Solution for Q1

Consider FBD of pin :

$+\uparrow \Sigma F_y = 0$: $2 \cdot \frac{1}{2} W_0 (20) - 60(0 \cdot 4) = 0$

$\Rightarrow W_0 = 1 \cdot 2 \text{ kN/m} = 1 \cdot 2 \text{ N/mm}$

For $0 \leqslant x < 20 \text{ mm}$

$+\uparrow \Sigma F_y = 0$: $V + \frac{1}{2} \left(\frac{1 \cdot 2x}{20} \right) x = 0$

$\Rightarrow V = -0 \cdot 03 x^2$ ANS

$\zeta + M_{sec} = 0$: $M - \frac{1}{2} \left(\frac{1 \cdot 2x}{20} \right) \left(\frac{x}{3} \right) = 0$

$\Rightarrow M = 0 \cdot 01 x^3$ ANS

For $20 \leqslant x < 80 \text{ mm}$

$+\uparrow \Sigma F_y = 0$: $V + \frac{1}{2} \left(W_0 \right) (20) - (0 \cdot 4)(x-20) = 0$

$V = 0 \cdot 4 (x-20) - 10 (1 \cdot 2)$

$= 0 \cdot 4 x - 20$ ANS

$\zeta + M_{sec} = 0$: $M + 0 \cdot 4 (x-20) \frac{(x-20)}{2}$

$\qquad - \frac{1}{2} (1 \cdot 2)(20) \left(x - \frac{40}{3} \right) = 0$

$M = 12 \left(x - \frac{40}{3} \right) - 0 \cdot 2 (x-20)^2$

$= - (0 \cdot 2 x^2 - 20x + 240)$ ANS.

Max. moment.

occurs in portion $20 \leqslant x \leqslant 80 \text{ mm}$

when $V = 0 \Rightarrow x = 50 \text{ mm}$

Sub $x = 50$ in M

$M = - (0 \cdot 2 \times 50^2 - 20 \times 50 + 240)$

$= + 260 \text{ Nmm}$

$0 \cdot 4 \text{ kN/m} = 0 \cdot 4 \text{ N/mm}$

W_0 W_0

20mm   60mm   20mm

$\frac{1}{2} \left(\frac{1 \cdot 2}{20} \right) x \cdot x$

$x/3$

$r(0 \cdot 4)(x-20)$

$\frac{(x-20)}{2}$

W_0

$\frac{1}{2} (W_0)(20)$

$\frac{20}{3}$

$V \uparrow (N)$.

20   50   80   100 $\rightarrow x$

12   12

$M \uparrow (Nmm)$

80   260   80 $\rightarrow x$
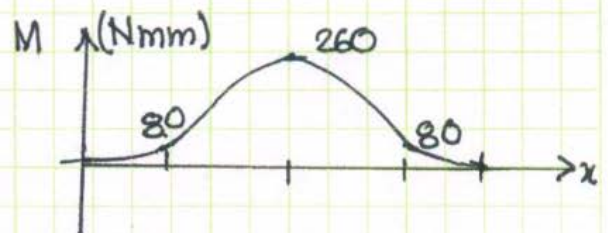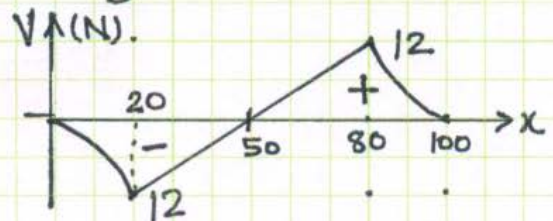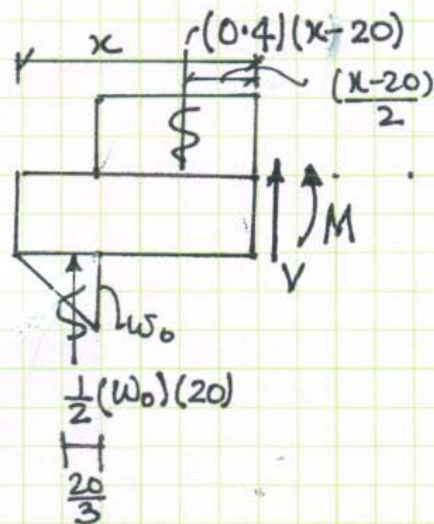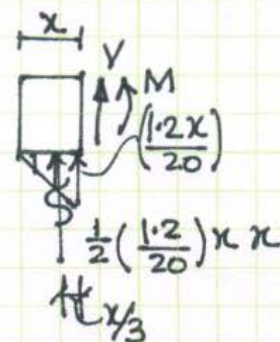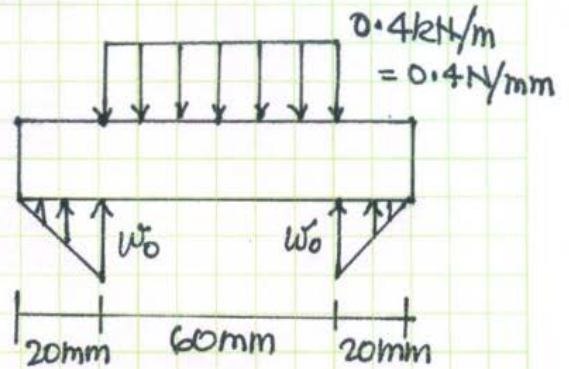
Grading Scheme

1. Correct determination of w_0 : 4 Marks. Note that credit is given for correct interpretation of w_0.
2. Correct SF diagram (with maximum values, correct zero crossing) : 6 Marks
3. Correct BM diagram with values at all critical points like the transition between the cubic and quadratic parts and maximum bending moment: 10 Marks
4. Note: no mark is deducted for using the reverse of the convention taught in the class.
5. Some marks are awarded if the BM and SF are incorrect but are related to each other in the correct manner, i.e. if slope of the BMD is appropriately related to the magnitude of the SFD.
6. No credit is given if the BMD and SFD are not drawn.