

Series Editor
Gilles Pijaudier-Cabot

Structural Analysis 1

Statically Determinate Structures

Salah Khalfallah

Color section

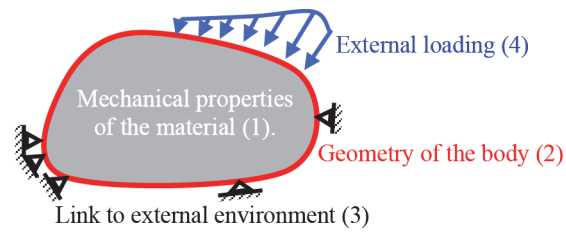


Figure 1.1. *The conditions for defining a structure*

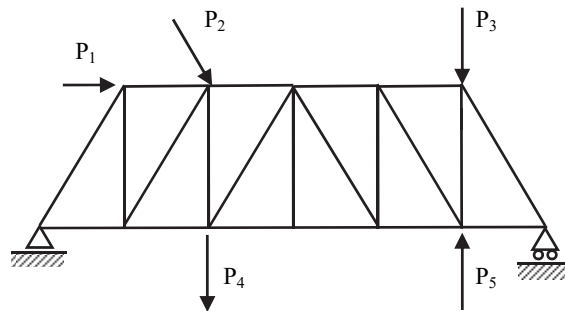


Figure 1.2. *Truss*

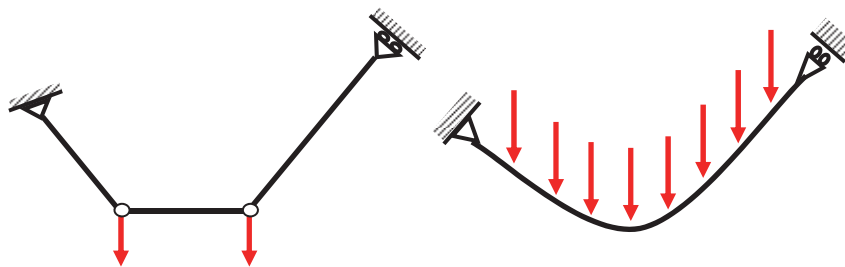


Figure 1.3. *Membranous structures*

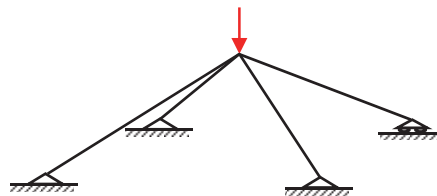


Figure 1.4. *Spatial trusses*

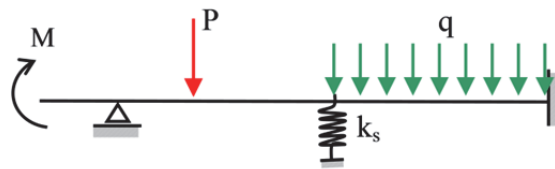


Figure 1.5. Beams

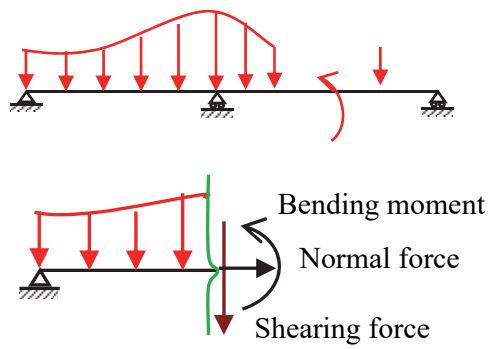


Figure 1.6. Internal actions

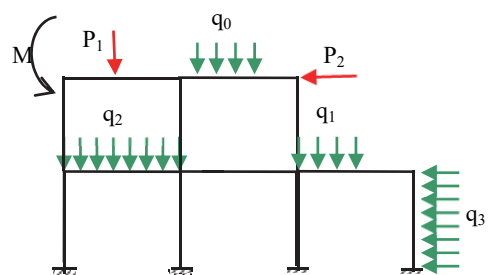


Figure 1.7. Frames

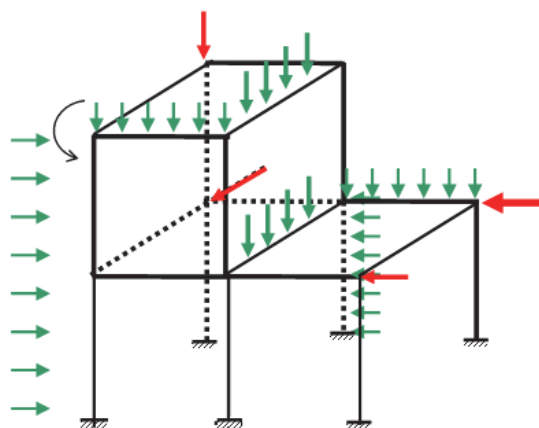


Figure 1.8. Three-dimensional frames

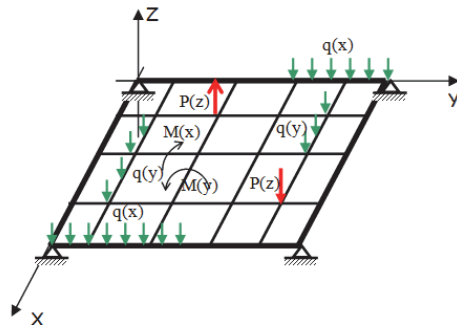


Figure 1.9. *Crossbeam structures*

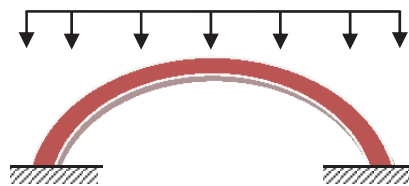


Figure 1.10. *A given arch*



Figure 1.11. *Types of support and associated reactions*

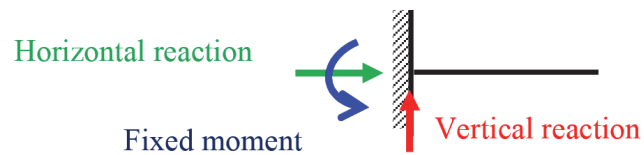


Figure 1.14. *Reaction at fixed node*



Figure 1.18. *Sign conventions of internal actions*

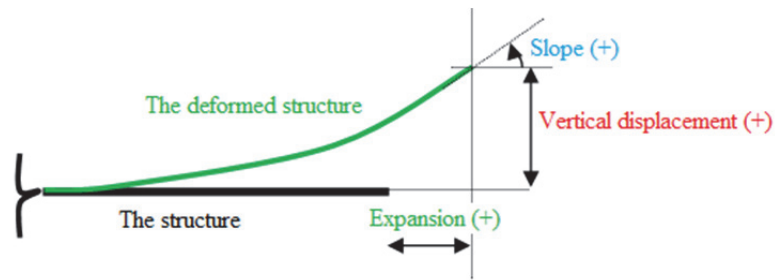
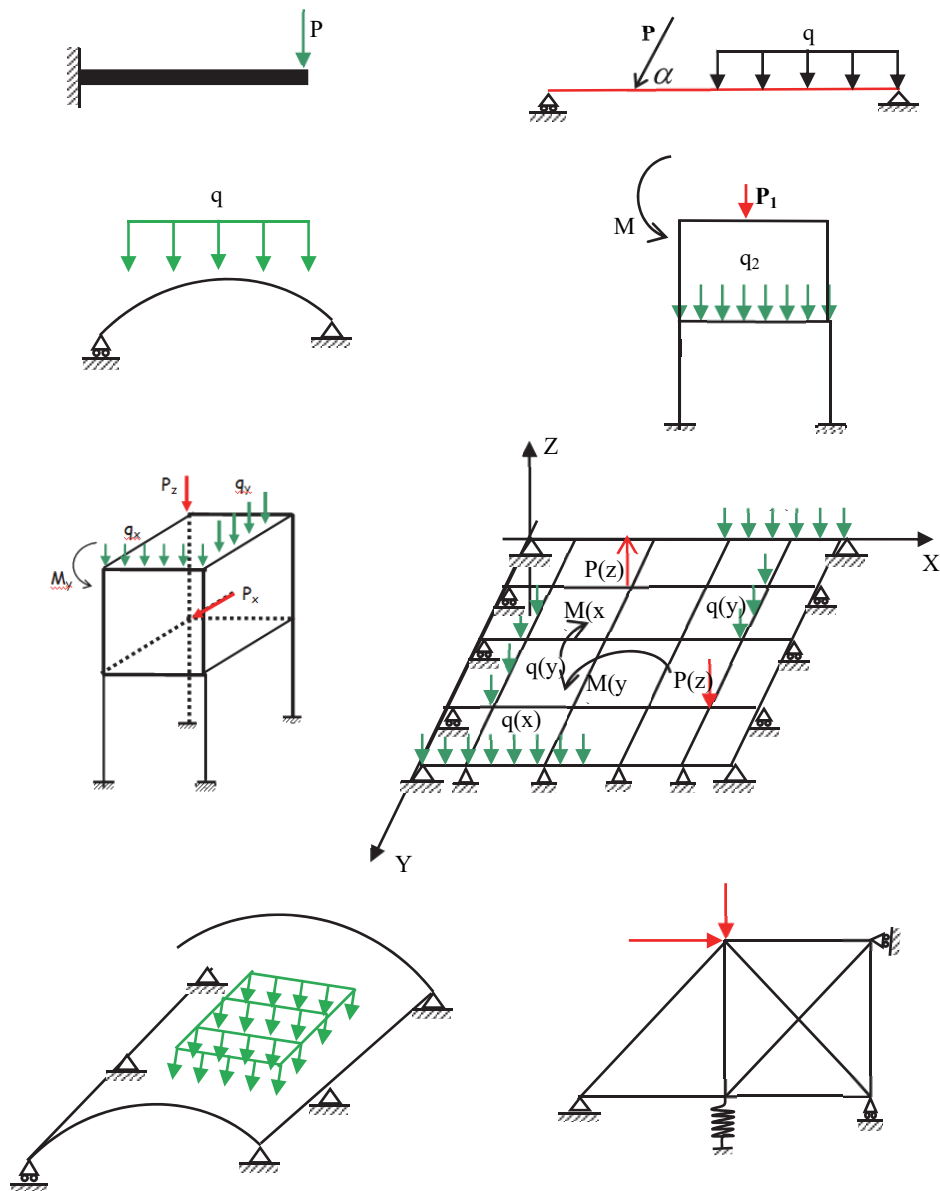
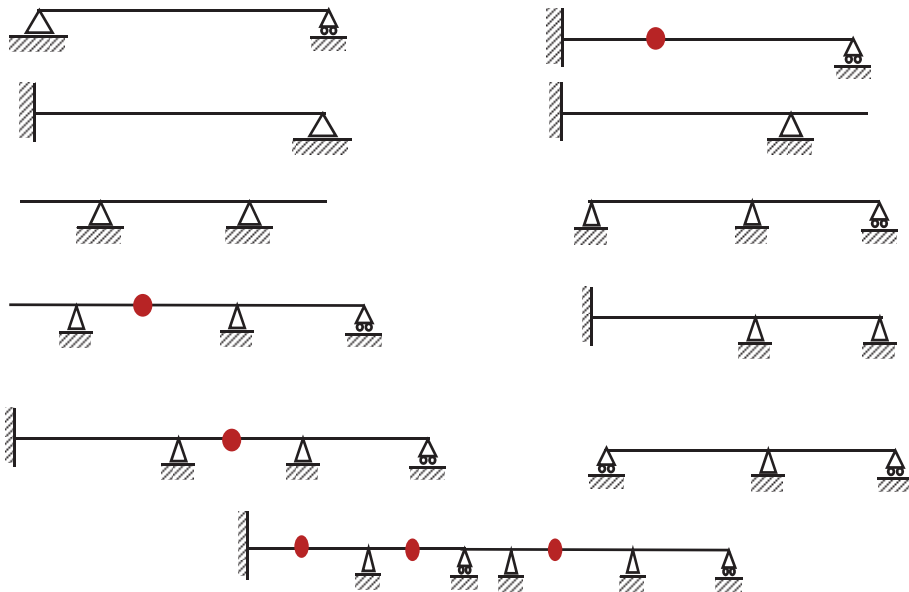


Figure 1.19. Sign conventions of deflections

Chapter 1, Exercise 1

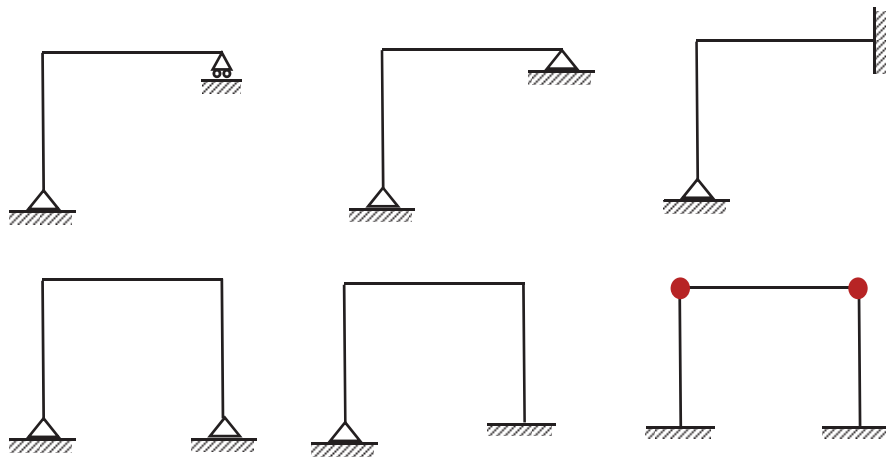


Chapter 1, Exercise 3



● (designates a hinge)

Chapter 1, Exercise 4



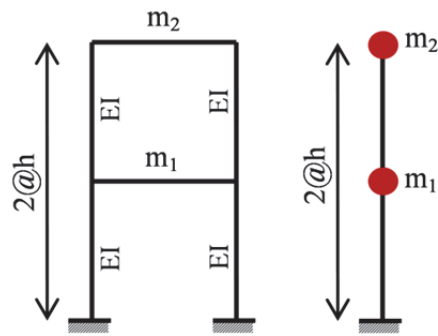


Figure 2.5. Structure and its modeling

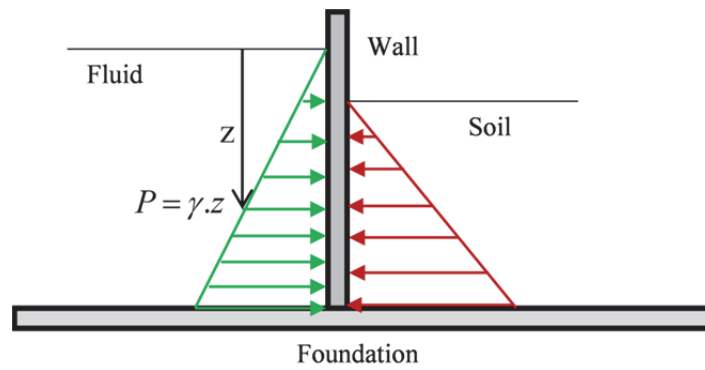
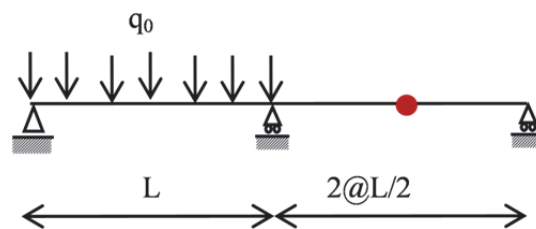
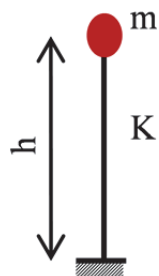


Figure 2.6. Hydrostatic pressure and land thrust.

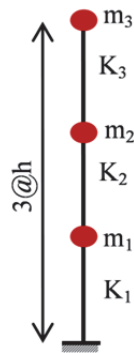
Chapter 2, Exercise 4



Chapter 2, Exercise 7



Chapter 2, Exercise 8



Chapter 2, Exercise 10

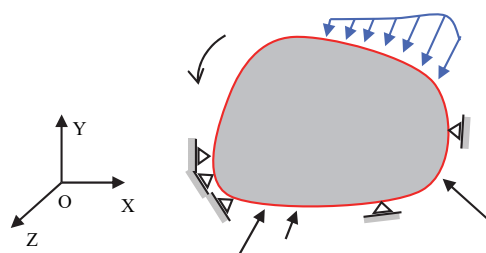
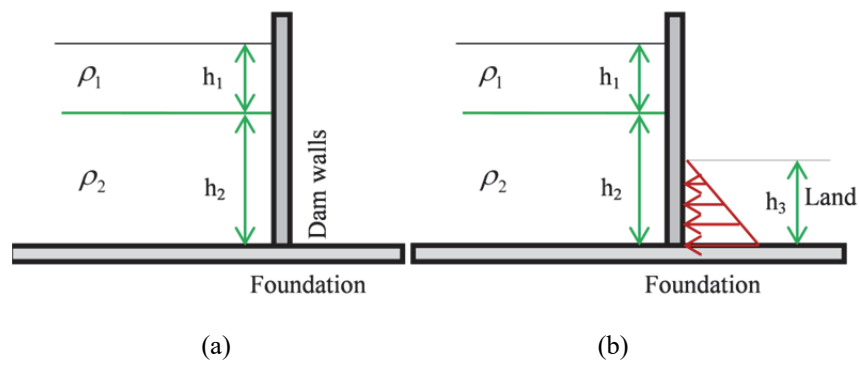


Figure 3.1. Three-dimensional structure

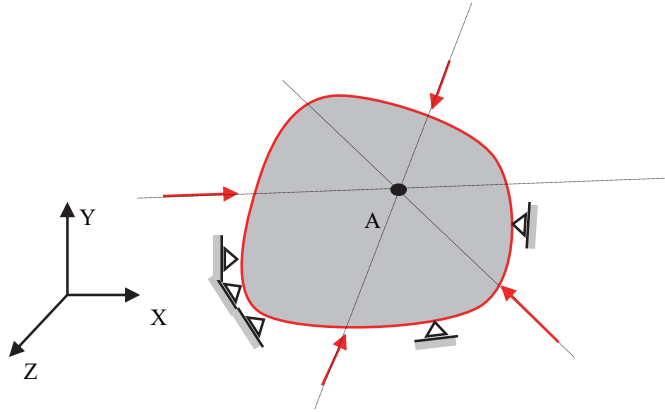


Figure 3.2. *Structure under concurrent forces*

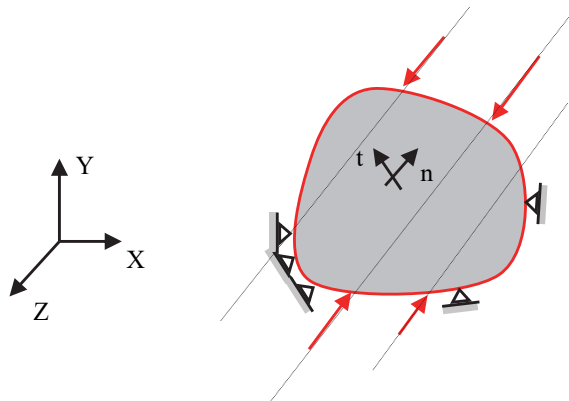


Figure 3.3. *Structure subject to parallel forces*

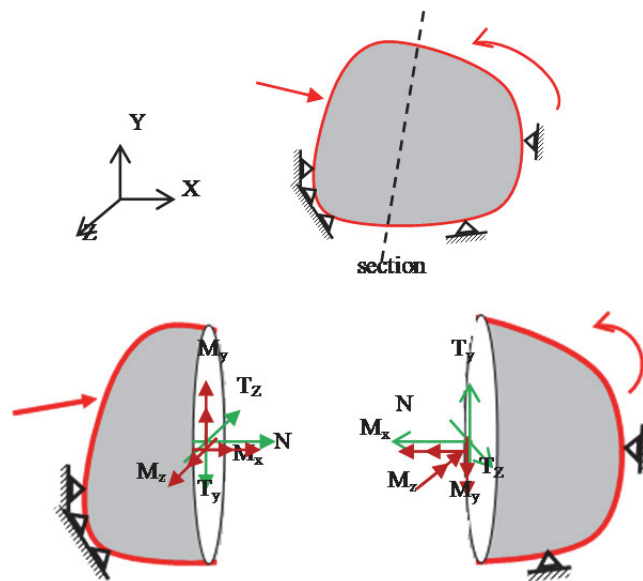


Figure 3.4. Internal actions

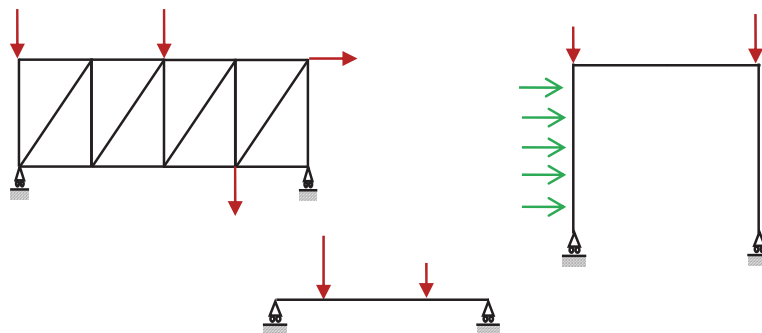


Figure 3.7. Unstable structures

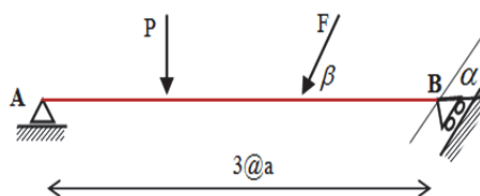


Figure 3.10. Given beam

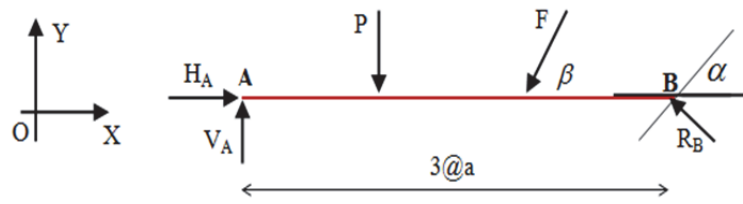


Figure 3.11. Free-body beam

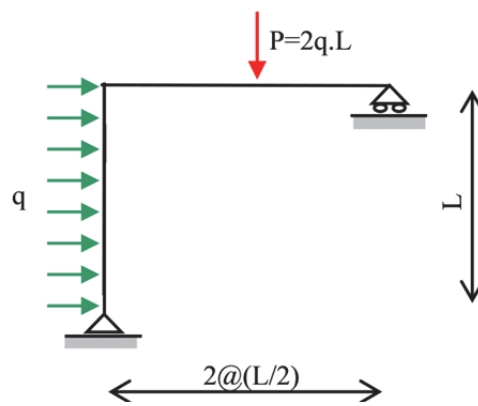


Figure 3.12. Given frame

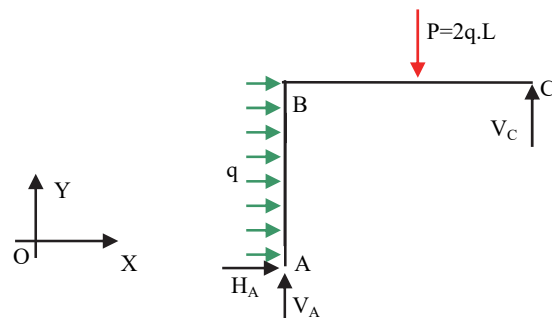


Figure 3.13. Free-body diagram

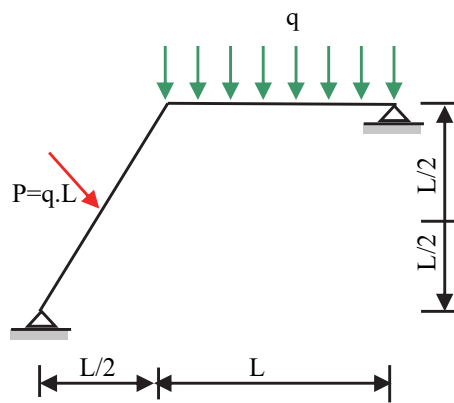


Figure 3.14. *Statically indeterminate frame*

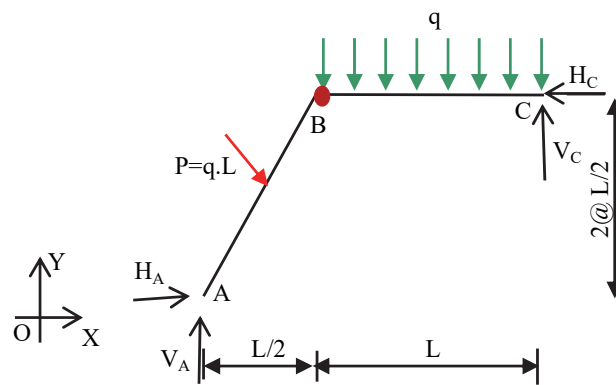


Figure 3.15. *Free-body frame*

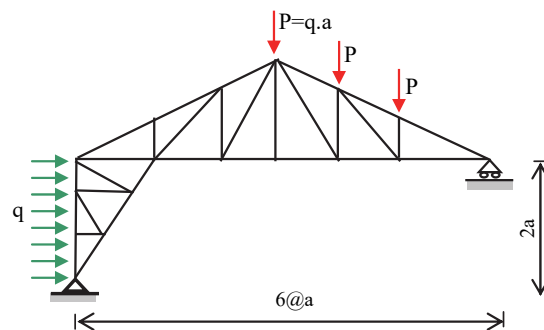


Figure 3.16. *Truss*

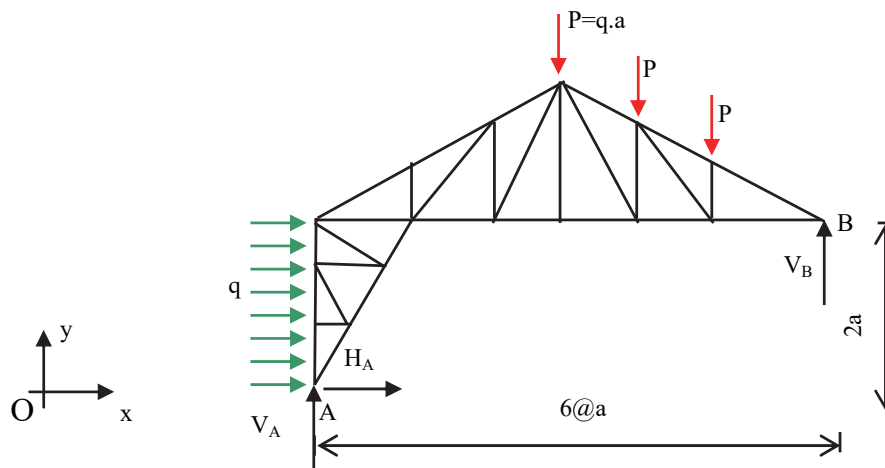


Figure 3.17. Free-body diagram

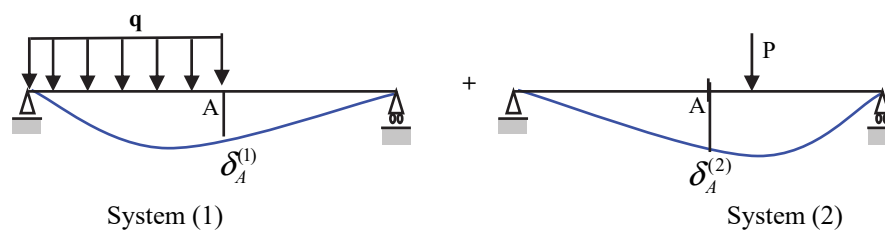


Figure 3.19. Beam deflections

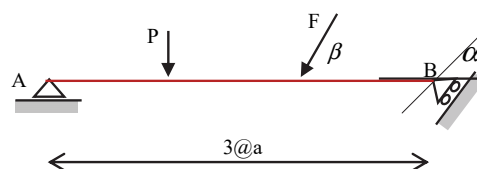


Figure 3.20. Statically determinate beam

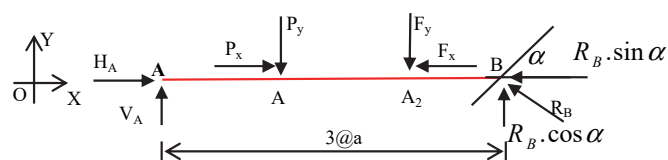


Figure 3.21. Free-body beam

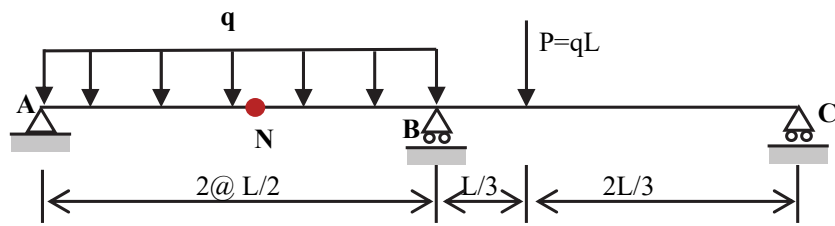


Figure 3.22. Given beam

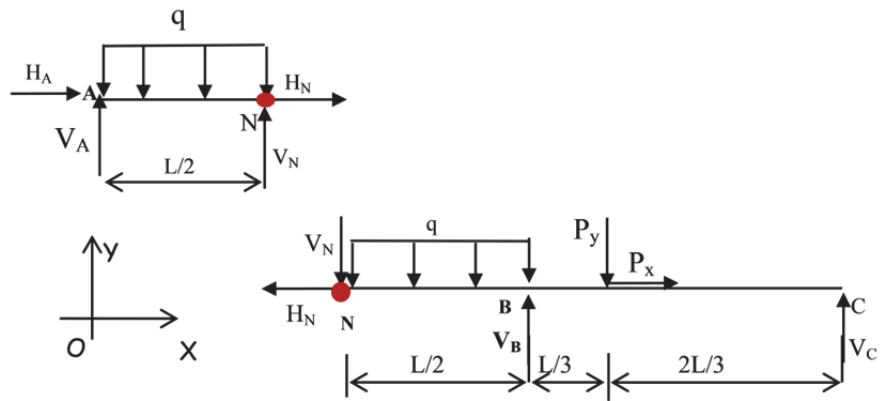


Figure 3.23. Beam decomposition

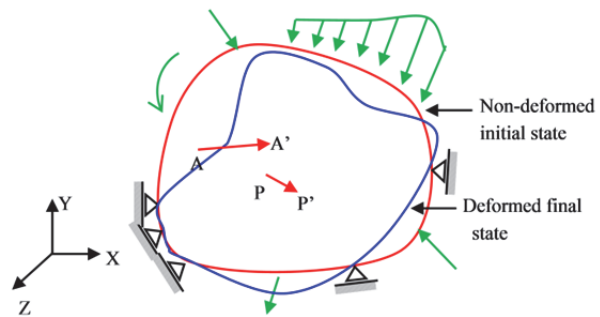


Figure 3.24. Deformation of a structure

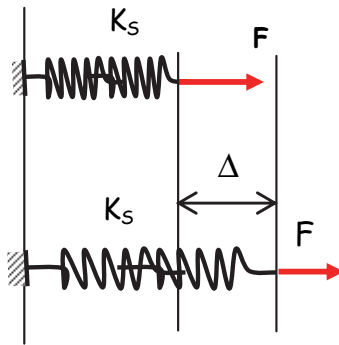


Figure 3.25. “Spring” mechanical model

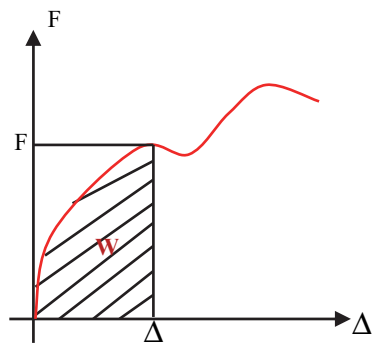


Figure 3.26. Force–displacement relationship

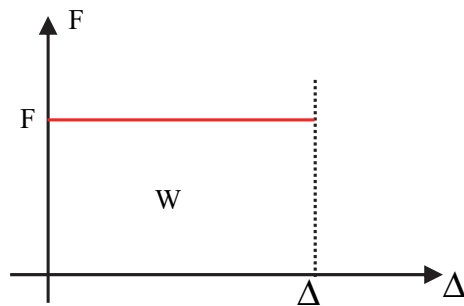


Figure 3.27. Force and displacement are independent

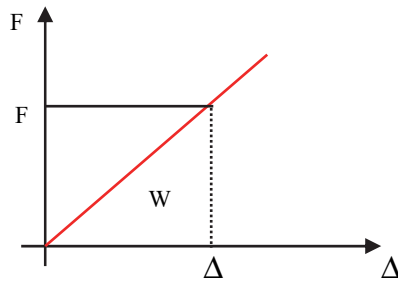


Figure 3.28. Linear behavior law

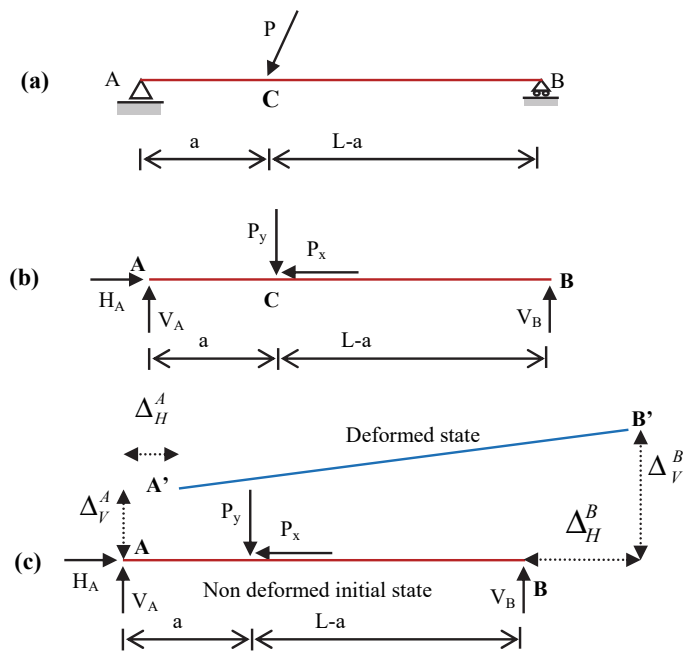


Figure 3.29. Displacements of the beam

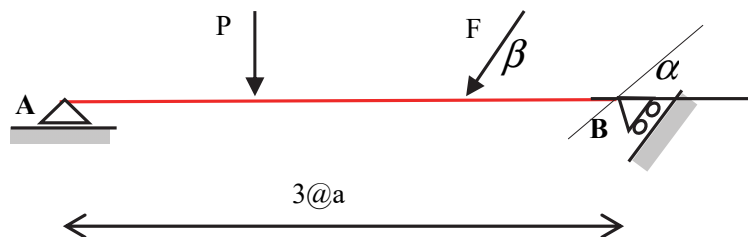


Figure 3.30. Given beam

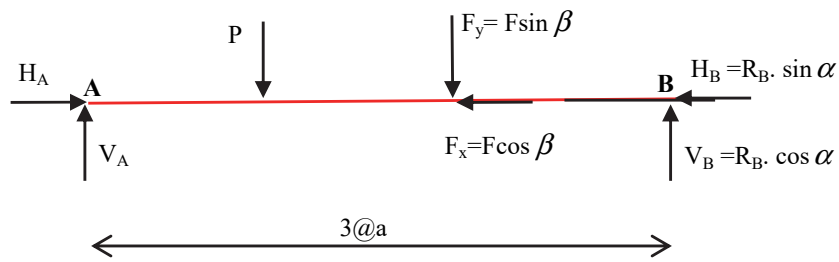


Figure 3.31. Free-body beam

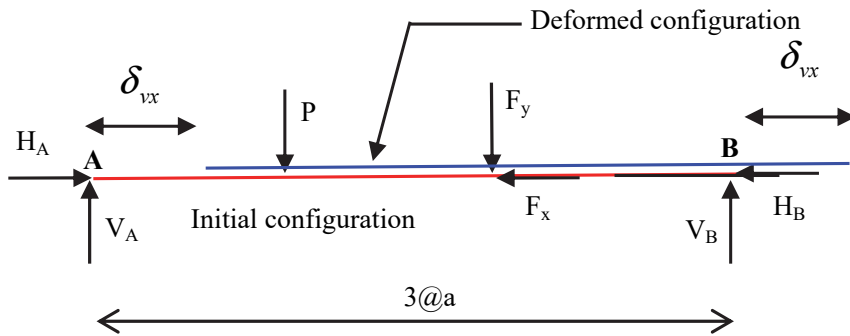


Figure 3.32. Effect of horizontal forces

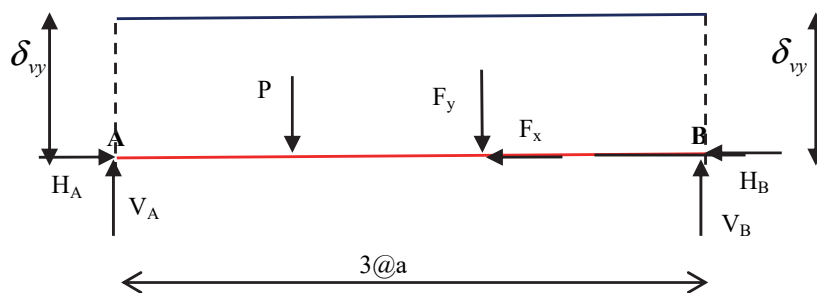


Figure 3.33. Effect of vertical forces

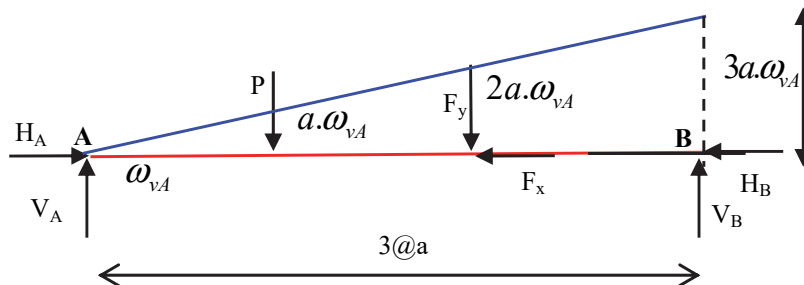
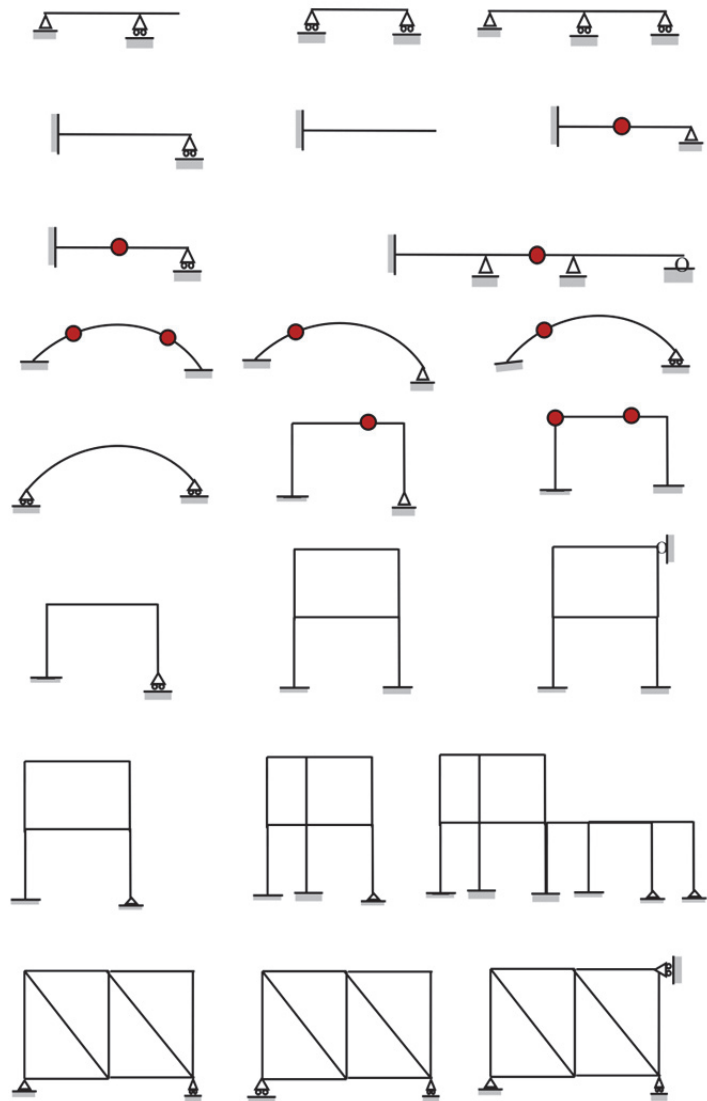
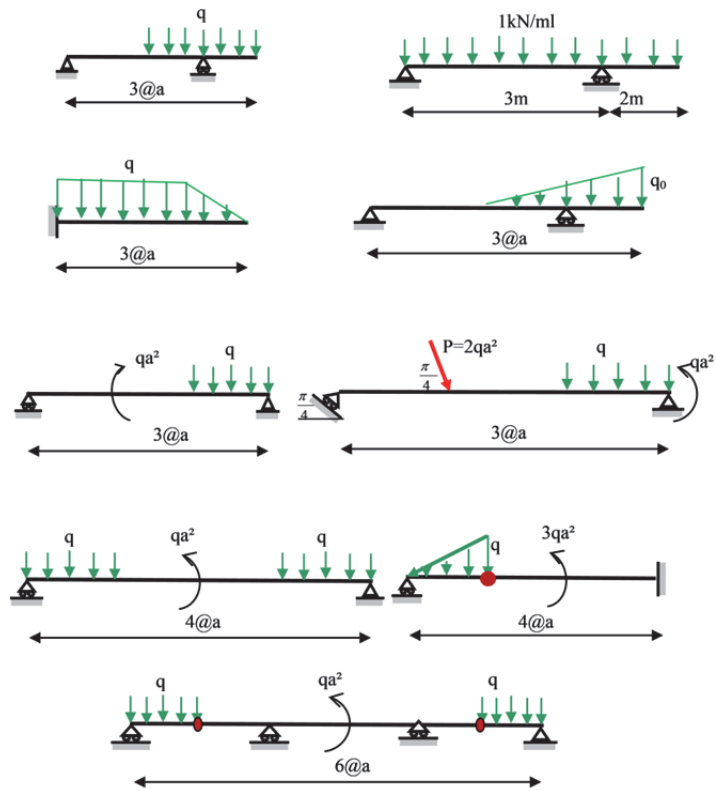


Figure 3.34. Effect of moments

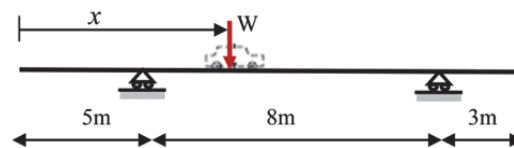
Chapter 3, Exercise 1



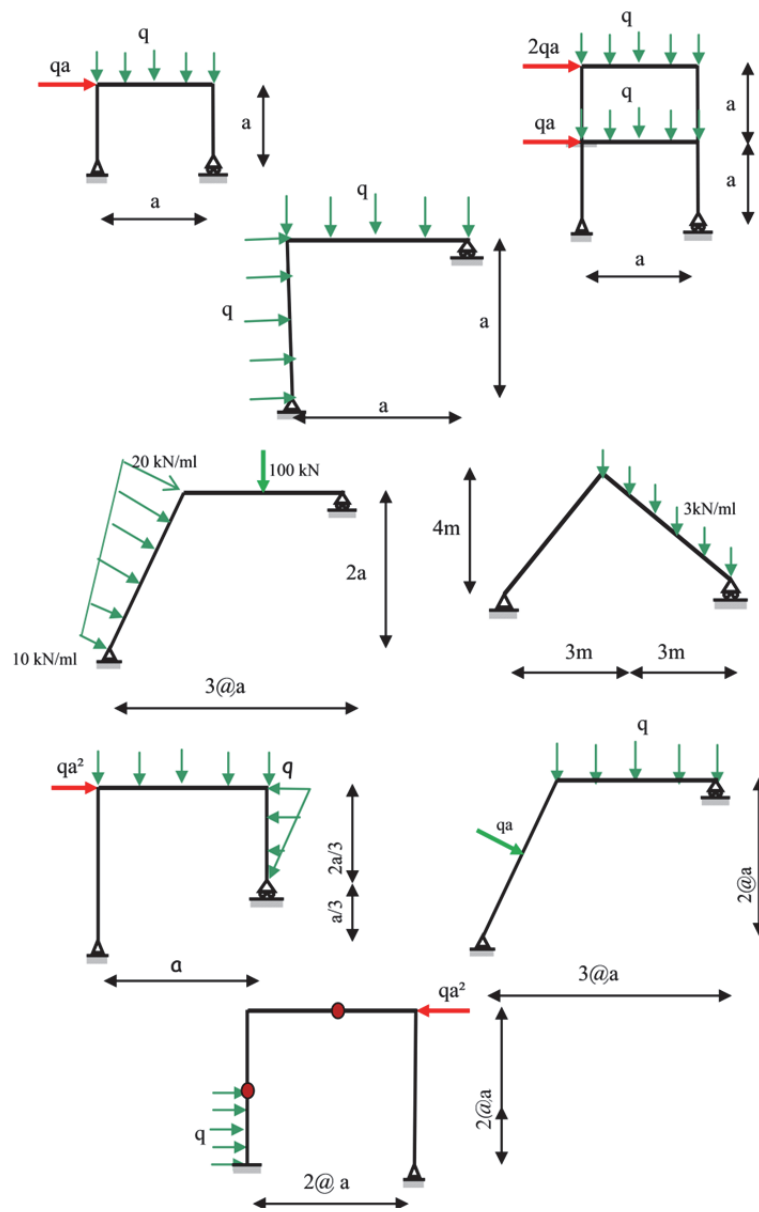
Chapter 3, Exercise 2



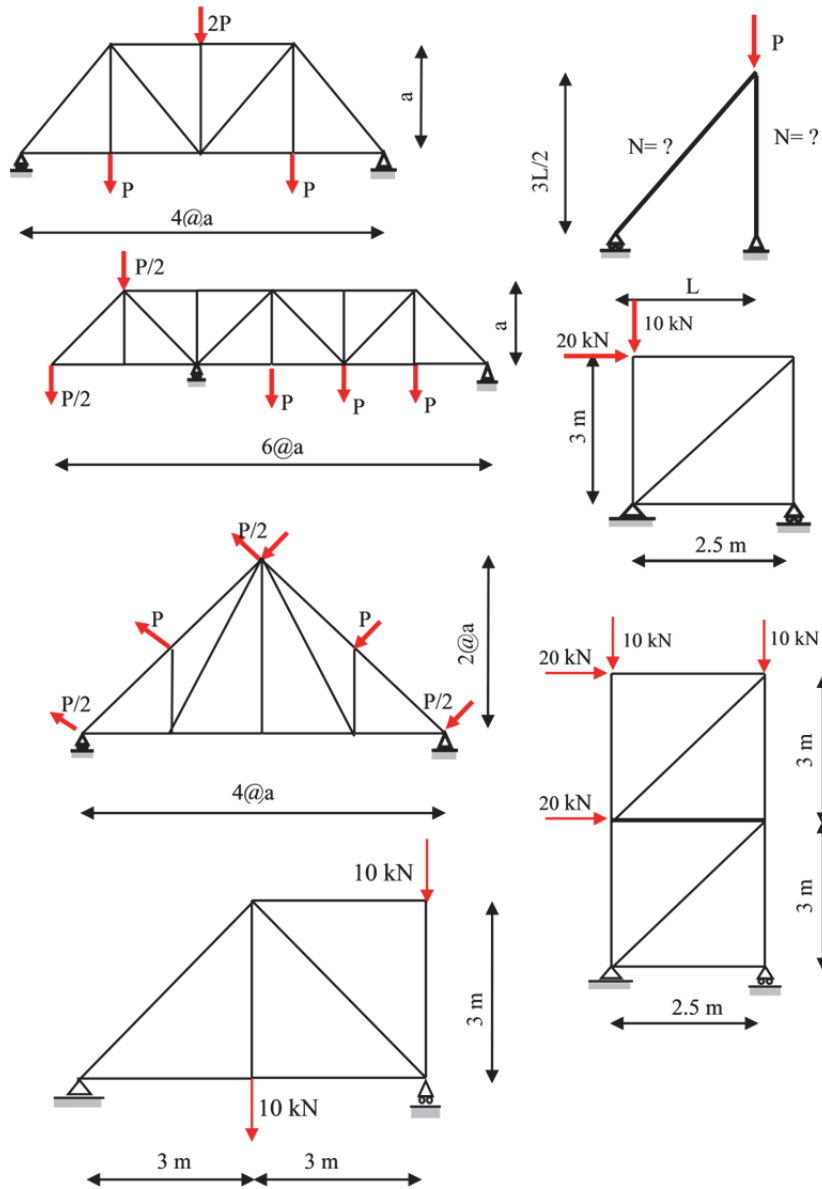
Chapter 3, Exercise 3



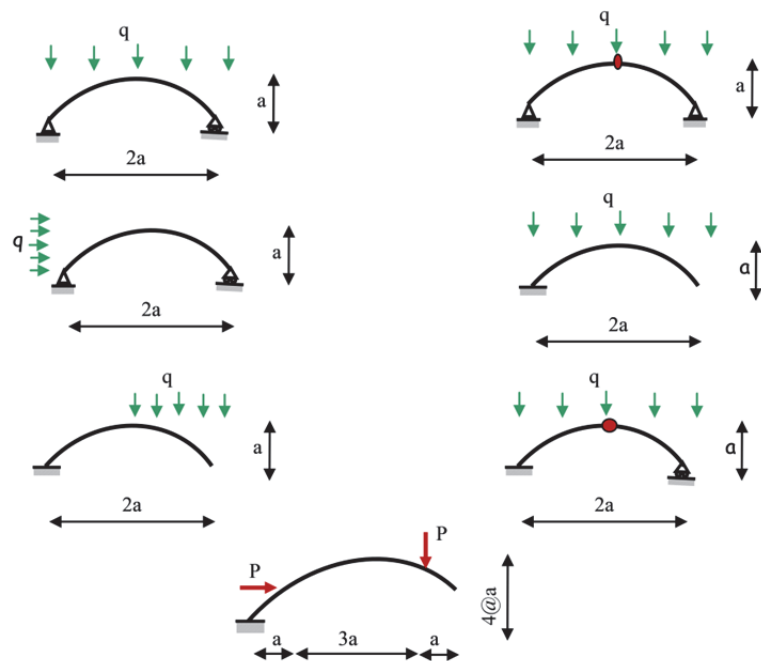
Chapter 3, Exercise 4



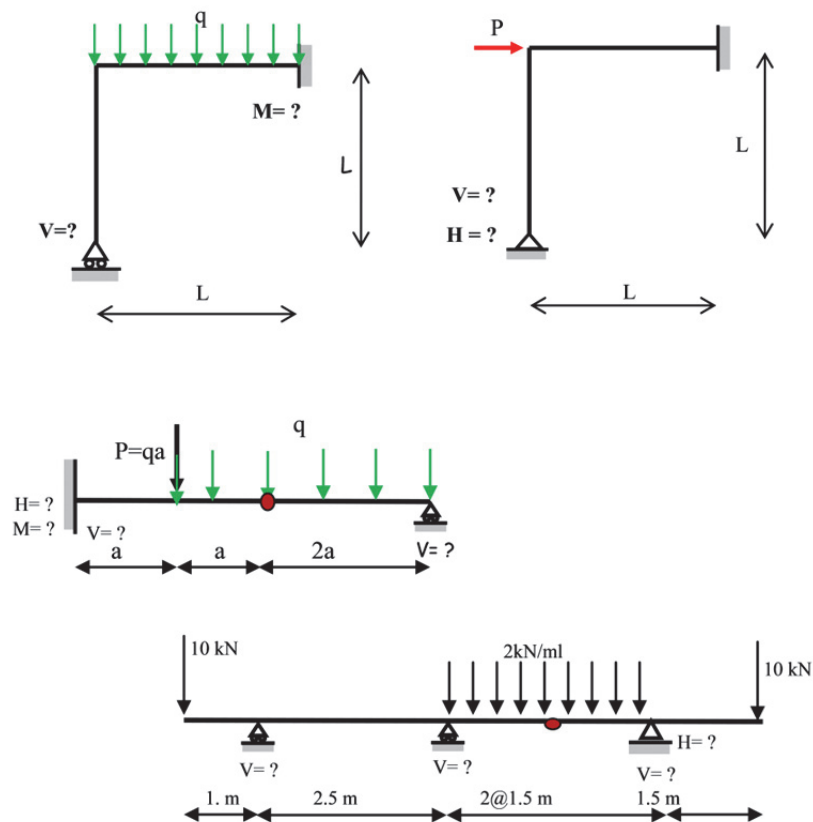
Chapter 3, Exercise 5



Chapter 3, Exercise 6



Chapter 3, Exercise 7



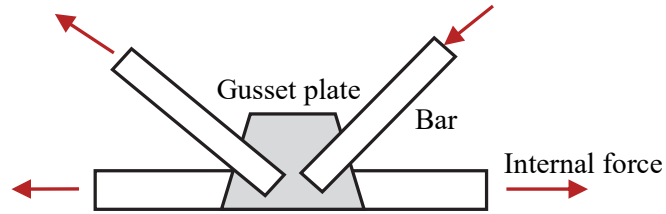


Figure 4.1. *Connecting gusset*

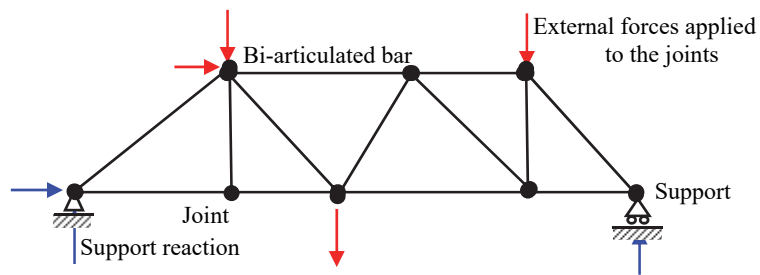


Figure 4.4. *Model of a truss*

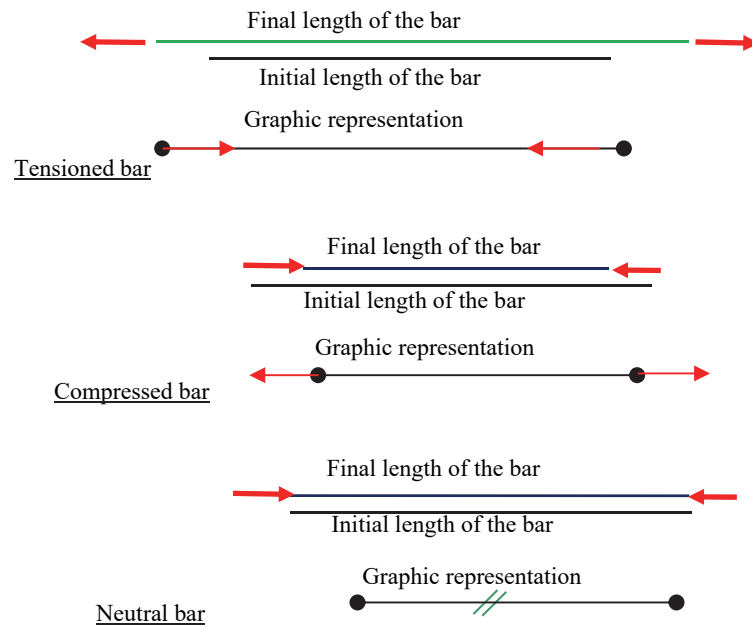


Figure 4.5. *Sign convention*

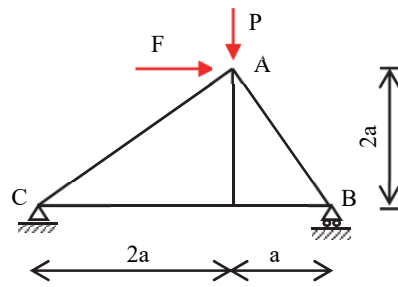


Figure 4.8. Truss

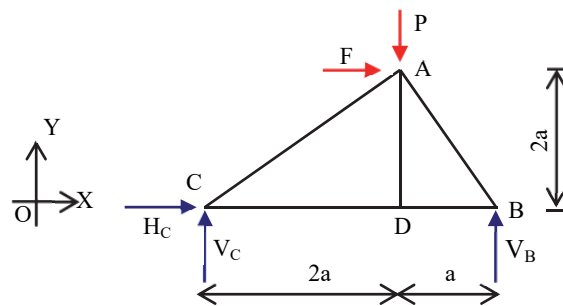
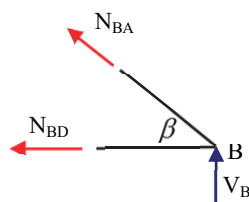
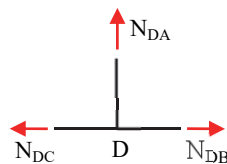
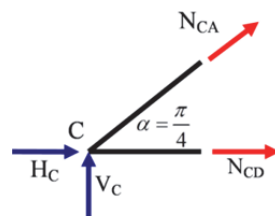


Figure 4.9. Free-body diagram



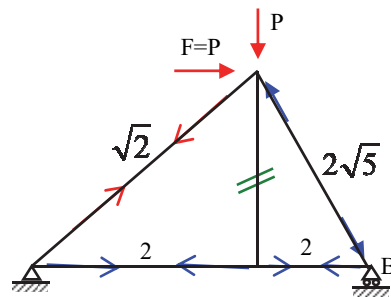
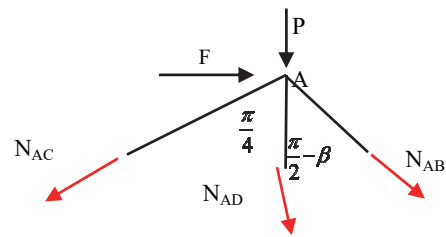


Figure 4.10. Normal force $\left(\frac{P}{3}\right)$

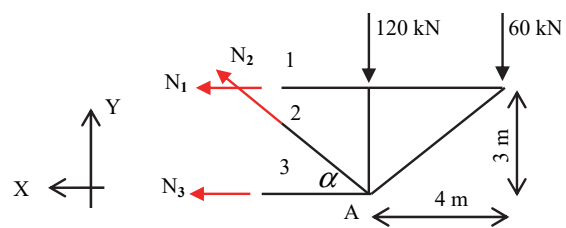


Figure 4.12. Part of the structure proposed

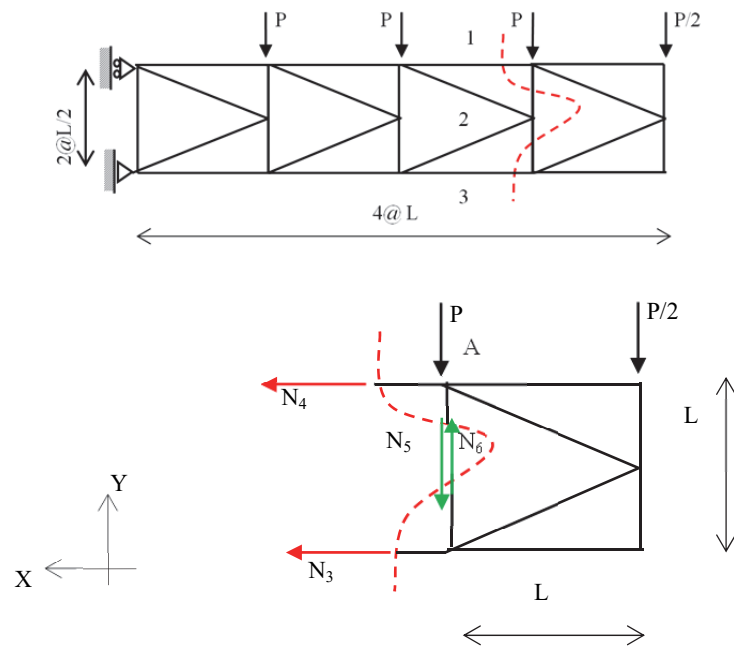


Figure 4.14. Part considered

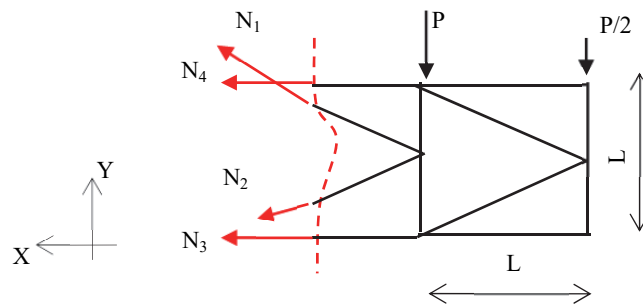


Figure 4.15. Forces on bars 1, 2, and 3

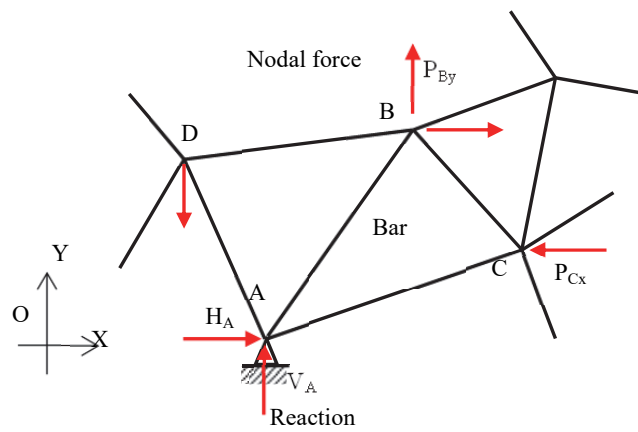


Figure 4.16. Portion of a truss

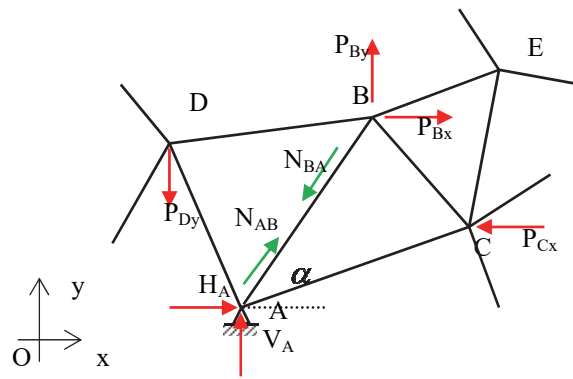


Figure 4.17. Study of bar (AB)

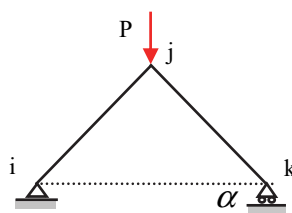


Figure 4.18. Given structure

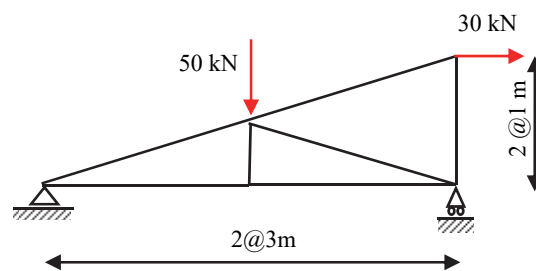


Figure 4.19. Given structure

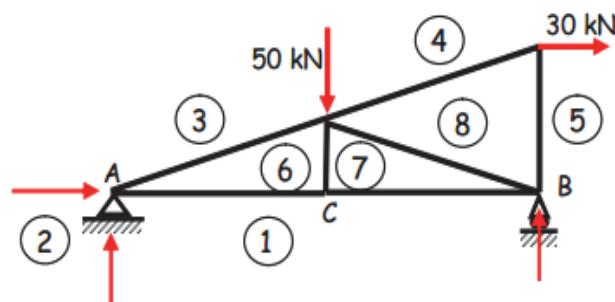


Figure 4.20. Numbering of joints and bars

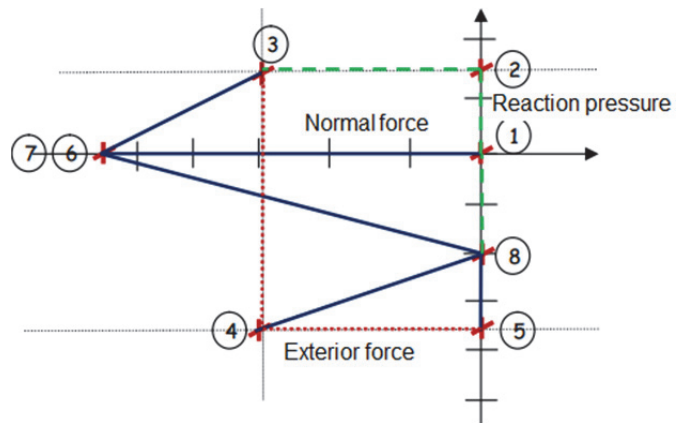


Figure 4.21. Cremona diagram

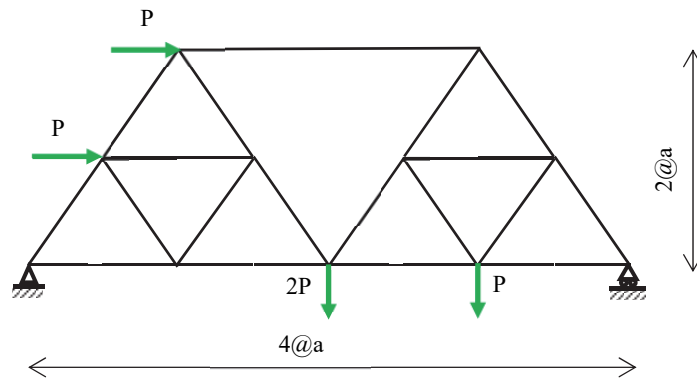


Figure 4.23. Composite structure

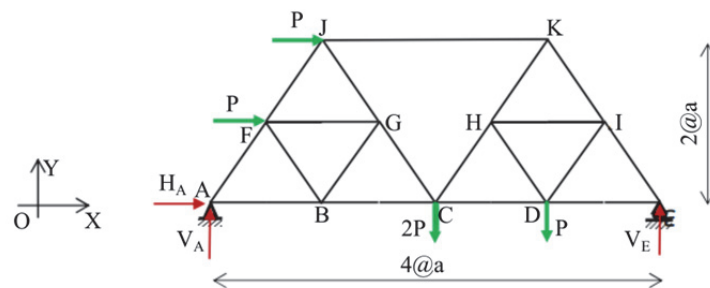


Figure 4.24. Free-body diagram

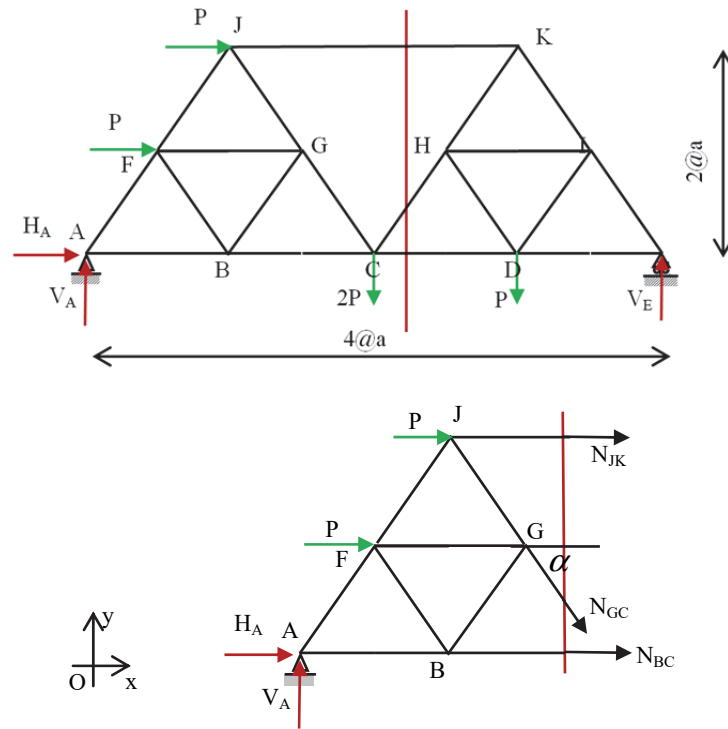
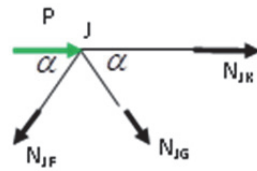
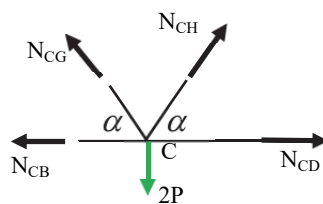
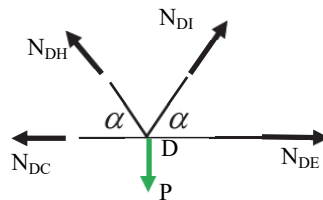


Figure 4.25. Method of sections

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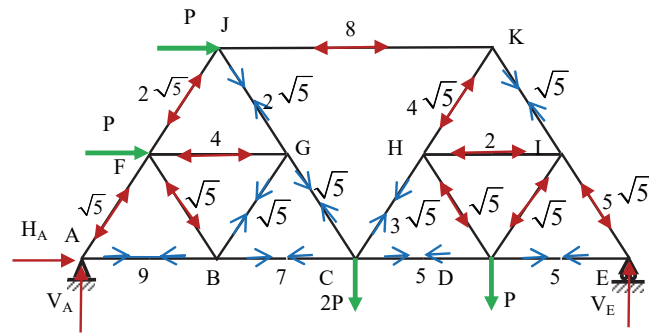


Figure 4.26. Normal force diagram $\ast \left(\frac{P}{4}\right)$

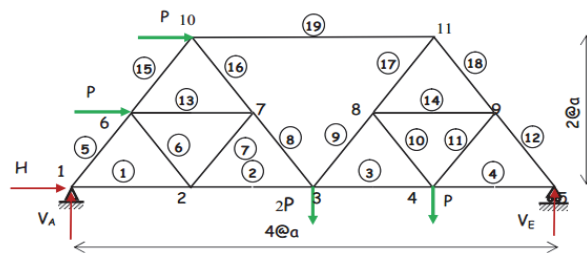


Figure 4.27. Numbering of joints and bars

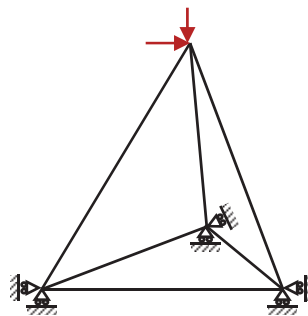


Figure 4.29. Space truss

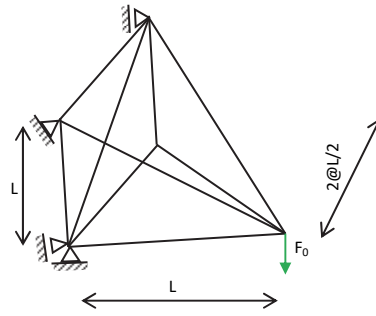


Figure 4.30. Spatial truss

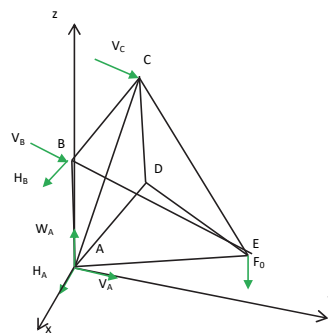
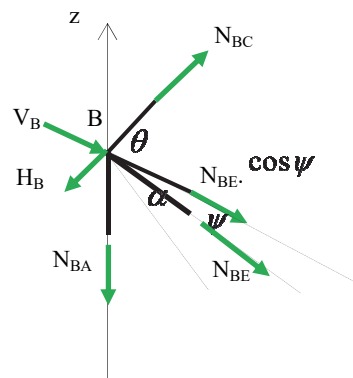
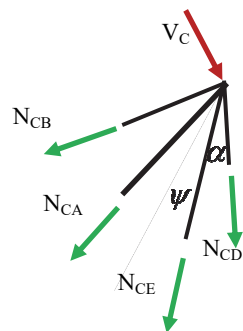
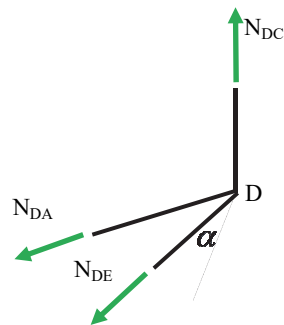
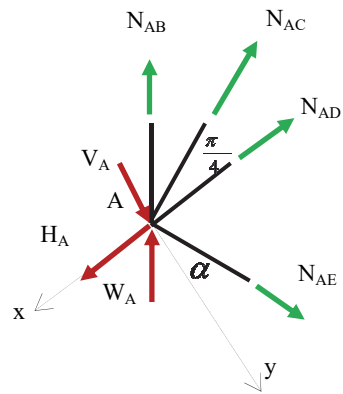


Figure 4.31. Free-body diagram





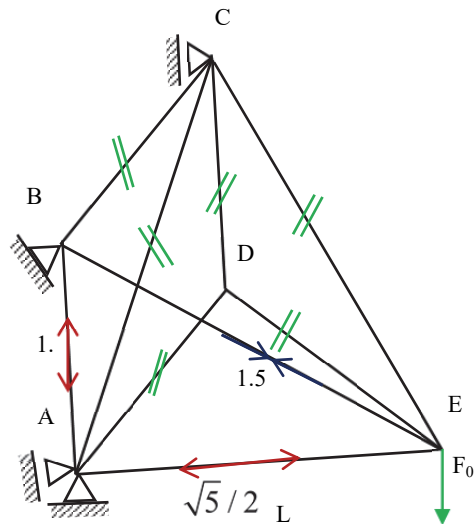
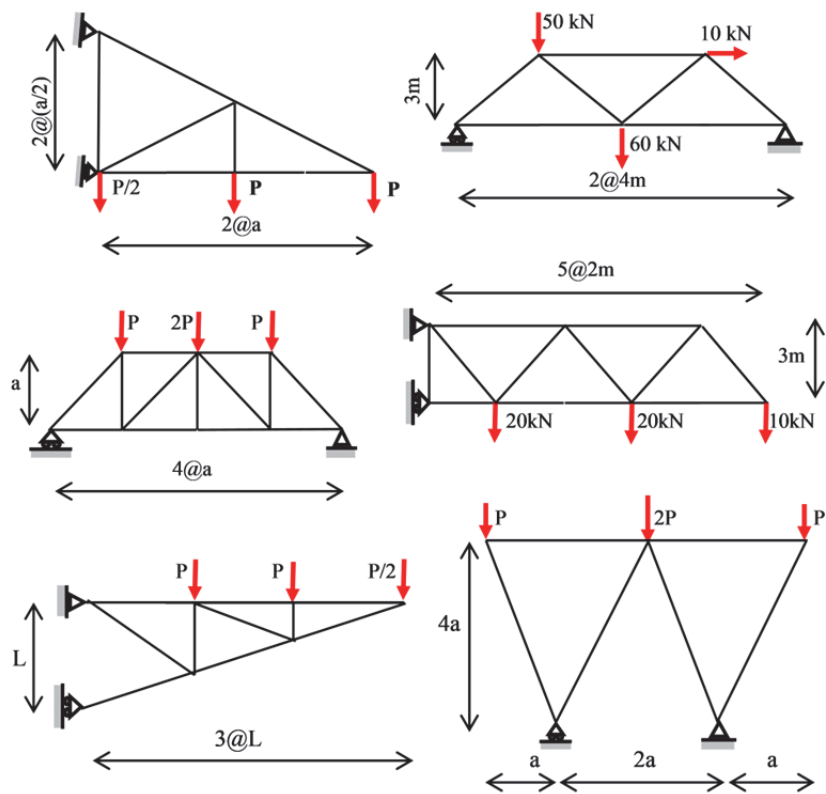
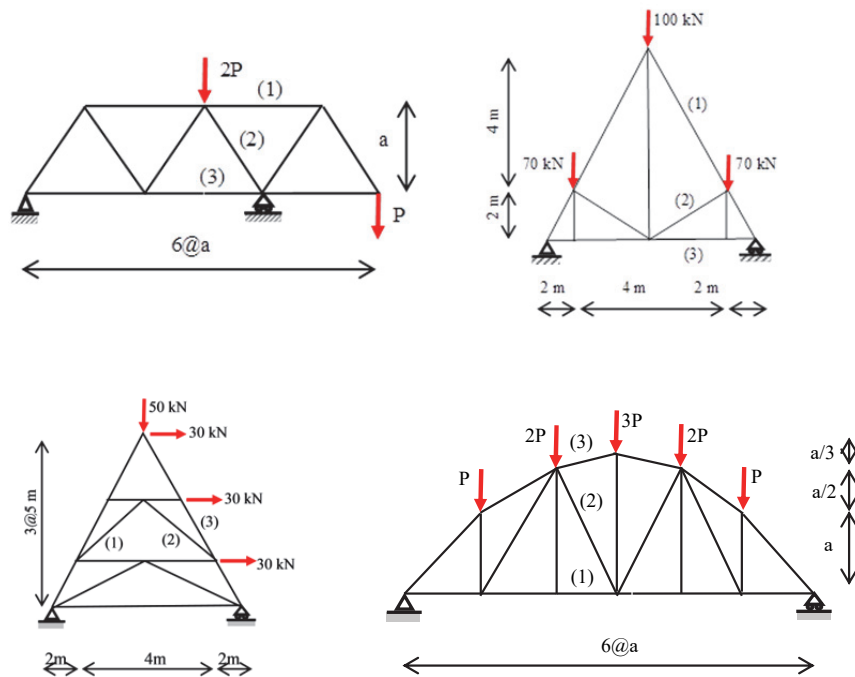


Figure 4.32. Normal force on the bars $\ast(F_0)$

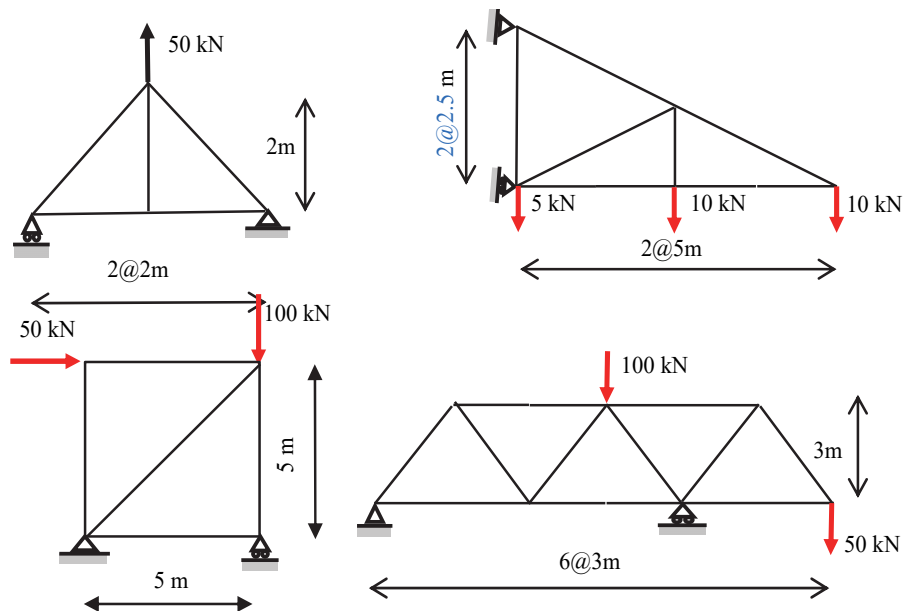
Chapter 4, Exercise 2

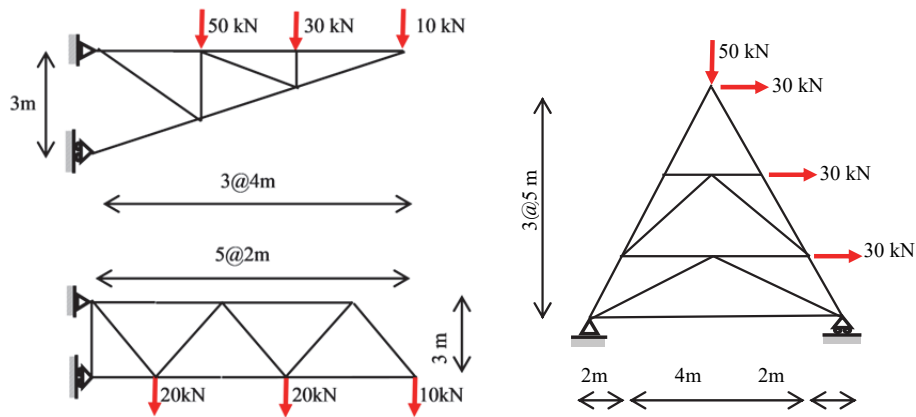


Chapter 4, Exercise 3

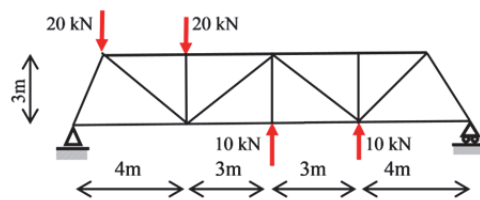
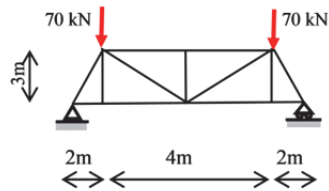
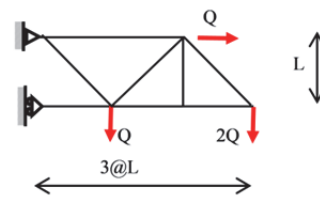
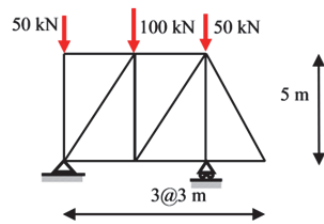
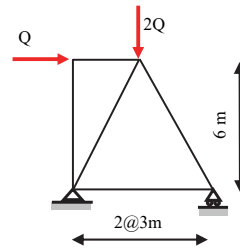
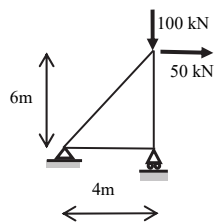


Chapter 4, Exercise 4

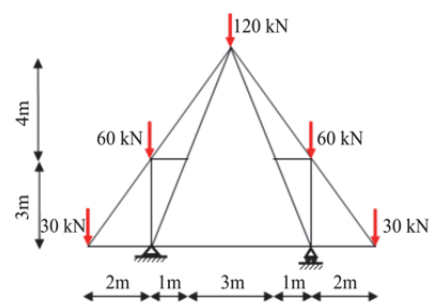
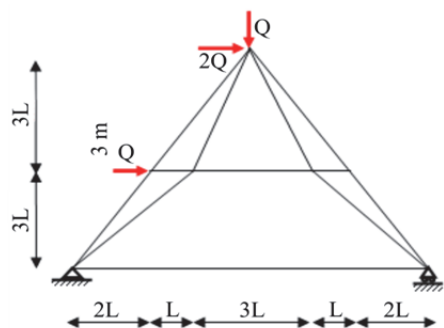
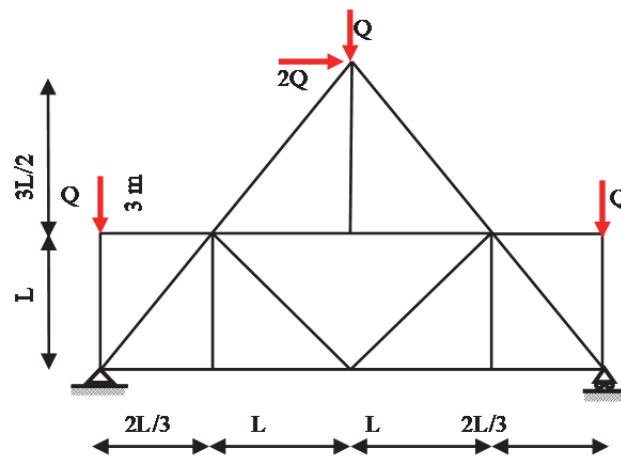
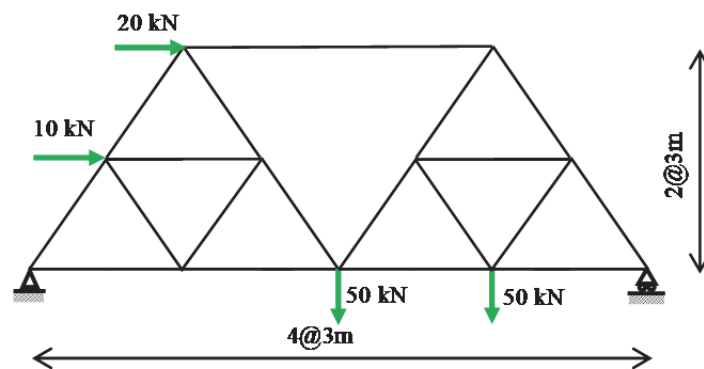
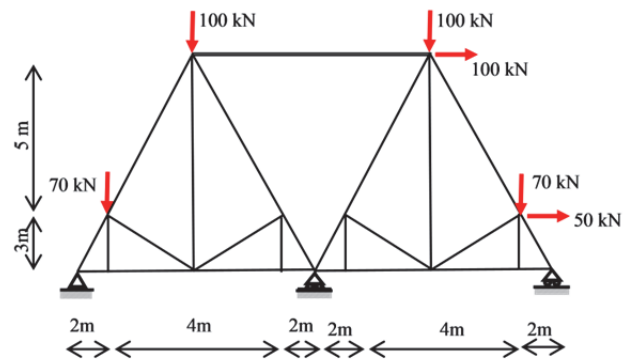




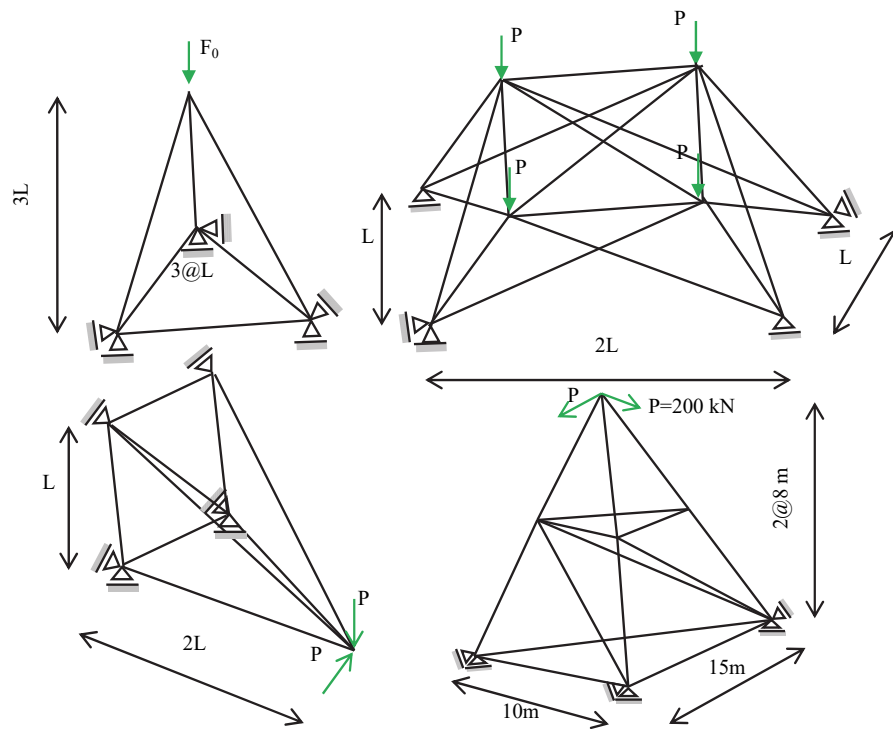
Chapter 4, Exercise 5



Chapter 4, Exercise 6



Chapter 4, Exercise 7



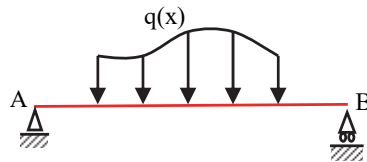


Figure 5.1. Studied beam

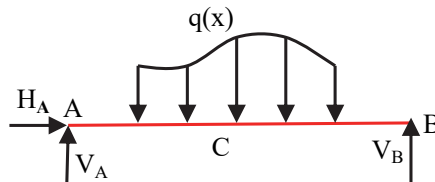


Figure 5.2. Free-body beam

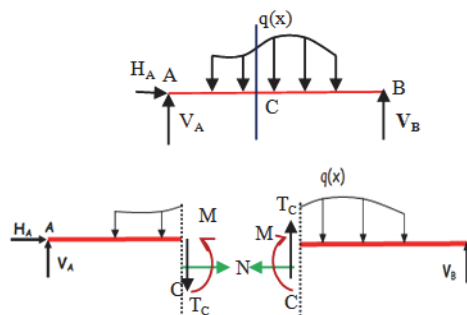


Figure 5.3. Internal actions at any section

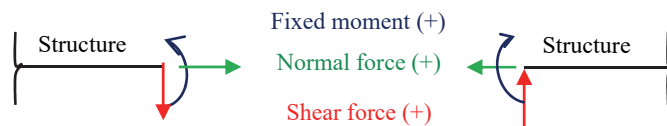


Figure 5.4. Sign convention

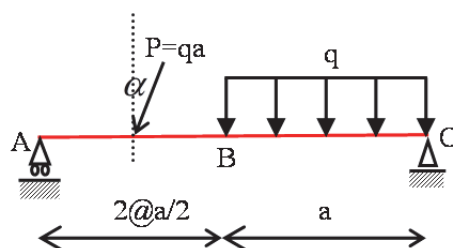


Figure 5.5. Given beam

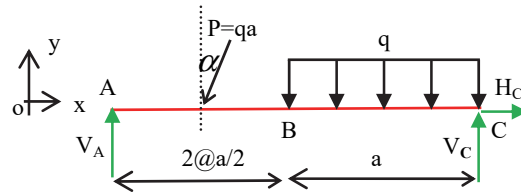


Figure 5.6. Free-body beam

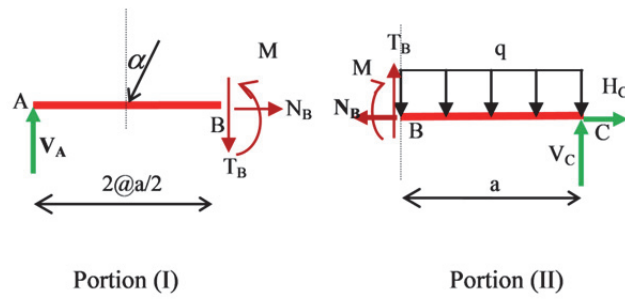


Figure 5.7. Reduction elements of section B

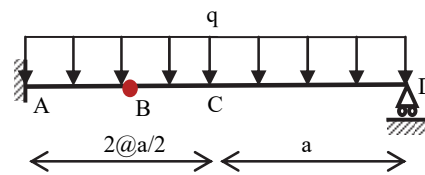


Figure 5.8. Given beam

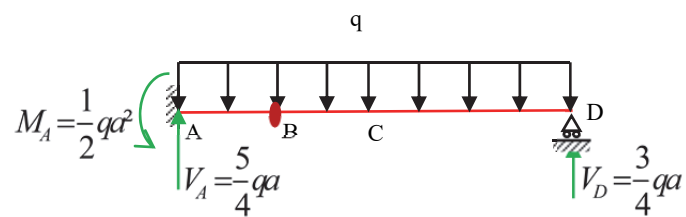


Figure 5.9. Support reactions

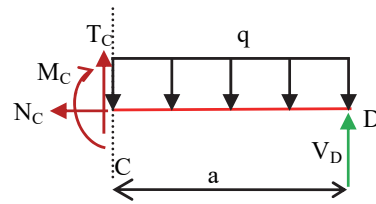
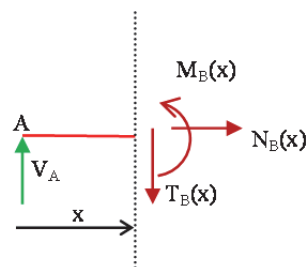
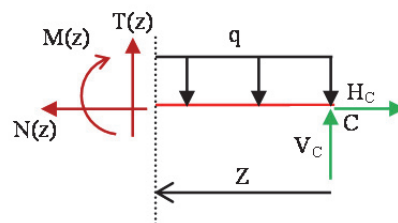
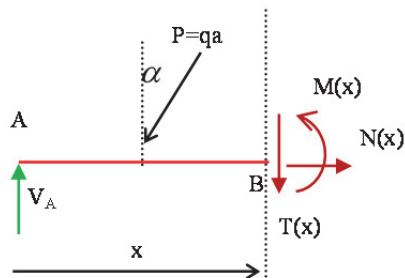


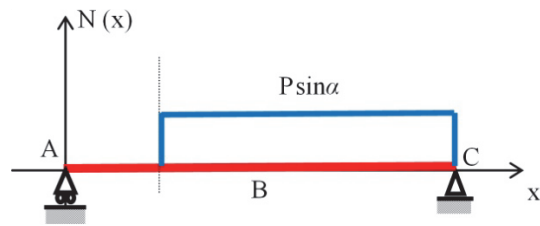
Figure 5.10. Right portion

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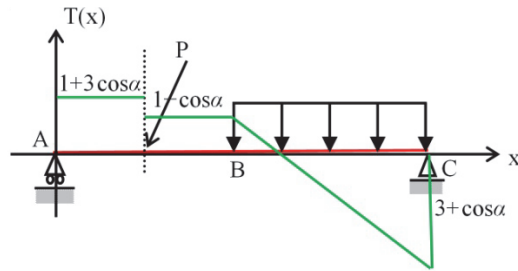


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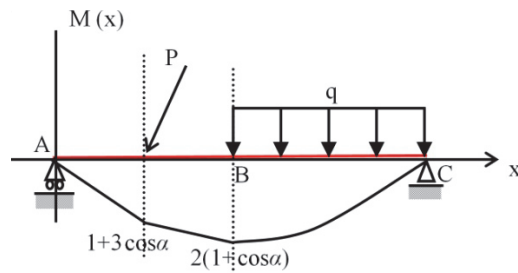




Normal force diagram



Shear force diagram $\ast(\frac{qa}{4})$



Bending moment diagram $\ast(\frac{qa^2}{8})$

Figure 5.11. Diagram of internal actions

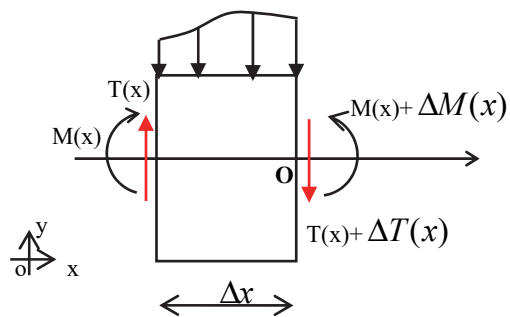


Figure 5.12. Study of an element Δx

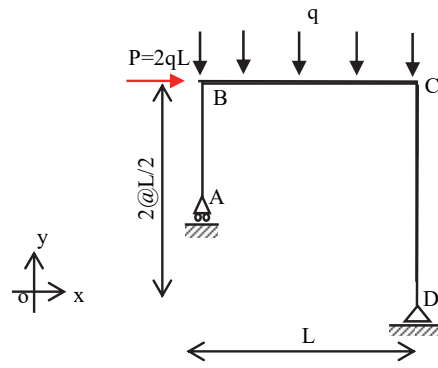


Figure 5.14. *Given frame*

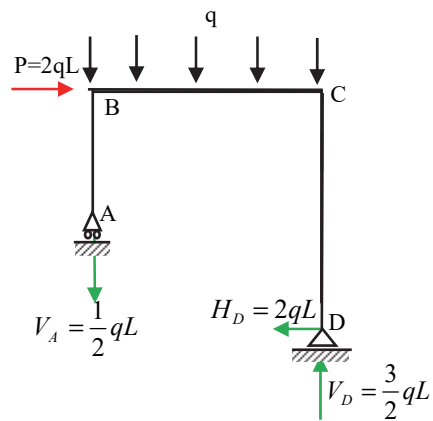


Figure 5.15. *Support reactions*

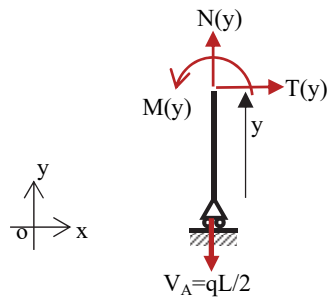


Figure 5.16. *Bar (AB)*

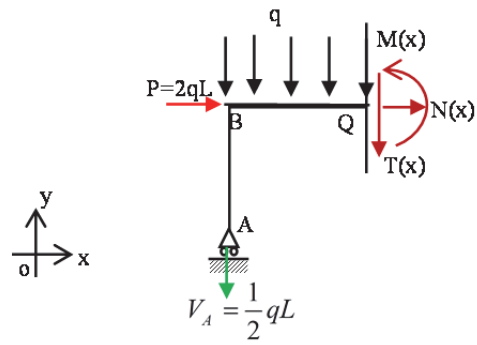


Figure 5.17. Bar (BC)

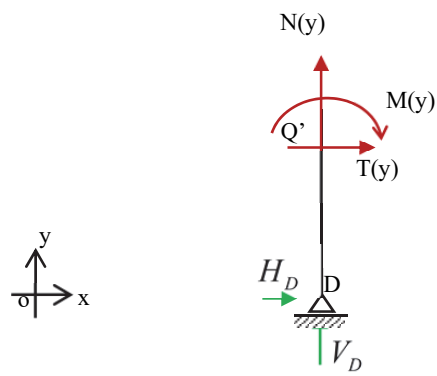


Figure 5.18. Bar (CD)

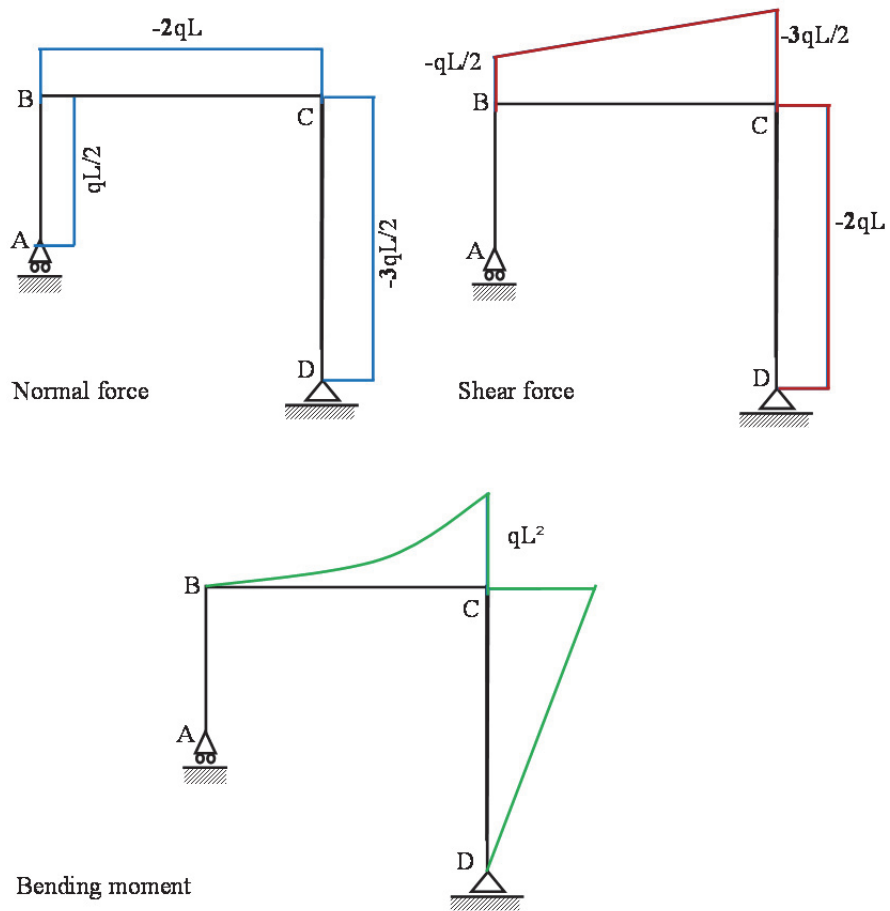


Figure 5.19. Diagram of internal actions

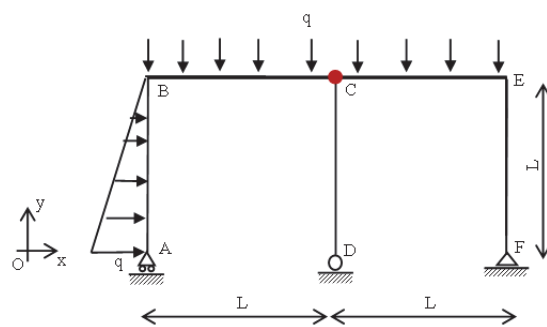


Figure 5.20. Given frame

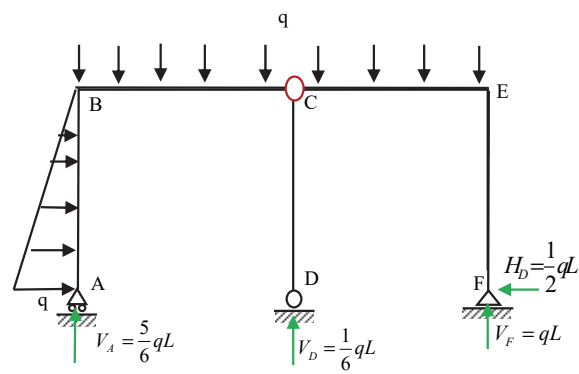
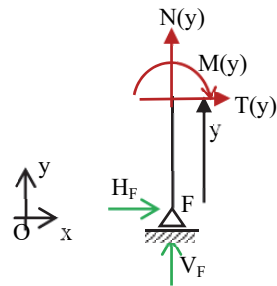
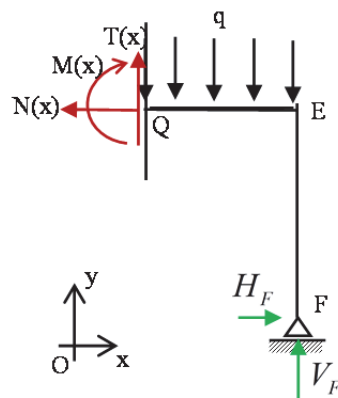


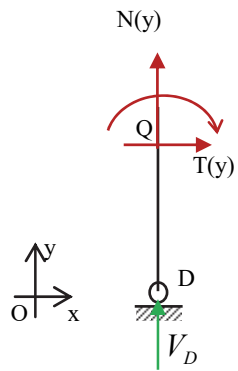
Figure 5.21. Support reactions

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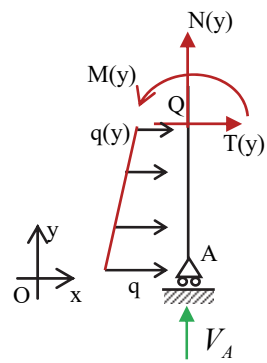


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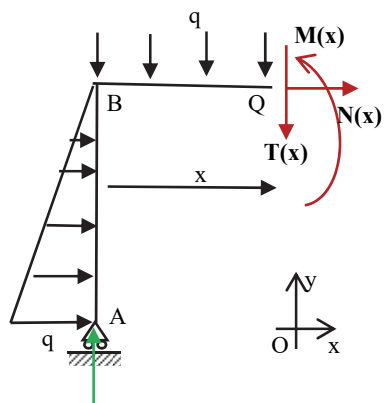




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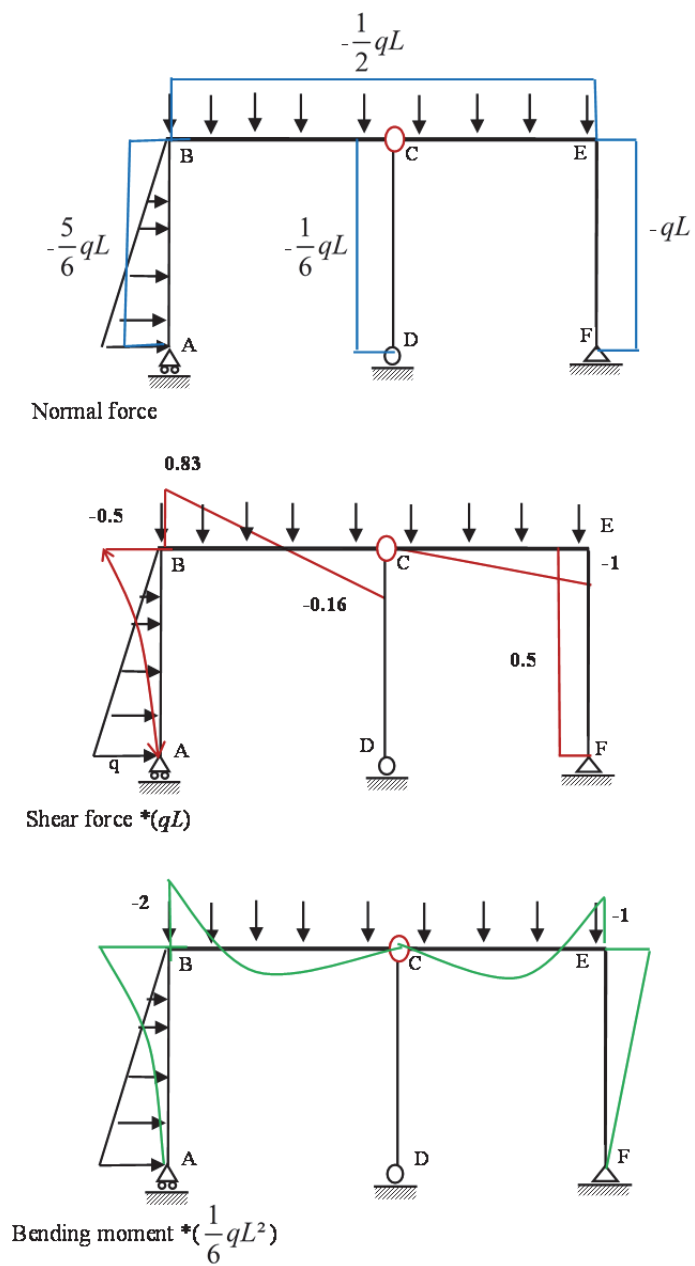
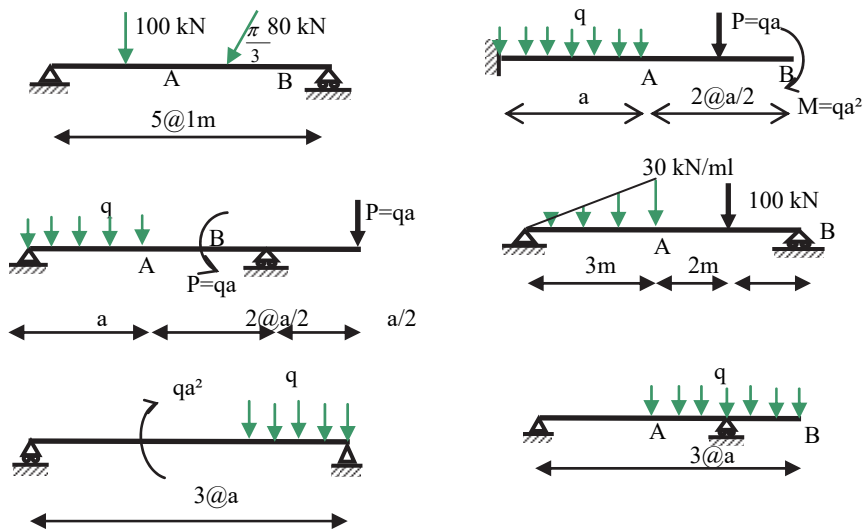
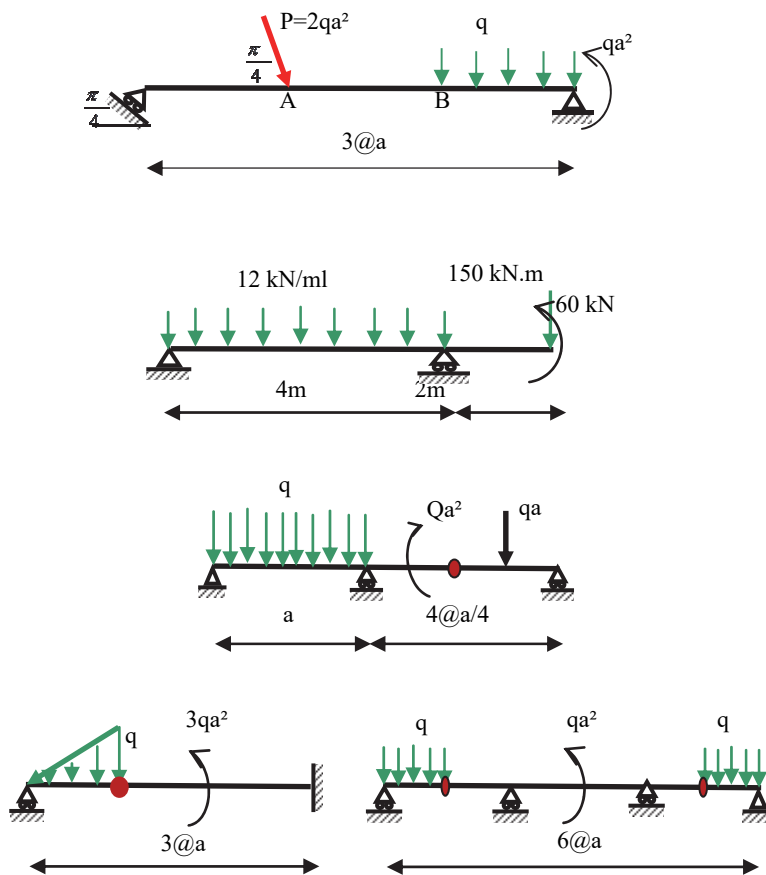


Figure 5.22. Diagrams of internal actions

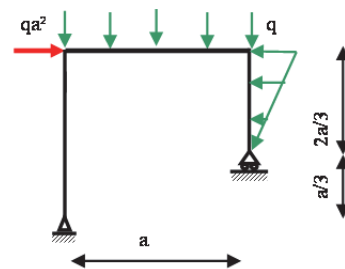
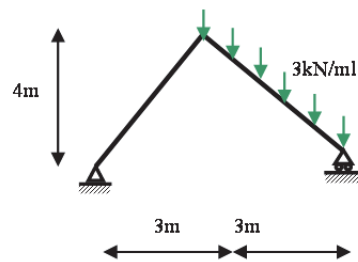
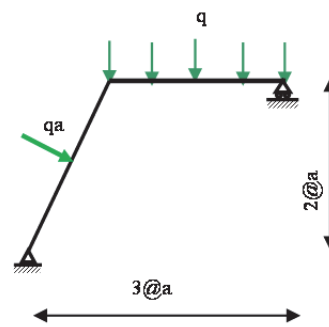
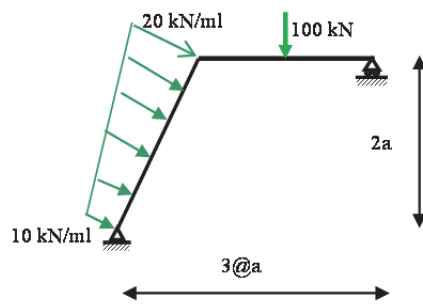
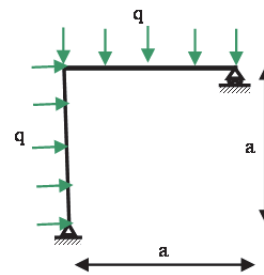
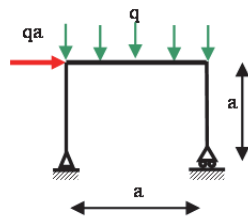
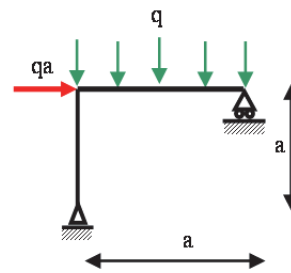
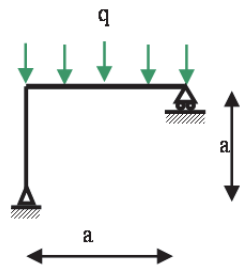
Chapter 5, Exercise 3

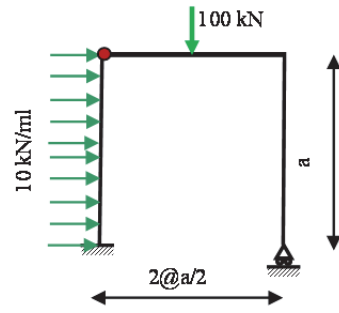
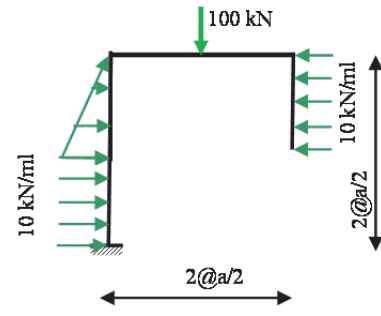
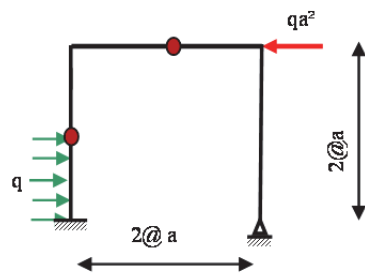


Chapter 5, Exercise 4



Chapter 5, Exercise 5





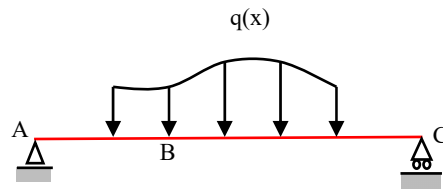


Figure 6.1. Studied beam

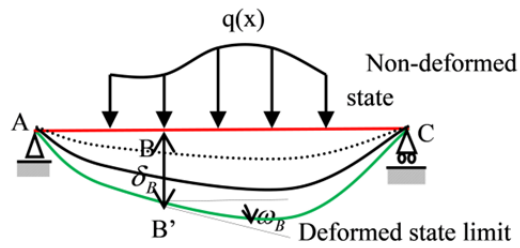


Figure 6.2. Deformed beam

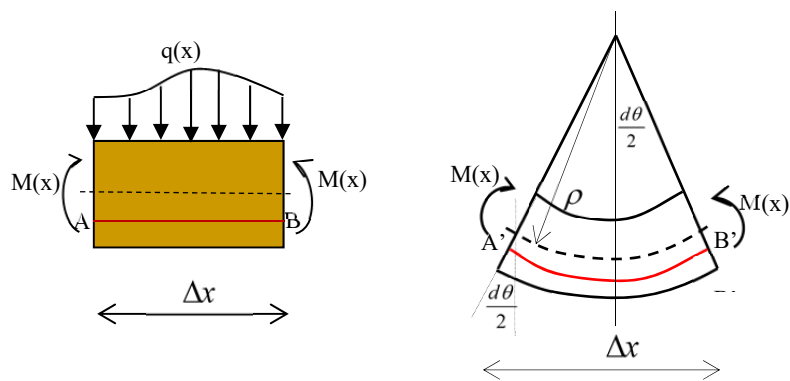


Figure 6.3. Deflection of element Δx

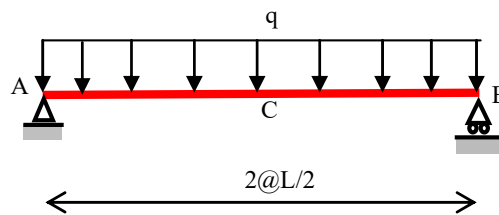


Figure 6.4. Given beam

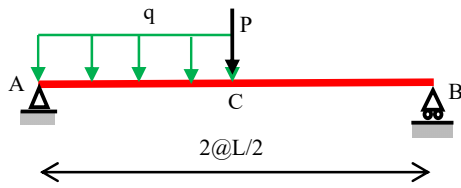


Figure 6.5. *Given beam*

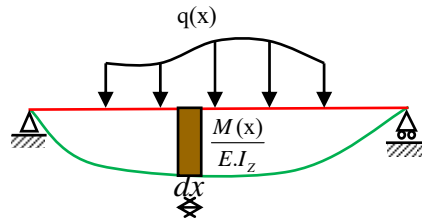


Figure 6.6. *Deformed beam*

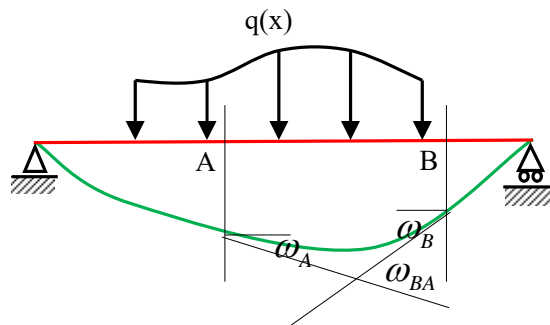


Figure 6.7. *Relationships of sections A and B*

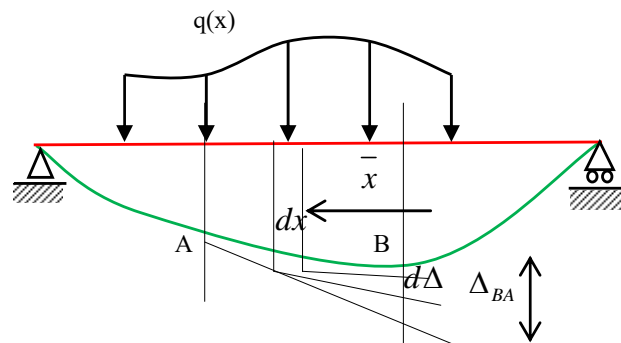


Figure 6.8. *Displacements of points A and B*

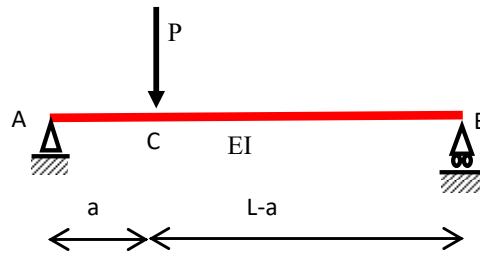


Figure 6.9. *Given beam*

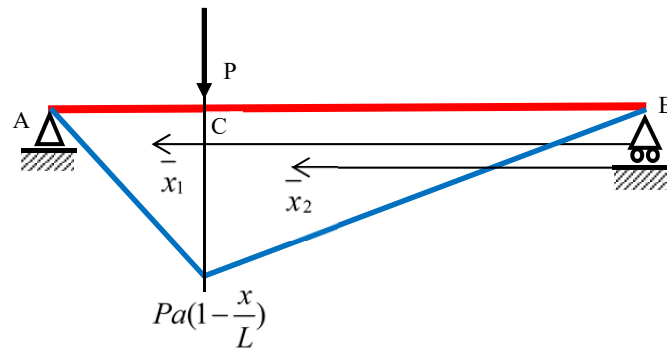


Figure 6.10. *Bending moment diagram*

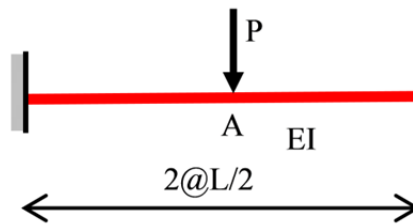


Figure 6.11. *Given cantilever*

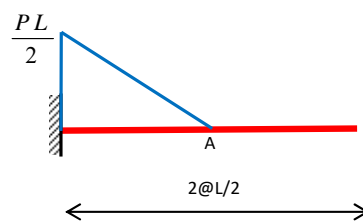


Figure 6.12. *Bending moment diagram*

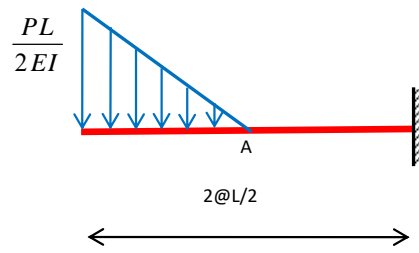


Figure 6.13. Conjugate beam loading

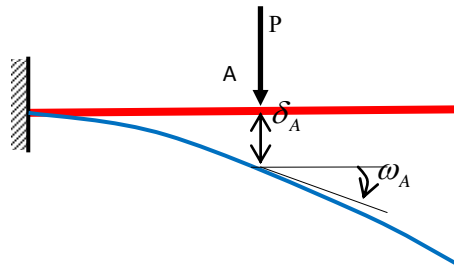


Figure 6.14. Deformed cantilever

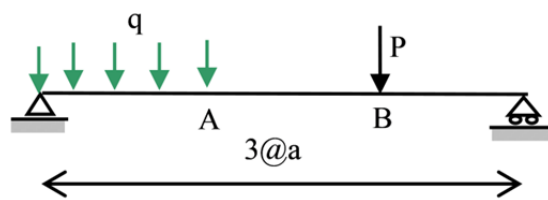


Figure 6.15. Given beam

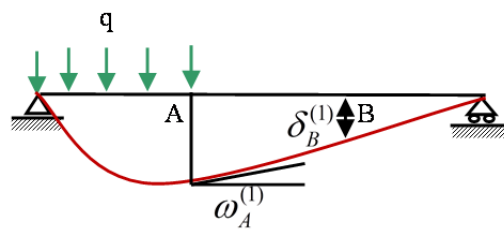


Figure 6.16. Load force q

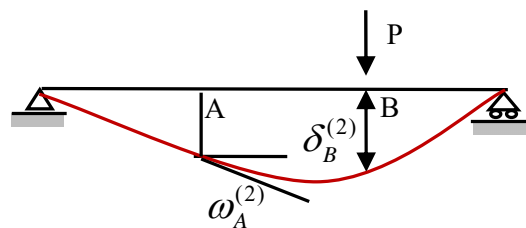


Figure 6.17. Load force P

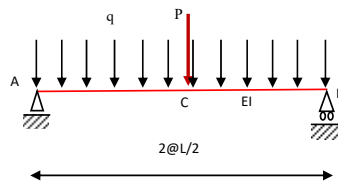
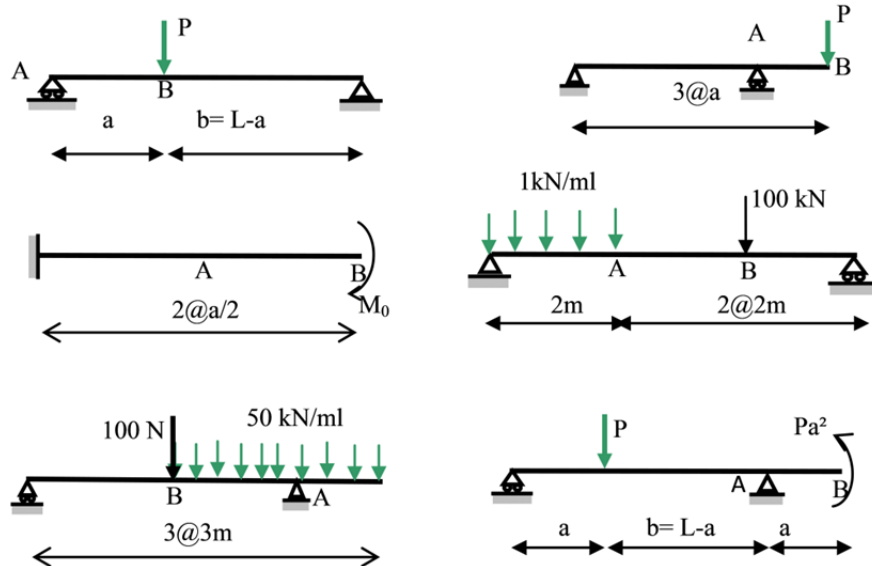
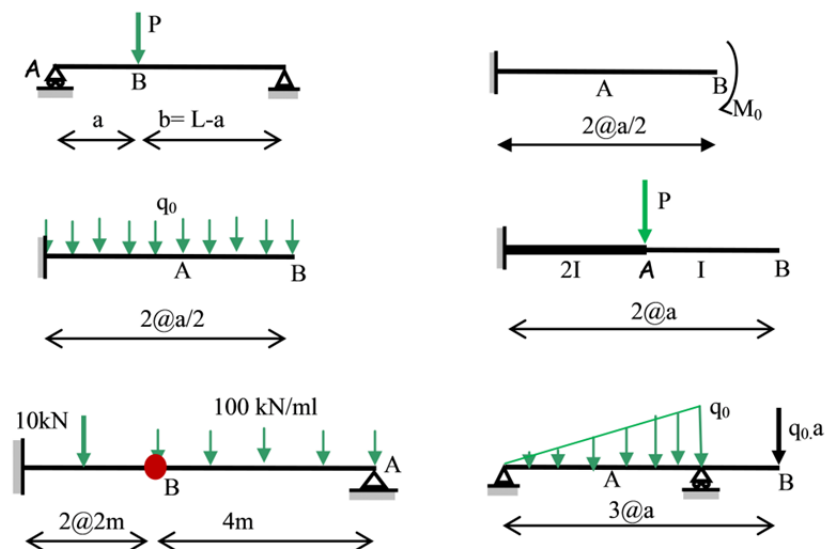


Figure 6.18. Given beam

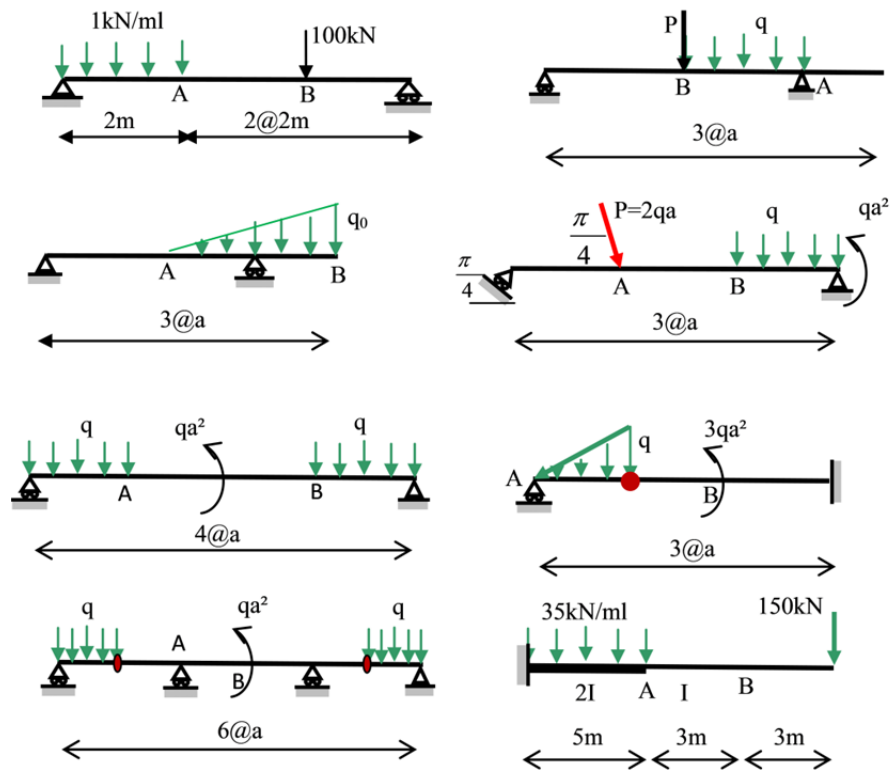
Chapter 6, Exercise 1



Chapter 6, Exercise 3



Chapter 6, Exercise 4



Chapter 6, Exercise 5

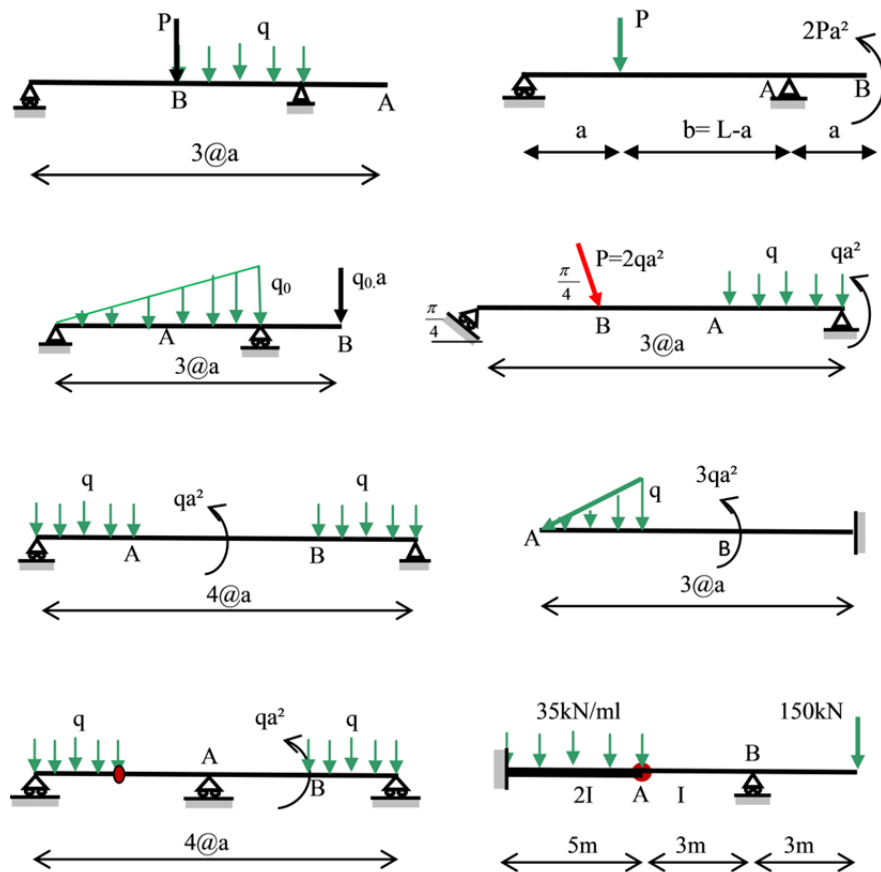




Figure 7.1. Axial force

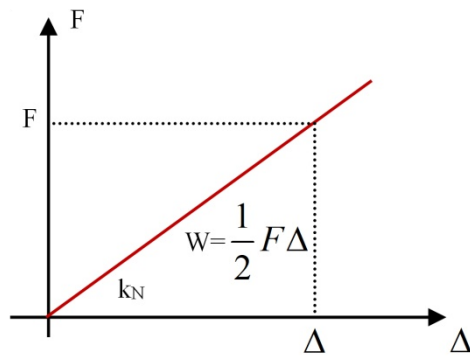


Figure 7.2. Work of force F

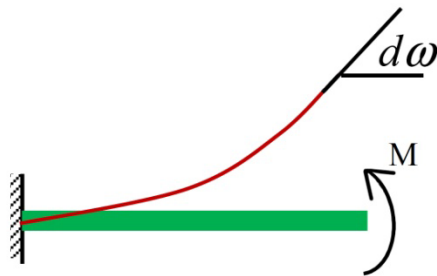


Figure 7.3. Bending moment

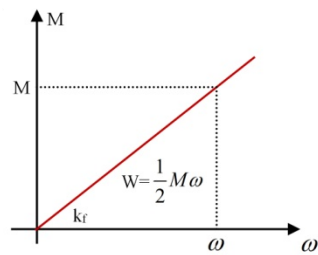


Figure 7.4. Mechanical work of moment M

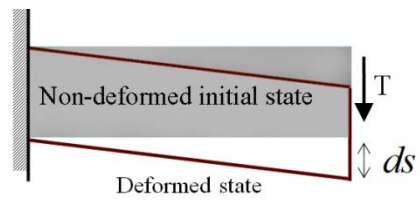


Figure 7.5. Transversal or shear force

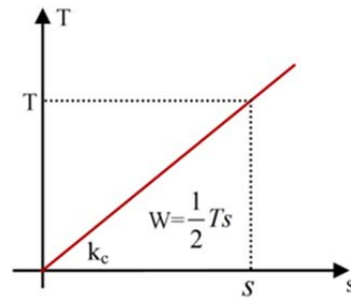


Figure 7.6. Work of transversal force

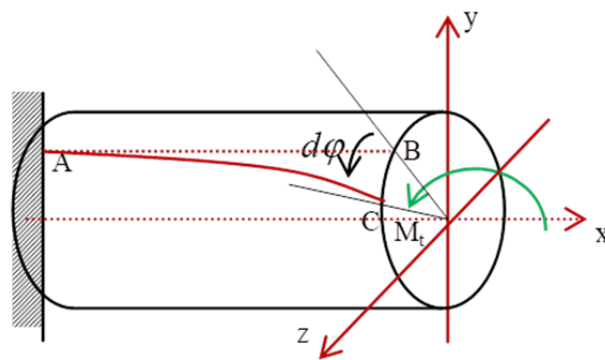


Figure 7.7. Angular deformation due to torque moment

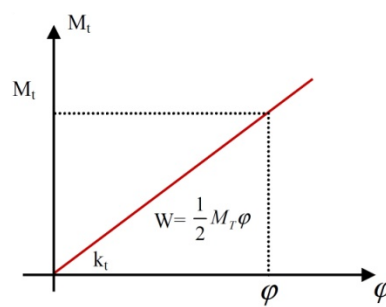


Figure 7.8. Work of torque moment

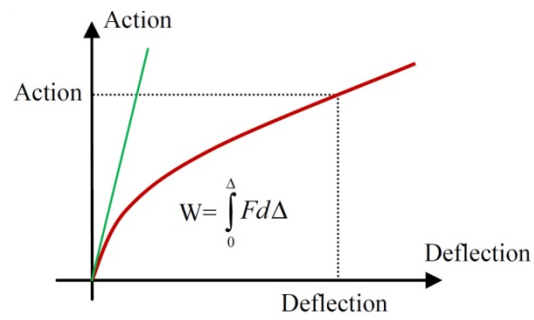


Figure 7.9. *Work of force F*

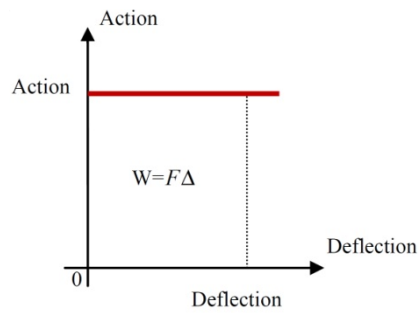


Figure 7.10. *Work of an action independent of deflection*



Figure 7.11. *Normal force*



Figure 7.12. *Bending moment*



Figure 7.13. *Normal force*



Figure 7.14. *Bar deflection*



Figure 7.15. *Bending*

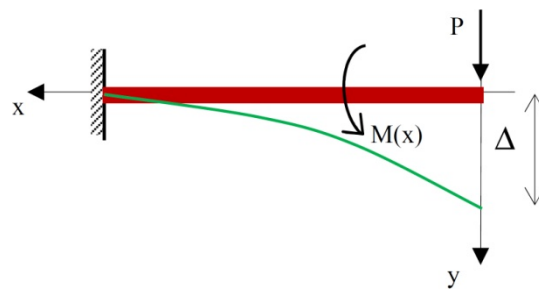


Figure 7.16. *Beam deflection*



Figure 7.17. *Pure bending*

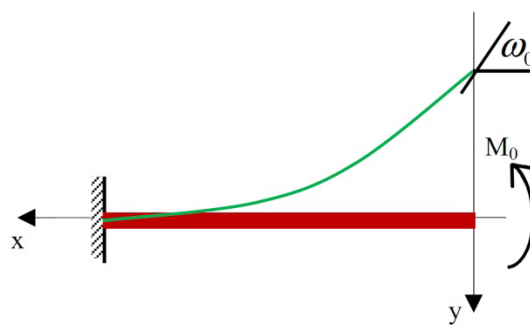


Figure 7.18. *Cantilever deflection*

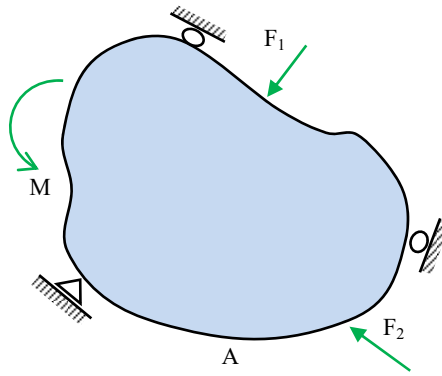


Figure 7.19. *Deformable body*

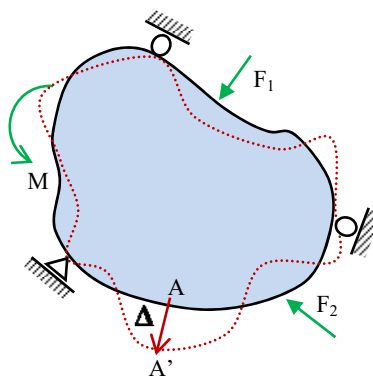


Figure 7.20. *Deformed body*

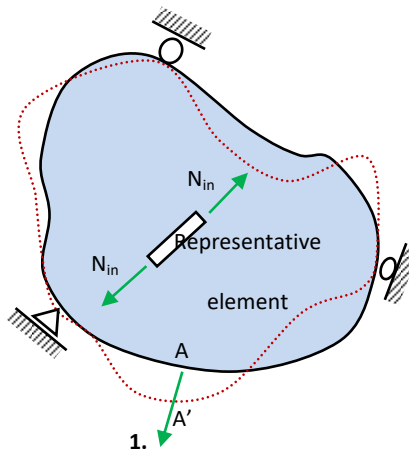


Figure 7.21. *Internal force*

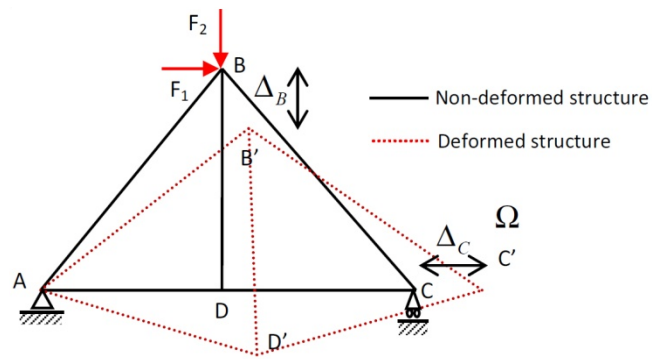


Figure 7.22. Truss forces

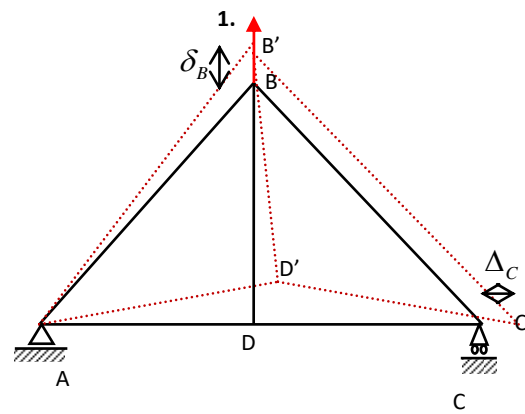


Figure 7.23. Virtual deflection of the structure

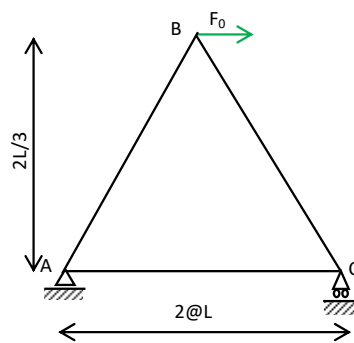


Figure 7.24. Given structure

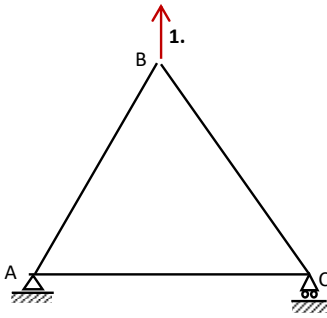


Figure 7.25. *Given structure*

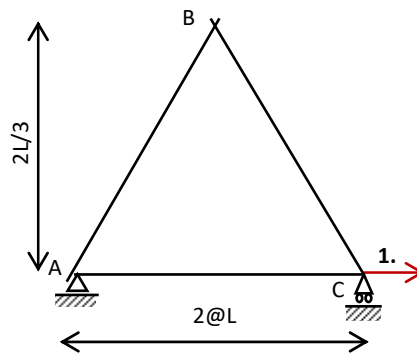


Figure 7.26. *Given structure*

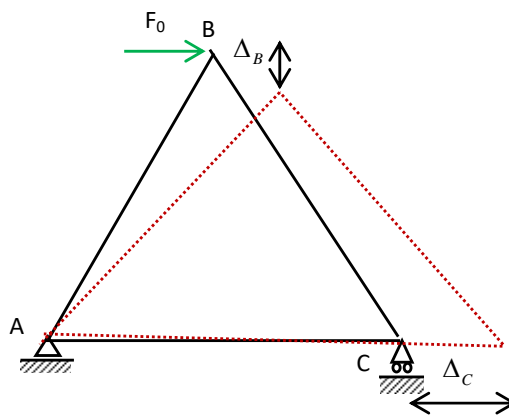


Figure 7.27. *Deformation of the structure*

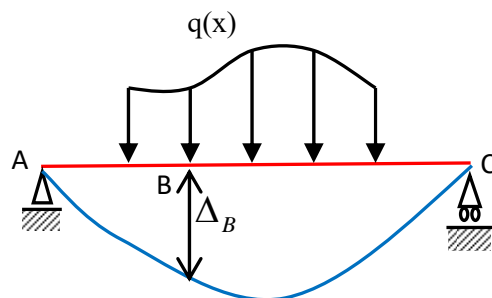


Figure 7.28. *Given beam*

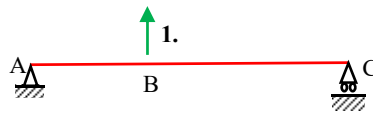


Figure 7.29. *Unit action*

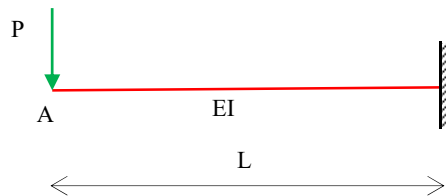


Figure 7.30. *Given beam*

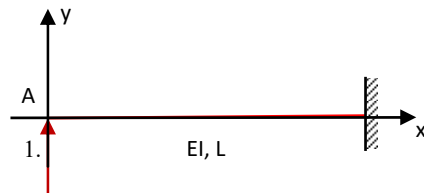


Figure 7.31. *Virtual force*



Figure 7.32. *Unit structure*

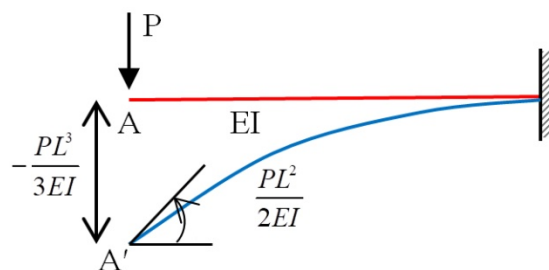


Figure 7.33. *Deformed cantilever*

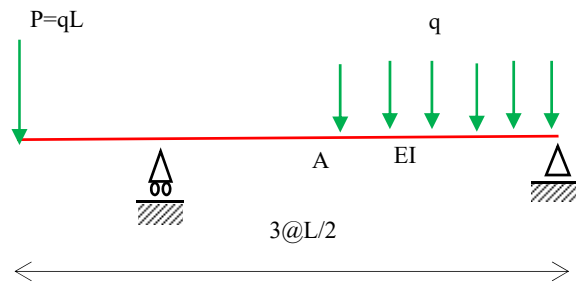


Figure 7.34. Given beam

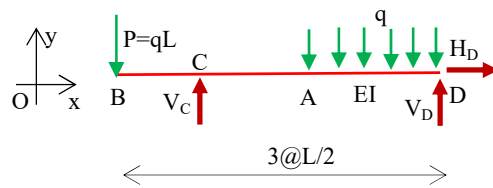


Figure 7.35. Free-body beam

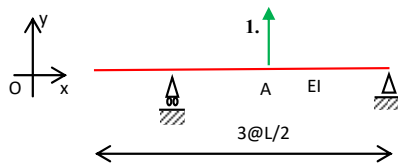


Figure 7.36. Unit force

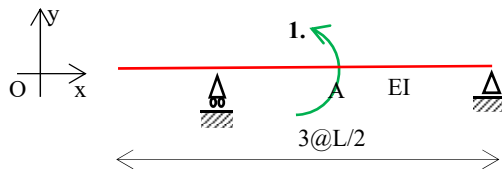


Figure 7.37. Unit moment

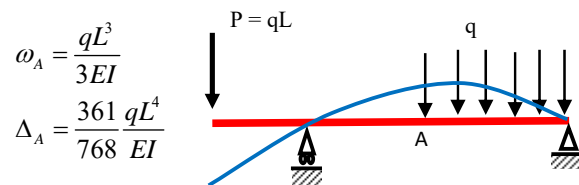


Figure 7.38. Deformed beam

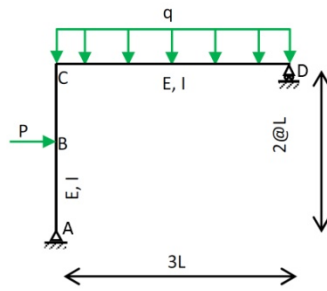


Figure 7.39. *Given frame*

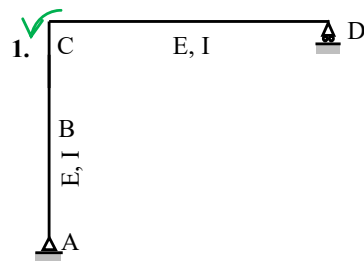


Figure 7.40. *Unit moment*

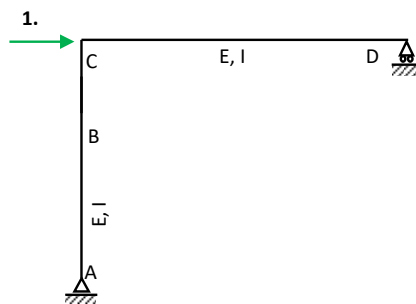


Figure 7.41. *Effect of the virtual force*

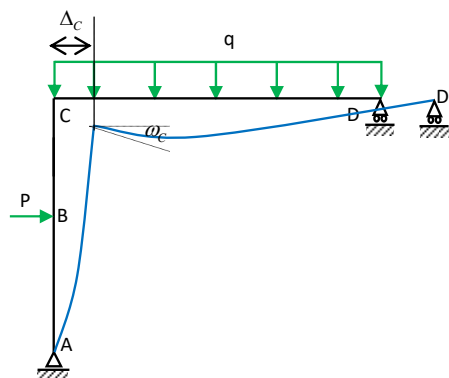


Figure 7.42. *Deformed frame*

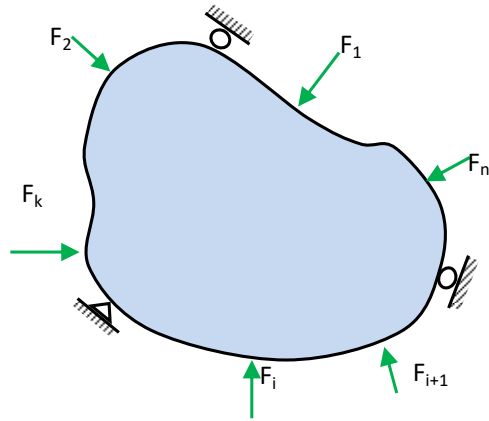


Figure 7.43. *Solid body*

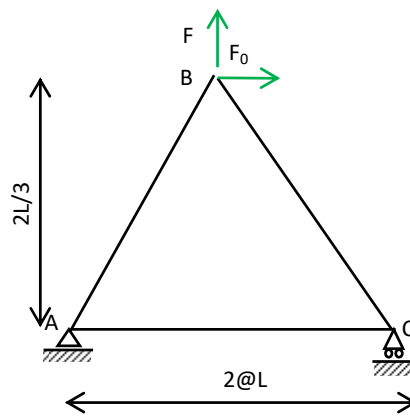


Figure 7.44. *Given structure*

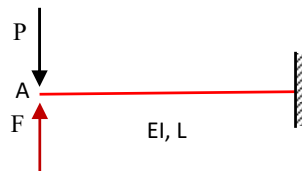


Figure 7.45. *Given cantilever*

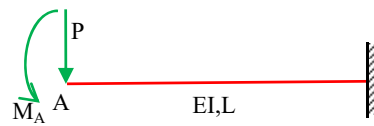


Figure 7.46. *Given cantilever beam*

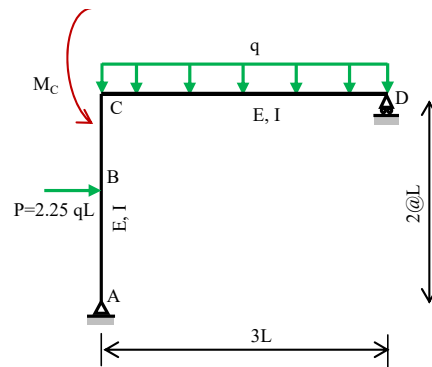


Figure 7.47. Application of MC

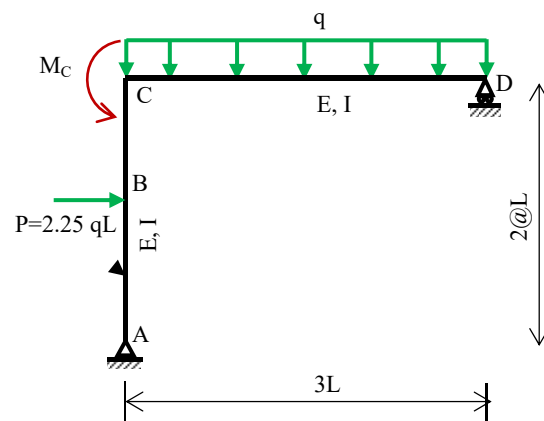


Figure 7.48. Force at joint C

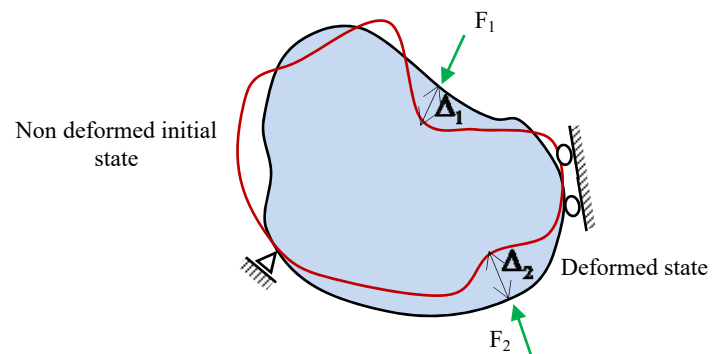


Figure 7.49. Deformable body

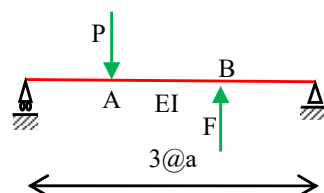


Figure 7.50. Given beam

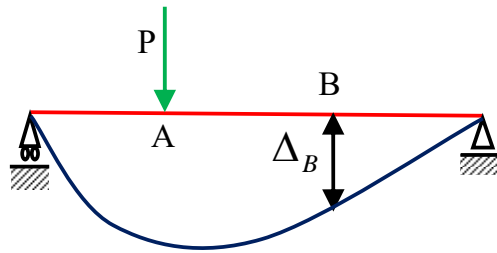


Figure 7.51. Application of force in A

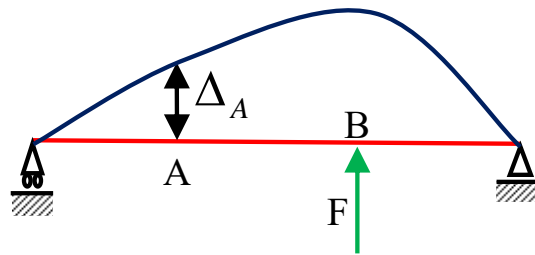
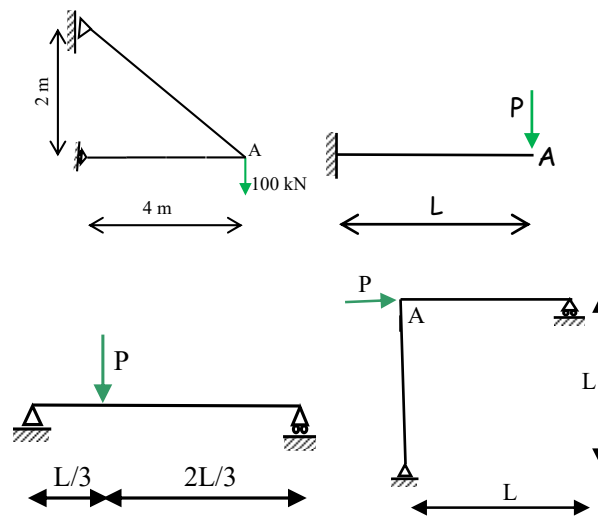
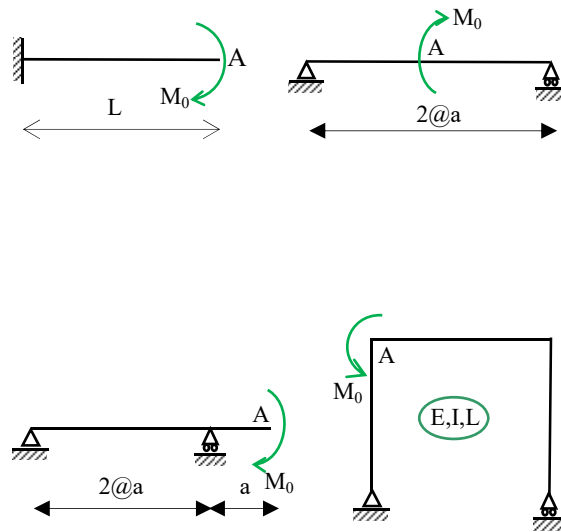


Figure 7.52. Application of force in B

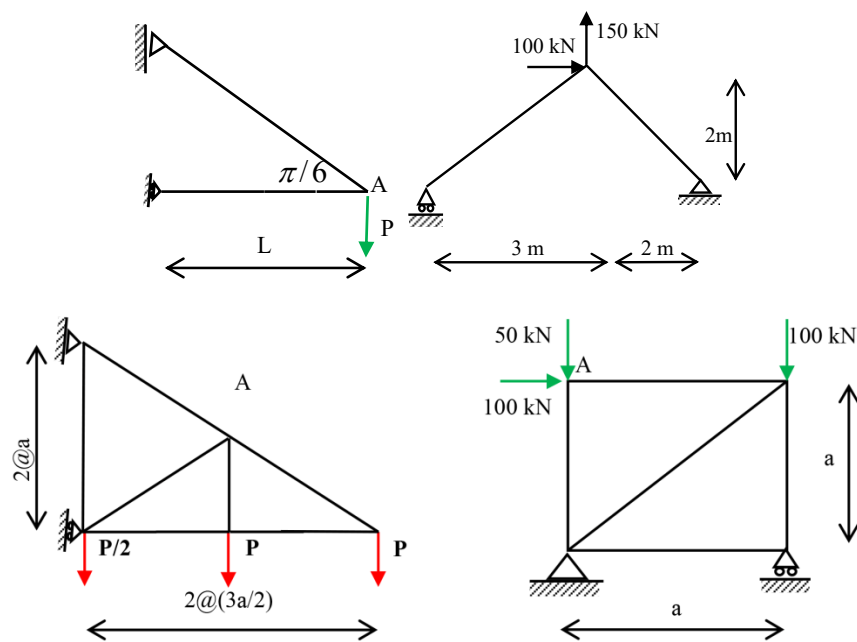
Chapter 7, Exercise 1



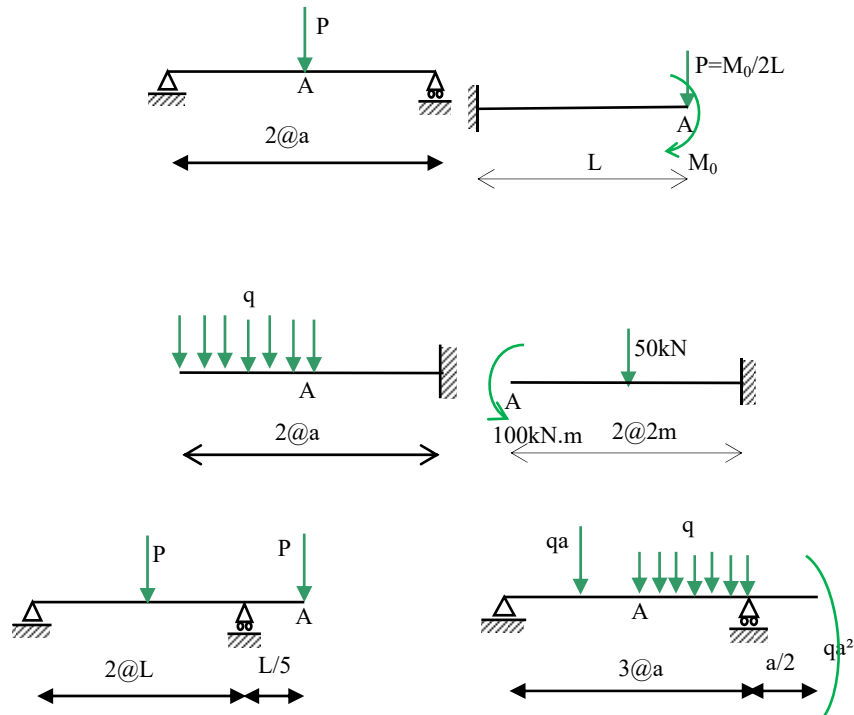
Chapter 7, Exercise 2



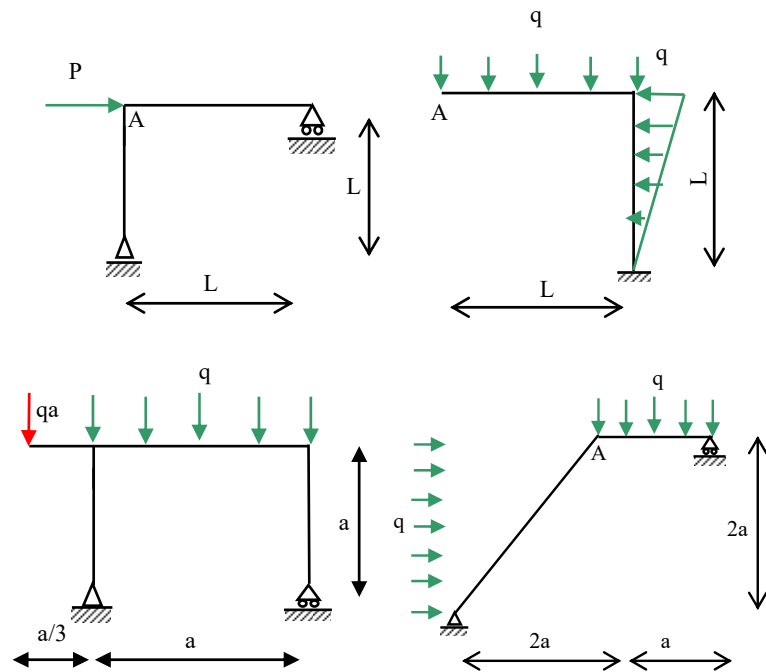
Chapter 7, Exercise 3

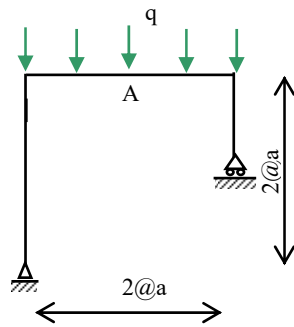


Chapter 7, Exercise 4

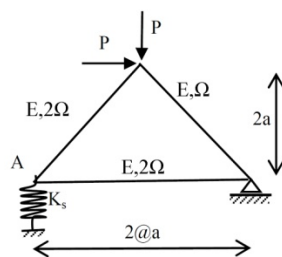
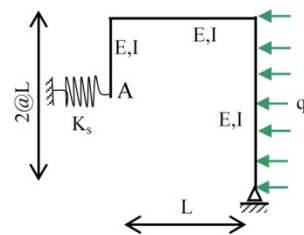
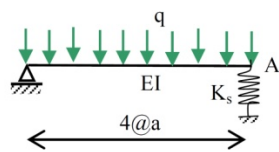
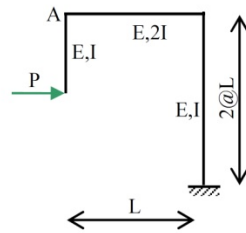
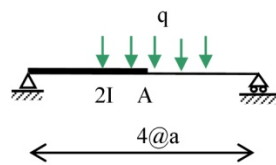


Chapter 7, Exercise 5

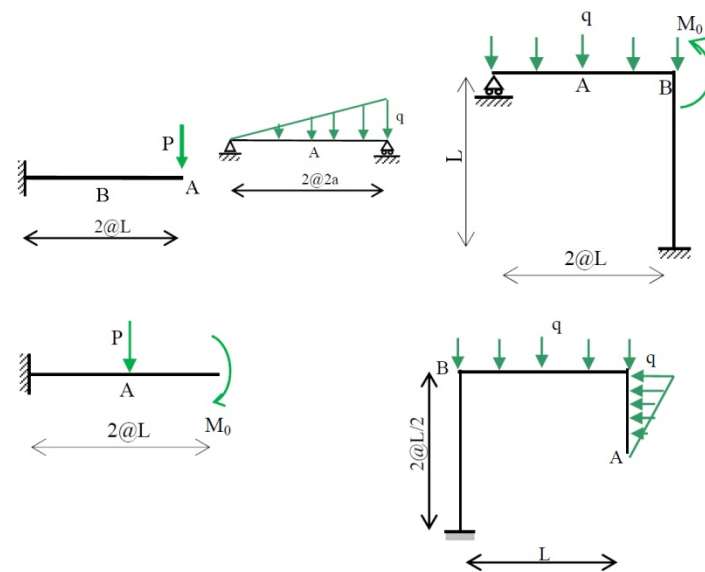




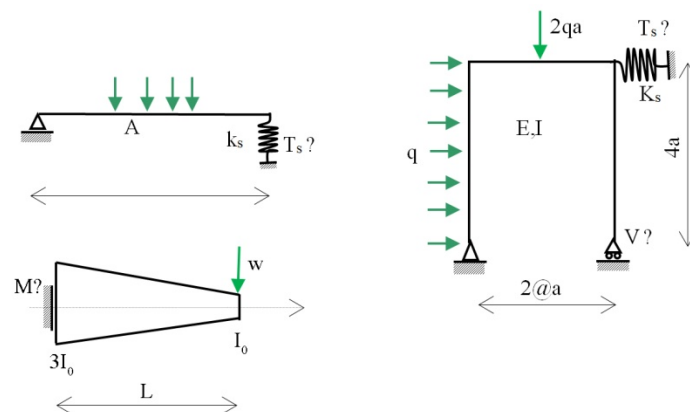
Chapter 7, Exercise 6



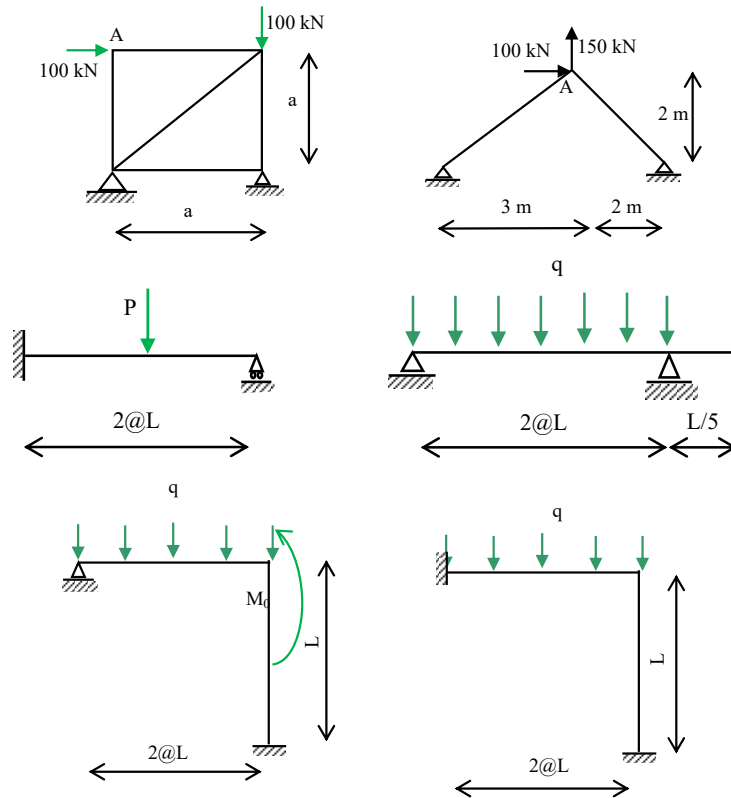
Chapter 7, Exercise 7



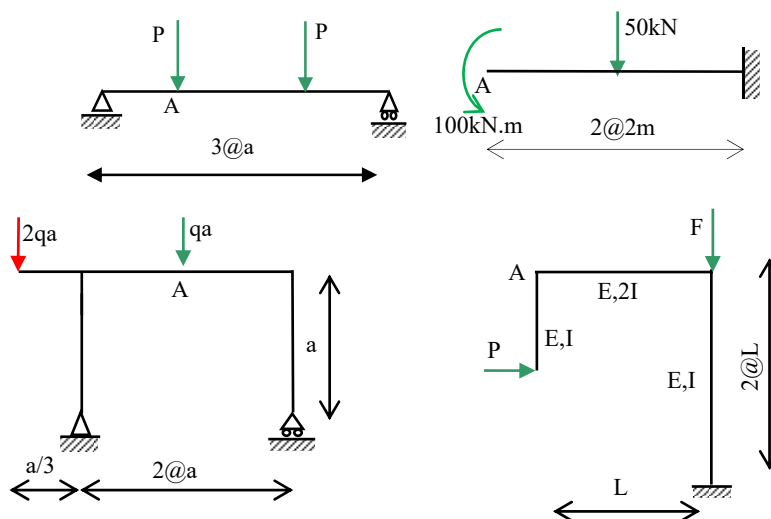
Chapter 7, Exercise 8



Chapter 7, Exercise 9



Chapter 7, Exercise 10



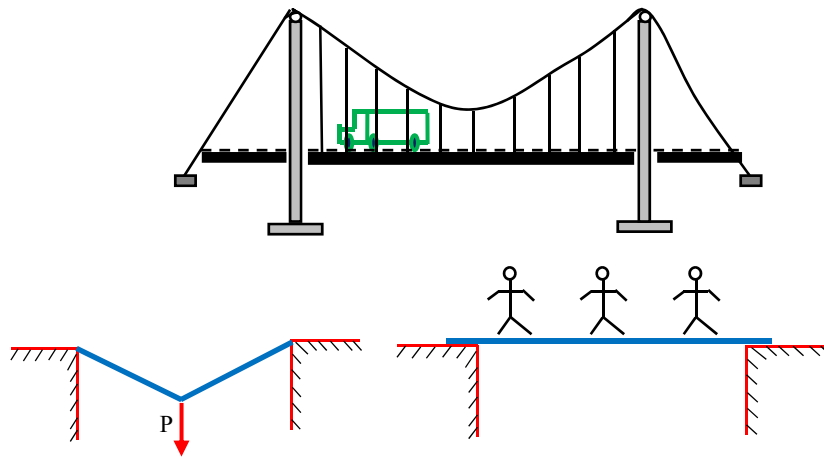


Figure 8.1. Cables

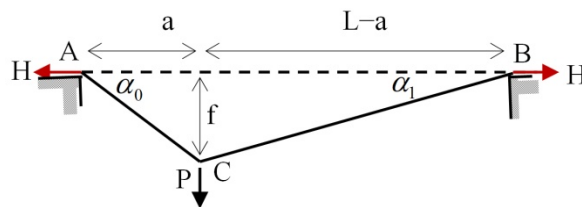


Figure 8.2. Given cable

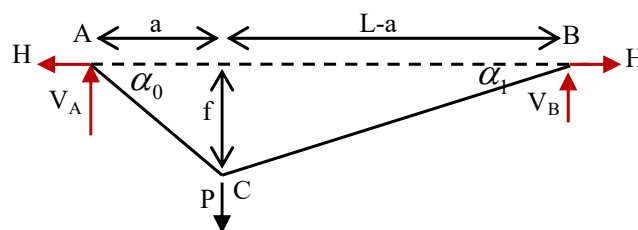


Figure 8.3. Free-body diagram

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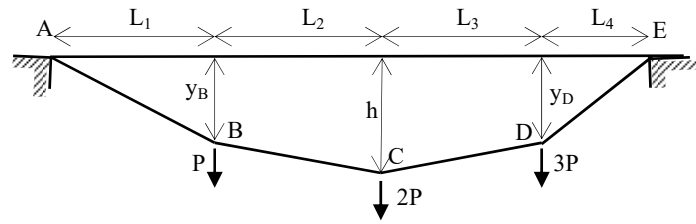


Figure 8.4. Cable structure under concentrated forces

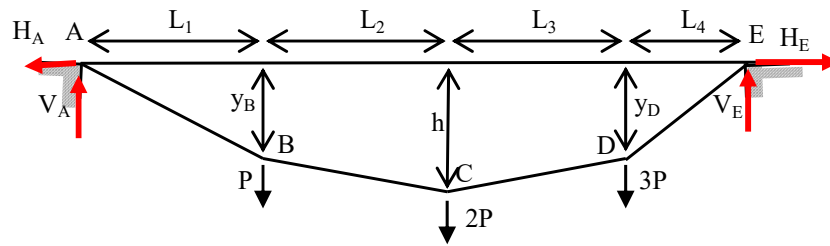
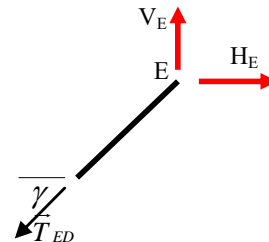
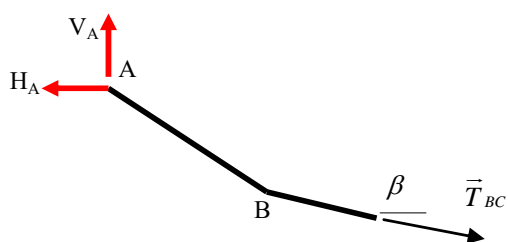
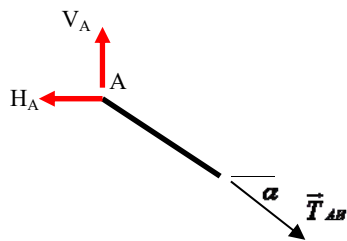


Figure 8.5. Support reactions

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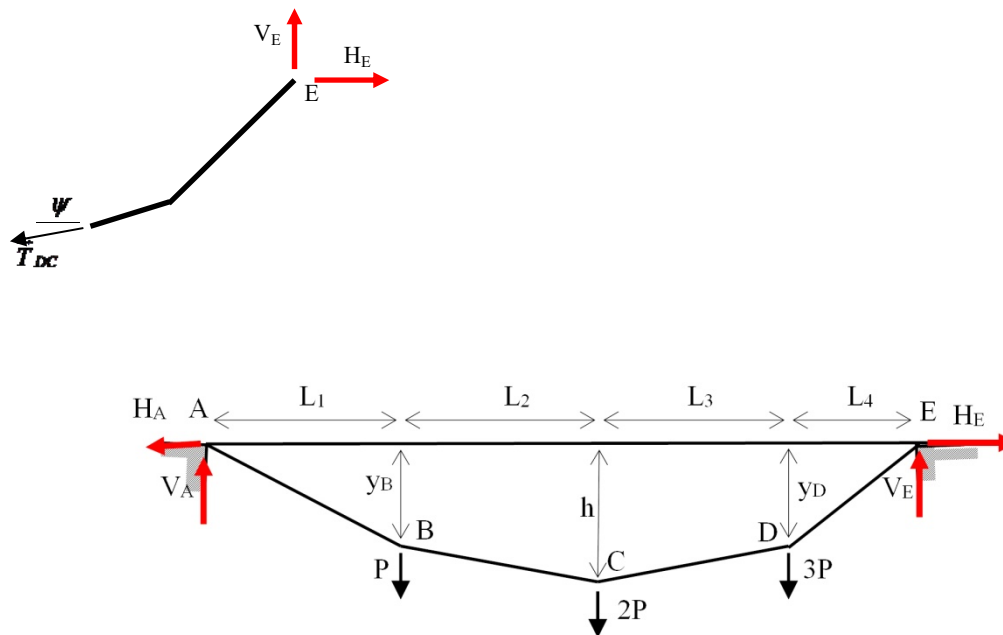


Figure 8.6. Normal force in cable sections

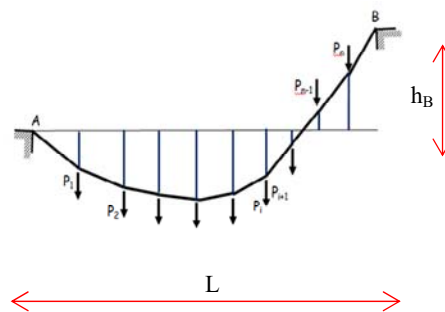


Figure 8.7. Cable under concentrated force

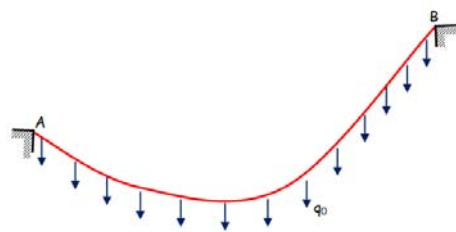


Figure 8.8. Cable under distributed force

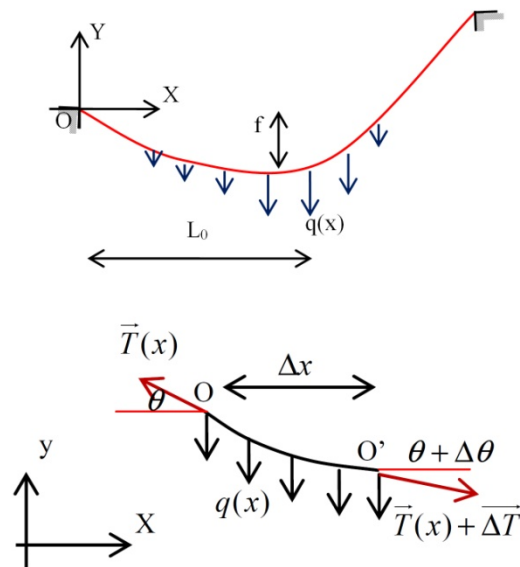


Figure 8.9. Cable portion

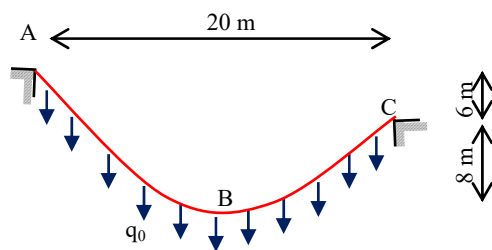


Figure 8.10. Given cable

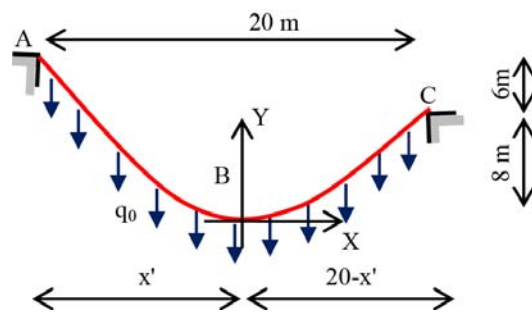


Figure 8.11. Spotting the structure

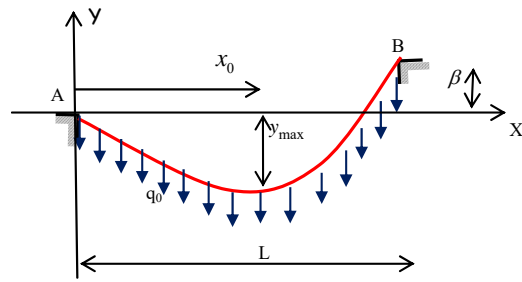


Figure 8.12. Given cable

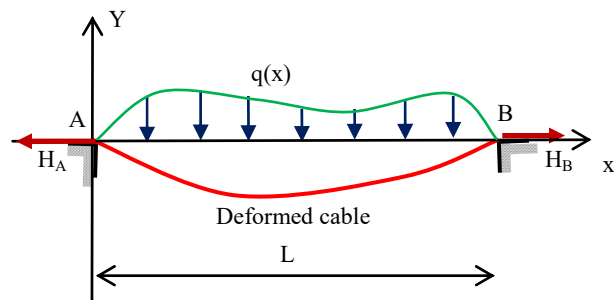


Figure 8.13. Given structure

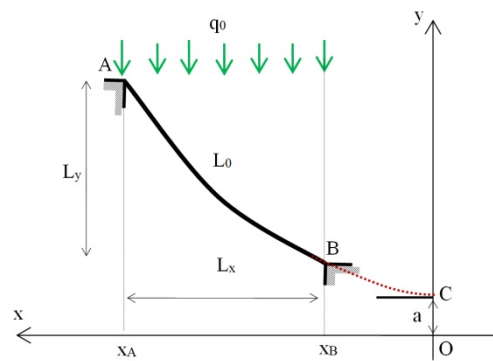


Figure 8.14. Given cable

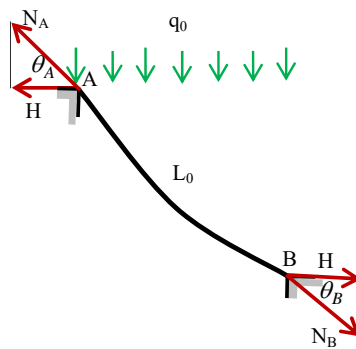


Figure 8.15. Support forces

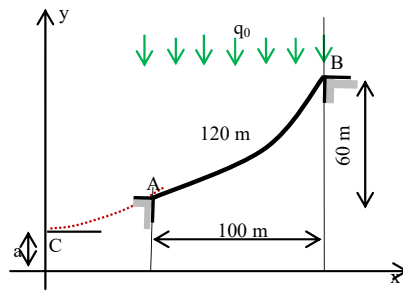


Figure 8.16. Given cable

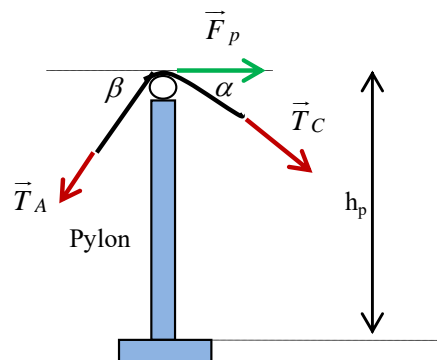


Figure 8.18. Forces on the pulley

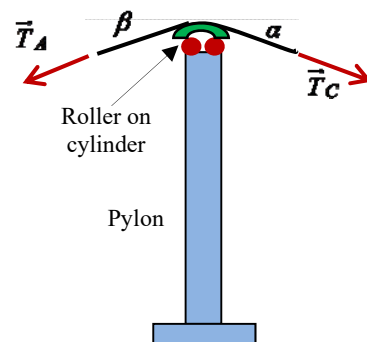


Figure 8.19. Arrangement at the end of the pylon

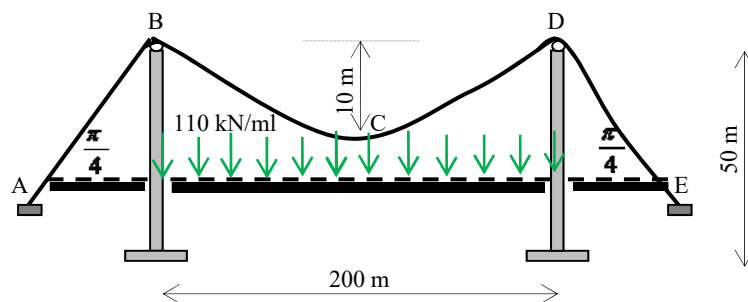
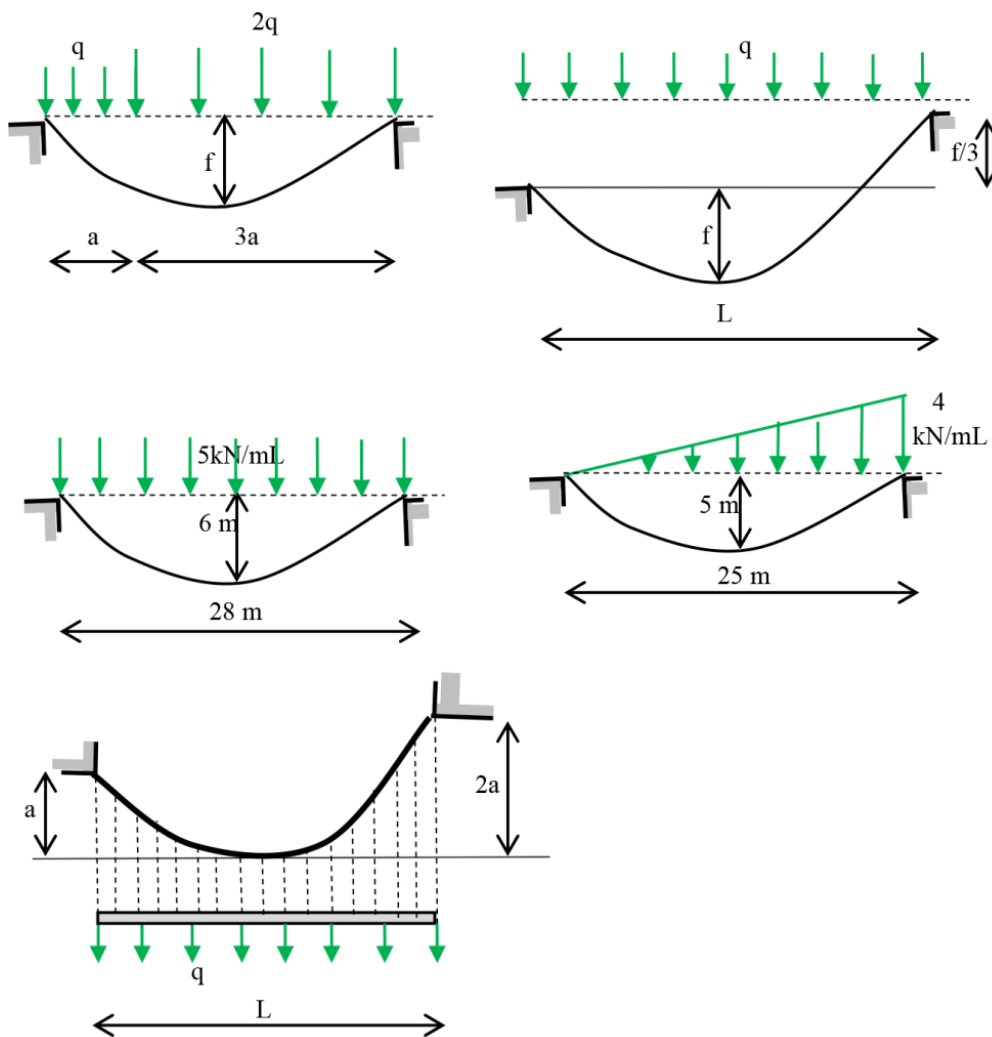
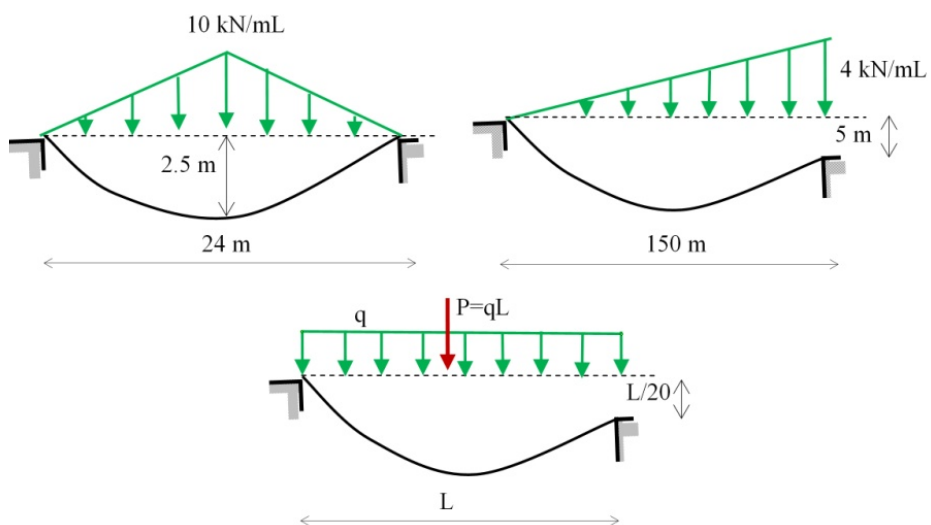


Figure 8.20. Given suspension bridge

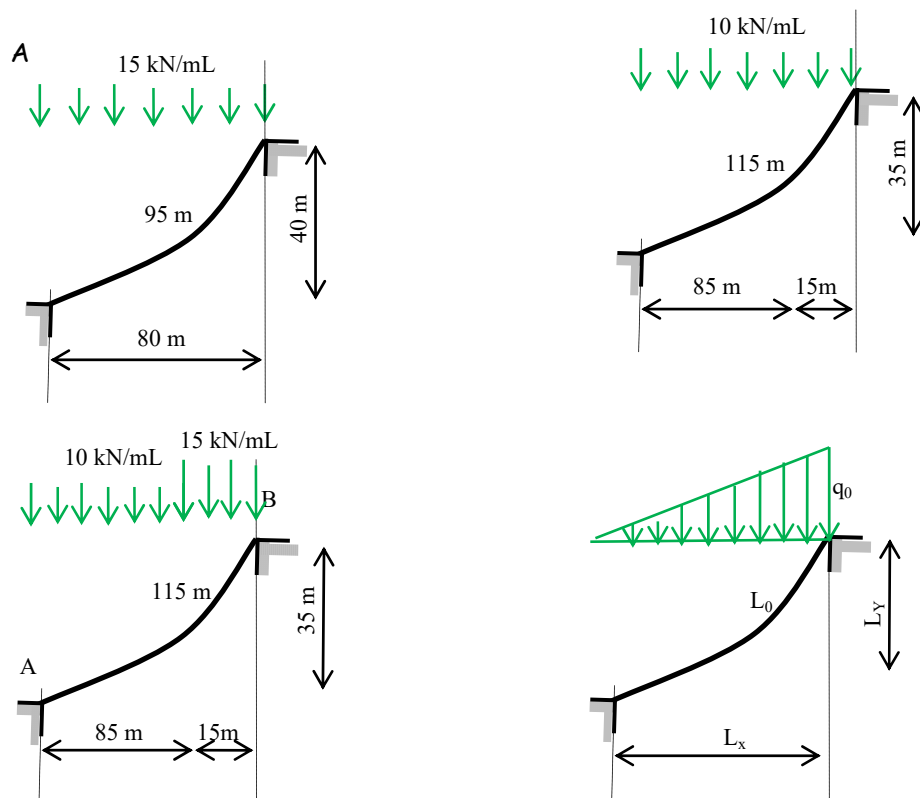
Chapter 8, Exercise 3



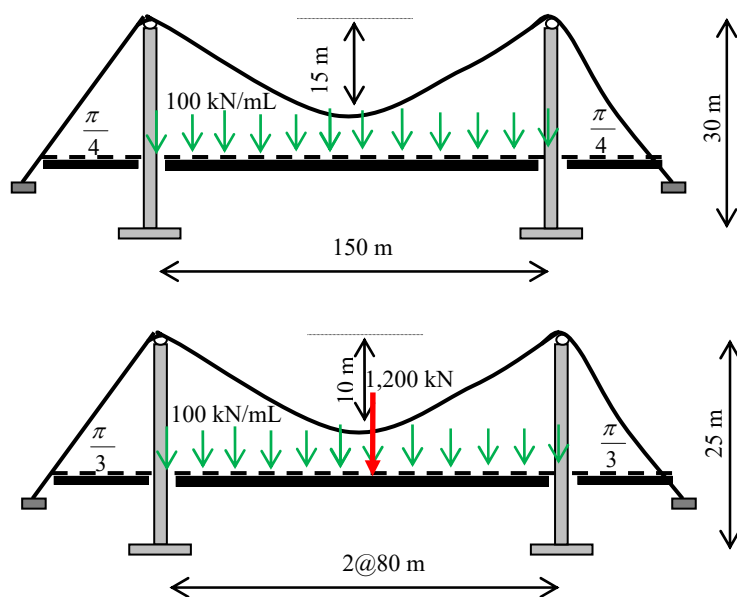
Chapter 8, Exercise 5

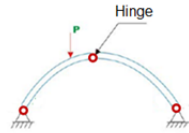


Chapter 8, Exercise 6

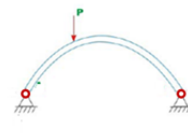


Chapter 8, Exercise 7

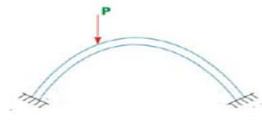




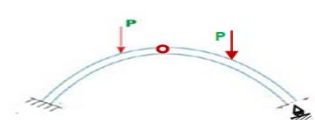
Three-hinged arch



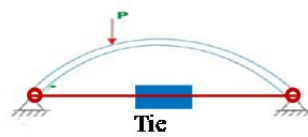
Bi-hinged arch



Bi-fixed arch



Arch with one fixed side



Tied arch

Figure 9.1. *Types of arch structure*

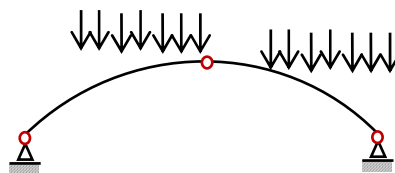


Figure 9.2. *Three-hinged arch*

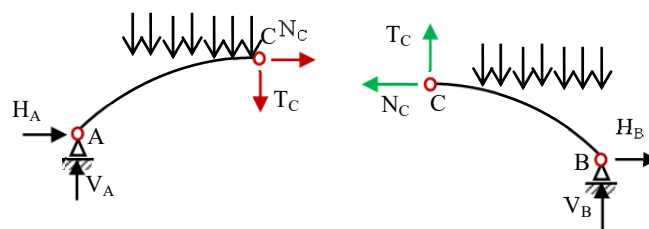


Figure 9.3. *Dividing the arch*

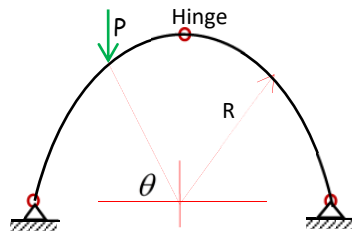


Figure 9.4. *Given arch*

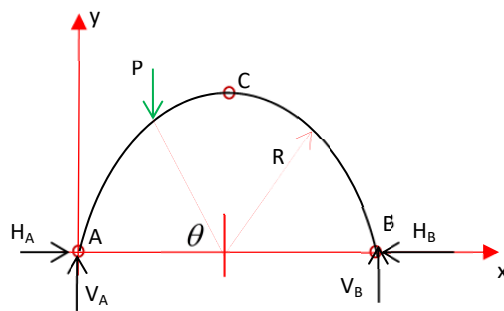


Figure 9.5. *Free-body arch*

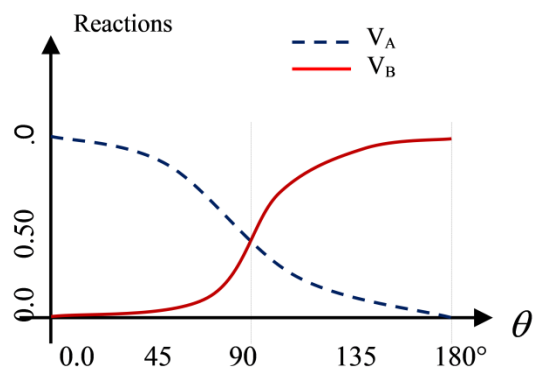


Figure 9.6. *Variation of V_A and V_B*

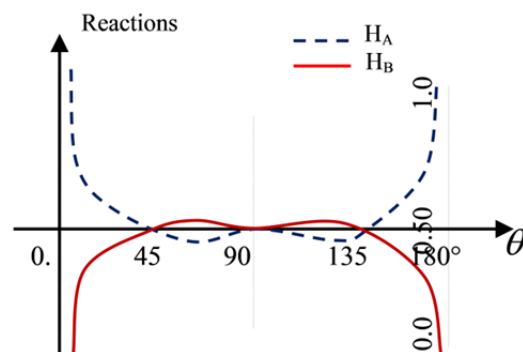


Figure 9.7. *Variation of H_A and H_B*

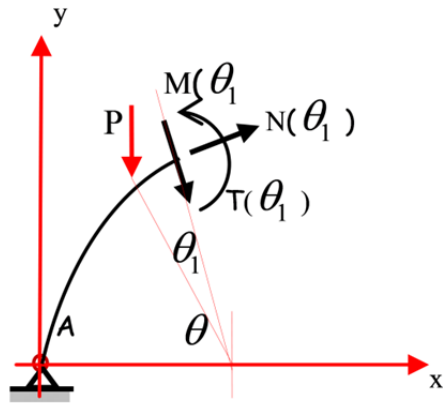


Figure 9.8. Section $\theta_1 \leq \theta$

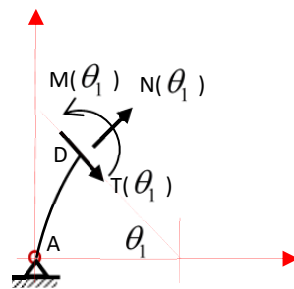


Figure 9.9. Section $\theta \leq \theta_1 \leq \frac{\pi}{2}$

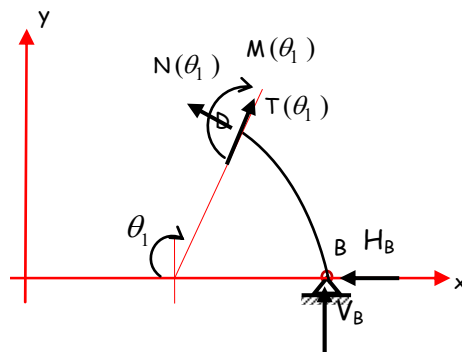


Figure 9.10. Section $\frac{\pi}{2} \leq \theta_1 \leq \pi$

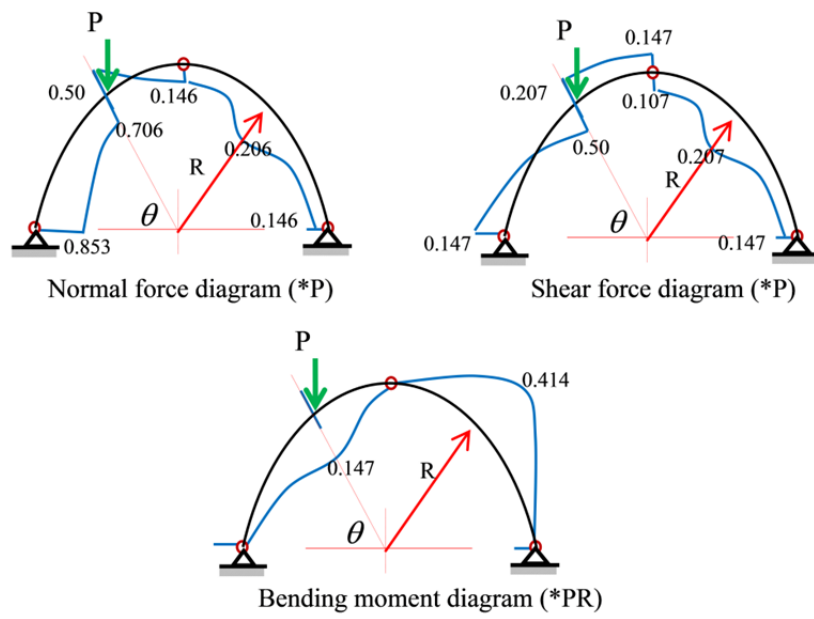


Figure 9.11. Diagrams of internal actions

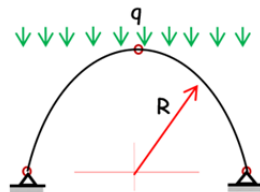


Figure 9.12. Given arch

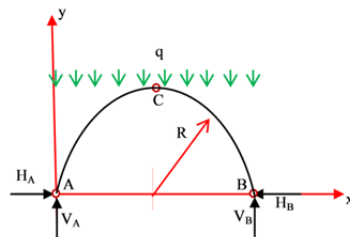


Figure 9.13. Free-body arch

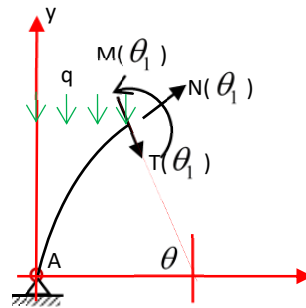


Figure 9.14. Section $\theta \leq \frac{\pi}{2}$

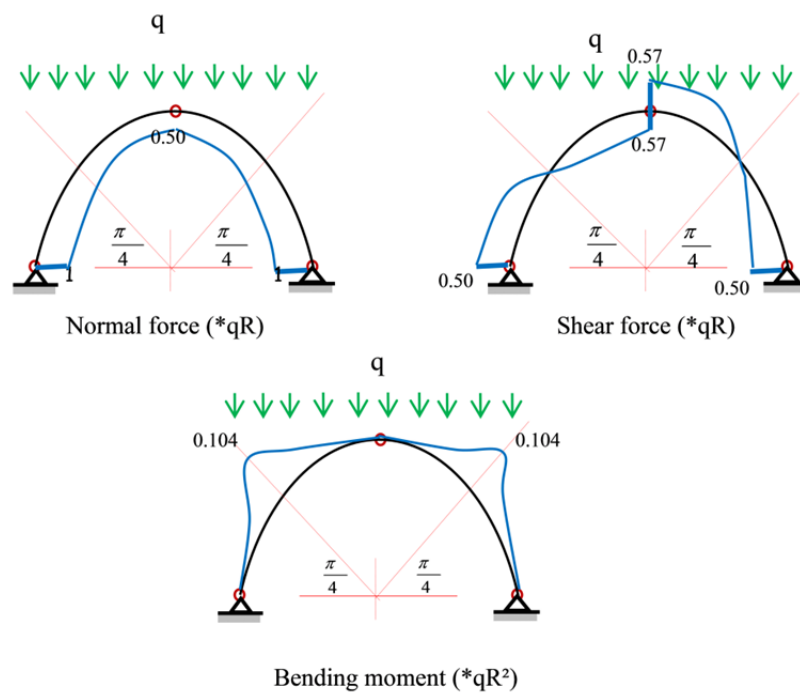


Figure 9.15. Diagrams of internal actions

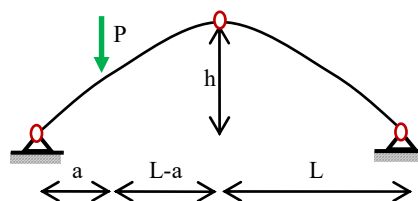


Figure 9.16. Parabolic arch

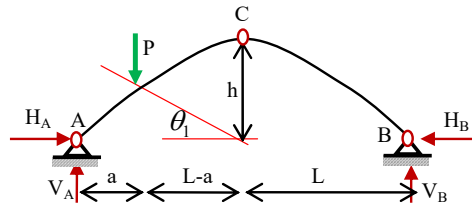


Figure 9.17. *Support reactions*

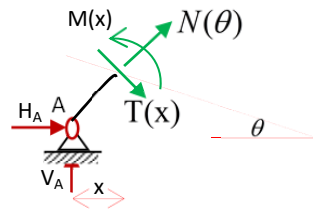


Figure 9.18. *Section $0 \leq x \leq a$*

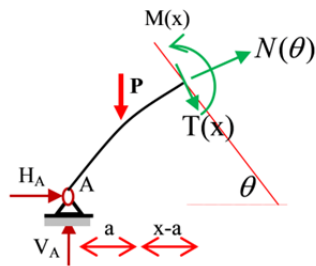


Figure 9.19. *Section $a \leq x \leq L$*

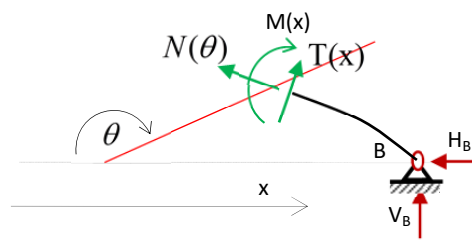


Figure 9.20. *Section $L \leq x \leq 2L$*

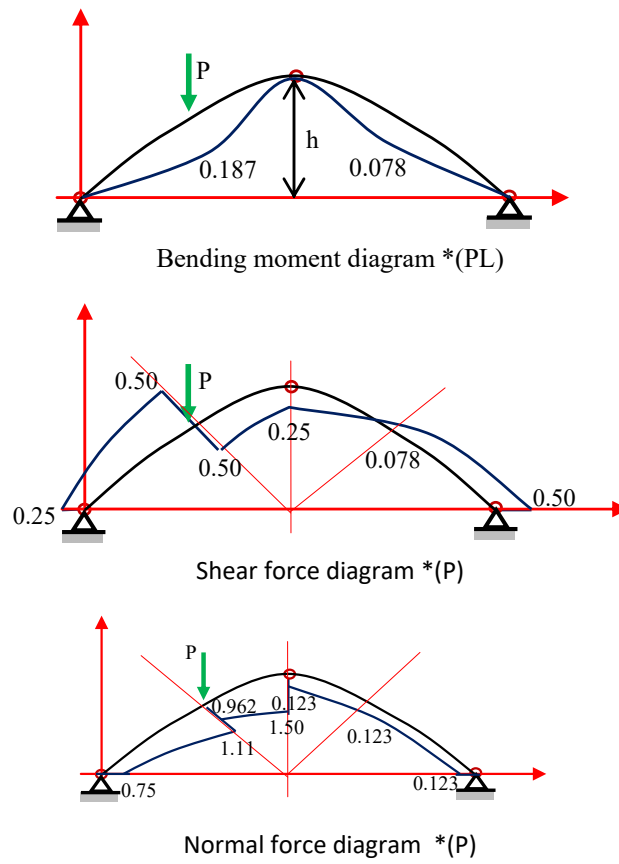


Figure 9.21. *Diagram of internal actions*

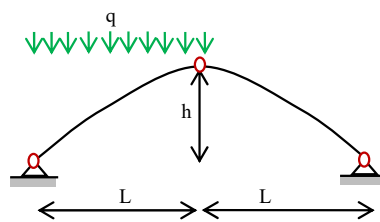


Figure 9.22. *Parabolic arch*

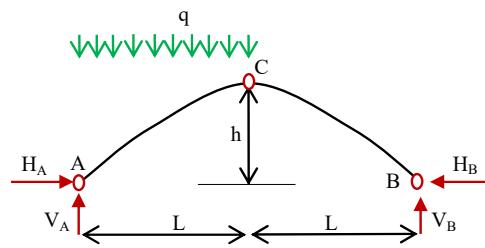


Figure 9.23. Free-body arch

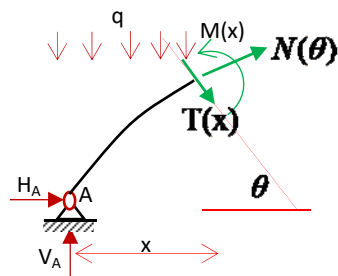


Figure 9.24. Section $0 \leq x \leq L$

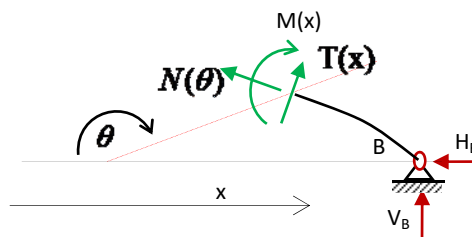
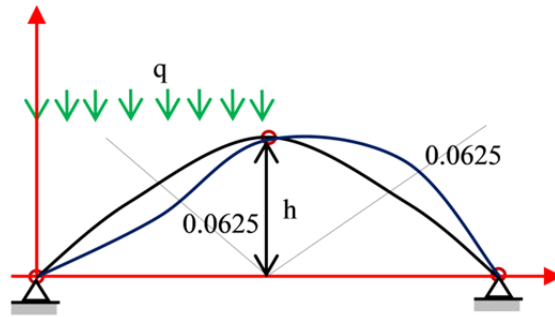
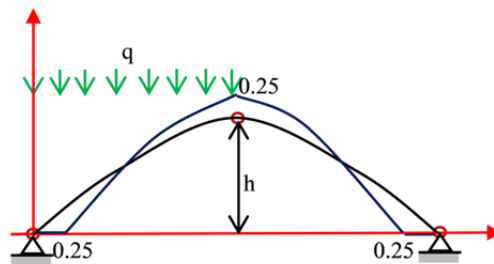


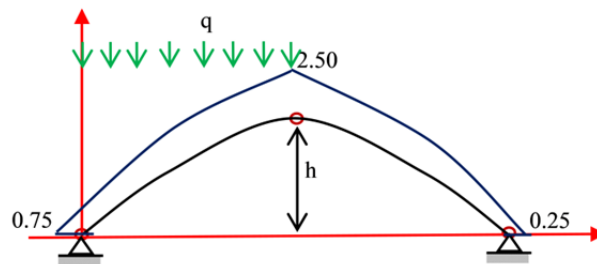
Figure 9.25. Section $L \leq x \leq 2L$



Bending moment diagram $\ast(qL^2)$



Shear force diagram $\ast(qL)$



Normal force diagram $\ast(qL)$

Figure 9.26. *Diagram of internal actions*

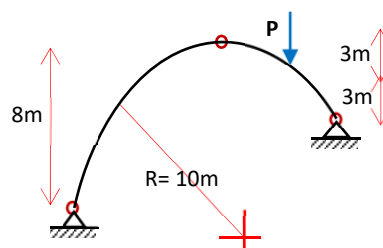


Figure 9.27. *Arch with level supports*

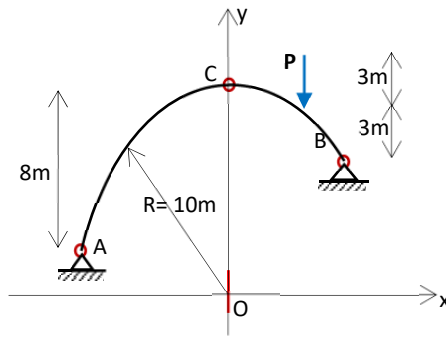


Figure 9.28. *Identifying the arch*

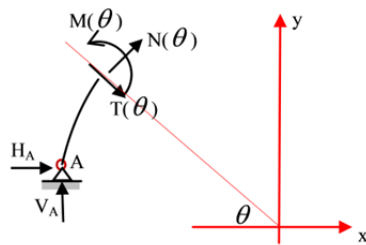


Figure 9.29. *Section $11.53^\circ \leq \theta \leq 90^\circ$*

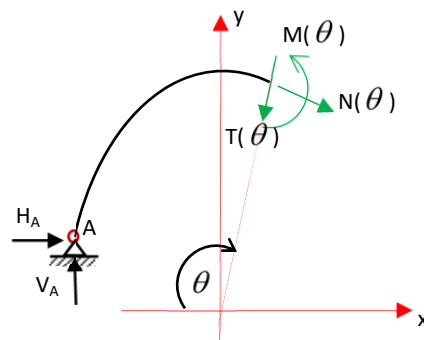


Figure 9.30. *Section $90^\circ \leq \theta \leq 135.56^\circ$*

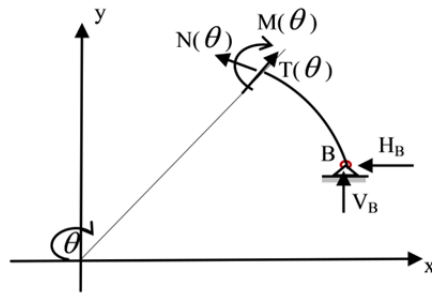


Figure 9.31. Section $135.56^\circ \leq \theta \leq 156.42^\circ$

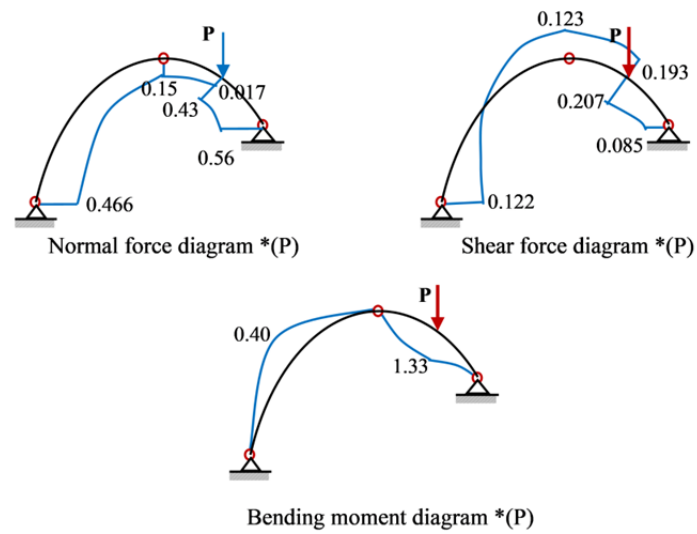


Figure 9.32. Diagram of internal actions

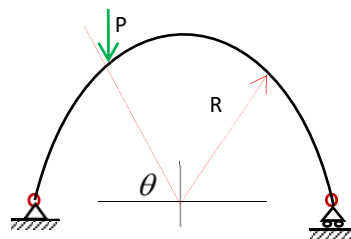


Figure 9.33. Bi-hinged arch

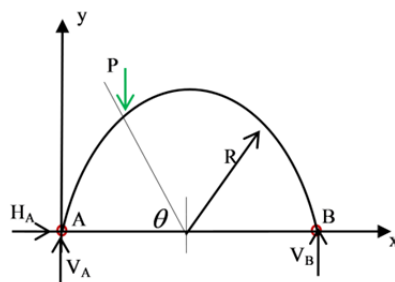


Figure 9.34. Free-body arch

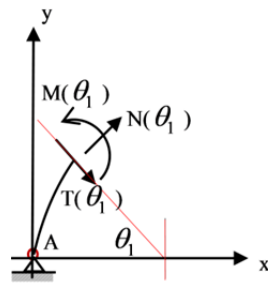


Figure 9.35. Section $\theta_1 \leq \theta$

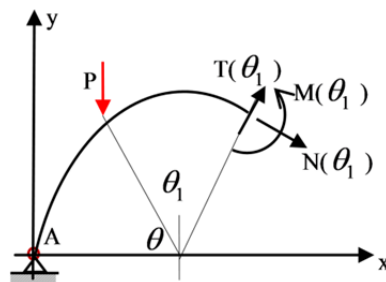


Figure 9.36. Section $\theta \leq \theta_1 \leq \pi$

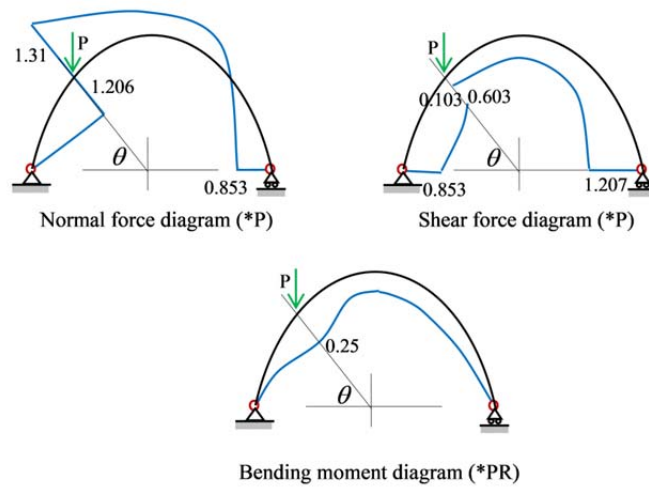
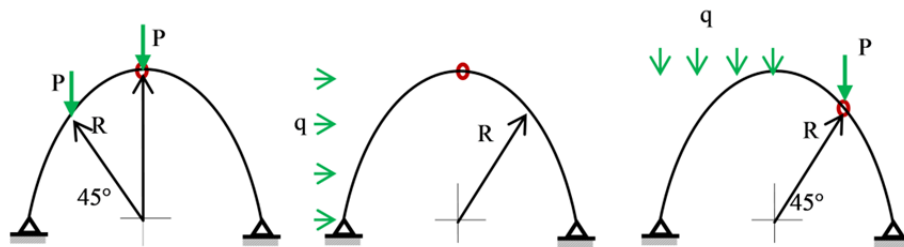
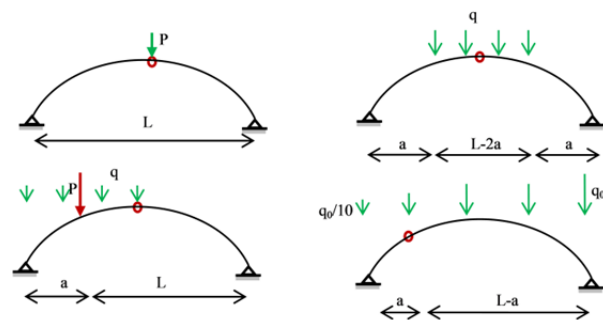


Figure 9.37. Diagrams of internal actions

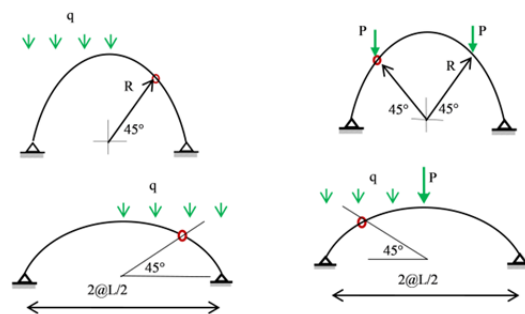
Chapter 9, Exercise 1



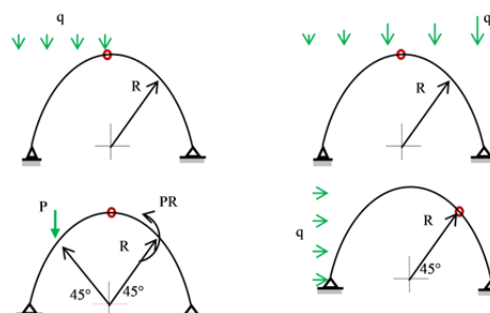
Chapter 9, Exercise 2



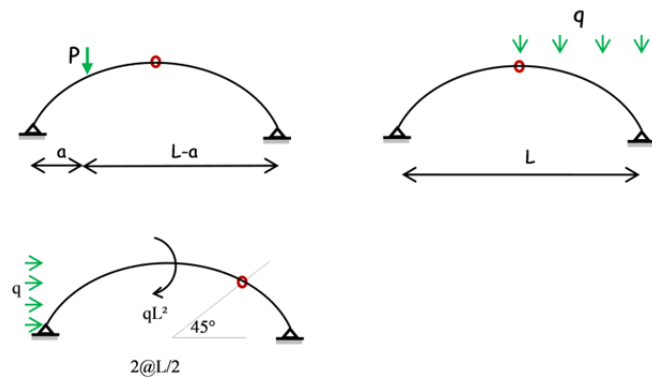
Chapter 9, Exercise 3



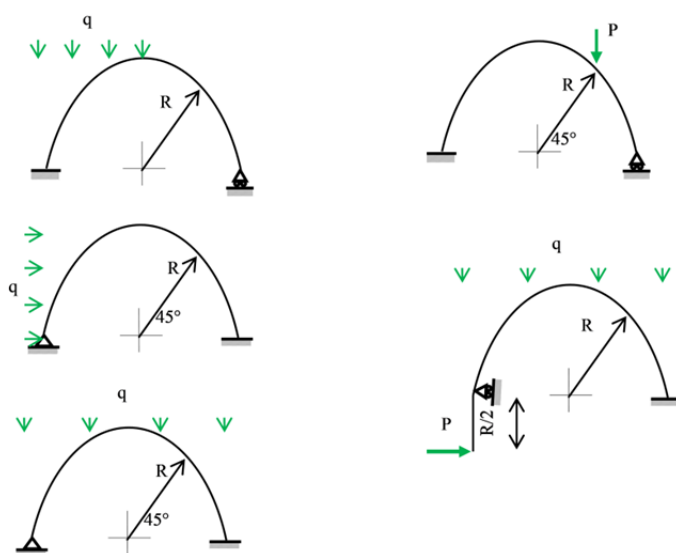
Chapter 9, Exercise 4



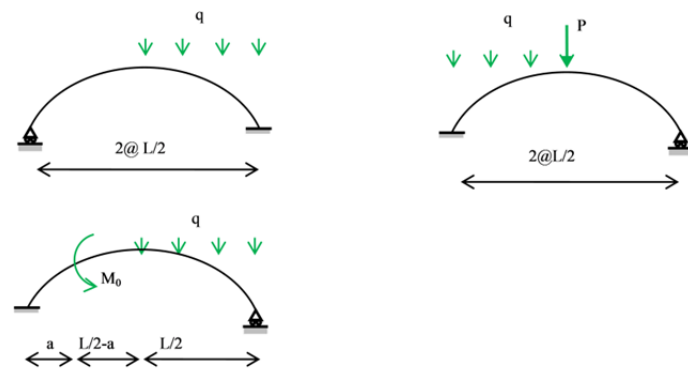
Chapter 9, Exercise 5



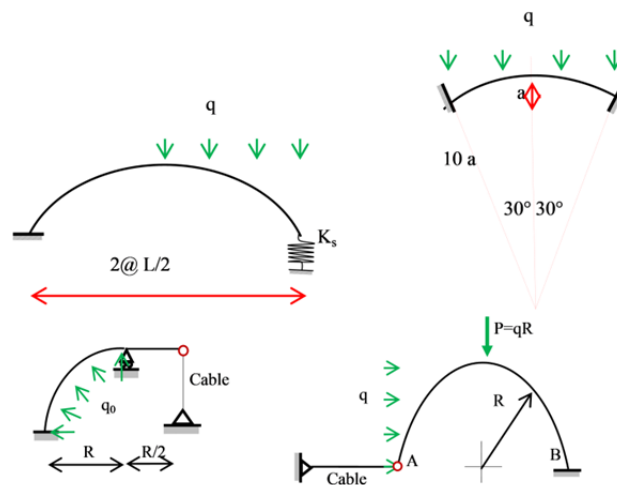
Chapter 9, Exercise 6



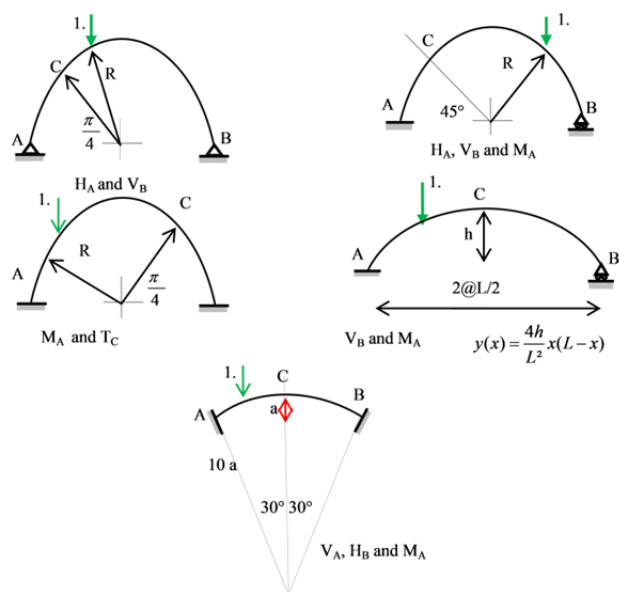
Chapter 9, Exercise 7



Chapter 9, Exercise 8



Chapter 9, Exercise 9



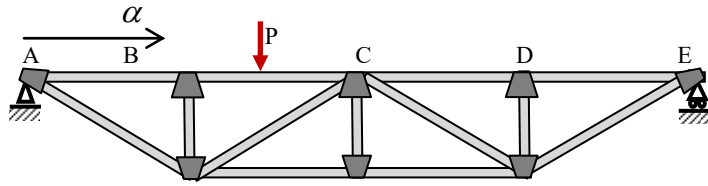


Figure 10.1. Moving mass on a bridge

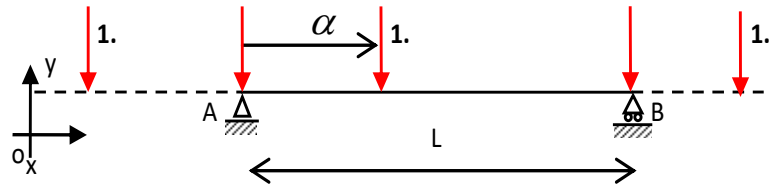


Figure 10.2. Moving unit force on a beam

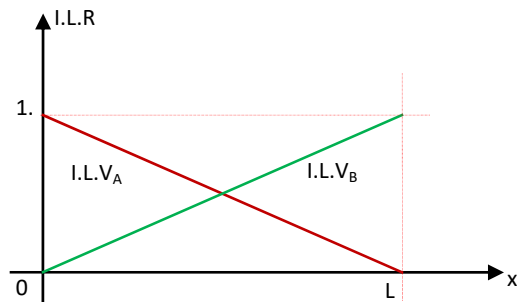


Figure 10.3. Influence lines of support reactions

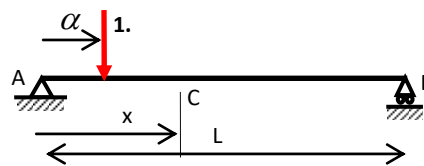


Figure 10.4. Beam studied

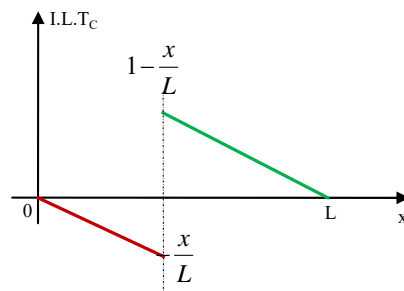


Figure 10.5. Influence line of a shear force

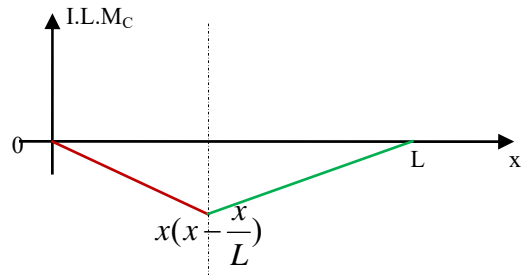


Figure 10.6. Influence line of a bending moment

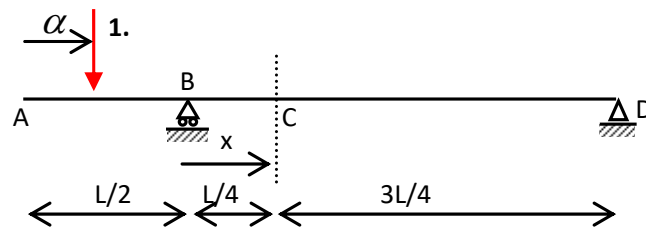


Figure 10.7. Given beam

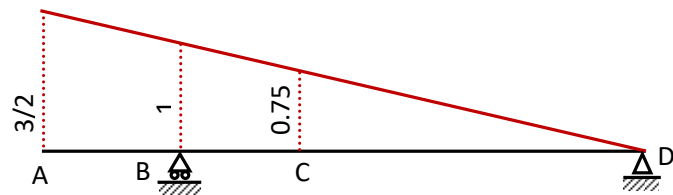


Figure 10.8. Influence line of support reaction V_B

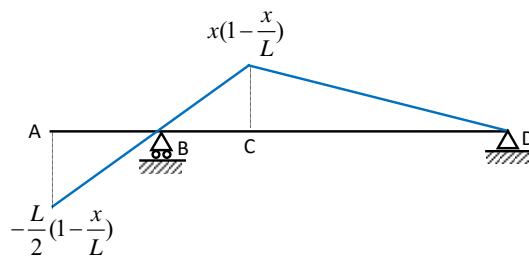


Figure 10.9. Influence line of moment M_C

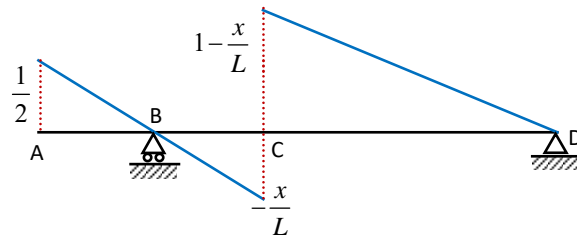


Figure 10.10. Influence line of TC

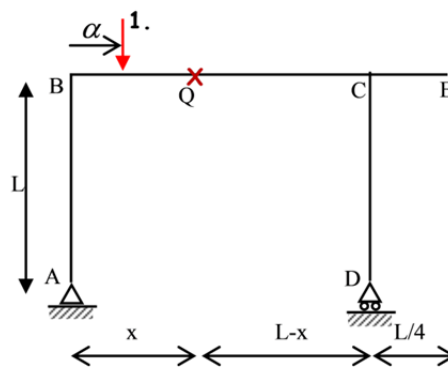


Figure 10.11. Given frame

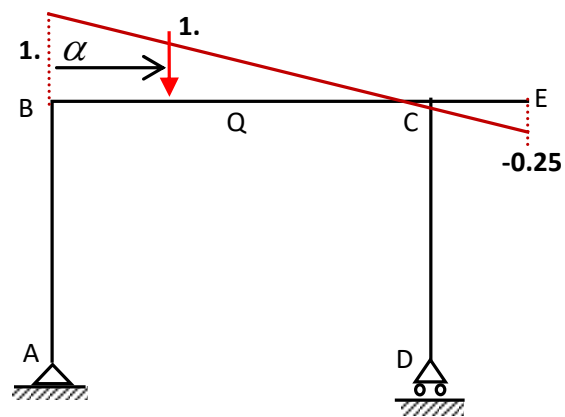


Figure 10.12. Influence line of VA

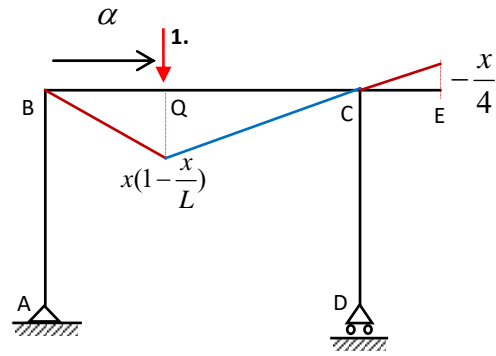


Figure 10.13. Influence line of M_Q

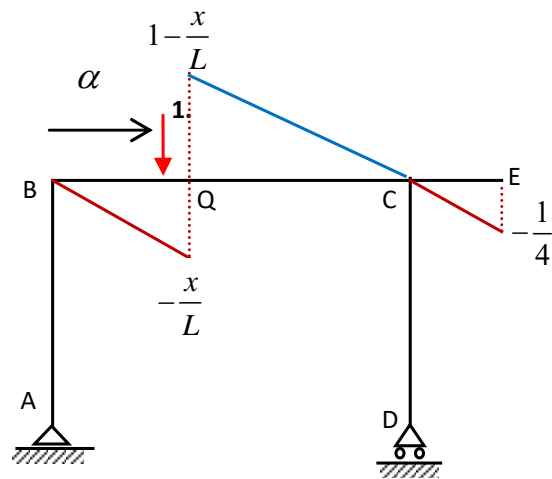


Figure 10.14. Influence line of T_Q

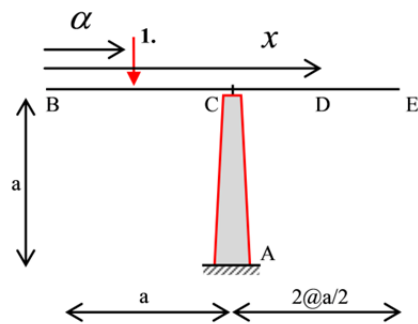


Figure 10.15. Given structure

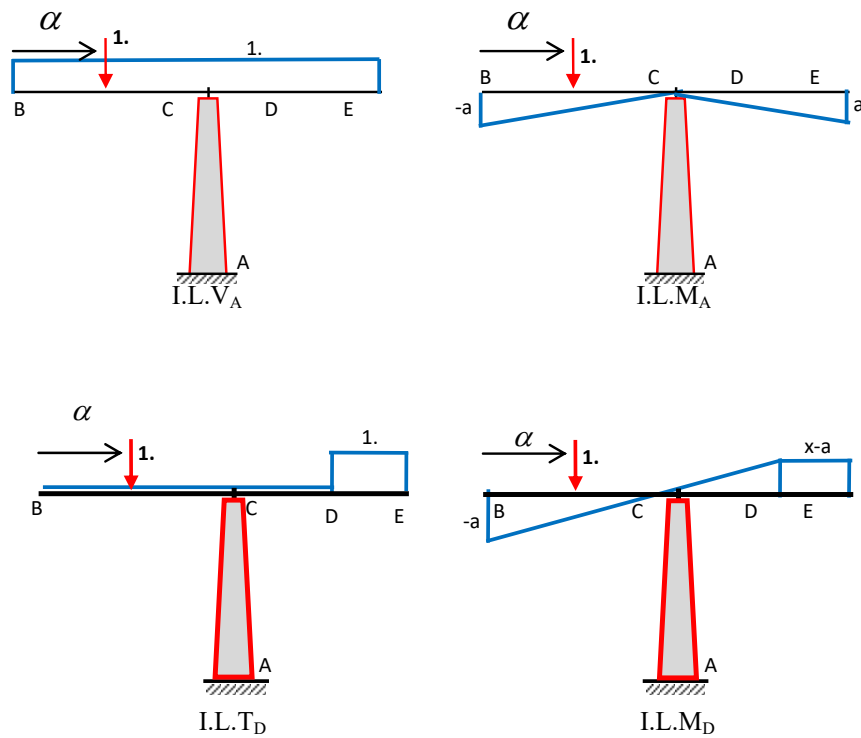


Figure 10.16. Influence lines at points A and D

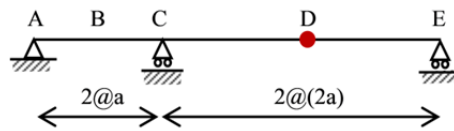


Figure 10.17. Given beam

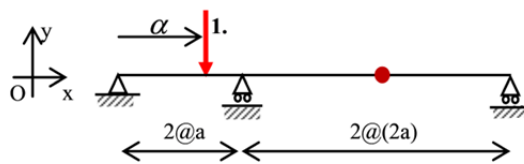


Figure 10.18. Beam with a hinge

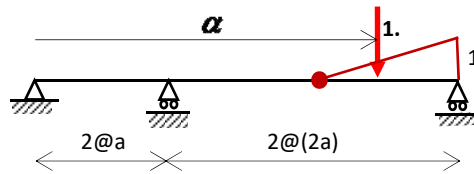


Figure 10.19. Influence line of VE

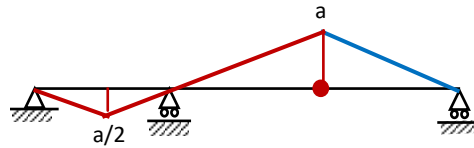


Figure 10.20. Influence line of moment MB

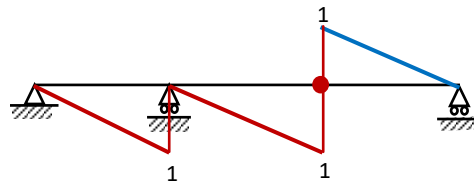


Figure 10.21. Influence line of TC

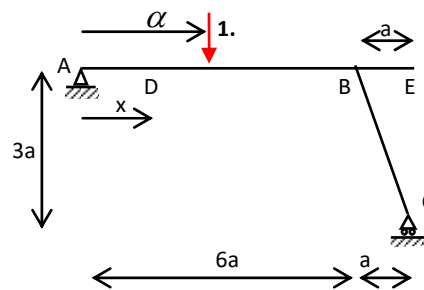


Figure 10.22. Given frame

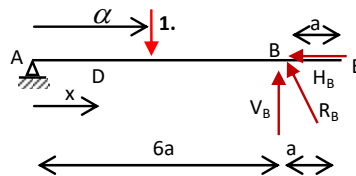


Figure 10.23. Bar (AB)

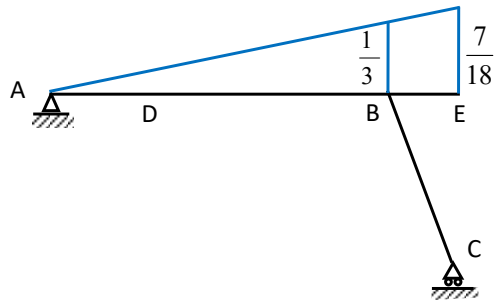


Figure 10.24. $I.L.H_A$

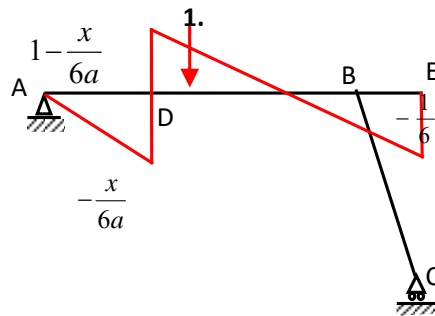


Figure 10.25. $I.L.T_D$

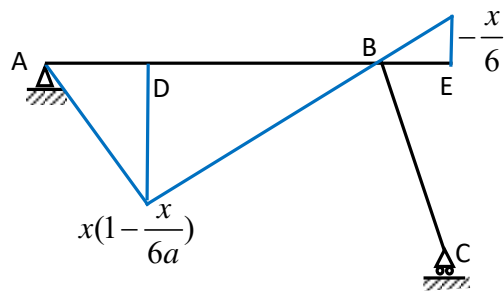


Figure 10.26. $I.L.M_D$

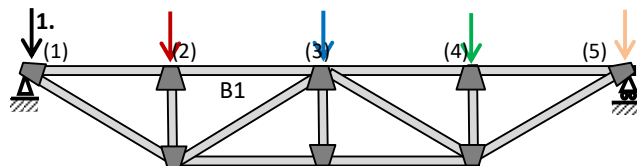


Figure 10.27. *Truss*

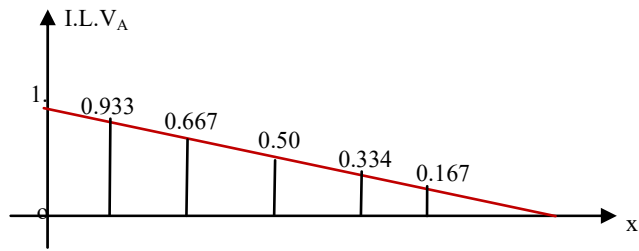


Figure 10.30. $I.L. V_A$

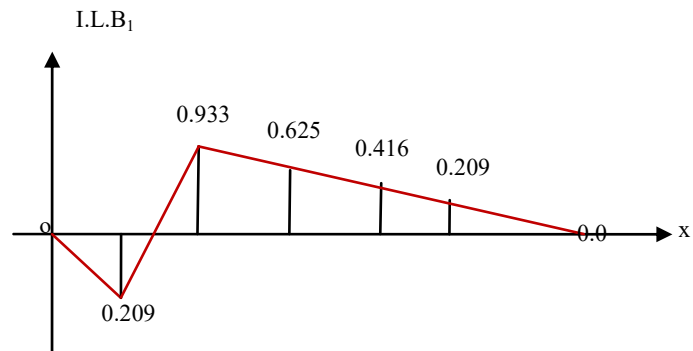


Figure 10.31. $I.L. B_1$

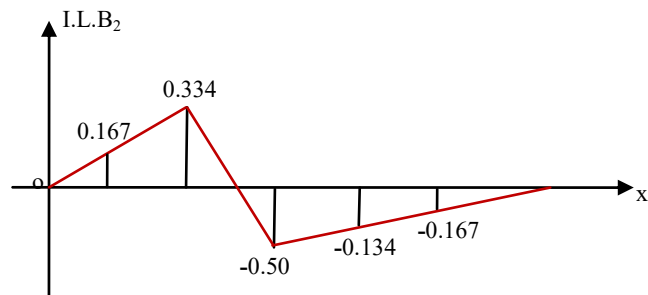


Figure 10.32. $I.L. B_2$

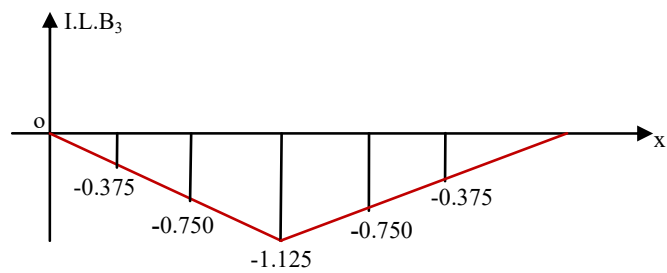


Figure 10.33. $I.L. B_3$

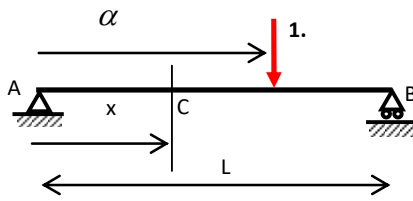


Figure 10.34. Given beam

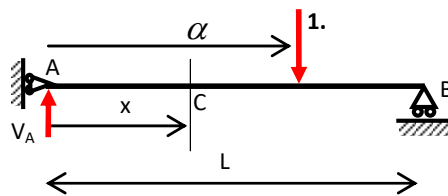


Figure 10.35. Given beam

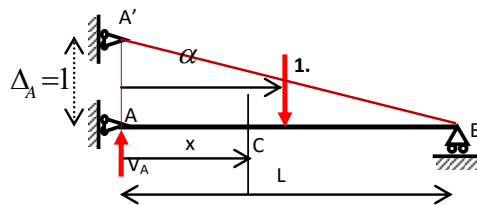


Figure 10.36. Virtual unit displacement

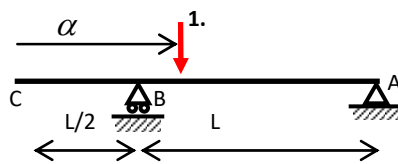


Figure 10.37. Given beam

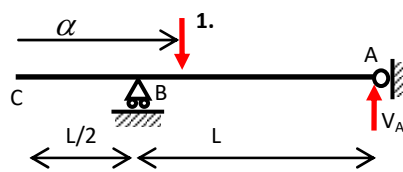


Figure 10.38. Effect of reaction V_A

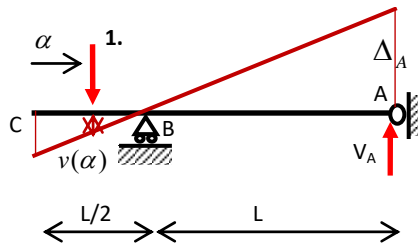


Figure 10.39. Unit force $0 \leq \alpha \leq L/2$

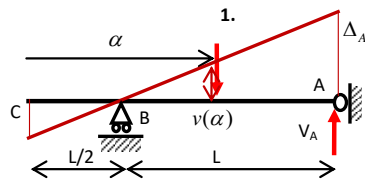


Figure 10.40. Unit force $\frac{L}{2} \leq \alpha \leq \frac{3L}{2}$

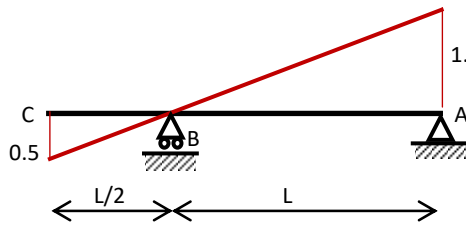


Figure 10.41. $I.L. V_A$

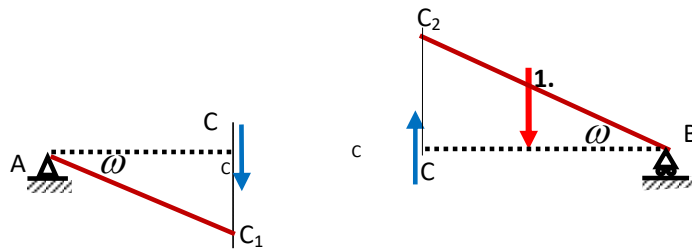


Figure 10.42. Shear force at point C

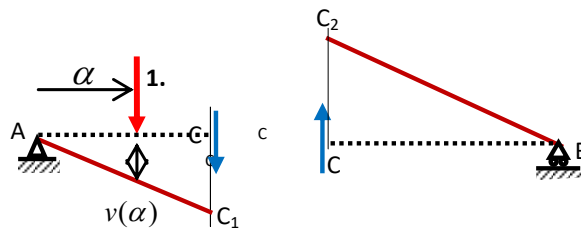


Figure 10.43. T_c for $\alpha \leq x$

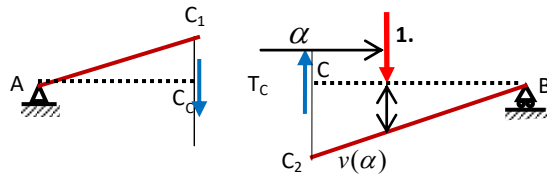


Figure 10.44. T_C for $x \leq \alpha \leq L$

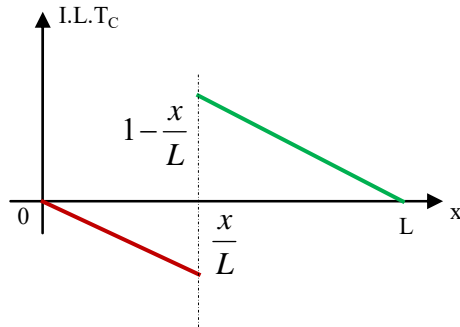


Figure 10.45. $I.L. T_C$

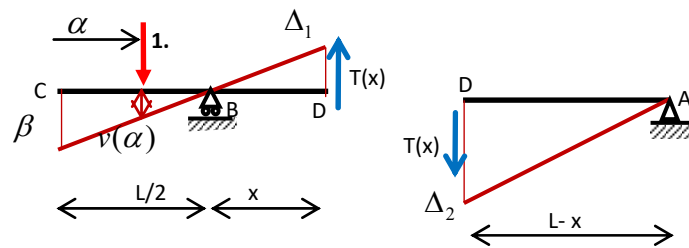


Figure 10.46. Shear force $0 \leq \alpha \leq \frac{L}{2}$

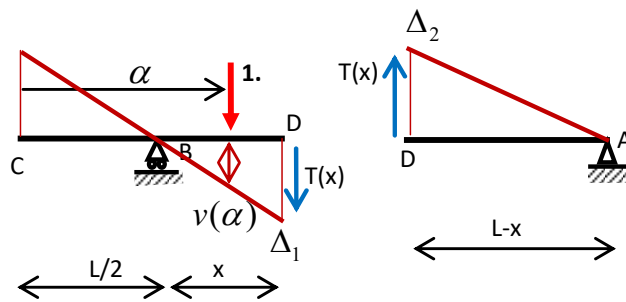


Figure 10.47. Shear force $\frac{L}{2} \leq \alpha \leq \frac{L}{2} + x$

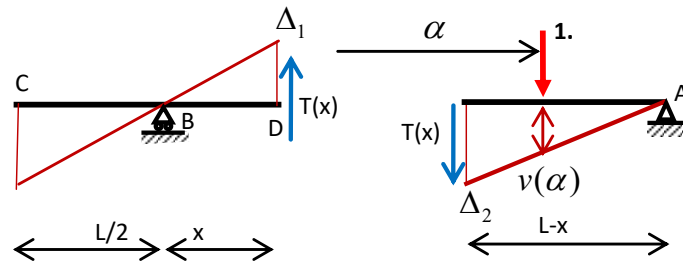


Figure 10.48. Shear force $x \leq \alpha \leq \frac{3L}{2}$

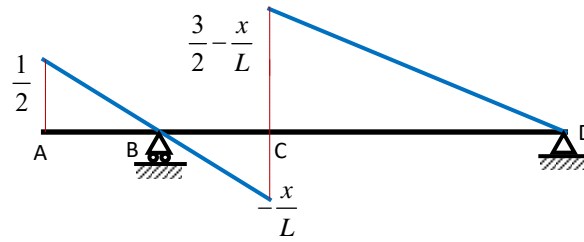


Figure 10.49. Influence line of a shear force relating to point D.

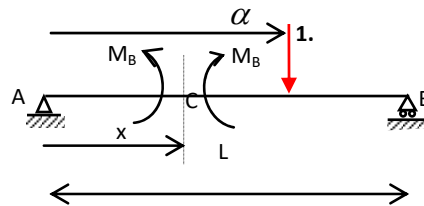


Figure 10.50. Given beam

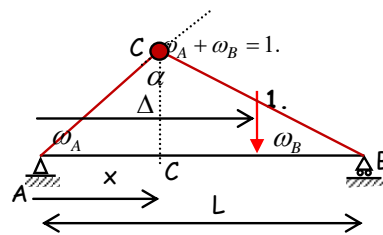


Figure 10.51. Beam deflection

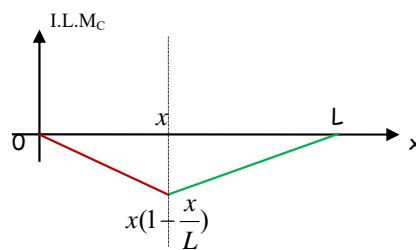


Figure 10.52. $I.L.M_C$

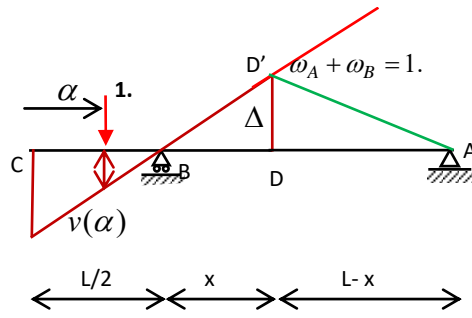


Figure 10.53. Force $0 \leq \alpha \leq \frac{L}{2}$

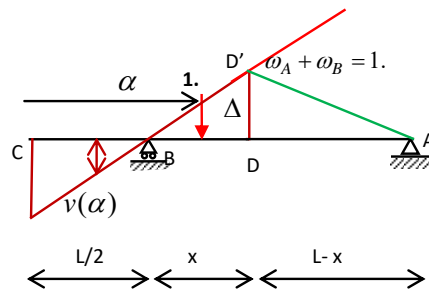


Figure 10.54. Force $\frac{L}{2} \leq \alpha \leq \frac{L}{2} + x$

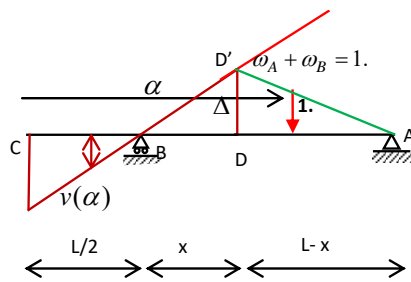


Figure 10.55. Force $x \leq \alpha \leq \frac{3L}{2}$

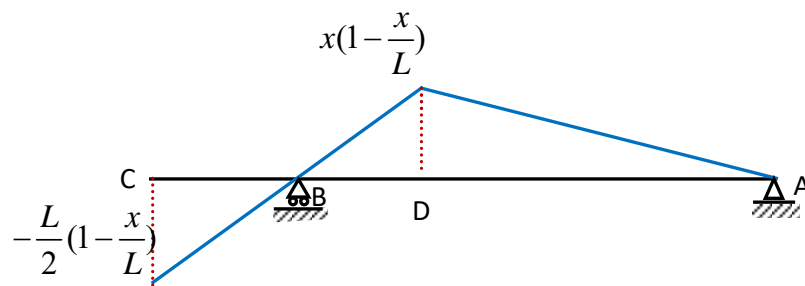


Figure 10.56. $I.L.M_D$

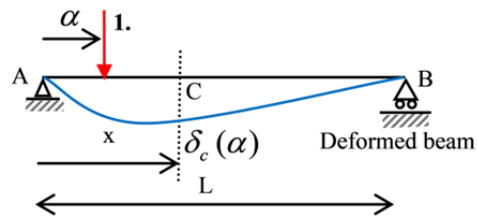


Figure 10.57. Given beam

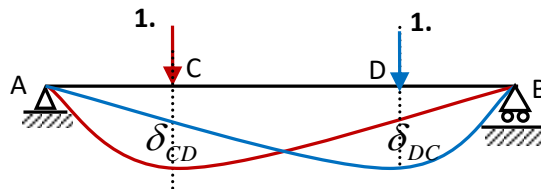


Figure 10.58. Maxwell-Betti law

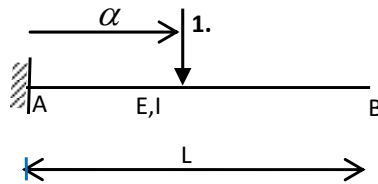


Figure 10.59. Given cantilever beam

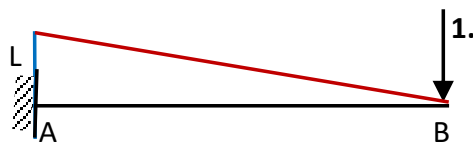


Figure 10.60. Bending moment diagram

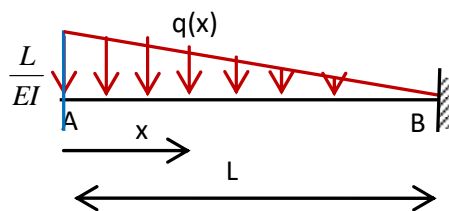
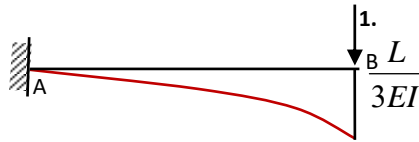
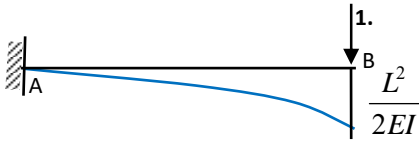


Figure 10.61. Conjugate beam



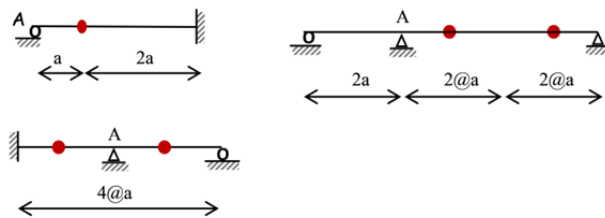
Influence line of displacement at point B



Influence line of the slope at point B

Figure 10.62. Influence lines of δ_B and ω_B .

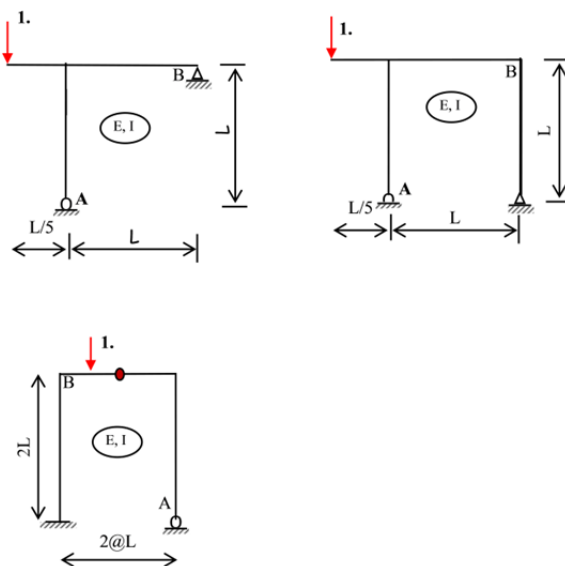
Chapter 10, Exercise 2



Chapter 10, Exercise 3



Chapter 10, Exercise 5



Chapter 10, Exercise 8

