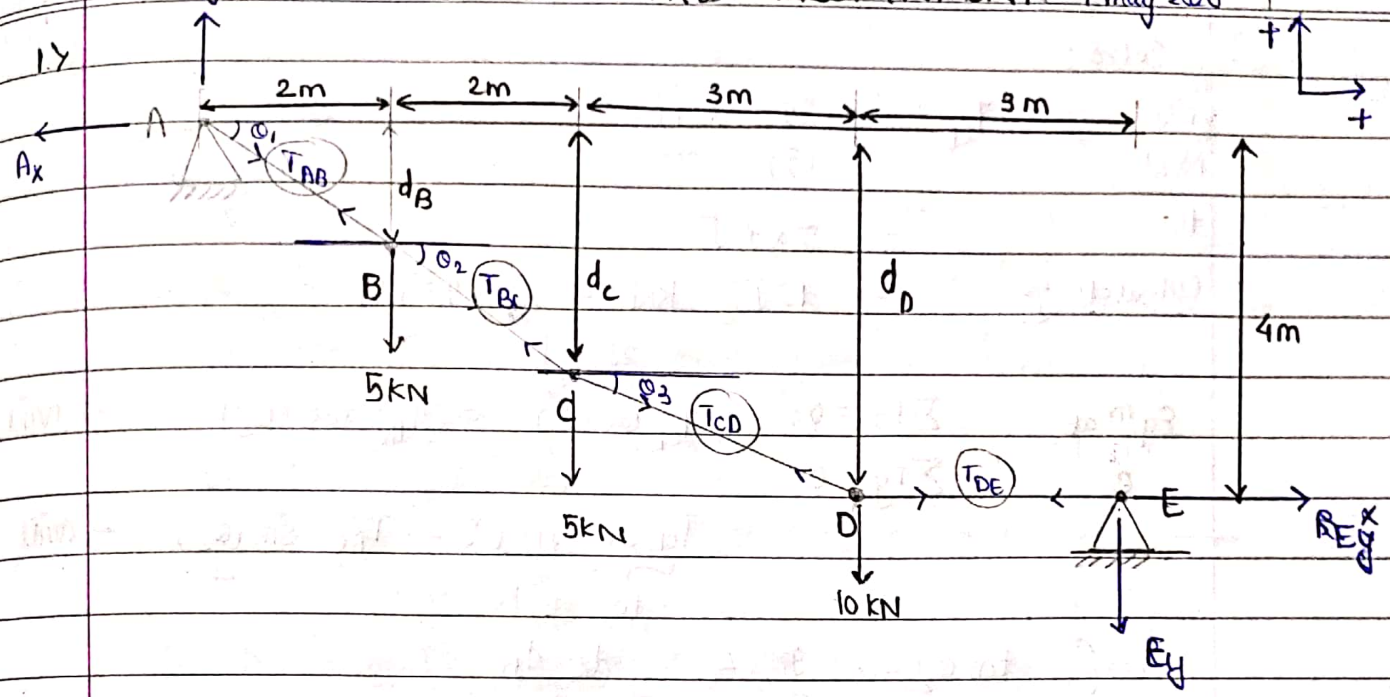
U19CS012 (D-12)

CABLES LECTURE ASSIGNMENT

Date: 7 May 2020



~~Equi~~ Since DE part of cable is horizontal

$$[d_D = 4m]$$

ANS: (1)

(I) Eq^m of E

$\Sigma F_x = 0 \Rightarrow E_x - T_{DE} = 0$ $\boxed{E_x = T_{DE}}$ — (i)

$\Sigma F_y = 0 \Rightarrow -E_y = 0$ $\boxed{E_y = 0}$ — (ii)

(II) Taking moment about Point A

$$\Sigma M_A = 0 \Rightarrow (-(2\times5)) + (-(4\times5)) + (-(7\times10)) + (+(E_x\times4)) = 0$$

(Clockwise = -ve)

ANS: (2) $\boxed{E_x = \frac{10+20+70}{4} = 25 \text{ kN}}$ — (iii)

(III) Eq^m of point D

$\Sigma F_x = 0$ $T_{CD}\cos\theta_3 = T_{DE}$ using (i) ($\because T_{DE} = E_x = 25$ kN)

$\Sigma F_y = 0$ $\boxed{T_{CD}\cos\theta_3 = 25}$ — (iv)

$\boxed{T_{CD}\sin(\theta_3) = 10}$ — (V)

Dividing (V)/(iv) ~~$\theta_3 = \tan^{-1}($~~ $\tan\theta_3 = \frac{2}{5} = \frac{(d_D - d_c)}{3}$, with $d_D = 4$

ANS: (3) $\boxed{d_c = 4 - 6/5 = 14/5 = 2.8 \text{ m}}$ — (vi)

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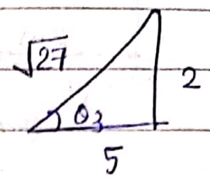
Extra :

No Need to Calculate

$T_{CD} = \frac{25}{(5)} \sqrt{27}$ (9×3)

$= 5 \times 3\sqrt{3}$

$= 15\sqrt{3}$ KN $= 25.98$ KN



Eqm at C

$\Sigma F_x = 0$ $\quad \overbrace{T_{CD}\cos(\theta_3)}^{25} = T_{BC}\cos(\theta_2)$ — (vii)

$\Sigma F_y = 0$ $\quad \underbrace{T_{CD}\sin(\theta_3)}_{10} + 5 = T_{BC}\sin(\theta_2)$ — (viii)

(Extra)

$\tan\theta_2 = \frac{3}{5} = \frac{d_C - d_B}{2}$

$d_B = 2.8 - (6/5)$ (1.2)

$[\, d_B = 1.6 \text{ m} \,]$

Eqm at B

$\Sigma F_x = 0$ $\quad \overbrace{T_{BC}\cos(\theta_2)}^{25} = T_{AB}\cos(\theta_1)$

$\Sigma F_y = 0$ $\quad \underbrace{T_{BC}\sin(\theta_2)}_{15} + 5 = T_{AB}\sin(\theta_1)$

Eqm at A

$\Sigma F_x = 0$ $\quad T_{AB}\cos(\theta_1) = A_x = 25$ KN

$\Sigma F_y = 0$ $\quad T_{AB}\sin(\theta_1) = A_y = 20$ KN

ANS:

$d_C = 2.8$ m

$E_y = 0$ KN $\qquad A_y = 20$ KN

$E_x = 25$ KN $\qquad A_x = 25$ KN

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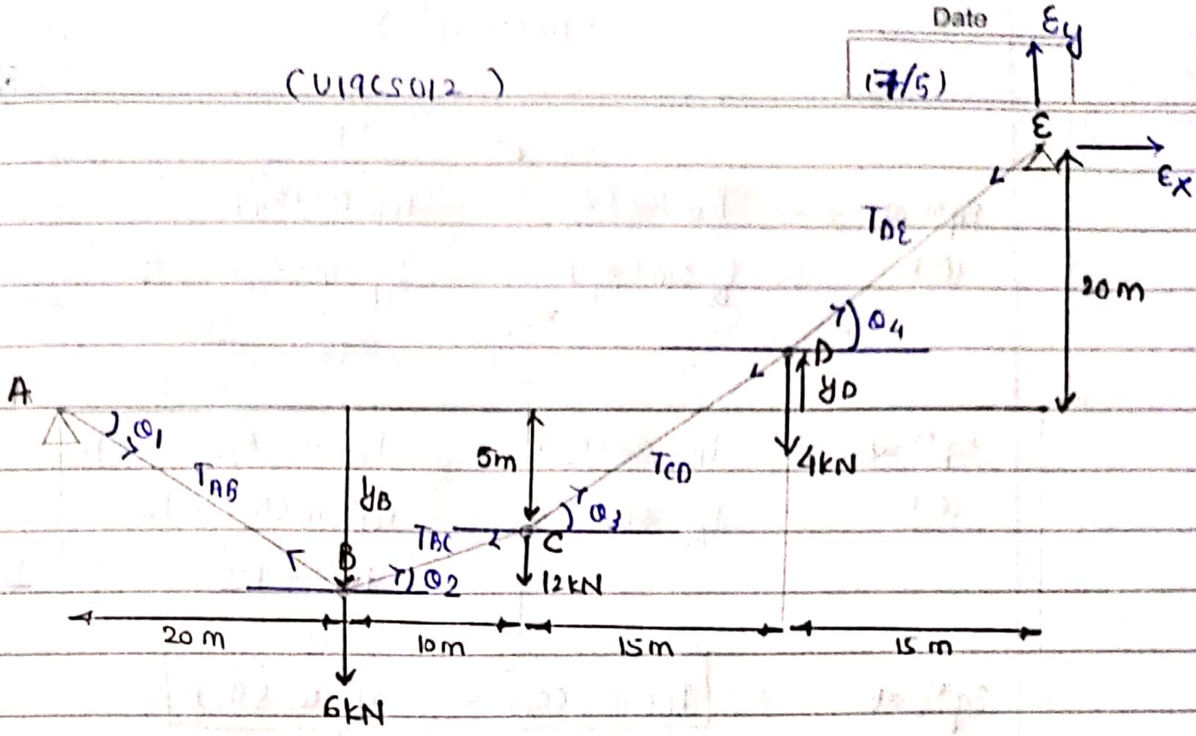
2.)



Let the Normal R_x^n at E be E_x & E_y. (as shown)

$\Sigma M_A = 0$ $(-(20\times6)) + (-(30\times12)) + (-(45\times4)) + (-(20\times E_x)) + (+(60\times E_y)) = 0$

$\boxed{30E_y - 10E_x = 330}$ — (i)

$\Sigma M_C = 0$ (The Right portion) $(-(15\times4)) + (-(25\times E_x)) + (+(30\times E_y)) = 0$

$\boxed{30E_y - 25E_x = 60}$ — (ii)

Solving (i) & (ii) $\boxed{E_x = \frac{270}{15} = 18\text{ kN}}$ — (iii)

$\boxed{E_y = 17\text{ kN}}$ — (iv)

Eqn at E $\Sigma F_x = 0$ $18 = E_x = T_{ED}\cos(\theta_4)$ — (v)

$\Sigma F_y = 0$ $17 = E_y = T_{ED}\sin(\theta_4)$ — (vi)

$\left.\begin{matrix}(vi)\\(v)\end{matrix}\right\} \Rightarrow$ $\tan\theta_4 = \frac{17}{18} = \frac{(20-y_D)}{15}$

ANS: (1) $\boxed{y_D = 20 - \left(\frac{15\times17}{18}\right) = 5.83\text{ m above A}}$

Eq^m at (D)

$$T_{CD}\cos(\theta_3) = \overbrace{T_{ED}\cos(\theta_4)}^{18}$$

$$T_{DC}\sin(\theta_3) = \underbrace{T_{ED}\sin(\theta_4)}_{17} - 4 = (13)$$

Eq^m at (C)

$$T_{BC}\cos(\theta_2) = \overbrace{T_{CD}\cos(\theta_3)}^{} = 18$$

$$T_{BC}\sin(\theta_2) = \underbrace{T_{CD}\sin(\theta_3)}_{13} - 12$$

$$= 13 - 12 = 1$$

Eq^m at (B)

$$\boxed{T_{AB}\cos(\theta_1) = \overbrace{T_{BC}\cos(\theta_2)}^{18}}$$

$$\underbrace{T_{BC}\sin(\theta_2)}_{1} + T_{AB}\sin(\theta_1) = 6$$

$$\boxed{T_{AB}\sin(\theta_1) = 5}$$

$$\tan\theta_1 = \left(\frac{5}{18}\right) = \frac{(y_B)}{(20)}$$

ANS (2) : $\boxed{y_B = \frac{100}{18} = 5.56 \text{ m below A}}$

$$\theta_4 = \tan^{-1}\left(\frac{17}{18}\right) \qquad \theta_1 = \tan^{-1}\left(\frac{\cancel{5.56}\ \cancel{100}^{\,5}}{(18)\cancel{(20)}}\right)$$

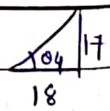
$$= 47.36° \qquad = 15.52°$$

$\because \theta_4 > \theta_1$ (Angle with horizontal greater)

(T_{DE} is maximum Tension)

ANS(3): Maximum slope $= \tan(\theta_4) = 17/18 = \boxed{0.944}$

ANS (4) : $\boxed{T_{DE} = \frac{18}{\cos(\theta_4)} = \sqrt{17^2 + 18^2} = 24.758 \text{ kN} \approx 24.8 \text{ kN}}$



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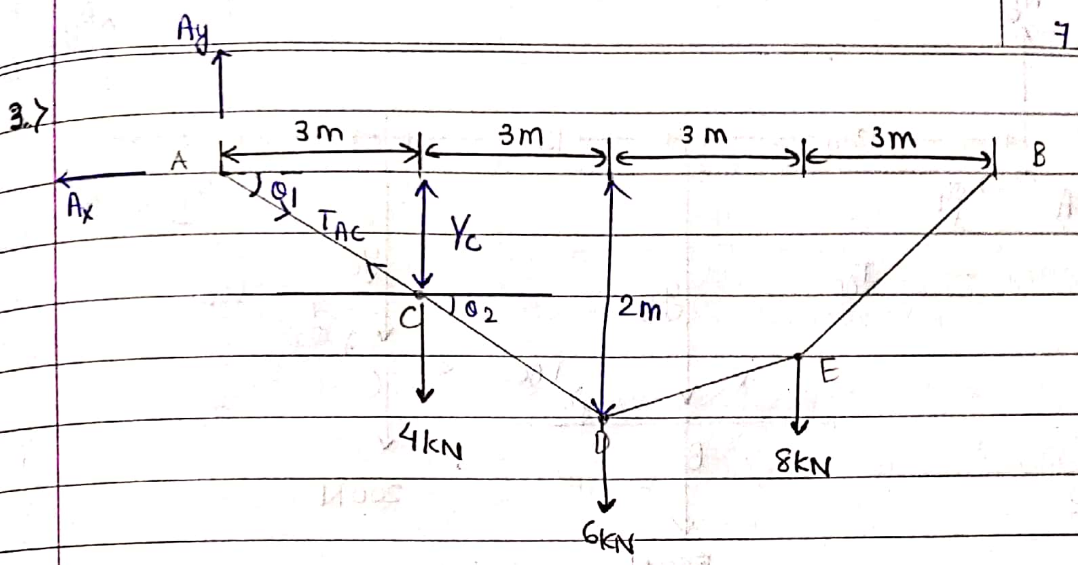

$\Sigma M_B = 0 \quad (-(12 \times A_y)) + (9 \times 4) + (6 \times 6) + (8 \times 3) = 0$

ANS(1) : $\boxed{A_y = \frac{(36 + 36 + 24)}{12} = 8 \text{ kN}}$ — (i)

$\Sigma M_D = 0 \quad (4 \times 3) + (-(6 \times A_y)) + (A_x \times 2) = 0$ (8)

(Left side)

ANS(2) : $\boxed{A_x = \frac{(48-12)}{2} = 18 \text{ kN}}$

Eq^n at A

$\Sigma F_x = 0 \quad A_x = T_{AC} \cos \theta_1 = 18 \text{ kN}$ — (iii)

$\Sigma F_y = 0 \quad A_y = T_{AC} \sin \theta_1 = 8 \text{ kN}$ — (iv)

$\tan(\theta_1) = \frac{8}{18} = \frac{Y_c}{(3)}$

ANS(3) : $\boxed{Y_c = 8/6 = 1.33 \text{ m}}$ — (v)

Eq^n at C $\quad \Sigma F_x = 0 \quad T_{AC} \cos\theta_1 = T_{CD} \cos(\theta_2)$

$\frac{(18)}{\cos(\theta_2)} = T_{CD}$

(2 − 1.33)

3

θ2

$T_{CD} = \frac{18}{(3)} \sqrt{3^2 + (2 - Y_c)^2}$

ANS (4) : $\boxed{T_{CD} = 6\sqrt{9 + (0.666)^2} = 18.44 \text{ kN} \approx 18.5 \text{ kN}}$

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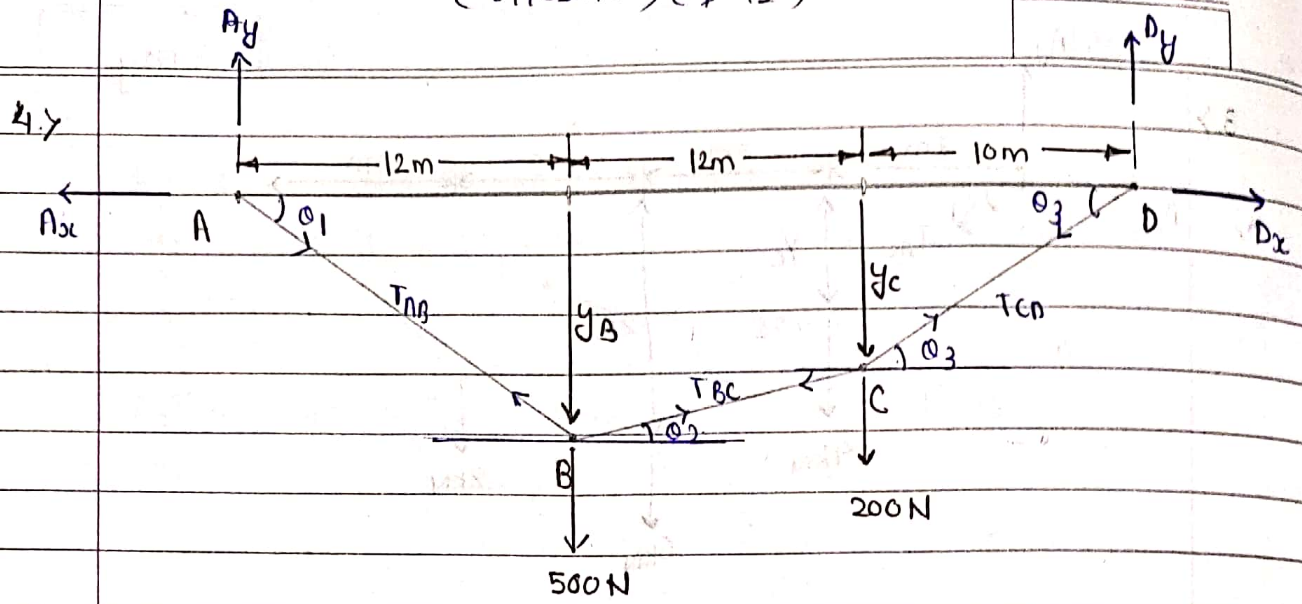

$\Sigma M_D = 0 \quad (-(34 \times A_y)) + (+(22 \times 500)) + (+(10 \times 200)) = 0$

$\boxed{A_y = 382.353\ N \approx 382\ N}$ —(i)

$\Sigma M_A = 0 \quad (D_y \times 34) - (200 \times 24) - (500 \times 12) = 0$

$\boxed{D_y = 317.65\ N \approx 318\ N}$ —(ii)

Since Nearest load to point A (500 N) is greater than that of Nearest load to point D

$\Rightarrow \theta_1 > \theta_3$

$\Rightarrow T_{AB} > T_{CD}$

∴ The maximum tension held in $\boxed{T_{AB} = 1000\ KN}$ —(iii)

Since there is no external load acting on A,

$$A_x^2 + A_y^2 = (T_{AB})^2$$

$$A_x = \sqrt{(T_{AB})^2 - (A_y)^2}$$

$$= \sqrt{(1000 \times 1000)^2 - (382)^2}$$

$\boxed{A_x = 924\ N}$ —(iv)

$\boxed{D_x = A_x = 924\ N}$ —(v) {The horizontal component in this cable system is same}

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$$(T_{CD}) = \sqrt{D_x^2 + D_y^2} = \sqrt{(924)^2 + (318)^2}$$

$$= 977.189 \text{ N}$$

$$\boxed{T_{CD} \approx 977 \text{ N}} \quad \text{— (vi)}$$

Eq^m at A

$\Sigma F_x = 0 \qquad A_x = T_{AB} \cos \theta_1 = 924$

$\Sigma F_y = 0 \qquad A_y = T_{AB} \sin \theta_1 = 382$

$$\tan(\theta_1) = \frac{382}{924} = \frac{y_B}{(12)}$$

$$\boxed{y_B = 4.967 \text{ m} = 4.97 \text{ m}} \quad \text{— (vii)}$$

Eq^m at D

$\Sigma F_x = 0 \qquad D_x = T_{CD} \cos \theta_3$

$\Sigma F_y = 0 \qquad D_y = T_{CD} \sin \theta_3$

$$\tan \theta_3 = \frac{y_C}{(10)} = \frac{D_y}{D_x}$$

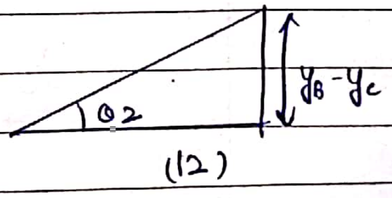
$$\boxed{y_C = \frac{318 \times 10}{924} = 3.44 \text{ m}} \quad \text{— (viii)}$$

Eq^m at B

$$\Sigma F_x = 0 \qquad \underbrace{T_{AB} \cos \theta_1}_{924} = T_{BC} \cos(\theta_2)$$

$$\neq \cancel{T_{BC}} \; \cancel{\sin(\theta)}$$

$$T_{BC} = \frac{924}{(12)} \sqrt{12^2 + (1.53)^2}$$



$$\boxed{T_{BC} \approx 931 \text{ N}} \quad \text{— (ix)}$$

$$\text{Total Length} = \sqrt{12^2 + y_B^2} + \sqrt{12^2 + (y_B - y_C)^2} + \sqrt{10^2 + y_C^2}$$

Substituting y_B & y_C

$$\boxed{\text{Length of cable} \approx 35.7 \text{ m}} \quad \text{— (x)}$$

—X—

Submitted By: U19CS012 (D-12)