</td>
</tr>
<tr>
<td>35</td>
<td>20-46</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

$$\delta_{43} = 1800 \text{ kips} \times 10 \text{ ft} / EI$$
Problem 1) The frame shown originally had 9 reactions, 6 of which have been removed as redundants, as shown. Solve for δ43 for use in the solution for the reactions. Note that the figure is NOT TO SCALE. Blank sheets follow the problems for your work. USE THEM.

\[ \begin{align*}
\sum F_x &= A_x = 0 \\
A_x &= 1 \\
\sum M_A &= 0 = M_A + 1(15) \\
M_A &= 15 \text{ k-ft}
\end{align*} \]

Deflection \( \delta \) caused by unit load at 3

Using Vol. Integrals:

\[ \delta_{43} = \frac{1}{EI} \left[ \int_{-3.0}^{1.5} \frac{x}{45} \, dx + \int_{1.5}^{10} \frac{45}{45} \, dx \right] \]

\[ \begin{align*}
\delta_{43} &= \frac{1}{EI} \left[ \frac{30(1)(15+45)}{2} + 20(45)(1) \right] \\
\delta_{43} &= \frac{1800}{EI}
\end{align*} \]
Problem 2) An influence line for moment at c in a beam is shown below. Use a wheel spacing \( L = 15 \) ft, \( P = 60 \) k, \( W_{\text{live}} = 6 \) k/ft, \( W_{\text{dead}} = 1 \) k/ft, with the height “h” of the influence line at \( c = 20 \) ft. Solve for the maximum possible negative moment at c.
Problem 2) An influence line for moment at c in a beam is shown below. Use a wheel spacing
L = 15 ft, P = 60 k, Wlive = 6 k/ft, Wdead = 1 k/ft, with the height “h” of the influence line at c = 20 ft.
Solve for the maximum possible negative moment at c.

For point loads we’ll try different scenarios:

Scenario 1:

60K
\[ \Downarrow \]
\[ IL = -26.667 \]
\[ IL = -1.667 \]
\[ \leftarrow 15ft \rightarrow \]

Influence = 60(-26.667) + 20(-1.667)
\[ = -1733.33K.\text{ft} \]

Scenario 2:

\[ \Downarrow \]
\[ IL = -1.667 \]
\[ IL = -1.667 \]

Influence = 60(-1.667) + 20(-1.667)
\[ = -433.33K.\text{ft} \]

Choosing Scenario 1:

Answer:
Max possible negative moment
-1733.33 - 2200 + 100 = \[ -3333.33K.\text{ft} \]

For dead loads: they will be placed all over the beam:

\[ 1k/ft \]

Its influence is measured by:
\[ (44^4) \]
\[ F \]
\[ = 1(-266.667 + 150 + 200 - 33.333 - 66.667 + 100) \]
\[ = 100 K.\text{ft} \]

The live loads will be placed from \( a \) to \( b \) and \( d \) to \( f \):

\[ 6k/ft \]

Its influence is measured by:
\[ F \]
\[ = 6(-266.667 - 33.333 - 66.667) \]
\[ = -2200 K.\text{ft} \]
Problem 2) An influence line for moment at c in a beam is shown below. Use a wheel spacing
L = 15 ft, P = 60 k, W-live = 6 k/ft, W-dead = 1 k/ft, with the height “h” of the influence line at c = 20 ft.
Solve for the maximum possible negative moment at c.

- \( h_c = \frac{20}{20} = 1 \)
- \( h_a = \frac{20}{15} \)
  \( \Rightarrow h_a = -26.67 \) (Corrected from the original calculation)
- \( h_e = \frac{20}{20} = 1 \)
  \( \Rightarrow h_e = -6.67 \) (Corrected from the original calculation)
- \( h_b = \frac{6.67}{10} = 0.67 \)
  \( \Rightarrow h_b = 3.33 \) (Corrected from the original calculation)

Max Neg Moment:
From Dead Load:
\[
M_c = \left[ 1(-26.67)(20) + 1(20)(45) + 1(-6.67)(20) + 1(3.33)(10) \right] / 2 \text{ WHEELS} \\
= 100 \text{ k-FT}
\]

From Live Load:
\[
M_c = \left[ 6(-26.67)(20) + 6(-26.67)(30) \right] / 2 \\
= -2200.5 \text{ k-FT}
\]

From Wheels:
\[
M_c = 60(-26.67) + 20(-6.67) \\
= -1733.6 \text{ k-FT}
\]

TOTAL = DEAD + LIVE + WHEELS
Max Neg
\[
M_c = -3834.1 \text{ k-FT}
\]
Problem 2) An influence line for moment at \( c \) in a beam is shown below. Use a wheel spacing \( L = 15 \text{ ft} \), \( P = 60 \text{ k} \), \( W_{\text{live}} = 6 \text{ k/ft} \), \( W_{\text{dead}} = 1 \text{ k/ft} \), with the height "\( h \)" of the influence line at \( c = 20 \text{ ft} \). Solve for the maximum possible negative moment at \( c \).

\[
\frac{26.667}{20} = \frac{6.66}{5}
\]

\[
\frac{3.33}{1.667} = 2
\]

\[
\text{W}_{\text{live}}(\cdot)
\]

\[
1 \text{k/ft}
\]

\[
-266.67(15\text{ft}) + 450(1\text{k/ft}) - 100(15) + 16.66(1)
\]

\[
\text{W}_{\text{dead}} = [+100.]
\]

\[
\text{W}_{\text{live}}
\]

\[
-266.67(6) + 100(6)
\]

\[
= -2200.024
\]

\[
\text{point}
\]

\[
-60(26.667) - 6.66(20)
\]

\[
= [-1733.355]
\]

\[
\text{Max Net Moment}
\]

\[
3833.375 \text{ kft}
\]
Problem 3) Draw influence lines, including values, for the cases listed below. Note the pins at C and F in the beam.

\[ \frac{10}{16} = \frac{2}{6} \]
Problem 3) Draw influence lines, including values, for the cases listed below. Note the pins at C and F in the beam.