(a) First determine an expression for the loading as a function of $x$:

$g(x)$

- Loading is linear, $w x$
  
  $\Rightarrow g(x) = w x + b$
• At \( x = 0 \), load \( q \) acts downward with magnitude \( q_0 \)
  \[
  \Rightarrow q(0) = -q_0
  \]
  Giving: \( -q_0 = m(0) + b \)
  \[
  \Rightarrow b = -q_0
  \]

• At \( x = L \), load \( q \) acts upward with magnitude \( q_0 \)
  \[
  \Rightarrow q(L) = +q_0
  \]
  Giving: \( +q_0 = m(L) + b \)
  and \( b = -q_0 \)
  \[
  \Rightarrow m = +\frac{2q_0}{L}
  \]
  \[
  \therefore q(x) = \frac{2q_0}{L}x - q_0 = q_0 \left( \frac{2x}{L} - 1 \right)
  \]

- Do a check... should cross over and equal 0 at midpoint \( x = \frac{L}{2} \)
  \[
  q \left( \frac{L}{2} \right) = 0 = q_0 \left( \frac{2}{2} - 1 \right) \checkmark \text{Yes}
  \]

- Move forward to ---.
Step 1 - Free Body Diagram

\[ g(x) = \phi_0 \left( 2 \frac{x}{L} - 1 \right) \]

\[ \rightarrow \text{Apply Equilibrium to get reactions} \]

(Note: Value of \( g(x) \) accounts for direction of but loading so use \( g(x) \) generically as \( + \) or \( - \) direction)

\[ \sum F_x = 0 \implies H = 0 \]
\[ \sum F_z = 0 \implies V + \int_0^L g(x) \, dx = 0 \]

Working:
\[ V + \int_0^L \phi_0 \left( 2 \frac{x}{L} - 1 \right) \, dx = 0 \]
\[ V = -\phi_0 \left[ \frac{x^2}{2} - x \right]_0^L \]
\[ = -\phi_0 \left( \frac{L^2}{2} - L \right) = 0 \implies V = 0 \]

(makes sense since net force of \( g(x) \) loading is 0)

\[ \sum M_0 = 0 \implies -M + \int_0^L g(x) x \, dx = 0 \]
Working:

\[ M = \int_0^L p_o \left( 2 \frac{x^2}{L} - x \right) \, dx \]

\[ = \left[ p_o \left( \frac{2x^3}{3L} - \frac{x^2}{2} \right) \right]^L_0 \]

\[ = p_o \left[ \frac{2L^3}{3L} - \frac{L^2}{2} \right] = \frac{p_o L^2}{6} \]

\[ \Rightarrow M = \frac{p_o L^2}{6} \]

Step 2 - Work to get shear and moment results to:

\[ \rightarrow \quad \text{use } \quad \frac{dS}{dx} = f(x) \quad \Rightarrow \quad S(x) = \int f(x) \, dx \]

Working:

\[ S(x) = \int p_o \left( 2 \frac{x}{L} - 1 \right) \, dx \]

\[ = p_o \left( \frac{x^2}{L} - x \right) + C_1 \]

**Clamped boundary condition:**

@ \( x = 0 \), \( S = V \) (reaction force and no other point load)

\( V = 0 \Rightarrow S(0) = 0 \)

**Gives:** \( C_1 = 0 \)

Thus:

\[ S(x) = p_o \left( \frac{x^2}{L} - x \right) \]
\[ \text{Use } \frac{dM}{dx} = S(x) = M(x) = \int S(x) \, dx \]

\[ \text{Working:} \]
\[ M(x) = \int \rho_0 \left( \frac{x^2}{L} - x \right) \, dx \]
\[ = \rho_0 \left( \frac{x^3}{3L} - \frac{x^2}{2} \right) + C_2 \]

- Use a boundary condition:
  \[ @ x = 0, \quad M(x) = M \]
  \[ \Rightarrow \quad \frac{\rho_0 L^2}{6} = C_2 \]

Thus:
\[ M(x) = \rho_0 \left( \frac{x^3}{3L} - \frac{x^2}{2} + \frac{L^2}{6} \right) \]

Check: at the tip \((x = L)\) moment is zero:
\[ M(L) = 0 = \rho_0 \left( \frac{L^3}{3L} - \frac{L^2}{2} + \frac{L^2}{6} \right) \]
\[ = \frac{1}{3} - \frac{1}{2} + \frac{1}{6} \quad \checkmark \text{Yes} \]

\[ \text{Step 3: Proceed to moment-displacement} \]
\[ \text{(i.e. curvature) relationship} \]
\[ M = EI \frac{d^2w}{dx^2} \]
\[ \frac{d^2 w}{dx^2} = \frac{\phi_0}{E I} \left( \frac{x^3}{3 L} - \frac{x^2}{2} + \frac{L^2}{6} \right) \]

→ take an integral to fit slope \( \frac{dw}{dx} \):

\[ \frac{dw}{dx} = \int \frac{\phi_0}{E I} \left( \frac{x^3}{3 L} - \frac{x^2}{2} + \frac{L^2}{6} \right) dx \]

\[ = \frac{\phi_0}{E I} \left( \frac{x^4}{12 L} - \frac{x^3}{6} + \frac{L^2 x}{6} \right) + C_3 \]

→ take an integral to fit displacement \( w \):

\[ w = \int \frac{\phi_0}{E I} \left( \frac{x^4}{12 L} - \frac{x^3}{6} + \frac{L^2 x}{6} \right) + C_3 \] \[ \] \[ dx \]

\[ = \frac{\phi_0}{E I} \left( \frac{x^5}{60 L} - \frac{x^4}{24} + \frac{L^2 x^2}{12} \right) + C_3 x + C_4 \]

→ use two boundary conditions on displacement and/or slope to determine the two constants \( C_3 \) and \( C_4 \):

For a clamped boundary, displacement and slope are zero. So:

\( \circ \) \( x = 0, \frac{dw}{dx} = 0 \) \[ \Rightarrow C_3 = 0 \]

\( \circ \) \( x > 0, w = 0 \) \[ \Rightarrow C_4 = 0 \]
• Use these results and also normalize the dependence on $x$ by the length of the beam, $L$: i.e. $(\frac{x}{L})$

\[
\begin{align*}
\phi : w(x) &= \frac{P_0 L^4}{EI} \left\{ \frac{1}{60} \left( \frac{x}{L} \right)^5 - \frac{1}{24} \left( \frac{x}{L} \right)^4 + \frac{1}{12} \left( \frac{x}{L} \right)^2 \right\} \\
\end{align*}
\]

**Step 4:** Check for the maximum (in magnitude)

Need to check at ends of configuration and within configuration.

• Check ends by calculating values there:

@ $x = 0$, $w = 0$ (as noted in boundary condition)

@ $x = L$, $w = \frac{P_0 L^4}{EI} \left\{ \frac{1}{60} - \frac{1}{24} + \frac{1}{12} \right\}$

\[= \frac{P_0 L^4}{EI} \left\{ \frac{2 - 5 + 10}{120} \right\} \]

\[\Rightarrow w(L) = \frac{7}{120} \frac{P_0 L^4}{EI} \]

• Check within structure by taking first derivative and set to zero within

\[0 < x < L: \]
\[
\frac{dw}{dx} = \frac{P_0 L^3}{EI} \left\{ \frac{1}{12} \frac{(x/L)^4}{L^4} - \frac{1}{6} \frac{(x/L)^3}{L^3} + \frac{1}{6} \frac{(x/L)}{L} \right\}
\]

This does not equal zero within 
\[0 < x < L, \text{ only at } x = 0.\]

There:

\[
W_{\text{max}} = \frac{7}{120} \frac{P_0 L^4}{EI}
\]

at \[x = L\]

\[\text{(NOTE: Cantilevered beams generally have maximum deflection at tip except for very specific load configurations).}\]

Also check units:

\[
[L] = \frac{[F/L][L^4]}{[F/L][L^4]} = [L]^7 \checkmark \text{ OK}
\]

(6) To find the maximum magnitude of the axial stress, start with:

\[
\sigma_{xx} = -\frac{M_2}{I}
\]
- If and I do not vary in $x$, so look for the maximum magnitude of:

$$\frac{\sigma_{xx}}{(2/3)} = -M(x)$$

Earlier in, we found:

$$M(x) = \frac{2}{\rho_0 L^2} \left( \frac{x^3}{3} - \frac{x^2}{2} + \frac{L^2}{6} \right)$$

Normalizing:

$$M(x) = \frac{\rho_0 L^2 \left( \frac{1}{3} \left( \frac{x}{L} \right)^3 - \frac{1}{2} \left( \frac{x}{L} \right)^2 + \frac{1}{6} \right)}{\rho_0 L^2}$$

To find maximum magnitude, first evaluate values at end points:

$$M(0) = \frac{\rho_0 L^2}{6}$$

$$M(L) = 0$$

(As earlier noted)

Second check within $0 < x < L$ by taking derivative and setting to zero:

$$\frac{dM(x)}{dx} = \frac{\rho_0 L}{2} \left( \frac{(x/L)^2}{(x/L)} \right)$$

Its value is zero only at the ends ($x = 0, L$)

Thus, maximum magnitude of axial stress, $\sigma_{xx}$, occurs at $x = 0$: 
Thus:

\[ |\sigma_{xx,\text{max}}| = \frac{P_0 L^2}{6} \left( \frac{3}{4} \right) \]

at \( x = 0 \)

Again, check units:

\[
\begin{align*}
\left[ \frac{F}{L^2} \right] & \overset{?}{=} \left[ \frac{F}{L^2} \right] \left[ L^2 \right] - \frac{[L]}{[L]^4} \\
& = \left[ \frac{F}{L^2} \right] \checkmark \text{ Yes}
\end{align*}
\]

(c) To find the maximum magnitude of the shear stress, start with:

\[ \sigma_{xz} = -\frac{5Q}{1b} \]

For the \( \sigma_{xx} \) case, \( Q, I, \) and \( b \) do not vary in \( x \), so look for the maximum magnitude of:

\[ \frac{\sigma_{xx}}{(Q/1b)} = -S(x) \]
Earlier in (a) found:

\[ S(x) = \psi_0 \left( \frac{x^2}{c^2} - x \right) \]

Normalization:

\[ \int \psi_0 \left( \frac{x^2}{c^2} - x \right) dx = \psi_0 \int \left( \frac{x^2}{c^2} - \frac{x}{c} \right) dx \]

To find maximum magnitude, first evaluate values at end points:

\[ S(0) = 0 \]
\[ S(L) = \psi_0 L \left( 1 - \frac{L}{c} \right) = 0 \]
(Casper Boundary Condition)

Second, check within \(0 < x < L\) by taking derivative and setting to zero:

\[ \frac{dS(x)}{dx} = \psi_0 \left( 2 \frac{x}{c} - 1 \right) \]

(Note: This is expression for \(g(x)\) as expected)

Setting to zero:

\[ 0 = \psi_0 \left( 2 \frac{x}{c} - 1 \right) \]
\[ \Rightarrow \frac{x}{c} = \frac{1}{2} \]
\[ \Rightarrow x = \frac{L}{2} \]

Evaluate at this point:
\[ S \left( \frac{y_2}{2} \right) = P_0 L \left\{ \frac{1}{4} - \frac{1}{2} \right\} = \frac{P_0 L}{4} \]

The maximum magnitude of shear stress \( \sigma_{x7} \) occurs at \( x = \frac{y_2}{2} \):

\[
|\sigma_{x7, \text{max}}| = \frac{P_0 L}{4} \left( \frac{Q}{16} \right)
\]

at \( x = \frac{y_2}{2} \).

Again, check units:

\[
\left[ \frac{F}{L^2} \right] = \left[ \frac{F}{L} \right] \left[ \frac{L}{L^4} \right] = \left[ \frac{L^3}{L^2} \right] \quad \text{Yes}
\]
Consider the wing configuration of M7 (M.5.2). The case of constant lift load is shown:

\[ p(x) = \frac{q(x)}{L} = \frac{P}{L} \]

\[ x = \text{distance from root} \]

Close the results for the internal load resultants determined in M7 (M.4.2) for each of the three load cases.

Summarize these from those results for one wing: \( 0 < x < \frac{L}{2} \)

(Note: use subscript on expressions to indicate case)
Case 1:
\[ q_1(x) = p_0 = \frac{P}{L} \]
\[ F_1(x) = 0 \]
\[ S_1(x) = P \left( \frac{x}{L} - \frac{1}{2} \right) \]
\[ M_1(x) = \frac{PL}{2} \left\{ \left( \frac{x}{L} \right)^2 - \left( \frac{x}{L} \right) + \frac{1}{4} \right\} \]

Case 2:
\[ q_2(x) = \frac{4P}{3L} \left( 1 - \frac{x}{L} \right) \]
\[ F_2(x) = 0 \]
\[ S_2(x) = \frac{4P}{3} \left\{ \frac{1}{2} \left( \frac{x}{L} \right)^2 + \frac{x}{L} - \frac{3}{8} \right\} \]
\[ M_2(x) = \frac{4}{3}PL \left\{ \frac{1}{6} \left( \frac{x}{L} \right)^3 + \frac{1}{2} \left( \frac{x}{L} \right)^2 - \frac{3}{8} \left( \frac{x}{L} \right) + \frac{1}{12} \right\} \]

Case 3:
\[ q_3(x) = \frac{3P}{2L} \left( 1 - 4 \left( \frac{x}{L} \right)^2 \right) \]
\[ F_3(x) = 0 \]
\[ S_3(x) = \frac{3P}{2} \left\{ -\frac{4}{3} \left( \frac{x}{L} \right)^3 + \left( \frac{x}{L} \right) - \frac{1}{3} \right\} \]
\[ M_3(x) = \frac{3PL}{2} \left\{ -\frac{1}{3} \left( \frac{x}{L} \right)^4 + \frac{1}{2} \left( \frac{x}{L} \right)^2 - \frac{1}{3} \left( \frac{x}{L} \right) + \frac{1}{6} \right\} \]

Now proceed....
(a) The axial stress is related to the moment via:

\[ \sigma_{xx} = \frac{-M(x)}{I} \]

This stress varies at any point \( x \) along the beam with distance from the axis \( z \).

The specifics of the cross-section are not given and terms \( z \) and \( I \) cannot be determined. However, it is given that the cross-sectional shape and properties (i.e., \( I \)) are constant along the beam. Thus \( z/I \) does not affect the distribution of \( \sigma_{xx} \) along \( x \), with the maximum stress occurring where \( z \) is a maximum value. Thus, the distribution of \( \sigma_{xx} \) with \( x \) is the same as \( M(x) \) with the value modified by \( -z/I \):

\[ \frac{\sigma_{xx}(x)}{(-z/I)} = M(x) \]

Note that the moment is always positive, so the other will be negative (compressive) for \( +z \) and positive (tensile) for \( -z \). This is consistent for a beam that bends up.
The maximum moment occurs at the root in all cases. Thus:

$$\text{Maximum } |\sigma_{xx}| \text{ at } x = 0, \frac{1}{2}, \text{ maximum}$$

Consider the maximum values of the moment that occurs at the root:

$$M_{1,\text{max}} = \frac{PL}{8} = 0.125\, PL$$

$$M_{2,\text{max}} = \frac{PL}{2} = 0.111\, PL$$

$$M_{3,\text{max}} = \frac{3PL}{32} = 0.094\, PL$$

Plot is same as for $M(x)$ as in previous week with $M(x)$ being symmetric about the root i.e. $\sigma_{xx}(x)$ here:

\[
\sigma_{xx}(x) = \frac{-1}{x^2} \frac{(PL)}{x^2}
\]
As always do unit check:

\[
\frac{\sigma_{xx}}{(-\frac{dL}{dx})(PL)} \quad \text{is normalized?}
\]

\[
\frac{[F/L^2]}{[L]} = \frac{[F/L^2]}{[L]^2} \quad \checkmark \quad \text{yes}
\]

(b) The shear stress is related to the shear resultant via:

\[
\sigma_{xz} = -\frac{S(x)Q}{I_b}
\]

Again, the specific of the cross-section are not known, but they do not vary along the beam (i.e., \(S(x)\)). Thus, it can be said that \(\sigma_{xz}\) varies in \(x\) in the same way as \(S(x)\) and that the maximum \(\sigma_{xz}\) occurs where \(Q/I_b\) is a maximum. Thus, modify the distribution of \(\sigma_{xz}\) with \(x\) by

by \(-Q/I_b\).
\[
\frac{\sigma_{xz}(x)}{(- Q/1b)} = S(x)
\]
The maximum absolute value of the shear resultant \( |S(x)| \), occurs at the root in all cases and is the same value of \( P/2 \) in all cases. Thus

\[\text{Maximum } |\sigma_{xz}| \text{ at } x = 0, \quad \frac{Q}{6} \text{ maximum}\]

\[S_1_{\text{max}} = S_2_{\text{max}} = S_3_{\text{max}} = \frac{P}{2}\]

The plot is the same as for \( S(x) \) as in previous week with \( S(x) \) being asymmetric about the root -- negative for \( 0 < x \), positive for \( x < 0 \).
Again, check units:

\[ \frac{\sigma \times 7}{(- Q/1b)(F)} \] is normalized?

\[
\frac{[F/L^2]}{[L^3]/[L]} = \frac{[F/L^2]}{[F]/[L^2]}
\]

\[ \checkmark \quad \text{Yes} \]

(c) The deflection of a beam, \( w \) is related to the moment \( M \) via:

\[ EI \frac{d^2w}{dx^2} = M(x) \]

\( M(x) \) is symmetric in \( x \), so \( w(x) \) must be as well. Thus, integrate the various moment equations for \( x > 0 \) only and similar results accounting for sign change will occur for \( x < 0 \).

Also note that \( EI \) does not change, so the various cases can be factors in all cases.
In integrating twice, there will be a need for 2 Boundary Conditions. Refer the deflection to the attachment to the fuselage at the root. So:

\[ @ x = 0, \ w = 0 \]

The other Boundary Condition comes from symmetry. Since the wing is continuous, it must have the same slope on each side of the fuselage (at \( x = 0 \)). Due to symmetry, the slope must thus be zero, so:

\[ @ x = 0, \ \frac{dw}{dx} = 0 \]

→ Work for each case:

**Case 1:** \( \left( \frac{d^2w}{dx^2} \right)_1 = \frac{PL}{2EI} \left\{ \left( \frac{x}{L} \right)^2 - \left( \frac{x}{L} \right) + \frac{1}{4} \right\} \)

\[ \Rightarrow \left( \frac{dw}{dx} \right)_1 = \frac{PL^2}{2EI} \left\{ \left( \frac{x}{L} \right)^3 - \frac{1}{2} \left( \frac{x}{L} \right)^2 + \frac{1}{4} \left( \frac{x}{L} \right) \right\} + C_1 \]

\[ @ x = 0, \ \frac{dw}{dx} = 0 \Rightarrow C_1 = 0 \]

Progressing:

\[ w_1 = \frac{PL^3}{2EI} \left\{ \frac{1}{12} \left( \frac{x}{L} \right)^4 - \frac{1}{6} \left( \frac{x}{L} \right)^3 + \frac{1}{8} \left( \frac{x}{L} \right)^2 \right\} + C_2 \]

\[ @ x = 0, \ w = 0 \Rightarrow C_2 = 0 \]
Case 2: \( \left( \frac{d^2w}{dx^2} \right)_2 = \frac{4PL}{3EI} \left\{ -\frac{1}{6} \left( \frac{x}{L} \right)^3 + \frac{1}{2} \left( \frac{x}{L} \right)^2 - \frac{3}{8} \left( \frac{x}{L} \right) + \frac{1}{12} \right\} \)

\[ \Rightarrow \left( \frac{dw}{dx} \right)_2 = \frac{4PL^2}{3EI} \left\{ -\frac{1}{24} \left( \frac{x}{L} \right)^4 + \frac{1}{6} \left( \frac{x}{L} \right)^3 - \frac{3}{16} \left( \frac{x}{L} \right)^2 + \frac{1}{12} \left( \frac{x}{L} \right) \right\} + C_3 \]

\( \Rightarrow x = 0, \frac{dw}{dx} = 0 \Rightarrow C_3 = 0 \)

Progressing:

\[ w_2 = \frac{4PL^3}{3EI} \left\{ -\frac{1}{120} \left( \frac{x}{L} \right)^5 + \frac{1}{24} \left( \frac{x}{L} \right)^4 - \frac{1}{16} \left( \frac{x}{L} \right)^3 + \frac{1}{24} \left( \frac{x}{L} \right)^2 \right\} + C_4 \]

\( \Rightarrow x = 0, w = 0 \Rightarrow C_4 = 0 \)

Case 3: \( \left( \frac{d^2w}{dx^2} \right)_3 = \frac{3PL}{2EI} \left\{ -\frac{1}{3} \left( \frac{x}{L} \right)^4 + \frac{1}{2} \left( \frac{x}{L} \right)^2 - \frac{1}{3} \left( \frac{x}{L} \right) + \frac{1}{12} \right\} \)

\[ \Rightarrow \left( \frac{dw}{dx} \right)_3 = \frac{3PL^2}{2EI} \left\{ -\frac{1}{15} \left( \frac{x}{L} \right)^5 + \frac{1}{6} \left( \frac{x}{L} \right)^3 - \frac{1}{6} \left( \frac{x}{L} \right)^2 + \frac{1}{16} \left( \frac{x}{L} \right) \right\} + C_5 \]

\( \Rightarrow x = 0, \frac{dw}{dx} = 0 \Rightarrow C_5 = 0 \)

Progressing:

\[ w_3 = \frac{3PL^3}{2EI} \left\{ -\frac{1}{90} \left( \frac{x}{L} \right)^6 + \frac{1}{24} \left( \frac{x}{L} \right)^5 - \frac{1}{18} \left( \frac{x}{L} \right)^3 + \frac{1}{32} \left( \frac{x}{L} \right)^2 \right\} + C_6 \]

\( \Rightarrow x = 0, w = 0 \Rightarrow C_6 = 0 \)

The maximum value must occur at the tip in all cases \( (x = L) \)
In all cases these are in terms of \( \frac{PL^3}{EI} \). Thus check units:

\[
[L] = \frac{[F]}{[F/L^2]} \frac{[L^3]}{[L^4]} = \frac{[L^3]}{[L^2]} = [L]
\]

Yes

So express in terms of these. Determine maximum \( w \) at \( x = 4/2 \):

\[
W_{\text{max}_1} = \frac{PL^3}{EI} \cdot \frac{1}{2} \left\{ \frac{1}{12} \left( \frac{1}{16} \right) - \frac{1}{6} \left( \frac{1}{8} \right) + \frac{1}{8} \left( \frac{1}{4} \right) \right\}
\]

\[
= \frac{PL^3}{EI} \cdot \frac{1}{2} \left\{ \frac{1}{192} - \frac{1}{48} + \frac{1}{32} \right\}
\]

\[
= \frac{PL^3}{EI} \cdot \frac{1}{2} \left\{ \frac{1 - 4 + 6}{192} \right\}
\]

\[
\Rightarrow W_{\text{max}_1} = \frac{PL^3}{EI} \left( \frac{3}{384} \right) = 0.00781 \frac{PL^3}{EI}
\]

\[
W_{\text{max}_2} = \frac{PL^3}{EI} \cdot \frac{4}{3} \left\{ -\frac{1}{120} \left( \frac{3}{2} \right) + \frac{1}{24} \left( \frac{1}{16} \right) - \frac{1}{16} \left( \frac{1}{8} \right) + \frac{1}{24} \left( \frac{1}{4} \right) \right\}
\]

\[
= \frac{PL^3}{EI} \cdot \frac{1}{24} \left\{ -\frac{1}{120} + \frac{1}{12} - \frac{1}{4} + \frac{1}{3} \right\}
\]

\[
= \frac{PL^3}{EI} \cdot \frac{1}{24} \left\{ \frac{-1 + 10 - 30 + 40}{120} \right\}
\]

\[
\Rightarrow W_{\text{max}_2} = \frac{PL^3}{EI} \left( \frac{19}{2880} \right) = 0.00660 \frac{PL^3}{EI}
\]
\[ W_{max_3} = \frac{PL^3}{EI} \cdot \frac{3}{2} \left\{ -\frac{1}{90} (\frac{1}{64}) + \frac{1}{24} (\frac{1}{16}) - \frac{1}{16} (\frac{1}{8}) + \frac{1}{32} (\frac{1}{4}) \right\} \]

\[ = \frac{PL^3}{EI} \cdot \frac{3}{32} \left\{ -\frac{1}{90} (\frac{1}{4}) + \frac{1}{24} - \frac{1}{9} + \frac{1}{2} (\frac{1}{4}) \right\} \]

\[ = \frac{PL^3}{EI} \cdot \frac{3}{32} \left\{ -\frac{1}{360} + \frac{1}{24} - \frac{1}{9} + \frac{1}{8} \right\} \]

\[ = \frac{PL^3}{EI} \cdot \frac{3}{32} \left\{ \frac{1+15-40+45}{360} \right\} \]

\[ = \frac{PL^3}{EI} \left( \frac{19}{3840} \right) = 0.00495 \frac{PL^3}{EI} \]

**Summary:**

\[ W_{max_1} = 0.00781 \frac{PL^3}{EI} \]
\[ W_{max_2} = 0.00660 \frac{PL^3}{EI} \]
\[ W_{max_3} = 0.00495 \frac{PL^3}{EI} \]

Proceed to a plot of approximate sketches.