

Lecture 20 - Superposition

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schedule

- 15 Nov - Beam Deflection (superposition)
- 17 Nov - Exam 3 Review
- 19 Nov - HW 9 Due, HW 8 Self-grade Due
- 22 Nov - Exam 3
- (24 Nov) - No Class Thanksgiving Break
- 29 Nov - Buckling, Stress Concentration
- 1 Dec - Final Exam Review
- 3 Dec - Project 3 Due, HW 10 & HW 9 Self-grade Due
- 6 Dec - Final Exam 11:00 - 12:50

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- superposition
- statically indeterminate

superposition

superposition

- The differential equation $EI \frac{d^4 v}{dx^4} = w(x)$ satisfies the requirements for superposition
- $w(x)$ is linearly related to $v(x)$
- Load does not significantly change the shape of the beam

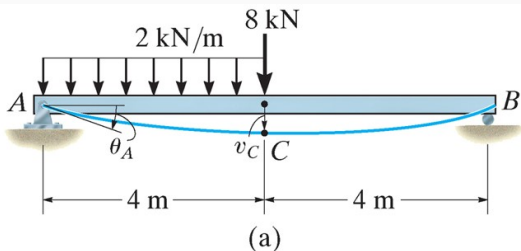
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superposition

- This means we can superpose multiple deflection solutions from simpler cases
- Appendix C in the text has many solutions that can be superposed

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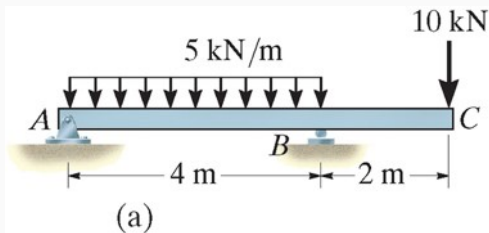
example 12.13



Use superposition to find the displacement at C and the slope at A

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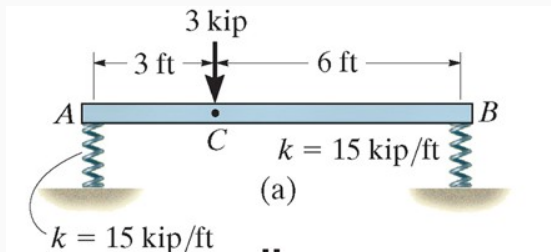
example 12.15



Use superposition to find the displacement at C

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example 12.16



The steel bar is supported by springs with $k=15 \text{ kip/ft}$ originally unstretched. For the force shown, determine the displacement at C. Take $E_{st} = 29 \text{ Msi}$ and $I = 12 \text{ in}^4$.

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statically indeterminate beams

statically indeterminate

- If we have redundant supports, we can have some difficulty finding the displacement
- There are several approaches to solve these problems, we will consider direct integration and superposition

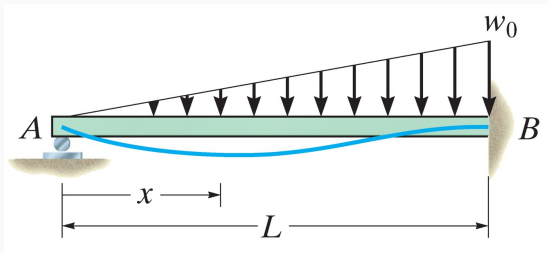
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integration

- We can take the extra unknowns and include them in our formulation for $M(x)$
- They will be solved for with the extra boundary conditions applied

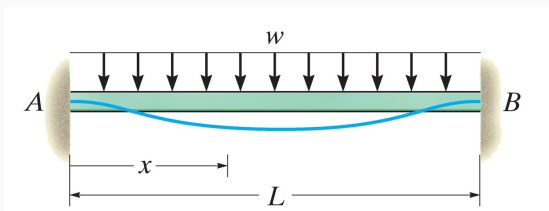
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example 12.17



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example 12.18



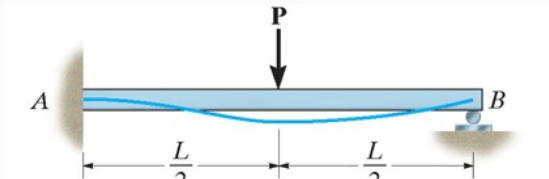
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indeterminate beams - superposition

superposition

- To use superposition for finding deflection of statically indeterminate beams, we must first identify redundant reactions
- We initially remove these, then superpose them back such that the deflection at that point is 0
- The choice of which reaction(s) is redundant is arbitrary, we can choose whatever we are most comfortable with
- We use Appendix C to find deflection and slope

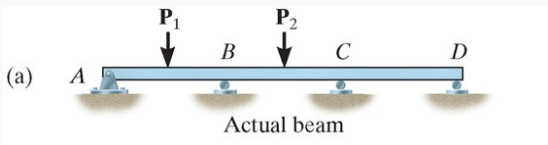
superposition



We can consider any reaction to be redundant.

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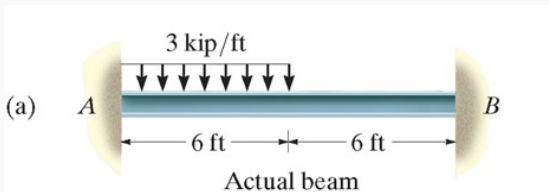
higher order indeterminacy



We need to treat each reaction separately to match Appendix C.

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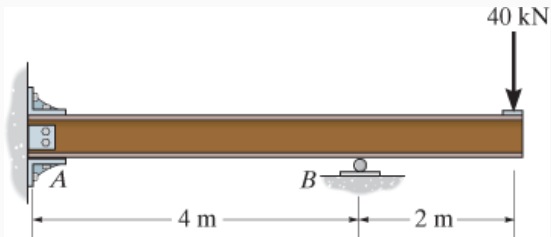
example 12.22



Determine the moment at *B*.

group problems

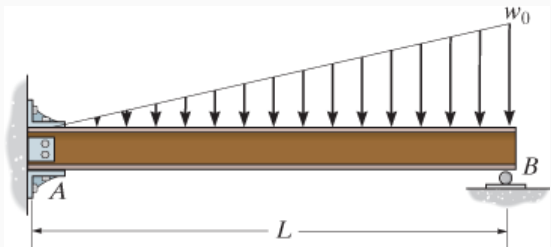
group one



Determine the reactions at A and B (EI is constant).

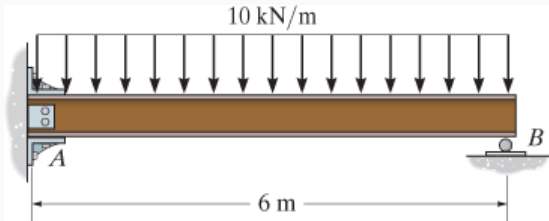
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group two



Determine the reactions at A and B (EI is constant).

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Determine the reactions at A and B. The support at B settles 2 mm. $E = 200 \text{ GPa}$, $I = 65.0(10^{-6}) \text{ m}^4$.