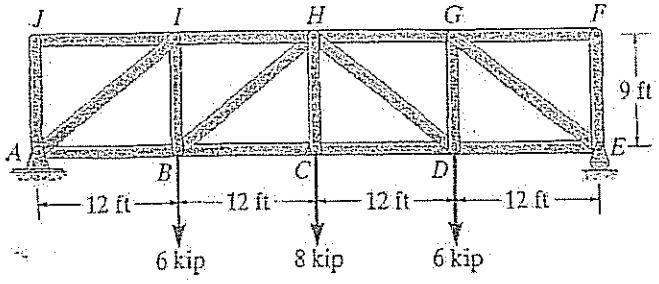
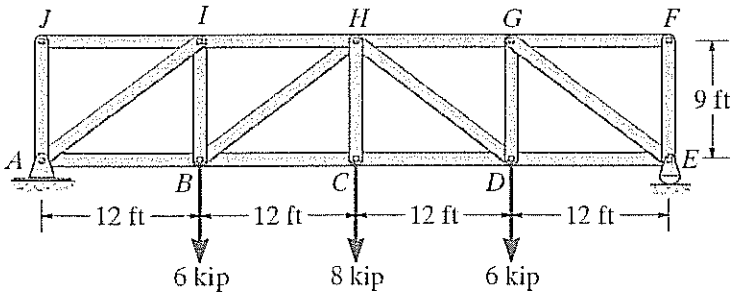
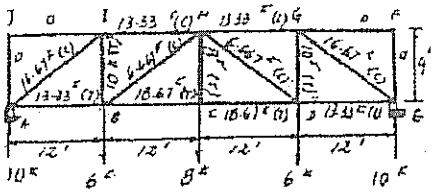
Problem [1] *(Vers. 6: page 375- Prob.9-31)*

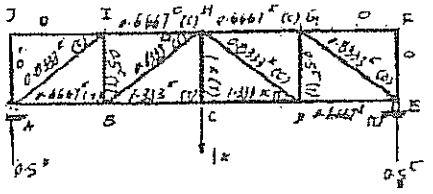
Use the method of Virtual Work and determine the *vertical displacement of joint C*. Take $E=29,000ksi$. Each steel member has a cross-sectional area of $4.5\ in^2$.





member	N	n	L	nNL
AJ	0	0	108	0
AI	-16.67	-0.8333	180	2500
AB	13.33	0.6667	144	1280
BI	10	0.500	108	540
BH	-6.667	-0.8333	180	1000
BC	16.67	1.333	144	3204
CH	8.00	1.00	108	864
CD	13.33	0.667	144	1280
DH	-6.667	-0.833	180	1000
DG	10.00	0.50	108	540
DE	13.33	0.667	144	1280
EG	-16.67	-0.833	180	2500
EF	0	0	144	0
FG	0	0	108	0
GH	11.33	0.667	144	1088
HF	-13.33	-0.667	144	1280
IJ	0	0	144	0
				Σ 21232





$$1\cdot\Delta_{C_v}=\Sigma\frac{nNL}{AE}$$

$$\Delta_{C_v}=\frac{21\,232}{4.5\,(29\,(10^3))}=0.163\ \text{in.}\quad \text{Ans}$$

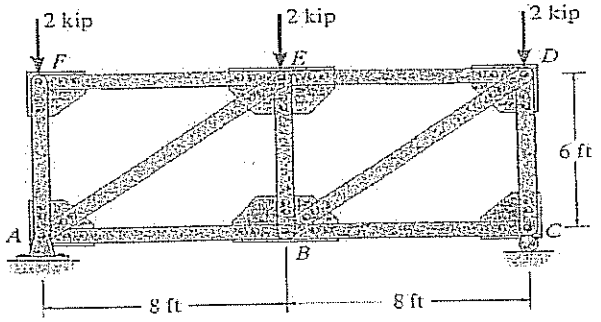
Problem [2] *(Vers. 6: page 373- Prob.9-9, 9-11)*

For the truss shown in the accompanying figure, each steel member has a cross-sectional area of *1.5 in²*. Using the method of Virtual Work and taking *E=29,000 ksi*. Solve the following:

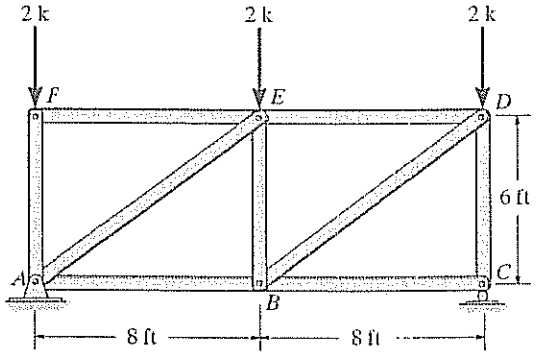
[a] determine the ***vertical displacement of joint B.***

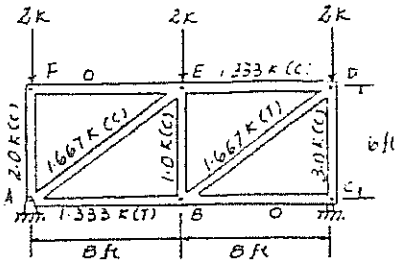
[b] determine the ***vertical displacement of joint E.***

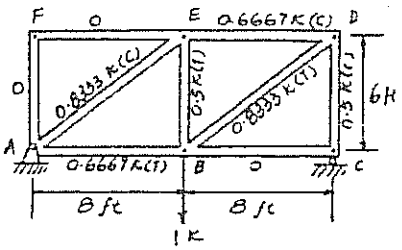
[c] deduce the ***axial deformation in member BE.***



[a] Determine the vertical displacement of joint *B*. For each member $A = 1.5\ \text{in}^2$, $E = 29(10^3)$ ksi. Use the method of virtual work.







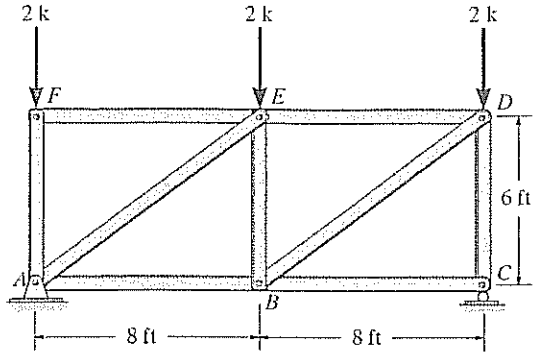
$$1 \cdot \Delta_{B_v} = \Sigma \frac{nNL}{AE}$$

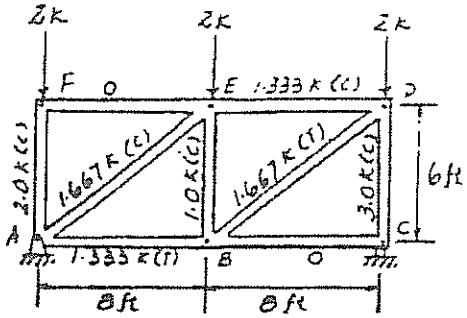
$$\Delta_{B_v} = \frac{1}{AE}\{(-1.667)(-0.8333)(10) + (1.667)(0.8333)(10) + (0.6667)(1.333)(8) + (-0.6667)(-1.333)($$

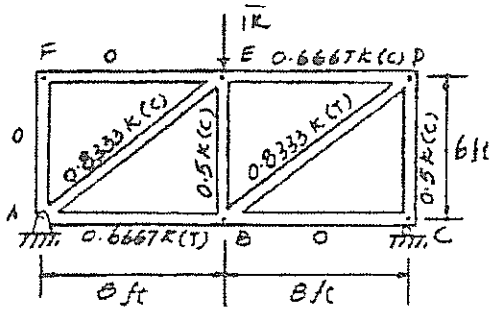
$$+ (-1)(0.5)(6) + (-0.5)(-3)(6)\}(12)$$

$$= \frac{576}{1.5\,(29)(10^3)} = \underline{0.0132\ \text{in.}} \qquad \text{Ans}$$

[b] Determine the vertical displacement of joint E. For each member $A = 1.5\ \text{in}^2$, $E = 29(10^3)$ ksi. Use the method of virtual work.







$$\Delta_{E_v} = \Sigma \frac{nNL}{AE} = \frac{1}{AE}\{(-0.8333)(-1.667)(10) + (0.8333)(1.6667)(10) + (0.6667)(1.333)(8) + (-0.6667)(-1.333)(8) + (-1)(-0.5)(6) + (-0.5)(-3)(6)\}(12)$$

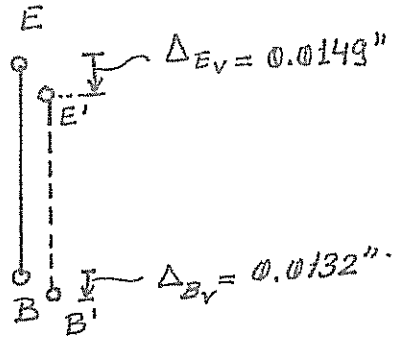
$$= \frac{648}{1.5\,(29)(10^3)} = \underline{\underline{0.0149\ \text{in.}}} \qquad \text{Ans}$$

[c] Axial Deformation in EB :-

$$\delta L_{EB} = U_B - U_E = 0.0132'' - 0.0149''$$

$$= \underline{\underline{\ominus\, 0.0017\ \text{in.}}}$$

indicates reduction in Length.



OR

$$\delta L_{EB} = \frac{F_{EB} * L_{EB}}{(EA)_{EB}} = \frac{(-1.0^{k}) * 6' * 12''/'}{29000\ \text{ksi} * 1.5\ \text{in}^2}$$ (From [a])

$$= \underline{\underline{\ominus\, 0.0017\ \text{in.}}}$$

indicates reduction in Length

Problem [3] *(Vers.6: page 376- Prob.9-39, 9-40, 9-41)*

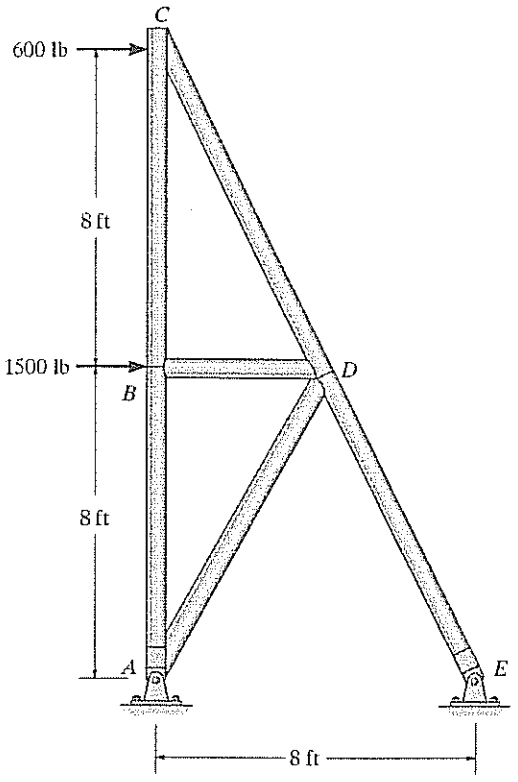
For the truss shown in the accompanying figure, assume all members are pin connected at their end points and that their **EA** is constant. Using the method of Virtual Work, solve the following:

[a] determine the ***horizontal displacement of joint C*** due to the given set of external loads.

[b] determine the ***horizontal displacement of joint C*** if all external loads are removed from the truss and members *AB* and *BC* experience a temperature increase of $\Delta T=200^{\circ}F$. Use $A=2in^2$, $E=29{,}000ksi$ *and* $\alpha=1x10^{-6}/^{\circ}F$.

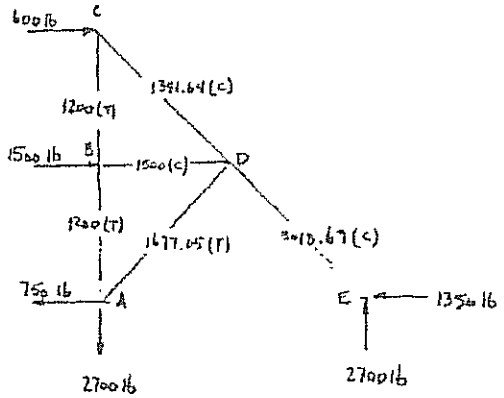
[c] determine the ***horizontal displacement of joint C*** if all external loads are removed from the truss and member *CD* is fabricated *0.5 in.* too short.

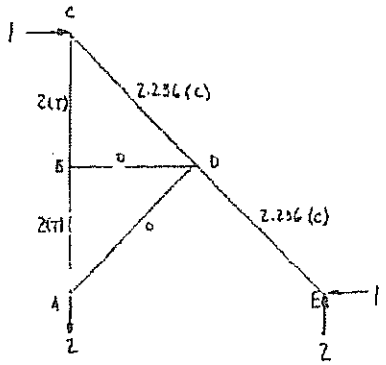
[a] Determine the horizontal deflection at *C*. Use the method of virtual work. Assume the members are pin connected at their end points. *AE* is constant.



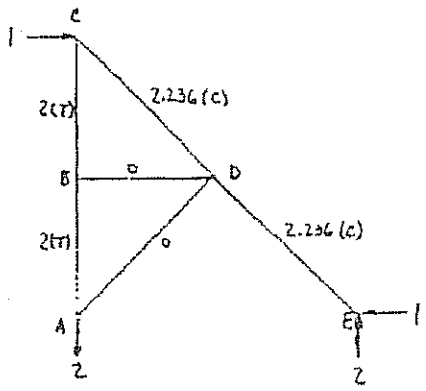
$$(\Delta_C)_h = \sum \frac{nNL}{AE} = 2\left[\frac{(2)(1200)(8)(12)}{AE}\right] + \frac{(-2.236)(-1341.64)(\sqrt{80})(12)}{AE} + \frac{(-2.236)(-3018.69)(\sqrt{80})(12)}{AE}$$

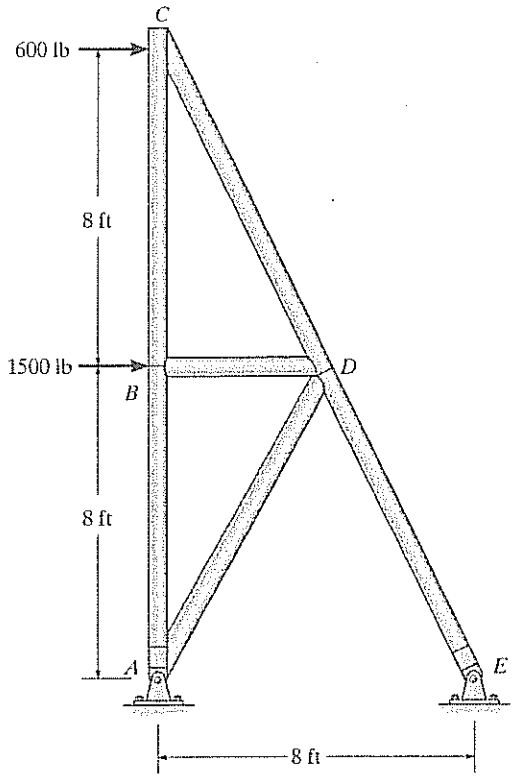
$$= \frac{1.51(10^6)\ \text{lb-in.}}{AE} \rightarrow \quad \text{Ans}$$





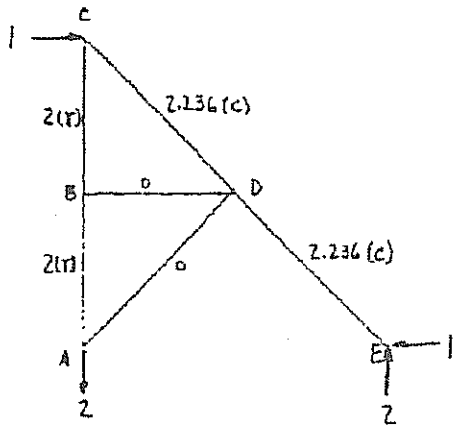
[b] Remove the loads on the truss in Prob. 9–42 and determine the horizontal displacement of point C if members AB and BC experience a temperature increase of $\Delta T = 200°\text{F}$. Take $A = 2\ \text{in}^2$ and $E = 29(10^3)$ ksi. Also, $\alpha = 10^{-6}/°\text{F}$.

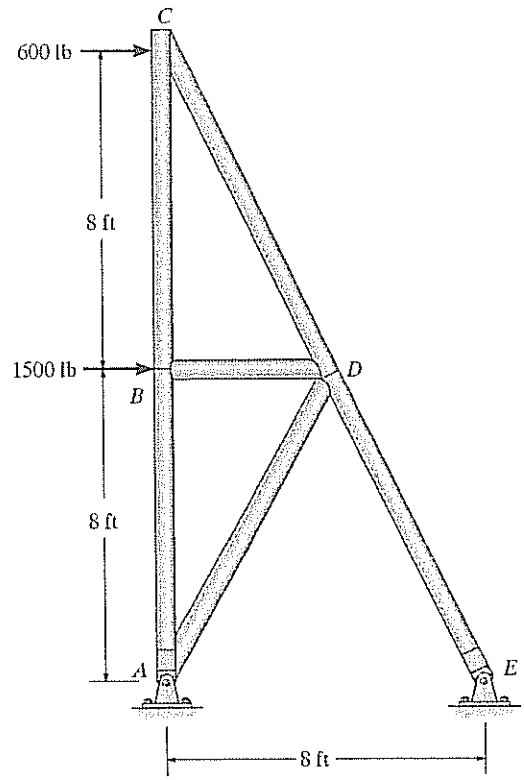




$$(\Delta_C)_h = \Sigma n \alpha \Delta T L = (2)(10^{-6})(200)(8)(12) + (2)(10^{-6})(200)(8)(12) = 0.0768\ \text{in.} \rightarrow \quad \text{Ans}$$

[c] Remove the loads on the truss in Prob. 9–42 and determine the horizontal displacement of point C if member CD is fabricated 0.5 in. too short.





$$(\Delta_C)_h = \Sigma n \Delta L = (-2.236)(-0.5) = 1.12\ \text{in.} \rightarrow \quad \text{Ans}$$