I am a graduating senior – circle one: Yes  No

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, or if you write so small normal engineers cannot read it, 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)

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.

Do not grade problem 1  2  3  4  5  6

If you don’t circle one of the above, I will not grade Problem 1.
VOLUME INTEGRALS

\[
\begin{align*}
&\frac{\text{La}(c+d)}{2}, \frac{\text{La}(2c+d)}{6}, \frac{\text{La}(2d+e)}{6}, \frac{\text{La}(c+2d)+\text{Lb}(c+2d)}{6}, \frac{\text{ac}(L+L_2)+ad(L+L_1)}{6} \\
&\frac{\text{Lac}}{2}, \frac{(L+L_1)\text{ac}}{6}, \frac{(L+L_2)\text{ac}}{6}, \frac{\text{ac}(L+L_2)+bc(L+L_3)}{6}, \frac{\text{ac}(2-(L_1-L_3)^2/2L_1L_2)}{6} \\
&\frac{\text{Lac}}{3}, \frac{\text{Lac}}{12}, \frac{\text{Lac}}{4}, \frac{\text{Lc}(a+3b)}{12}, \frac{\text{ac}(3L_1+L_2)^2/L}{12} \\
&\frac{2\text{lad}}{3}, \frac{\text{lad}}{3}, \frac{\text{lad}}{3}, \frac{\text{lad}(a+b)}{3}, \frac{\text{ad}(L+(L_1L_2)/L)}{3}
\end{align*}
\]

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!
Problem 1) Using the portal method, solve for the shear and moment diagrams for the roof beam abcd. \( F = 12 \) kips, the column spacing is 16 feet, and the roof height = 12 feet. NOT TO SCALE.

\[
\sum F_H = 0 = +12 - 2 - k_k
\]

\[
\sum M_k = 0 = -2k_k(6') + \alpha_v(8')
\]

so \( \alpha_v = 1.5\) k

\[
\sum F_v = 0 = +1.5k_k - k_v
\]

so \( k_v = 1.5\) k

\( M_{\text{joint}} = 1.5k_k(8') = 12\) k-ft

See other quiz for how this repeats.
Problem 2) The truck wheel loading below will be moving across the bridge shown. Determine the maximum moment which it could cause. P1 = 20k, P2 = 10k, L = $\lambda^2$ feet.
Max moment under 3rd wheel from right end.

\[ \sum M_A = 0 = -(3 \times 20^k + 3 \times 10^k) \left[ \frac{100}{2} + 0.556 \right] + R_B(100) \]

\[ R_B = 45.50^k \]

Using \( FB \#1 \)

\[ \sum M_{out} = 0 = -M_{max} - 20^k(10') - 20^k(25') + R_B \left( \frac{100}{2} + 0.556 \right) \]

\[ S_0 M_{max} = 1602^k \text{ FT} \]
Problem 3) Draw influence lines for shear and moment at point C for the beam shown. Label all values.
Problem 4): In class we developed and practiced with a stiffness method called the Slope Deflection Method, which used the following equations to solve for the unknown moments and joint rotations in a structure, depending on the end rotations, the deflections of the ends of the members, and the fixed end moments applied to the beam.

\[ M_{\text{near end/far end}} = (2EI/L)*(2\theta_{\text{near}} + \theta_{\text{far}} - 3(\Delta_{\text{far}} - \Delta_{\text{near}})/L) + FEM_{\text{near end/far end}} \]

Example for a member with end joints a and b:

\[ M_{a/b} = (2EI/L)*(2\theta_{a} + \theta_{b} - 3(\Delta_{b} - \Delta_{a})/L) + FEM_{a/b} \]
\[ M_{b/a} = (2EI/L)*(2\theta_{b} + \theta_{a} - 3(\Delta_{b} - \Delta_{a})/L) + FEM_{b/a} \]

\(M_{\text{near end/far end}}\) meant the moment under your feet when you are standing on the near end of the beam, (joint = near) looking at the far end of the beam (joint = far).

Sign convention: The member end moments (both the fixed end moments and the final answer moments), the end rotations, and any member rotations are positive when counterclockwise.

FEM = Fixed End Moments (with joints fixed), as per the F.E. Reference Manual

\(\Delta_{b}\) = vertical deflection of joint b, \(\Delta_{a}\) = vertical deflection of joint a.

Set up the simultaneous equations necessary to solve for the moments and joint rotations for the beam shown, if \(L_{1} = 10\) feet, \(L_{2} = 20\) feet, \(L_{3} = 15\) feet, \(L_{4} = 18\) feet, \(P = 20\) kips, \(w = 2\) kips/foot.

\[ M_{AB} = \frac{2EI}{30} \left( 2\theta_{A} + \theta_{B} - 3 \left( \frac{\Delta_{B} - \Delta_{A}}{30} \right) \right) + \frac{20 \times 10 \times 20^2}{30^2} \]
\[ M_{BA} = \frac{EI}{15} \left( 2\theta_{B} + \theta_{A} \right) - 88.9 \text{ k-ft} \]
\[ M_{BA} = \frac{2EI}{30} \left( 2\theta_{B} + \theta_{A} - 3 \left( \frac{\Delta_{B} - \Delta_{A}}{30} \right) \right) + \frac{20 \times 10^2 \times 20}{30^2} \]
\[ M_{BA} = \frac{EI}{15} \left( 2\theta_{B} + \theta_{A} \right) - 44.4 \text{ k-ft} \]
\[ M_{BC} = \frac{2EI}{15} \left( 2\theta_{B} + \theta_{C} - 3 \left( \frac{\Delta_{C} - \Delta_{B}}{15} \right) \right) + \frac{2 \times 15^2}{12} \]
\[ M_{BC} = \frac{2EI}{15} \left( 2\theta_{C} + \theta_{B} \right) + 37.5 \text{ k-ft} \]
\[ M_{CB} = \frac{2EI}{15} \left( 2\theta_{B} + \theta_{C} - 3 \left( \frac{\Delta_{B} - \Delta_{C}}{15} \right) \right) - \frac{2 \times 15^2}{12} \]
\[ M_{CB} = \frac{2EI}{15} \left( 2\theta_{B} + \theta_{C} \right) - 37.5 \text{ k-ft} \]
\[ M_{CD} = \frac{2EI}{18} \left( 2\theta_{D} + \theta_{C} - 3 \left( \frac{\Delta_{D} - \Delta_{C}}{18} \right) \right) \]
\[ M_{CD} = \frac{2EI}{18} \left( 2\theta_{C} + \theta_{B} \right) \]

\(M_{BC} = \frac{2EI}{15} \left( 2\theta_{B} + \theta_{C} - 3 \left( \frac{\Delta_{B} - \Delta_{C}}{15} \right) \right) - \frac{2 \times 15^2}{12} \]
\[ M_{BC} = \frac{2EI}{15} \left( 2\theta_{B} + \theta_{C} \right) - 37.5 \text{ k-ft} \]

\[ M_{CD} = \frac{2EI}{18} \left( 2\theta_{D} + \theta_{C} - 3 \left( \frac{\Delta_{D} - \Delta_{C}}{18} \right) \right) \]
\[ M_{CD} = \frac{2EI}{18} \left( 2\theta_{C} + \theta_{B} \right) \]

\[ M_{BC} = \frac{2EI}{15} \left( 2\theta_{B} + \theta_{C} - 3 \left( \frac{\Delta_{B} - \Delta_{C}}{15} \right) \right) - \frac{2 \times 15^2}{12} \]
\[ M_{BC} = \frac{2EI}{15} \left( 2\theta_{B} + \theta_{C} \right) - 37.5 \text{ k-ft} \]

\[ M_{CD} = \frac{2EI}{18} \left( 2\theta_{D} + \theta_{C} - 3 \left( \frac{\Delta_{D} - \Delta_{C}}{18} \right) \right) \]
\[ M_{CD} = \frac{2EI}{18} \left( 2\theta_{C} + \theta_{B} \right) \]
Problem 4) In class we developed and practiced with a stiffness method called the Slope Deflection Method, which used the following equations to solve for the unknown moments and joint rotations in a structure, depending on the end rotations, the deflections of the ends of the members, and the fixed end moments applied to the beam.

\[ M_{\text{near end/far end}} = (2EI/L) \times (2\theta_{\text{near}} + \theta_{\text{far}} - 3(\Delta_{\text{far}} - \Delta_{\text{near}})/L) + FEM_{\text{near end/far end}} \]

Example for a member with end joints a and b:

\[ M_{a/b} = (2EI/L) \times (2\theta_a + \theta_b - 3(\Delta_b - \Delta_a)/L) + FEM_{a/b} \]
\[ M_{b/a} = (2EI/L) \times (2\theta_b + \theta_a - 3(\Delta_b - \Delta_a)/L) + FEM_{b/a} \]

M near end/far end meant the moment under your feet when you are standing on the near end of the beam, (joint = near) looking at the far end of the beam (joint = far).

Sign convention: The member end moments (both the fixed end moments and the final answer moments), the end rotations, and any member rotations are positive when counterclockwise.

FEM = Fixed End Moments (with joints fixed), as per the F.E. Reference Manual

\[ \Delta_b = \text{vertical deflection of joint b}, \quad \Delta_a = \text{vertical deflection of joint a}. \]

**NO DEFLECTIONS**

Set up the simultaneous equations necessary to solve for the moments and joint rotations for the beam shown, if L1 = 10 feet, L2 = 20 feet, L3 = 15 feet, L4 = 18 feet, P = 20 kips, w = 2 kips/foot.

![Beam diagram with moments and equations]

\[ \begin{align*}
M_{AB} &= \frac{2EI}{L} \left(2\theta_a + \theta_b - 3\left(\frac{\Delta_b - \Delta_a}{L}\right)\right) + 88.89 \text{ k-ft} \quad (1) \\
M_{BA} &= \frac{2EI}{L} \left(2\theta_b + \theta_a - 3\left(\frac{\Delta_a - \Delta_b}{L}\right)\right) - 44.44 \text{ k-ft} \quad (2) \\
M_{BC} &= \frac{2EI}{L} \left(2\theta_b + \theta_c - 3\left(\frac{\Delta_c - \Delta_b}{L}\right)\right) + 37.5 \text{ k-ft} \quad (3) \\
M_{CB} &= \frac{2EI}{L} \left(2\theta_c + \theta_b - 3\left(\frac{\Delta_b - \Delta_c}{L}\right)\right) - 37.5 \text{ k-ft} \quad (4) \\
M_{CD} &= \frac{2EI}{L} \left(2\theta_c + \theta_d - 3\left(\frac{\Delta_d - \Delta_c}{L}\right)\right) + 0 \quad (5) \\
M_{DC} &= \frac{2EI}{L} \left(2\theta_d + \theta_c - 3\left(\frac{\Delta_c - \Delta_d}{L}\right)\right) + 0 \quad (6)
\end{align*} \]

Unknowns: \( M_{AB}, M_{BA}, M_{BC}, M_{CB}, M_{CD}, M_{DC}, \theta_a, \theta_c, \theta_d \) - 9 unknowns - 10 equations
Problem 5) For the building shown, sketch the influence line for the moment in the column at support A and tell me where would you place the building live floor and live roof loads to cause the maximum positive and maximum negative moments at A. I don’t care if we agree on which load locations go with positive and which go with negative.
Zero slope required @ B & C

+MA LOADING

-MA LOADING

(or reverse)
Problem 6) The statically indeterminate frame shown below has $X = 20$ ft, $Y_1 = 15$ ft and $Y_2 = 30$ feet. To solve for the 9 unknown redundants, the primary structure shown to its right was selected. Solve for $\delta_{79}$.

\[ \int_0^{30} \frac{m_7 m_9 \text{d}x}{EI} = \frac{La}{2} + \frac{La}{2} \]

\[ = -30(30)(1) + \frac{(-30)(30)(1)}{2EI} + \frac{(-30)(30)(1)}{2EI} \]

\[ \delta_{79} = -\frac{900}{EI} \]
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______________________________  Signature of student

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Problem 1) In class we developed and practiced with a stiffness method called the Slope Deflection Method, which used the following equations to solve for the unknown moments and joint rotations in a structure, depending on the end rotations, the deflections of the ends of the members, and the fixed end moments applied to the beam.

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Example for a member with end joints a and b:

\[ M_{a/b} = (2EI/L)(2\theta_a + \theta_b - 3(\Delta_b - \Delta_a)/L) + FEM_{a/b} \]
\[ M_{b/a} = (2EI/L)(2\theta_b + \theta_a - 3(\Delta_b - \Delta_a)/L) + FEM_{b/a} \]

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\( FEM = \text{Fixed End Moments (with joints fixed), as per the F.E. Reference Manual} \)
\( \Delta_b = \text{vertical deflection of joint b, \( \Delta_a = \text{vertical deflection of joint a.} \) } \)

Set up the simultaneous equations necessary to solve for the moments and joint rotations for the beam shown, if \( L_1 = 18 \) feet, \( L_2 = 8 \) feet, \( L_3 = 15 \) feet, \( L_4 = 8 \) feet, \( P = 20 \) kips, \( w = 2 \) kips/foot.

\[ \text{NOT TO SCALE} \]

\[ M_{ab} = \frac{2EI}{18} \left\{ 2\theta_a + \theta_b - \frac{3[30]}{18} \right\} + 54 \text{kFt} \]
\[ M_{ba} = \frac{2EI}{18} \left\{ 2\theta_b + \theta_a - \frac{3[30]}{18} \right\} - 54 \text{kFt} \]
\[ M_{bc} = \frac{2EI}{8} \left\{ 2\theta_b + \theta_c - \frac{3[30]}{18} \right\} + 0 \]
\[ M_{cb} = \frac{2EI}{8} \left\{ 2\theta_c + \theta_b - \frac{3[30]}{18} \right\} - 0 \]
\[ M_{cd} = \frac{2EI}{23} \left\{ 2\theta_c + \theta_d - \frac{3[30]}{18} \right\} + 36.29 \]
\[ M_{dc} = \frac{2EI}{23} \left\{ 2\theta_d + \theta_c - \frac{3[30]}{18} \right\} - 68.05 \]

\[ \Theta_A = 0 \]
\[ M_{ba} + M_{bc} = 0 \]
\[ M_{cb} + M_{cd} = 0 \]
\[ M_{dc} = 0 \]
Problem 2) For the building shown, sketch the influence line for the moment in the column at support B and tell me where would you place the building live floor and live roof loads to cause the maximum positive and maximum negative moments at B. I don't care if we agree on which load locations go with positive and which go with negative.

Max + Moments
Put live loads on spans GH, EF, & KL

Max - Moments
Put live loads on JK, DE & HI
Zero slope required @ A & C

+M_B loading → -M_B loading

(or reverse)
Problem 3) The statically indeterminate frame shown below has $X = 20$ ft, $Y_1 = 15$ ft and $Y_2 = 30$ feet. To solve for the 9 unknown redundants, the primary structure shown to its right was selected. Solve for $\delta_{46}$.

$$\delta_{46} = \frac{45(-45)(-1)}{2} + \frac{45(-45)(10)}{2}$$

$$\delta_{46} = \frac{-2025}{EI} \text{ feet}$$
Problem 4) Solve for the shear and moment diagrams for the roof beam efgh using the portal method. NOT TO SCALE. P = 24 Kips, the column spacing is 20 feet, and the roof height = 34 feet.

\[
\begin{align*}
\text{FB1} & \\
\sum M_i &= 0 = -(24^k - 20^k)(17') + V_m(10') \\
\Rightarrow V_m &= 6.8^k \\
\sum M_e &= 6.8^k (10') = 68\text{ k-ft}
\end{align*}
\]

\[
\begin{align*}
\text{FB#2} & \\
\sum M_j &= 0 = +6.8^k (10') - 20^k (17') + V_m (17') + V_m (10') \\
\Rightarrow V_m &= 6.8^k
\end{align*}
\]

\[
\begin{align*}
\sum F_j &= 0 = -6.8^k + F_j + F_m \\
F_j &= 0^k
\end{align*}
\]

\[
\begin{align*}
\text{FB#3} & \\
\sum M_{fa} &= 6.8^k (10') = 68\text{ k-ft}
\end{align*}
\]
\[ F_0 = 4 \text{ kN} \]
\[ M = 6.8 \text{k}(10') = 68 \text{ kN.m} \]
\[ M = 8 \text{k}(17') = 136 \text{ kN.m} \]

\[ \sum F_H = 0 = +12 - 8 - F_0 \Rightarrow F_0 = 4 \text{kN} \]

\[ \sum M_k = 0 = +6.8 \text{k}(10') - (12 - 4)(17') + V_a(10') \]
\[ V_a = 6.8 \text{kN} \]

\[ \sum F_V = 0 = -6.8 + F_k + 6.8 \]
\[ F_k = 0 \]

**Shear diagram:**

**Moment diagram:**
Problem 5) Determine the maximum moment which could be caused by the truck wheel loading shown, traveling across the bridge. $P_1 = 20k$, $P_2 = 10k$, $L = \frac{L}{P}$ feet.

Identical to other exam except reversed.
Problem 6) Draw influence lines for shear and moment at point D for the beam shown. Label all values.

\[
\frac{2}{40} = \frac{20 \text{ FT}}{60} \quad \Rightarrow 13.33 \text{ FT}
\]

\[
\frac{13.33}{2} = 6.67 \text{ FT}
\]

\[
20 \text{ FT} = 13.33 \times \frac{30}{20}
\]