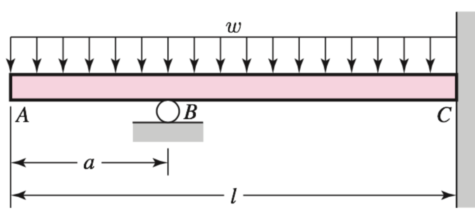
# Statically indeterminate problems

Suppose a mechanical system has redundant constraints — those that constrain the system in the same manner. The forces + moments of these systems cannot be solved for with force + moment balance equations alone. There will be an extra unknown variable for each redundant constraint.

We call such systems statically indeterminant. They can be solved by writing a deflection equation at the point of each redundant constraint (which gives an extra equation).

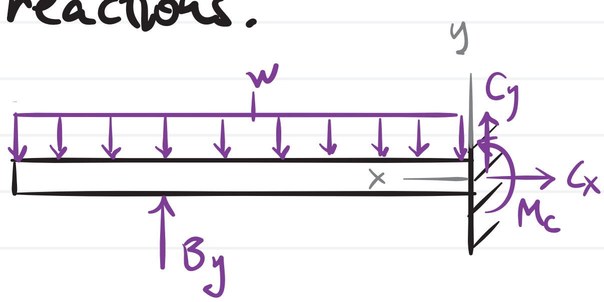
## Example

For the beam shown, determine the support reactions using superposition and procedure 1 from Sec. 4–10.




### 1. Determine redundant reactions.

Choose $B_y$ to be the redundant reaction.




### 2. Static balance equations

$\Sigma F_x = 0 \Rightarrow$
$C_x = 0$ (1)

$\Sigma F_y = 0$
$B_y + C_y - wL = 0$ (2)

$\Sigma M_c = 0$
$-B_y(L-a) + \frac{wL^2}{2} + M_c = 0$ (3)

## 3. Deflection equation.

beam 2: $$y_{B_2} = \frac{-B_y(l-a)^2}{6EI}\left((l-a)-3(l-a)\right)$$
$$= \frac{+B_y(l-a)^3}{3EI}$$

beam 3: $$y_{B_3} = \frac{w(l-a)^2}{24EI}\left(4l(l-a)-(l-a)^2-6l^2\right)$$

total: $$y_{B_2} + y_{B_3} = 0 \qquad (4)$$

## 4. Solve.

Solve the simultaneous, linear system of equations (1)-(4) to find our unknown reactions $B_y$, $C_x$, $C_y$, $M_c$.