CE222 STRUCTURAL MECHANICS I
DEPARTMENT OF CIVIL ENGINEERING
Quiz 2; March 28, 2019, 9-10pm

Problems carry equal weightage

Problem 1

For the beam shown in Figure 1, use the conjugate beam method to calculate vertical deflection at ***C*** and rotation at point ***E***.

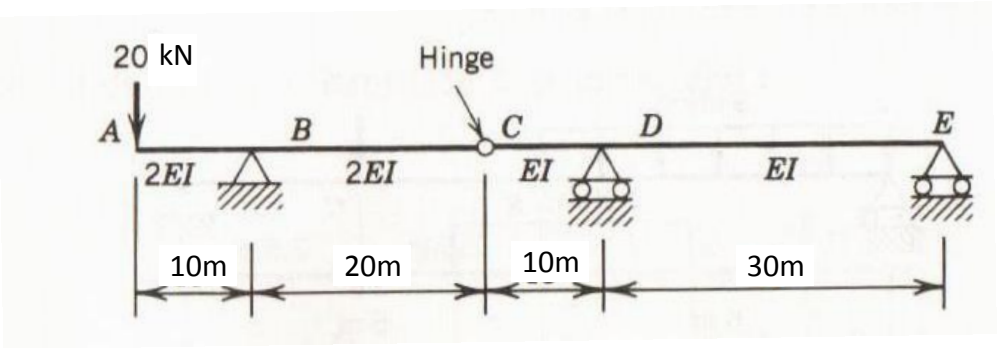

Figure 1

Problem 2

Calculate reaction at ***E*** and force in member ***BD*** of the truss shown in Figure 2. Assume *AE* same for all members.

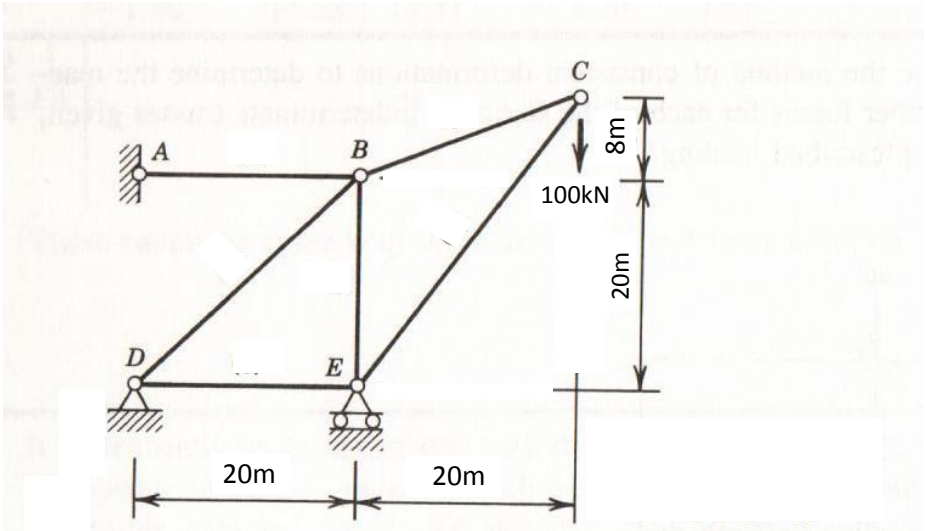

Figure 2

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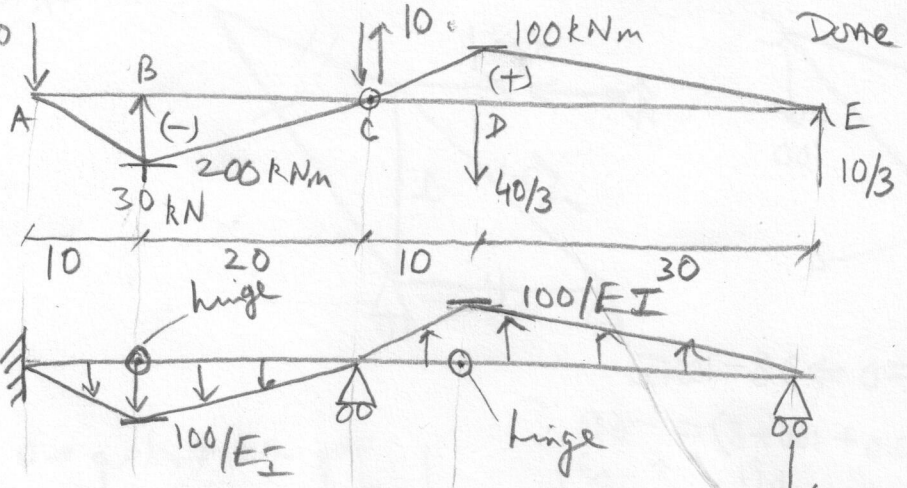
1) Done by Conj beam method
BMD, real beam.



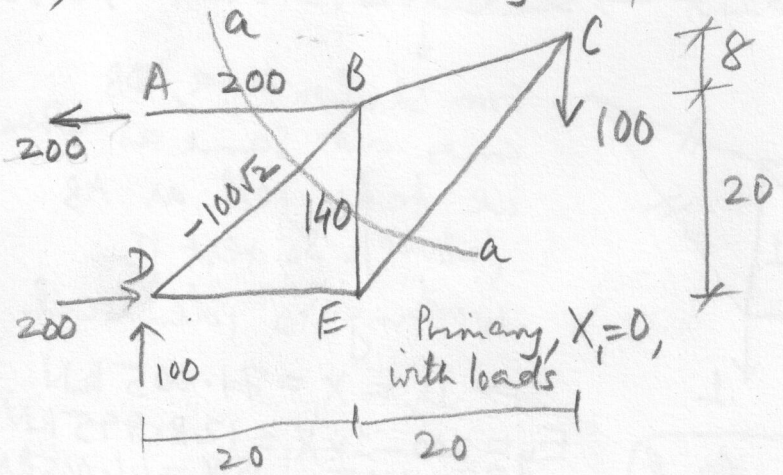
Loading, C-beam.

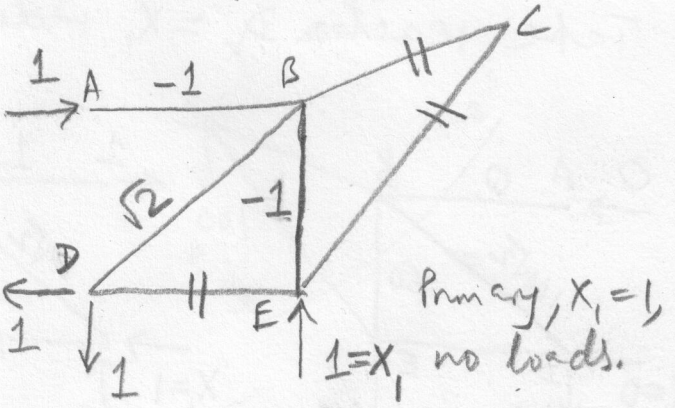
$\left(\frac{1}{2}.30.\frac{100}{EI}.\frac{1}{3}.30\right)/30 = \frac{500}{EI}$

$$W_C = \bar{M}_C = \frac{1}{2}.10.\frac{100}{EI}.\frac{2}{3}.10 + \frac{1}{2}.30.\frac{100}{EI}.\left(10+\frac{1}{3}.30\right) - \frac{500}{EI}.40 = \frac{40000}{3EI}$$

$$\theta_E = \bar{V}_E = \frac{500}{EI}$$

2). Take reaction $E_y = X_1$ = redundant. (ie 1 DoSI external)





	P	p	L	pPL	p^2L
AB	200	−1	20	−4000	20
DB	$-100\sqrt{2}$	$\sqrt{2}$	$20\sqrt{2}$	$-4000\sqrt{2}$	$40\sqrt{2}$
EB	(140)	−1	20	−2800	20
				$\Delta_{10} = -12456.85$	$f_{11} = 96.57$

$$\Delta_{10} + f_{11} X_1 = 0$$

$$X_1 = E_y = 128.995\ kN$$

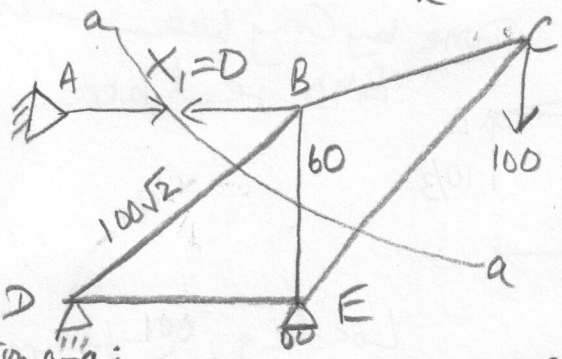
$$DB = -100\sqrt{2} + X_1\sqrt{2}$$

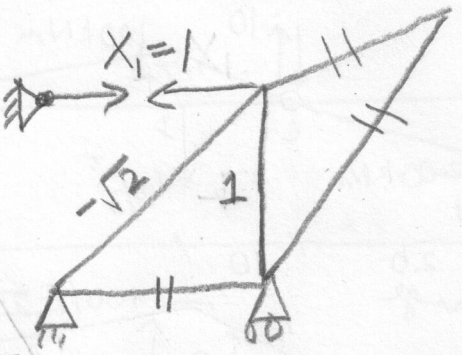
$$DB = 41.005$$

Section a-a, $\Sigma M_c = 0$: $BE = \frac{1}{20}\left(200*8 - 100*8 + 100*20\right) = 140$

(or equivalently reaction at A)

Take force in AB_L as redundant $= X_1$ (ie 1 DOSI internal or external)





section a-a:

$\Sigma M_E=0: \frac{DB}{\sqrt{2}}.20-100.20=0 \Rightarrow DB=100\sqrt{2}$

$\Sigma M_C=0: BE=\frac{1}{20}(-100*20+100*8)=-60$

	P	p	L	pPL	p^2L
AB	0	1	20	0	20
BD	$100\sqrt{2}$	$-\sqrt{2}$	$20\sqrt{2}$	$-4000\sqrt{2}$	$40\sqrt{2}$
BE	-60	1	20	-1200	20
				$\Sigma=-6856.85$ = gap	$\Sigma=96.57$ = overlap per unit X_1

gap + overlap = 0

$-6856.85+96.57X_1=0$

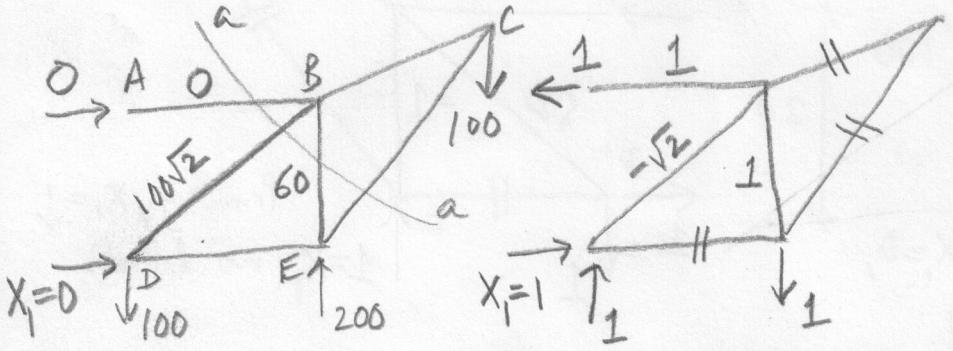
$X_1=71.005$ kN

$\Sigma M_D=0 \Rightarrow E_y=\frac{1}{20}(100*40-X_1*20)$

$=128.995$ kN

$DB=100\sqrt{2}-\sqrt{2}X_1=41.005$ kN

Take reaction $D_x=X_1$ redundant → see below. It same as above



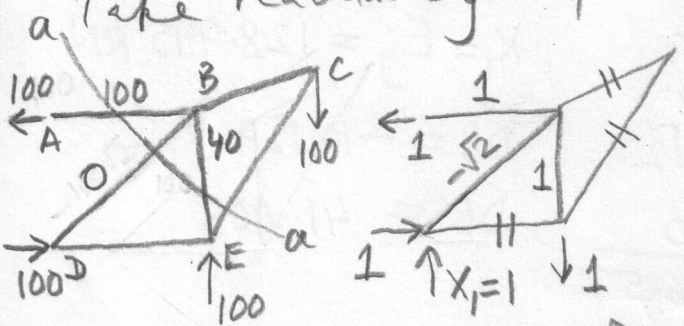
From section a-a, DB comes out same as when we take red. as AB (above). So rest of working is identical.

$\Rightarrow D_x=X_1=71.005$ kN

$E_y=200-1*X_1=128.995$ kN

$DB=100\sqrt{2}-\sqrt{2}X_1=41.005$ kN

Take reaction $D_y=X_1=$ redundant.



section a-a, $\Sigma M_C=0$: $BE=\frac{1}{20}(100*8)=40$

	P	p	L	pPL	p^2L
AB	100	1	20	2000	20
DB	0	$-\sqrt{2}$	$20\sqrt{2}$	0	$40\sqrt{2}$
BE	40	1	20	800	20
				$\Delta_{10}=2800$	$f_{11}=96.57$

$\Delta_{10}+f_{11}X_1=0$

$\Rightarrow X_1=-28.995=D_y$

$E_y=100-1*X_1=128.995$ kN

$DB=0-\sqrt{2}X_1=41.005$ kN