Mechanics of Materials

Ferdinand P.Beer, E.Russel Johnston, Jr., John T.Dewolf

Other Reference:
J.Wat Oler "Lectures notes on Mechanics od Materials"
Ibrahim A.Assakkaf "Lectures notes on Mechanics od Materials"

Homework-07

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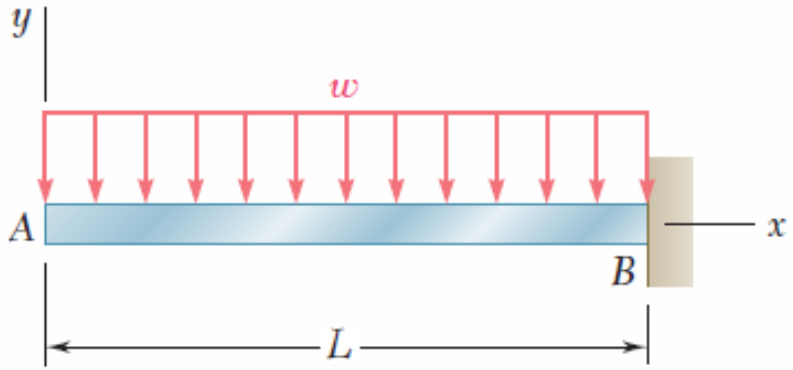
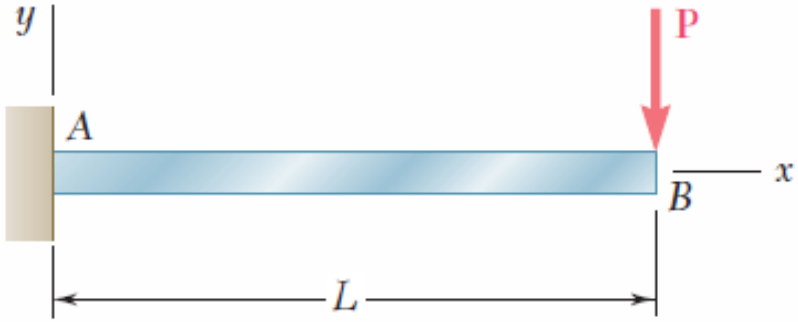
Homework-07

❑ Problem 01

For the loading shown, determine (a) the equation of the elastic curve for the cantilever beam AB, (b) the deflection at the free end, (c) the slope at the free end.



(*I*)



(*II*)

Key Answer:

I. $(a)\ y = -(w/24EI)(x^4 - 4L^3x + 3L^4),\quad (b)\ wL^4/8EI \downarrow,\quad (c)\ wL^3/6EI$ ◿

II. $(a)\ y = -(Px^2/6EI)(3L - x),\quad (b)\ PL^3/3EI \downarrow,\quad (c)\ PL^2/2EI$ ◺

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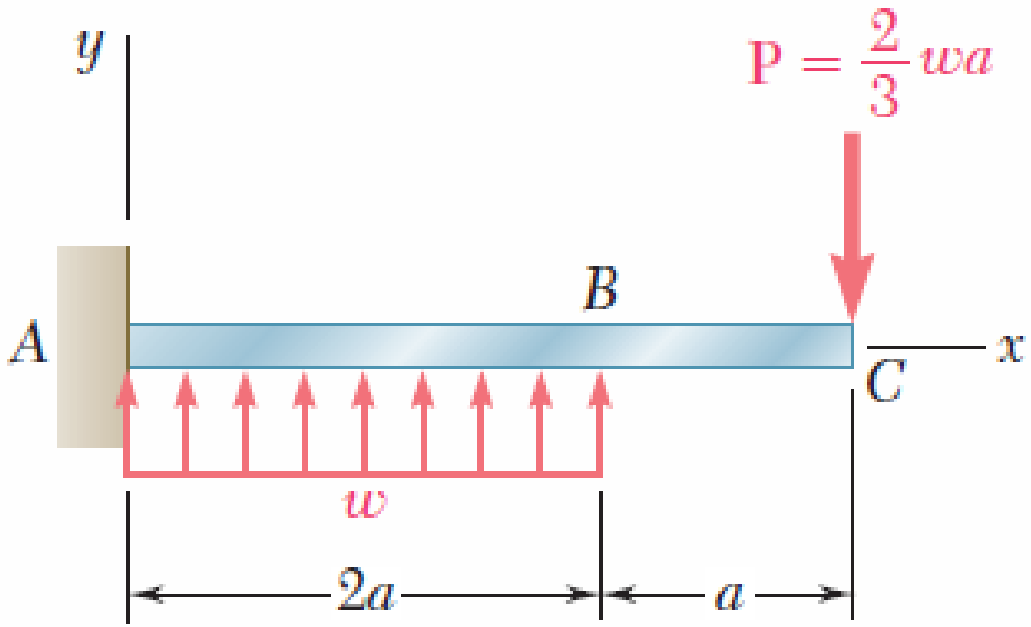
❑ Problem 02

For the cantilever beam and loading shown, determine (a) the equation of the elastic curve for portion AB of the beam, (b) the deflection at B, (c) the slope at B.



Key Answer:

$$(a)\ y = (w/72EI)(3x^4 - 16ax^3),\quad (b)\ 10wa^4/9EI \downarrow,\quad (c)\ 4wa^3/3EI \curvearrowright$$

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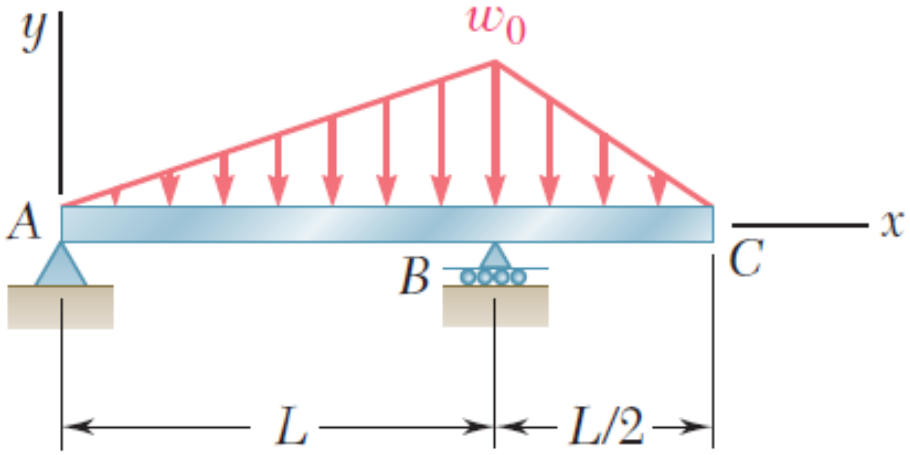
❑ Problem 03

For the beam and loading shown, determine (a) the equation of the elastic curve for portion AB of the beam, (b) the deflection at midspan, (c) the slope at B.



Key Answer:

$(a)\ y = (w_0 / EIL)(L^2 x^3 / 48 - x^5 / 120 - L^4 x / 80),\quad (b)\ w_0 L^4 / 256EI \downarrow,\quad (c)\ w_0 L^3 / 120EI$

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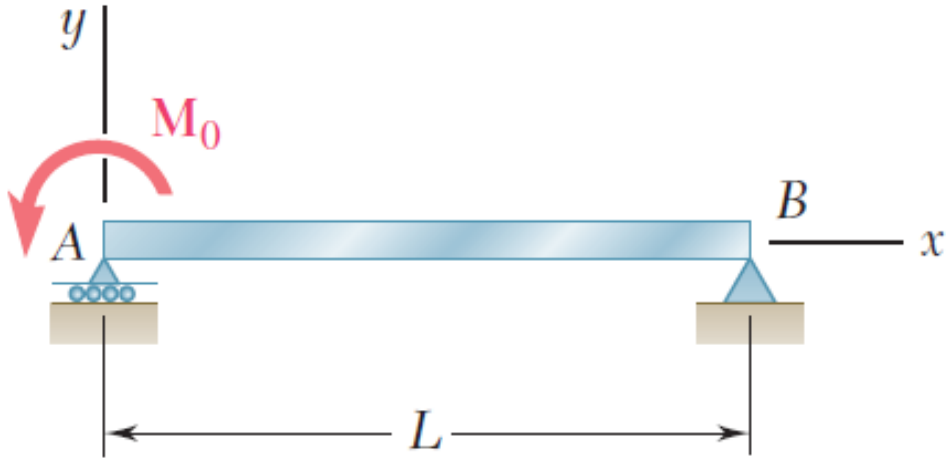
❑ Problem 04

(a) Determine the location and magnitude of the maximum deflection of beam AB.
(b) Assuming that beam AB is a W360 X 64, L = 3.5 m, and E = 200 GPa, calculate the maximum allowable value of the applied moment **M0** if the maximum deflection is not to exceed 1 mm.



Key Answer: $(a)\ 0.06415M_0L^2/EI \quad @x = 0.423L, \quad (b)\ 45.3kN.m$

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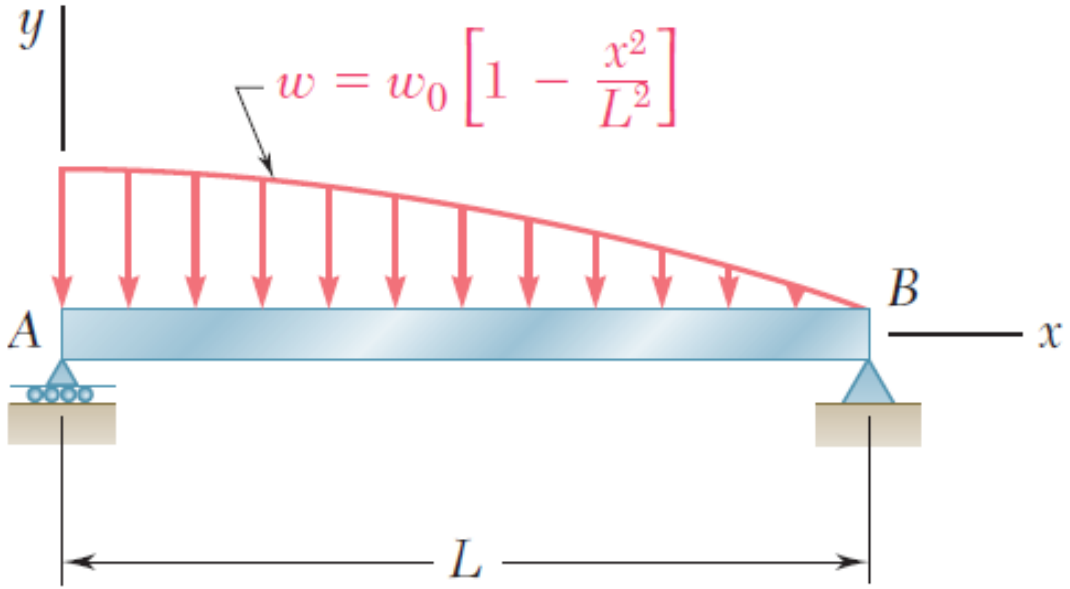
❑ Problem 05

For the beam and loading shown, determine (a) the equation of the elastic curve, (b) the slope at end A, (c) the deflection at the midpoint of the span.



Key Answer:

$(a)\ y = w_0\,(x^6 - 15L^2x^4 + 25L^3x^3 - 11L^5x)/360EIL^2,\quad (b)\ 11w_0L^3/360EI\ \searrow\ ,$

$(c)\ 0.00916w_0L^4/EI\ \downarrow$

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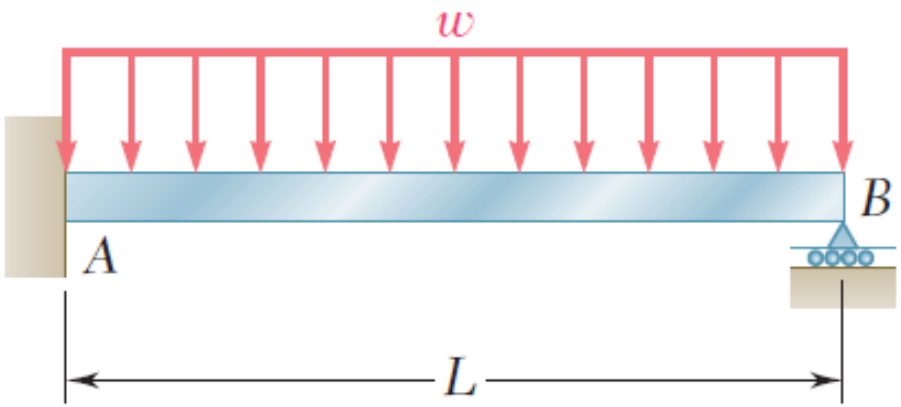
❑ Problem 06

For the beam and loading shown, determine the reaction at the roller support.



Key Answer: $3wL/8 \uparrow$

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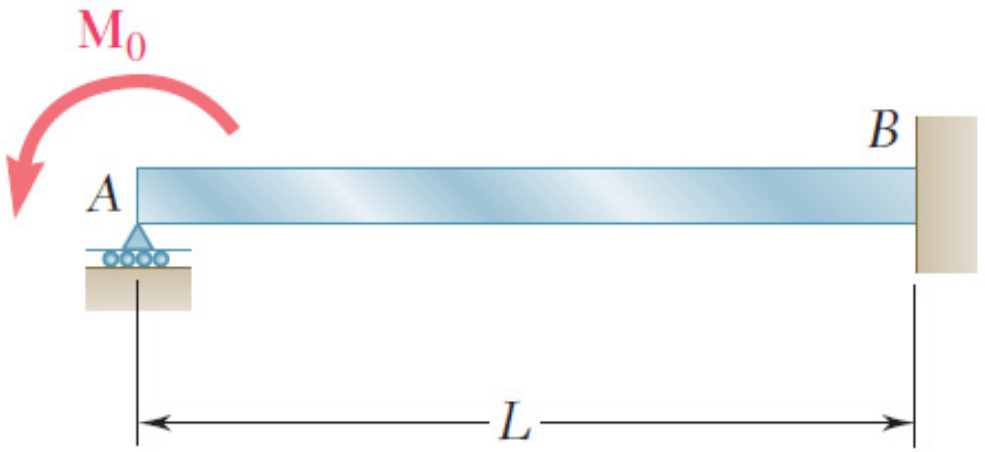
❑ Problem 07

For the beam and loading shown, determine the reaction at the roller support.



Key Answer: $3M_0 / 2L \uparrow$

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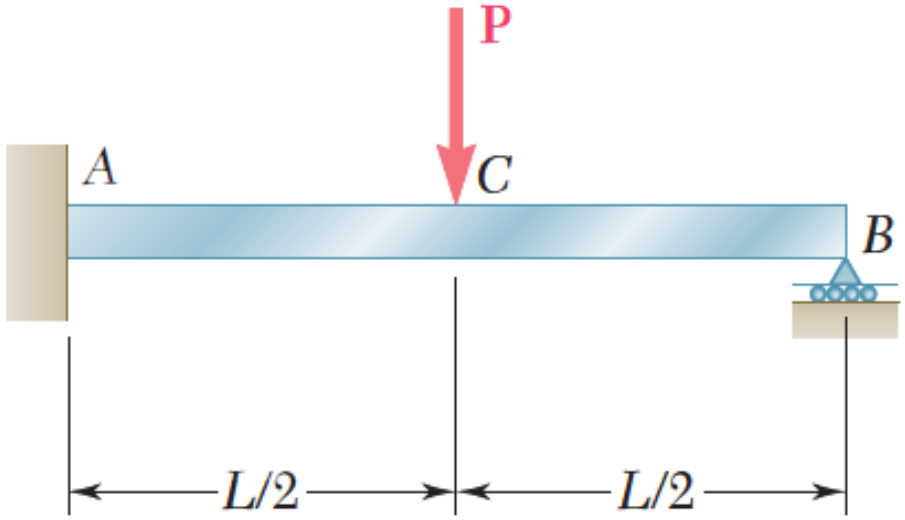
❑ Problem 08

Determine the reaction at the roller support and draw the bending moment diagram for the beam and loading shown.



Key Answer:

$$R_B = 5P/16 \uparrow \quad ; \quad M_A = -3PL/16 \quad ; \quad M_C = 5PL/32 \quad ; \quad M_B = 0$$

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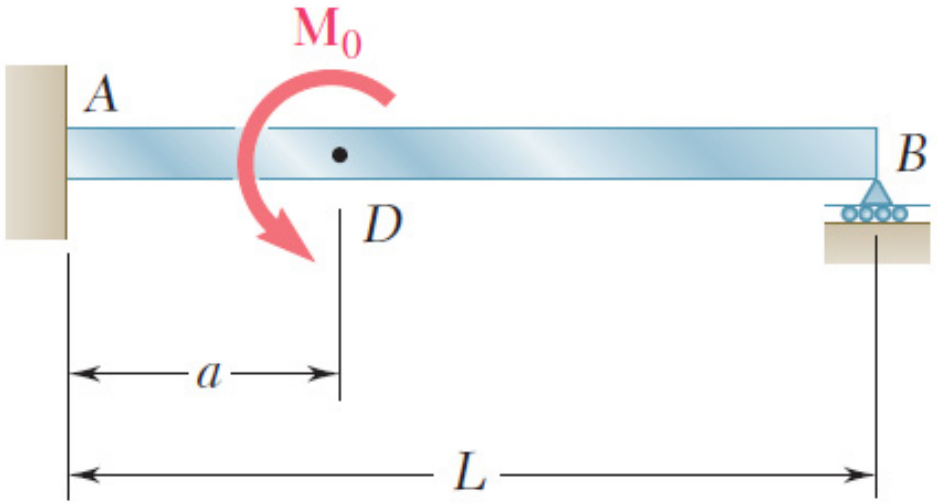
❑ Problem 09

Determine the reaction at the roller support and the deflection at point D if a is equal to L/3.



Key Answer: $R_B = 5M_0/6L \downarrow$; $y_D = 7M_0L^2/486EI \uparrow$

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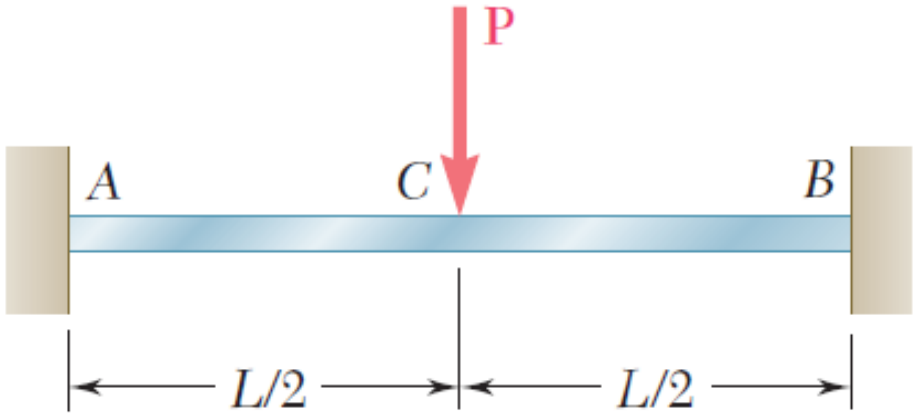
❑ Problem 10

Determine the reaction at A and draw the bending moment diagram for the beam and loading shown.



Key Answer: $R_B = 5M_0 / 6L \downarrow$; $y_D = 7M_0L^2 / 486EI \uparrow$

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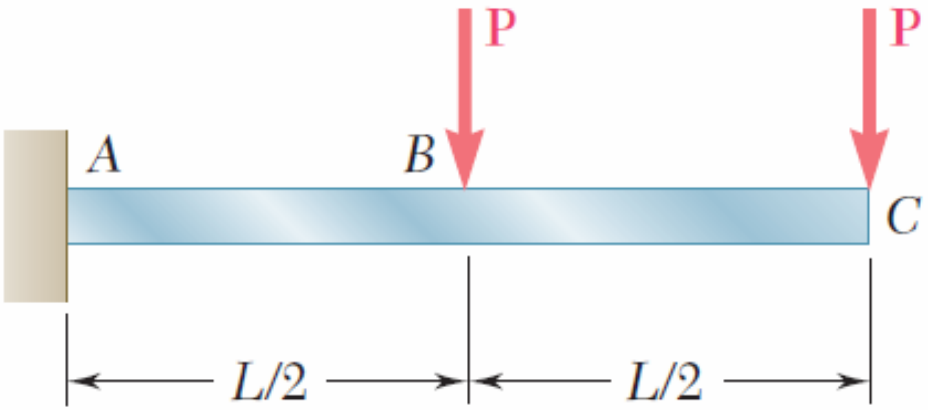
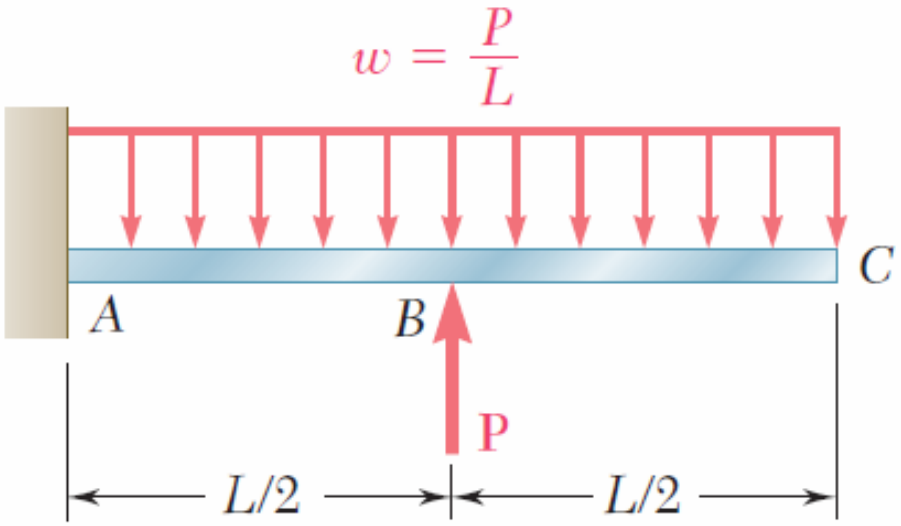
❑ Problem 11

For the cantilever beam and loading shown, determine the slope and deflection at the free end.



(*I*)



(*II*)

Key Answer:

$(I)\quad 5PL^2/8EI \curvearrowleft \;;\; 7PL^3/16EI \downarrow$

$(II)\quad PL^2/24EI \curvearrowleft \;;\; PL^3/48EI \downarrow$

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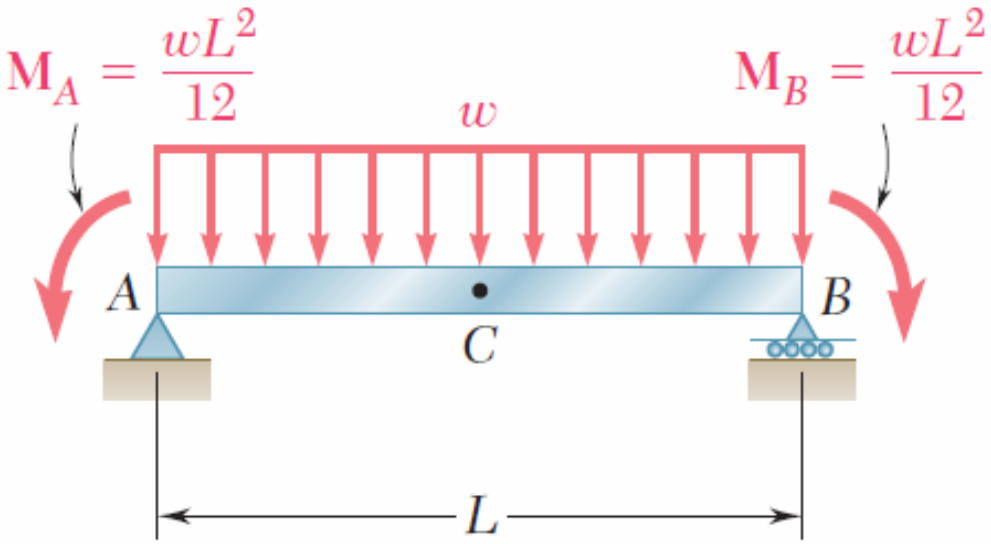
❑ Problem 12

For the beam and loading shown, determine (a) the deflection at C, (b) the slope at end A.



Key Answer: $(a)\ wL^4/384EI \downarrow$; $(b)\ 0$

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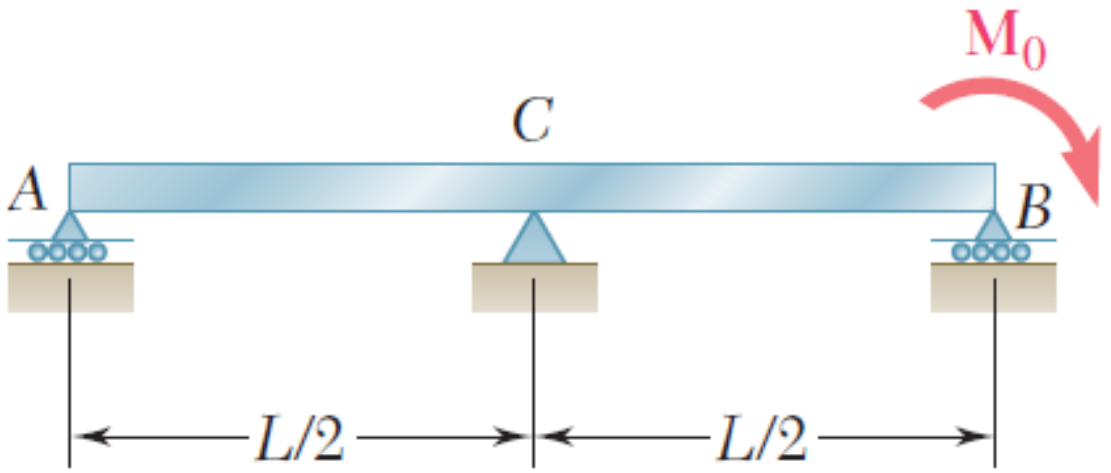
❑ Problem 13

For the uniform beam shown, determine the reaction at each of the three supports.



Key Answer: $R_A = M_0 / 2L \uparrow$; $R_B = 5M_0 / 2L \uparrow$; $R_C = 3M_0 / L \downarrow$

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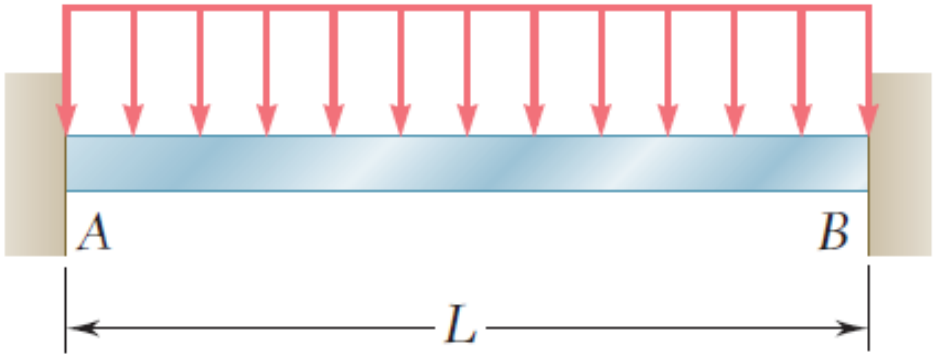
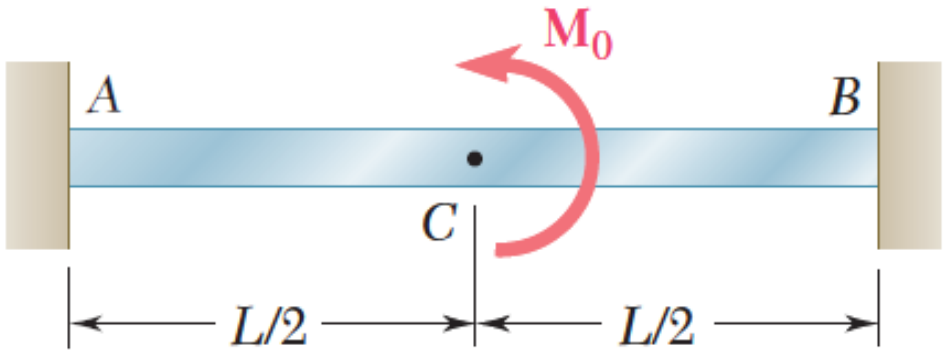
❑ Problem 14

For the beam shown, determine the reaction at B.



(I)



(II)

Key Answer:

$$(I)\quad R_A = R_B = wL/2 \uparrow \quad ; \quad M_A = -M_B = -wL^2/12$$

$$(II)\quad R_B = 3M_0/2L \downarrow \quad ; \quad M_B = -M_0/4$$

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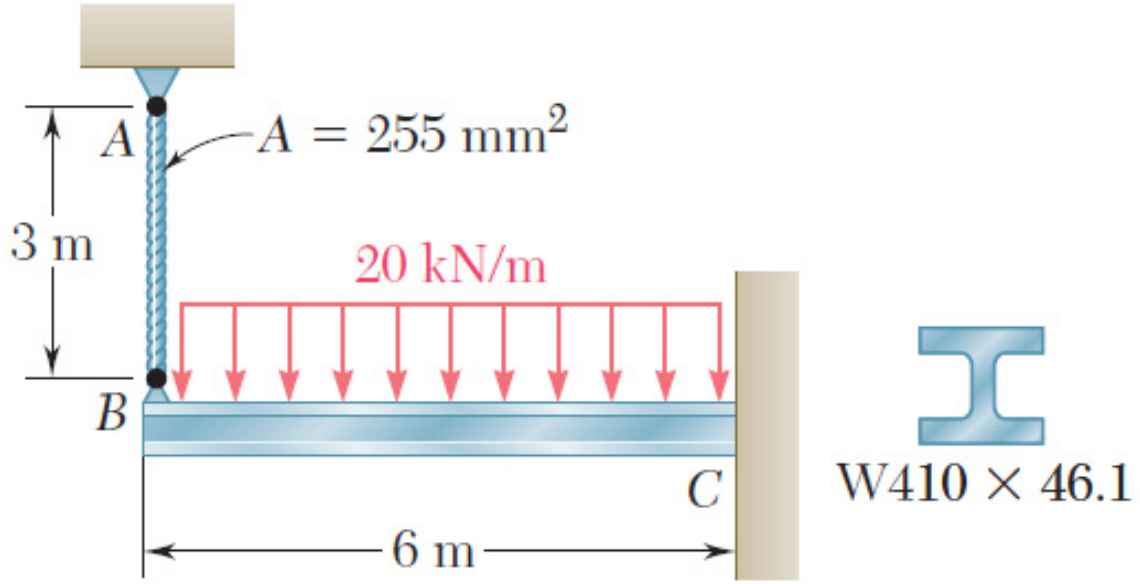
❑ Problem 15

The cantilever beam BC is attached to the steel cable AB as shown. Knowing that the cable is initially taut, determine the tension in the cable caused by the distributed load shown. Use E=200 GPa.



Key Answer: 43.90 *kN*.

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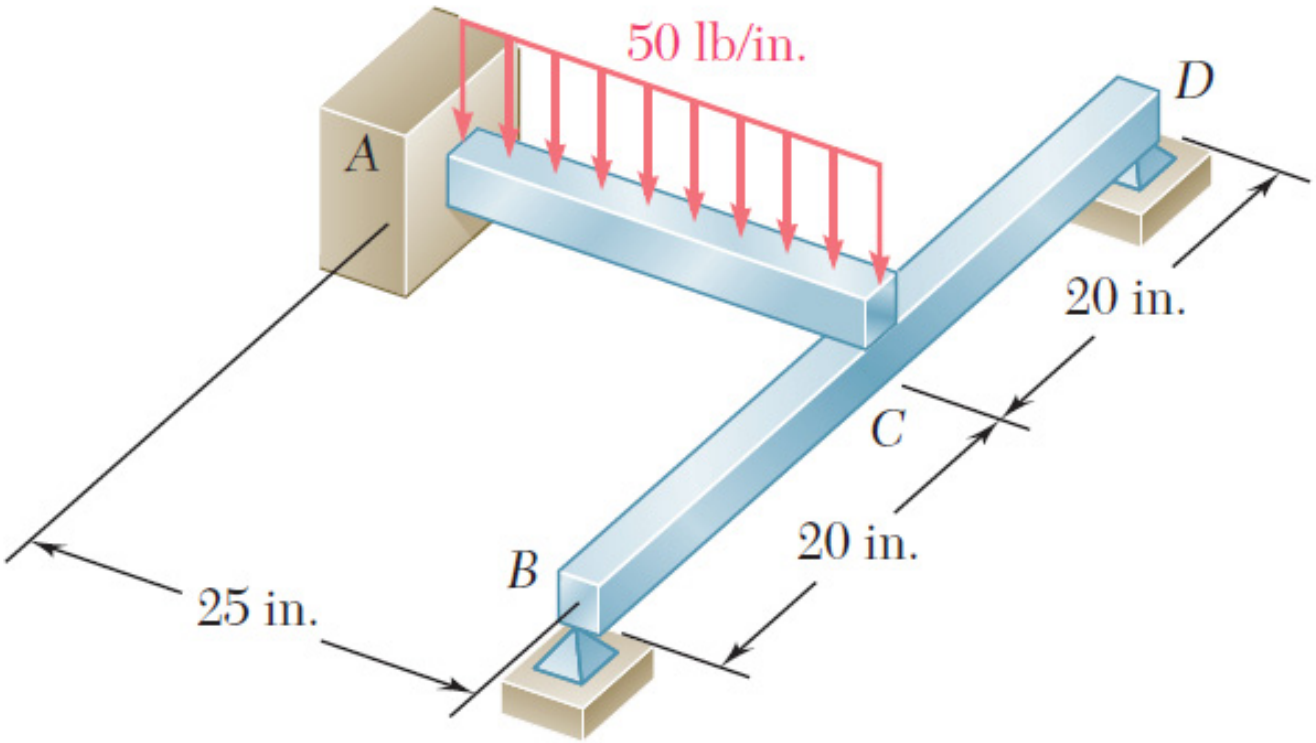
❑ Problem 16

For the loading shown, knowing that beams AC and BD have the same flexural rigidity, determine the reaction at B.



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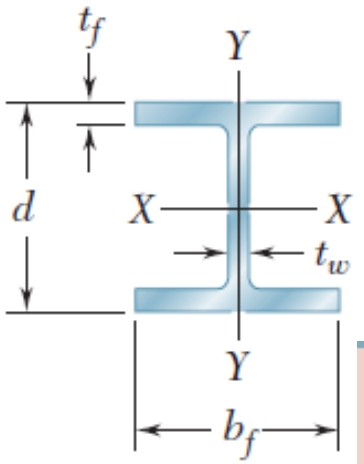

Designation†	Area A, mm^2	Depth d, mm	Flange: Width b_f, mm	Flange: Thickness t_f, mm	Web Thickness t_w, mm	Axis X-X: I_x 10^6 mm^4	Axis X-X: S_x 10^3 mm^3	Axis X-X: r_x mm	Axis Y-Y: I_y 10^6 mm^4	Axis Y-Y: S_y 10^3 mm^3	Axis Y-Y: r_y mm
W360 × 551	70300	455	419	67.6	42.2	2260	9950	180	828	3950	108
216	27500	376	394	27.7	17.3	712	3800	161	282	1430	101
122	15500	363	257	21.7	13.0	367	2020	154	61.6	480	63.0
101	12900	356	254	18.3	10.5	301	1690	153	50.4	397	62.5
79	10100	353	205	16.8	9.40	225	1270	150	24.0	234	48.8
64	8130	348	203	13.5	7.75	178	1030	148	18.8	185	48.0
57.8	7230	358	172	13.1	7.87	160	895	149	11.1	129	39.4
44	5710	351	171	9.78	6.86	121	688	146	8.16	95.4	37.8
39	4960	353	128	10.7	6.48	102	578	144	3.71	58.2	27.4
32.9	4190	348	127	8.51	5.84	82.8	475	141	2.91	45.9	26.4
W410 × 114	14600	419	262	19.3	11.6	462	2200	178	57.4	441	62.7
85	10800	417	181	18.2	10.9	316	1510	171	17.9	198	40.6
60	7610	406	178	12.8	7.75	216	1060	168	12.0	135	39.9
46.1	5890	404	140	11.2	6.99	156	773	163	5.16	73.6	29.7
38.8	4950	399	140	8.76	6.35	125	629	159	3.99	57.2	28.4