READ THE FOLLOWING 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. Box your final answers.
9) Each problem is of equal credit unless noted otherwise.

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

Ethical Standards:

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning, and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the TAMU community from the requirements or the processes of the Honor System.

"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

\[
\begin{align*}
\text{Lac} &\quad \frac{\text{Lac} \cdot \text{L} \cdot \text{L} \cdot \text{L}}{2} \\
\frac{\text{Lac}}{2} &\quad \frac{\text{Lac}}{3} &\quad \frac{\text{Lac}}{6} &\quad \frac{\text{L}(2\text{a} + \text{b})}{6} &\quad \frac{(\text{L} \cdot \text{L}_2)\text{ac}}{6} \\
\frac{\text{Lac}}{2} &\quad \frac{\text{Lac}}{6} &\quad \frac{\text{Lac}}{3} &\quad \frac{\text{L}(\text{a} + 2\text{b})}{6} &\quad \frac{(\text{L} + \text{L}_1)\text{ac}}{6} \\
\frac{\text{La}(\text{c} + \text{d})}{2} &\quad \frac{\text{La}(2\text{c} + \text{d})}{6} &\quad \frac{\text{La}(2\text{d} + \text{c})}{6} &\quad \frac{\text{La}(2\text{c} + \text{d}) + \text{Lb}(\text{c} + 2\text{d})}{6} &\quad \frac{\text{ac}(\text{L} - \text{L}_2) + \text{ad}(\text{L} + \text{L}_1)}{6} \\
\frac{\text{Lac}}{2} &\quad \frac{(\text{L} + \text{L}_3)\text{ac}}{6} &\quad \frac{(\text{L} + \text{L}_3)\text{ac}}{6} &\quad \frac{\text{ac}(\text{L} + \text{L}_4) + \text{bc}(\text{L} + \text{L}_5)}{6} &\quad \frac{\text{ac}(2 - (\text{L}_1 - \text{L}_2)^2 / (\text{L}_1 \cdot \text{L}_4))}{6} \\
\frac{\text{Lac}}{3} &\quad \frac{\text{Lac}}{12} &\quad \frac{\text{Lac}}{4} &\quad \frac{\text{Lc}(\text{a} + 3\text{b})}{12} &\quad \frac{\text{ac}(3\text{L}_1 \cdot \text{L}_4)}{12} \\
\frac{2\text{Lac}}{3} &\quad \frac{\text{Lac}}{6} &\quad \frac{\text{Lac}}{6} &\quad \frac{\text{Ld}(\text{a} + \text{b})}{3} &\quad \frac{\text{ad}(\text{L} + (\text{L} \cdot \text{L}_2)/\text{L})}{3} \\
\frac{\text{La}(\text{c} + 4\text{d} + \text{e})}{6} &\quad \frac{\text{La}(\text{c} + 2\text{d})}{6} &\quad \frac{\text{La}(2\text{d} + \text{e})}{6} &\quad \frac{\text{La}(2\text{d} + \text{e})}{6} &\quad \frac{\text{La}(\text{c} + 2\text{d}) + \text{Lb}(2\text{d} + \text{e})}{6}
\end{align*}
\]

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!
Pop Quiz:

Real Structure

(A) Good

(B) 

(C) 

13/16
Problem 1) For the frame shown, solve for horizontal deflection at the roller. Use $w = 2 \text{ k/ft}$, $L_1 = 12 \text{ ft}$, $L_2 = 20 \text{ ft}$, $L_3 = 16 \text{ ft}$, $E = 30,000 \text{ ksi}$ and $I = 100 \text{ inches}^4$. Note that the figure is NOT TO SCALE. Blank sheets follow this page for your work. If you are using integration, you do not need to actually perform the integration, but you MUST completely list the equations you intend to integrate along with the limits used. If you intend to use volume integrals you need not actually perform the calculations, but you MUST completely show the moments you intend to combine, all relevant moments and lengths, and the equations you would use to get the answers.

Note: The figure above was reversed on the exam. The solution is identical as shown below.
\[ \sum M_A = 0 = -40k(101) + R_{CV}(32') \]

\[ R_{CV} = 12.5k \]
\[ M_{\text{center}} = 175 \text{kFt} \]

For \( M_{\text{center}} \) by V.I.

\[
\sum M_{\text{cut}} = 0 = -27.5Kx + (2K/\text{ft})(x)(x/2) + M_{\text{ox}}^{AB}
\]

\[ M_{\text{ox}}^{AB} = 27.5x - \frac{2x^2}{2} \]

By \( \int \frac{M_m dx}{EI} \)
\[ M_0 = 150 \text{ kft} \]

\[ 12.5 \cos 53.1^\circ = 7.5k \]

For V.I.

\[ \frac{150 \text{ kft}}{20 \text{ ft}} = 7.5k \]

Member CB

\[ \Sigma M_{\text{cut}} = 0 = -M_{\text{max}} + 7.5k \quad 0 < x < 20 \]

So \[ M_{\text{max}} = 7.5k \]
\[ \Sigma M_{\text{cut}} = 0 \]
\[ 0 = -m - 0.5k(20') + 1k(16') \]
\[ m = 16 - 6 = 10 \text{ kft} \]

For \( F \):
\[ F = 0.5k \]

For \( M \):
\[ M = 0.5k \]
By \( \int_{A}^{B} \frac{M_m}{EI} \, dx \):

\[
\Delta_{10} = \int_{0}^{20} \left( \frac{27.5x - 2x^2}{2} \right) \left( 0.5x \right) \, dx + \int_{0}^{8} \frac{(7.5x)(0.5x)}{EI} \, dx
\]

\[
= \frac{16,665}{EI} + \frac{10,000}{EI}
\]

\[
= \frac{26,665}{30,000 \frac{K}{\text{in}^2} \left( 100 \frac{\text{in}^4}{\text{ft}} \right) \left( \frac{12 \text{in}}{1 \text{ft}} \right)^2}
\]

\[
= 1.279 \text{ ft} = 15.36''
\]
Volume Integral Problem Quiz 1

\[ \text{load} = 2 \text{ kips/ft} \]

Load diagram:

- Load labeled W on the structure.
- Load labeled A with a 16' length labeled L3.
- Load labeled B with a 20' length labeled L1.
- Load labeled C with a 12' length labeled L2.

Shear diagram:

- Shear labeled 68.75 kips at point D.
- Shear labeled 31.25 kips at point B.
- Shear labeled 175 kips at point A.

Not to scale.
\[
\frac{la(2d+e)}{6} + \frac{lac}{3} + \frac{(20')(10')(2 \cdot 175 + 150)}{6EI} + \frac{(20')(150)(10)}{3EI} \]

\[
\frac{16,667}{EI} + \frac{10,000}{EI} = \frac{26,667}{EI}
\]
"Quiz #1"
"x and y and z = feet, E = k/in^4, I = inches^4, limits of integration = feet"
"AnswerFt = feet, AnswerIn = inches"

\[ x1 = \int (27.5x - x^2)(0.5x), \ x, 0, 20 \]
\[ y1 = \int (7.5y - y^2)(0.5y), \ y, 0, 10 \]
\[ z1 = \int (7.5z)(0.5z), \ z, 0, 20 \]

\[ El = (30000*100)^{(1/144)} \]
\[ \text{AnswerFt} = (x1 + y1 + z1)/El \]
\[ \text{AnswerIn} = \text{AnswerFt} * 12 \]

"y = integral((0.125x)(3.25x), x, 0, 8)"

"junk"
\[ z\text{junk} = -450t^2 + 20t^3 - t^4/4 \]
\[ t=30 \]

**SOLUTION**

<table>
<thead>
<tr>
<th>Unit Settings: SI C kPa kJ mass deg</th>
</tr>
</thead>
<tbody>
<tr>
<td>AnswerFt = 1.28</td>
</tr>
<tr>
<td>AnswerIn = 15.36</td>
</tr>
<tr>
<td>El = 20833</td>
</tr>
<tr>
<td>t = 30</td>
</tr>
<tr>
<td>x = 20</td>
</tr>
<tr>
<td>t1 = 16665</td>
</tr>
<tr>
<td>z = 20</td>
</tr>
<tr>
<td>z1 = 10000</td>
</tr>
<tr>
<td>z\text{junk} = -67503</td>
</tr>
</tbody>
</table>

No unit problems were detected.
Problem 2) For the pop quiz solved earlier, and using Figure (B) as the primary structure, along with the reactions and redundants shown, solve for $\delta_{15}$. You can use the frames shown below to draw any required moment diagrams.

\[\Sigma M_A = 0 = H(8')\]
\[H = 0.125\]
\[H(8') = 0.125 K\]

\[\Sigma M_A = 0 = 1(26) - H(8')\]
\[H = 3.25 K\]
\[H(8') = 3.25 K\]

\[\delta_{15} = \int_0^{26} (1 \text{ KFT}) (1 \text{ M}) + \int_6^{24} (1 \text{ KFT}) (26 \text{ KFT}) + \int_0^8 (0.125 \text{ K}) (3.25 \text{ M})\]

\[= \frac{338}{EI} + \frac{624}{EI} + 69.33 = \frac{1031.3}{EI}\text{ feet}\]

By V. T.

\[\frac{\text{LAC}}{2EI} = \frac{(26)(1)(26)}{2EI} + \frac{(24)(1)(26)}{EI} + \frac{(8)(1)(26)}{3EI} = 1031.3 \text{ feet}\]
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Signature of student

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VOLUME INTEGRALS

\[
\begin{align*}
\text{Lac} & \quad \frac{\text{Lac}}{2} & \quad \frac{\text{Lac}}{2} & \quad \frac{\text{Lc}(a+b)}{2} & \quad \frac{(L+L_2)ac}{6} \\
\text{Lac} & \quad \frac{\text{Lac}}{3} & \quad \frac{\text{Lac}}{6} & \quad \frac{\text{Lc}(2a+b)}{6} & \quad \frac{(L+L_1)ac}{6} \\
\text{Lac} & \quad \frac{\text{Lac}}{6} & \quad \frac{\text{Lac}}{6} & \quad \frac{\text{Lc}(a+2b)}{6} & \quad \frac{(L+L_1)ac}{6} \\
\frac{\text{Lac} + cd}{2} & \quad \frac{\text{Lac}(2c+d)}{6} & \quad \frac{\text{Lac}(2d+c)}{6} & \quad \frac{\text{Lc}(2c+d + Lb(c+2d))}{6} & \quad \frac{\text{ac}(L+L_2) + ad(L+L_1)}{6} \\
\frac{\text{Lc}}{2} & \quad \frac{(L+L_2)ac}{6} & \quad \frac{(L+L_3)ac}{6} & \quad \frac{\text{ac}(L+L_4) + bc(L+L_3)}{6} & \quad \frac{\text{ac}(2 - (L_1 - L_3)\frac{3}{L-L_4})}{6} \\
\frac{\text{Lac}}{3} & \quad \frac{\text{Lac}}{12} & \quad \frac{\text{Lac}}{4} & \quad \frac{\text{Lc}(a+3b)}{12} & \quad \frac{\text{ac}(3L_1 + L_2)^2}{L} \\
\frac{2\text{lad}}{3} & \quad \frac{\text{lad}}{3} & \quad \frac{\text{lad}}{3} & \quad \frac{\text{lad}(a+b)}{3} & \quad \frac{\text{ad}(L+(L+L_2)/L)}{3} \\
\frac{\text{Lc}(c+4d+e)}{6} & \quad \frac{\text{Lc}(c+2d)}{6} & \quad \frac{\text{Lc}(2d+e)}{6} & \quad \frac{\text{Lc}(c+2d+Lb(2d+e))}{6} & \quad \frac{\text{Lc}(a+b)}{6}
\end{align*}
\]

\(L\) is the total length of the member.
\(d\) is the central ordinate of the parabola.
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Problem 1) For the frame shown, solve for horizontal deflection at the roller. Use \( w = 4 \text{ k/ft} \), \( L_1 = 10 \text{ ft} \), \( L_2 = 6 \text{ ft} \), \( L_3 = 8 \text{ ft} \). \( E = 30,000 \text{ ksi} \) and \( I = 100 \text{ inches}^4 \). Note that the figure is NOT TO SCALE. Blank sheets follow this page for your work. If you are using integration, you do not need to actually perform the integration, but you MUST completely list the equations you intend to integrate along with the limits used. If you intend to use volume integrals you need not actually perform the calculations, but you MUST completely show the moments you intend to combine, all relevant moments and lengths, and the equations you would use to get the answers.

\[
M_{AB} = 27.5x - 4(x)^2/2
\]

\[
M_{	ext{corner}} = 27.5(10') - 4(10')^2/2
= 75 \text{ kFT}
\]

\[
M_{5'} = 27.5(5') - 4(5')^2/2
= 87.5 \text{ kFT}
\]

\[
M_{CB} = 7.5x
\]

\[
M_{CB} = 7.5 \text{ kFt}
\]
UNIT LOADS

\[ \Sigma M_A = 0 = 1(8') - 16(R) \]

\[ R = 0.5K \]

\[ M_{AB} = 0.5K \]

\[ M_{1K} = 0.5K \]

\[ M_{CB} = 0.5K \]

\[ \int_0^1 \left( 27.5K - \frac{4K^2}{L} \right)(0.5K) + \int_0^1 (7.5K)(0.5K) = \]

\[ = 0.1 + 0.06 = 0.16 \text{ ft} \]

\[ = 1.92 \text{ inches} \]
By Y.I.

\[ \frac{L_a(2d+e)}{6EI} + \frac{L_a c}{3EI} \]

\[ = 10(5)[2 \cdot 87.5 + 75] \]
\[ \div 6 \left( \frac{30,000 K}{1 IN^4} \cdot 100 IN^4 \right) \left( \frac{121}{121} \right)^2 \]
\[ + \frac{(10)(5)(75)}{3 \left( \frac{30,000 \cdot 100}{112} \right)} \]
\[ = 0.1 + 0.06 = 0.16 \text{ FT} \]
\[ = 1.92 \text{ INCHES} \]
"Quiz #2"
"x and y and z = feet, E = k/in^42, l = inches^4, limits of integration = feet"
"AnswerFt = feet, AnswerIn = inches"

\[ x1 = \text{integral}(27.5^2 - 2^2 \cdot 2)^2(0.5^x) \times x, 0, 0, 10) \]
\[ y1 = \text{integral}(27.5^2 - y^2)^2(0.5^y) \times y, 0, 10) \]
\[ z1 = \text{integral}(27.5^2 - z^2)^2(0.5^z) \times z, 0, 10) \]

\[ EI = (300000^2) \times (1/144) \]
\[ \text{AnswerFt} = (x1 + y1 + z1)/EI \]
\[ \text{AnswerIn} = \text{AnswerFt} \times 12 \]

"junk"
\[ z_{\text{junk}} = -450^2 + 20^3 - t^4/4 \]
\[ t = 30 \]

**SOLUTION**

Unit Settings: SI C kPa kJ mass deg
\[ \text{AnswerFt} = 0.16 \quad \text{AnswerIn} = 1.92 \quad EI = 20833 \quad t = 30 \]
\[ x = 10 \quad x1 = 2083 \quad z = 10 \quad z1 = 1250 \]
\[ z_{\text{junk}} = -57500 \]

No unit problems were detected.
Problem 2) Solve for $\delta_1$ using Figure (B) as the primary structure from the pop quiz solved earlier. Use the reactions and redundants also shown. You can use the frames shown below to draw any required moment diagrams.

\[
\sum M_A = 1(38') - R(8') = 0
\]

\[
\sum M_A = 0 = 1 - H(8)
\]

\[\delta_1 = \int_0^{38} \frac{(N)(1)}{EI} \, dx + \int_0^{12} \frac{(38)(1)}{EI} \, dx + \int_0^{8} \frac{(4.75x)(0.125x)}{EI} \, dx
\]

\[= \frac{722}{EI} + \frac{456}{EI} + \frac{101.3}{EI} = \frac{1279.3}{EI}
\]

By V.I.

\[= \frac{38(38)(1)}{2EI} + \frac{(12)(38)(1)}{12EI} + \frac{8(38)(1)}{3EI}
\]

\[= \frac{722}{2EI} + \frac{456}{EI} + \frac{101.3}{EI} = \frac{1279}{EI}
\]