Ministry of Higher Education
Giza Higher Institute for Eng. & Tech.
Civil Engineering Department
Course Name: **Theory of Structures (3)**
Course Code : **CIV 301**

Academic Year : **2014–2015**
Semester : **First**
Level : **3rd**
Time : **1½ Hours**
Date : **23 / 11 / 2014**
Examiner: ***Dr. M. Abdel-Kader***

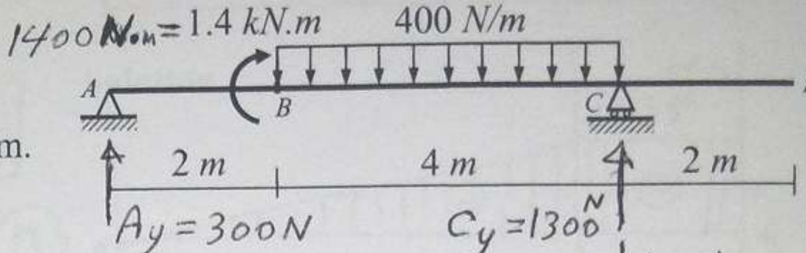
Mid-Term Exam

Question (1): (12 Marks)

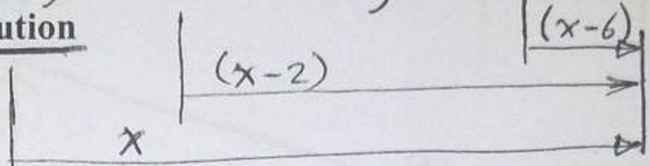
For the shown beam, using the **double integration method**, determine:

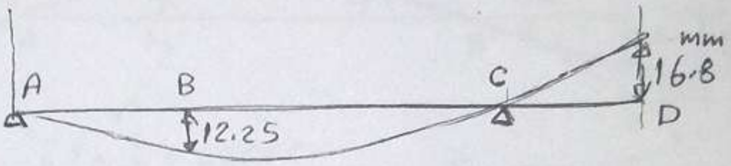
(a) the deflection at B
(b) the deflection at D
(c) the slope at D

and sketch the elastic curve of the beam.
$EI = 0.45\times10^6\ N.m^2$



Solution





Elastic curve

Reaction:

* $\circlearrowleft \Sigma M_c = 0$

$A_y(6) + 1400 - 1600(2) = 0$

$\therefore \boxed{A_y = 300N \uparrow}$

* $\uparrow \Sigma F_y = 0$

$300 - 1600 + C_y = 0$

$\therefore \boxed{C_y = 1300N \uparrow}$

* $EIy'' = M$

$$= 300x + 1400(x-2)^0 - 400\frac{(x-2)^2}{2} + 1300(x-6) + 400\frac{(x-6)^2}{2}$$

$$EIy' = 150x^2 + 1400(x-2) - \frac{200}{3}(x-2)^3 + 650(x-6)^2 + \frac{200}{3}(x-6)^3 + C_1$$

$$EIy = 50x^3 + 700(x-2)^2 - \frac{50}{3}(x-2)^4 + \frac{650}{3}(x-6)^3 + \frac{50}{3}(x-6)^4 + C_1x + C_2$$

B.C.: at $x=0$ $y=0 \Longrightarrow \boxed{C_2 = 0}$

at $x=6$ $y=0 \Longrightarrow 50(6)^3 + 700(4)^2 - \frac{50}{3}(4)^4 + C_1(6) = 0$

$\boxed{C_1 = -26600/9 = -2955.56}$

(a) $\delta_B = y_B = \frac{1}{EI}\left[50(2)^3 - 2955.56\right] = \frac{5511.1}{450000} = -0.012247\ m$

$\boxed{\delta_B = 12.25\ mm \downarrow}$

(b) $\delta_D = y_D = \frac{1}{EI}\left[50(8)^3 + 700(6)^2 - \frac{50}{3}(6)^4 + \frac{650}{3}(2)^3 + \frac{50}{3}(2)^4 - 2955.56(8)\right]$

$= \frac{7555.56}{450000} = 0.01679\ m$

$\boxed{\delta_D = 16.79\ mm \uparrow}$

(c) $\theta_D = y'_D = \frac{1}{EI}\left[150(8)^2 + 1400(6) - \frac{200}{3}(6)^3 + 650(2)^2 + \frac{200}{3}(2)^3 - 2955.56\right]$

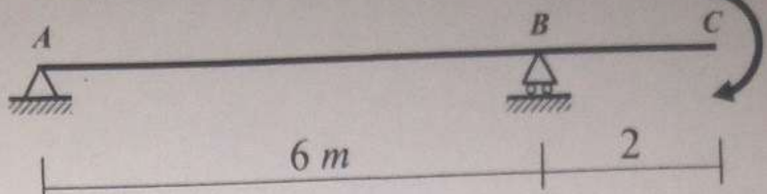
$= 3777.78/450000 = 0.008395\ rad$

$\boxed{\theta_D = 0.48^\circ}$

uestion (2): (8 Marks)

For the shown beam, using the **moment-area method**, determine the deflection at the right end *C* and sketch the elastic curve of the beam.

$EI = 0.45\times10^6\ N.m^2$

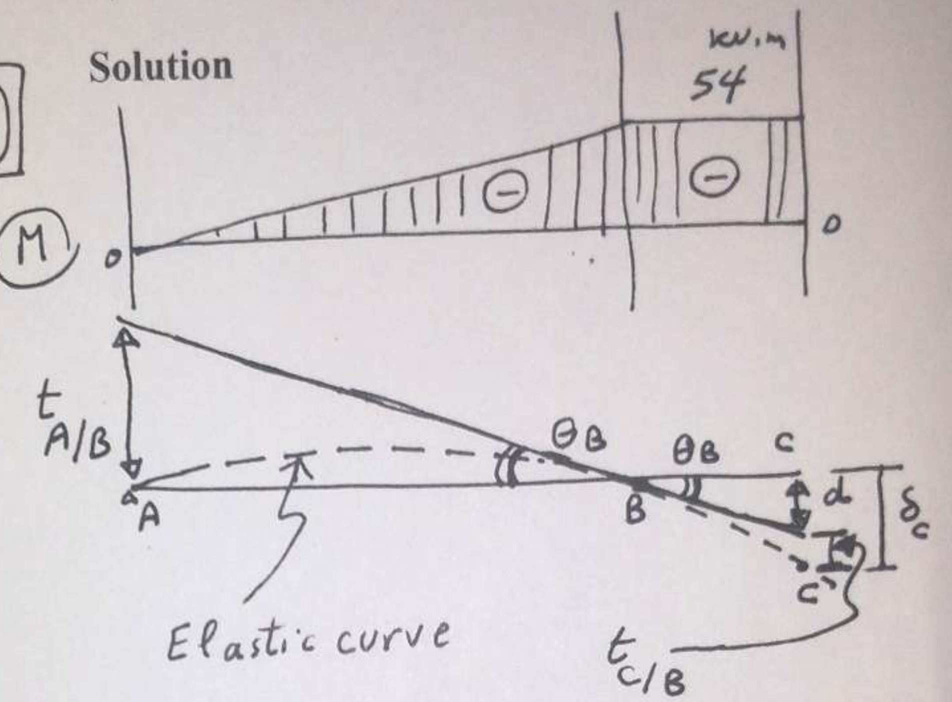


$$t_{A/B} = \frac{1}{EI}\left[Area_{AB}\cdot\bar{X}_A\right]$$

$$= \frac{1}{EI}\left[\tfrac{1}{2}(6)(-54)\left(\tfrac{2}{3}\times6\right)\right]$$

$$\boxed{t_{A/B} = \frac{-648}{EI}}$$

Solution



$$t_{C/B} = \frac{1}{EI}\left[Area_{AB}\cdot\bar{X}_c\right]$$

$$= \frac{1}{EI}\left[(2)(-54)\right]$$

$$\therefore \boxed{t_{C/B} = \frac{-108}{EI}}$$

$$\theta_B = \frac{t_{A/B}}{6} = \frac{d}{2} \Longrightarrow d = \frac{t_{A/B}}{3}$$

$$\delta_c = t_{C/B} + d = \frac{-108}{EI} + -\frac{648}{3EI} = \frac{-324}{EI}$$

$$\delta_c = \frac{324}{450} = 0.72\ m \downarrow$$

$$\therefore \boxed{\delta_c = 0.72\ m \downarrow}$$

the deflection is very large "EI" needs to be increased