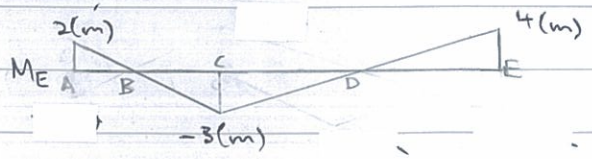
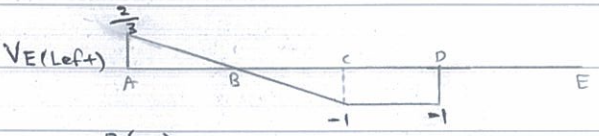
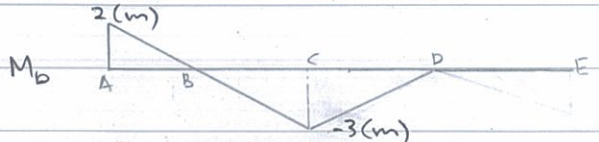
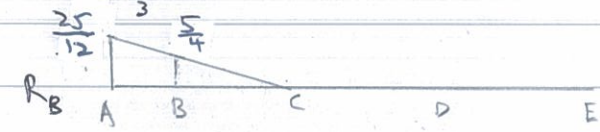
CV2012 16/17 sem 2

1. a)





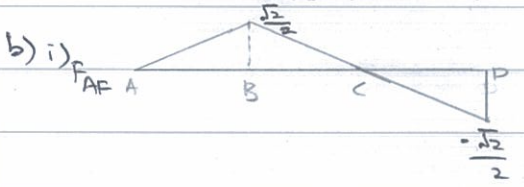


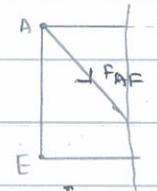


$M_{E,max(+)} = 5\times\left(\frac{1}{2}\times2\times2 - \frac{1}{2}\times3\times6 + \frac{1}{2}\times4\times4\right) + 10\times\left(\frac{1}{2}\times2\times2 + \frac{1}{2}\times4\times4\right) + 4\times20$

$= 185$ kN.m

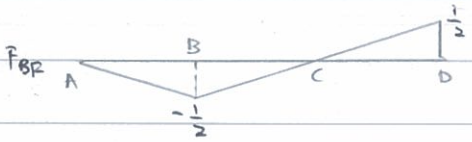
b) i)



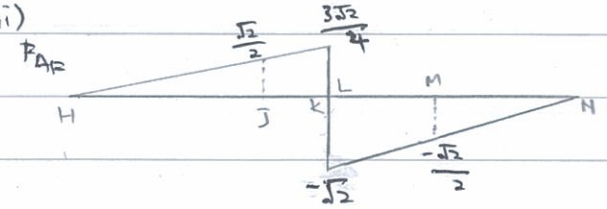


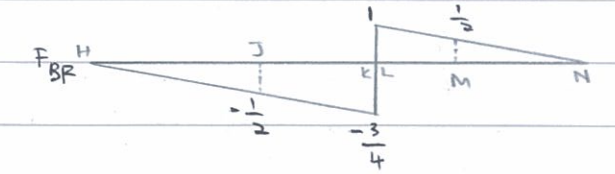
$F_{EF} = 0$ as no horizontal force exerted

So, take moment at B will get F_{BF}



ii)





$F_{BF,max(T)} = 20\times1 + 10\times\frac{3}{4}$

$= 27.5$ kN

$F_{BF,max(C)} = 20\times\frac{5}{8} + 10\times\frac{3}{4}$

$= 20$ kN

2. a) i) $A_y \times 6 = 18 \times 2 \times 5 + 24 \times 2 \times 3$

$A_y = 54$ kN, $D_y = 30$kN

1. $\Delta_B = \int_0^2 (-54x + 9x^2)(\frac{2}{3}x)\frac{dx}{EI} + \int_0^2 [-54(2+x) + 18 \times 2 \times (1+x) + 12x^2] \times (\frac{2}{3}(2+x-2)$

$\frac{dx}{EI} + \int_0^2 (-30x)(\frac{1}{3}x)\frac{dx}{EI}$

$= \int_0^2 -36x^2 + 6x^3 \frac{dx}{EI} + \int_0^2 -96 + 22x^2 - 4x^3 \frac{dx}{EI} + \int_0^2 -10x^2 \frac{dx}{EI}$

$= \frac{248}{EI} (\downarrow)$

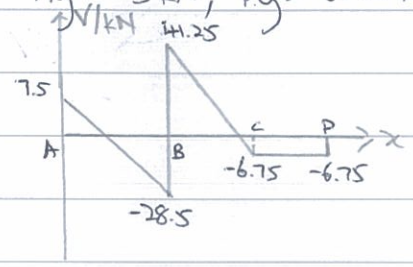
1. $f_{BB} = \int_0^2 (\frac{2}{3}x)^2 \frac{dx}{EI} + \int_0^2 [\frac{2}{3}(2+x) - x]^2 \frac{dx}{EI} + \int_0^2 (\frac{1}{3}x)^2 \frac{dx}{EI}$

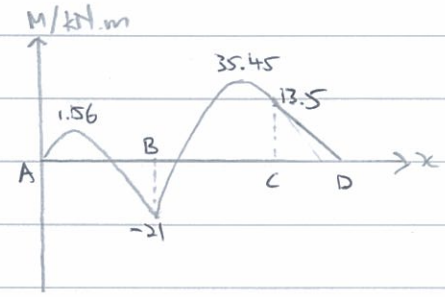
$= \frac{32}{9EI} (\uparrow)$

$-\frac{248}{EI} + B_y(\frac{32}{9EI}) = 0$

$B_y = 69.75$ kN

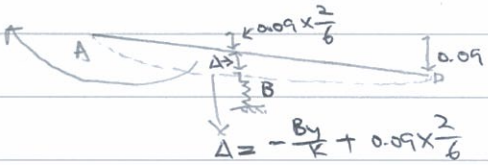
ii) $A_y = 7.5$ kN, $D_y = 6.75$ kN





b) $-\frac{248}{EI} + B_y(\frac{32}{9EI}) = 0.09 \times \frac{2}{6} - \frac{B_y}{K}$

$B_y = 50.04$ kN



3. a) $FEM_{BA} = \frac{10}{10^2}\left(7\times3^2 + \frac{1}{2}\times7^2\times3\right)$

$= 13.65$ kN.m

$FEM_{BC} = -\frac{1\times10^2}{12}$

$= -\frac{25}{3}$ kN.m

$FEM_{CB} = \frac{25}{3}$ kN.m

$FEM_{CD} = -\frac{70\times10}{8} = -12.5$ kN.m

$FEM_{DC} = 12.5$ kN.m

$M_{BA} = \frac{3EI}{10}(\theta_B - 0) + 13.65 = \frac{3}{10}EI\theta_B + 13.65$

$M_{BC} = \frac{2(2EI)}{10}(2\theta_B + \theta_C - 0) - \frac{25}{3} = \frac{4}{5}EI\theta_B + \frac{2}{5}EI\theta_C - \frac{25}{3}$

$M_{CB} = \frac{2(2EI)}{10}(2\theta_C + \theta_B) + \frac{25}{3} = \frac{4}{5}EI\theta_C + \frac{2}{5}EI\theta_B + \frac{25}{3}$

$M_{CD} = \frac{2EI}{10}(2\theta_C) - 12.5 = \frac{2}{5}EI\theta_C - 12.5$

$M_{DC} = \frac{2EI}{10}(\theta_C) + 12.5 = \frac{1}{5}EI\theta_C + 12.5$

$M_{BA} + M_{BC} = 0$

$\frac{11}{10}EI\theta_B + \frac{2}{5}EI\theta_C = -\frac{319}{60}$

$M_{CB} + M_{CD} = 0$

$\frac{6}{5}EI\theta_C + \frac{2}{5}EI\theta_B = \frac{25}{6}$

$EI\theta_C = 5.7845$

$EI\theta_B = -6.9368$

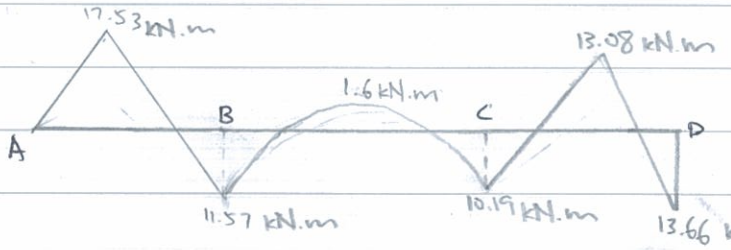
$M_{BA} = 11.57$ kN.m

$M_{BC} = -11.57$ kN.m

$M_{CB} = 10.19$ kN.m

$M_{CD} = -10.19$ kN.m

$M_{DC} = 13.66$ kN.m



Bending moment diagram

b) $M_{CD} = \frac{2EI}{10}\left(2\theta_C + \frac{5.5}{EI}\right) - 12.5 = \frac{2}{5}EI\theta_C - 11.4$

$M_{DC} = \frac{2EI}{10}\left(2\left(\frac{5.5}{EI}\right) + \theta_C\right) + 12.5 = \frac{1}{5}EI\theta_C + 14.7$

$M_{CB} + M_{CD} = 0$, $\frac{6}{5}EI\theta_C + \frac{2}{5}EI\theta_B = \frac{46}{15}$

$EI\theta_C = 4.7414$

$EI\theta_B = -6.5575$

$M_{BA} = 11.68$ kN.m, $M_{BC} = -11.68$ kN.m, $M_{CB} = 9.50$ kN.m, $M_{CD} = -9.50$ kN.m,

$M_{DC} = 15.65$ kN.m

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4. a) $K_{AB} = \frac{3EI}{4}$

$K_{BC} = \frac{4EI}{4} = EI$

$K_{BE} = \frac{3(2EI)}{3} = 2EI$

$K_{CD} = \frac{4EI}{4} = EI$

$K_{CF} = \frac{4(2EI)}{3} = \frac{8EI}{3}$

$DF_{AB} = DF_{EB} = 1$, $DF_{DC} = DF_{FC} = 0$

$DF_{BA} = \frac{\frac{3}{4}EI}{EI + 2EI + \frac{3}{4}EI} = 0.2$

$DF_{BE} = \frac{2EI}{EI + 2EI + \frac{3}{4}EI} = 0.533$

$DF_{BC} = 1 - 0.2 - 0.533 = 0.266$

$DF_{CB} = \frac{EI}{EI + EI + \frac{8}{3}EI} = 0.214$

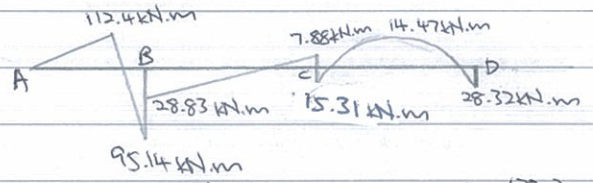
$DF_{CD} = 0.214$, $DF_{CF} = 0.571$

$FEM_{BA} = \frac{3 \times 160 \times 4}{16} = 120\ kN.m$

$FEM_{CD} = -\frac{18 \times 4^2}{12} = -24\ kN.m$

$FEM_{DC} = \frac{18 \times 4^2}{12} = 24\ kN.m$

	A	B			C			D	F
	AB	BA	BE	BC	CB	CF	CD	DC	FC
DF	1	0.2	0.533	0.266	0.214	0.571	0.214	0	0
		120					-24	24	
		-24	-64	-32	5.143	13.714	5.143		
				2.571	-16			2.571	6.857
		-0.514	-1.371	-0.686	3.429	9.143	3.429		
				1.714	-0.343			1.714	4.571
		-0.343	-0.914	-0.457	0.073	0.196	0.073		
				0.037	-0.229			0.037	0.098
		-0.007	-0.020	-0.009	0.049	0.131	0.049		
ΣM	0	95.14	-66.31	-28.83	-7.88	23.18	-15.31	28.32	11.53



Bending moment diagram for beam ABCD

b) $FEM_{BA} = 120 - \frac{3EI\left(\frac{20}{EI}\right)}{4^2} = 116.25\ kN.m$

$FEM_{BC} = \frac{6EI\left(\frac{20}{EI}\right)}{4^2} = 7.5\ kN.m = FEM_{CB}$

$FEM_{CD} = -24 + \boxed{\frac{2EI}{4} \times \frac{5}{EI}} = -21.5\ kN.m$

$FEM_{DC} = 24 + \boxed{\frac{2EI}{4} \times 2\left(\frac{5}{EI}\right)} = 29\ kN.m$

The two box formula come from $M_N = \frac{2EI}{L}[2\theta_N + \theta_F - 3\psi] + FEM$

So,

	A	B			C			D	F
	AB	BA	BE	BC	CB	CF	CD	DC	FC
		116.25		7.5	7.5		-21.5	29	
		-24.75	-66	-33	3	8	3		
				1.5	-16.5			1.5	4
		-0.3	-0.8	-0.4	3.536	9.429	3.536		
				1.768	-0.2			1.768	4.715
		-0.354	-0.943	-0.471	0.043	0.114	0.043		
				0.021	-0.236			0.021	0.057
		-0.004	-0.011	-0.006	0.051	0.135	0.051		
ΣM	0	90.84	-67.75	-23.05	-2.81	17.68	-14.87	32.29	8.77

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