University of Nottingham
Department of Mechanical Engineering

MM2MS3 Mechanics of Solids 3
Exercise Sheet 4 – Deflection of Beams

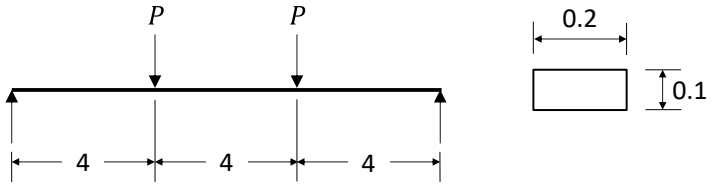
1. Derive expressions for the deflection and slope of the tip of a cantilever beam, length L, which carries:

   (a) A point force, P, at the tip
   (b) A point couple, M_o, at the tip
   (c) A uniformly distributed load, w per unit, across its entire length

   The second moment of area of the cross-section is Im^4 and the Young's modulus of the material is $EMPa$.

[Ans: a) $\frac{dy}{dx} = \frac{PL^2}{2EI}$ ***&*** $y = -\frac{PL^3}{3EI}$ ***b)*** $\frac{dy}{dx} = -\frac{M_oL}{EI}$ ***&*** $y = \frac{M_oL^2}{2EI}$ ***c)*** $\frac{dy}{dx} = \frac{wL^3}{6EI}$ ***&*** $y = -\frac{wL^4}{8EI}$***]***

2. Figure Q2 shows a simply supported beam carrying two concentrated loads at the positions indicated. Given that the beam has a rectangular cross-section as shown, calculate (a) the deflection of the beam at a position 3m from the left hand end (b) and at a position 5m from the right hand end. Assume $E_{steel} = 200GPa$.

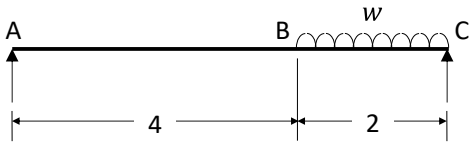


All dimensions in meters, P = 10kN

Fig Q2

[Ans: a) -130.5mm, b) -178mm]

3. Find (a) the slope at point A and (b) the deflection at point B of the beam shown in Figure Q3. Assume a Flexural Rigidity, EI, of 4MNm^2.



All dimensions in meters, w = 10kN/m

Fig Q3

[Ans: a) -4.72 x 10^{-3}rad, b) -10mm]

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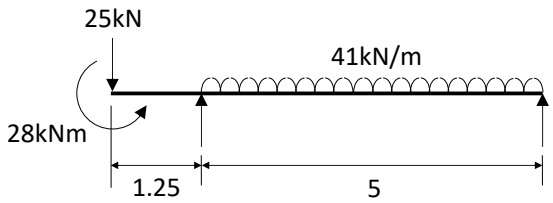
4. Determine (a) the slope and (b) the deflection at the left hand end of the beam shown in Figure Q4. Assume a Flexural Rigidity, EI, of 16.65MNm^2.



All dimensions in meters

Fig Q4

[Ans: a) $\mathbf{3.62 \times 10^{-3} rad}$***, b) 6.32mm upwards]***