K J SOMAIYA COLLEGE OF ENGINEERING, MUMBAI-77

(CONSTITUENT COLLEGE OF SOMAIYA VIDYAVIHAR UNIVERSITY)

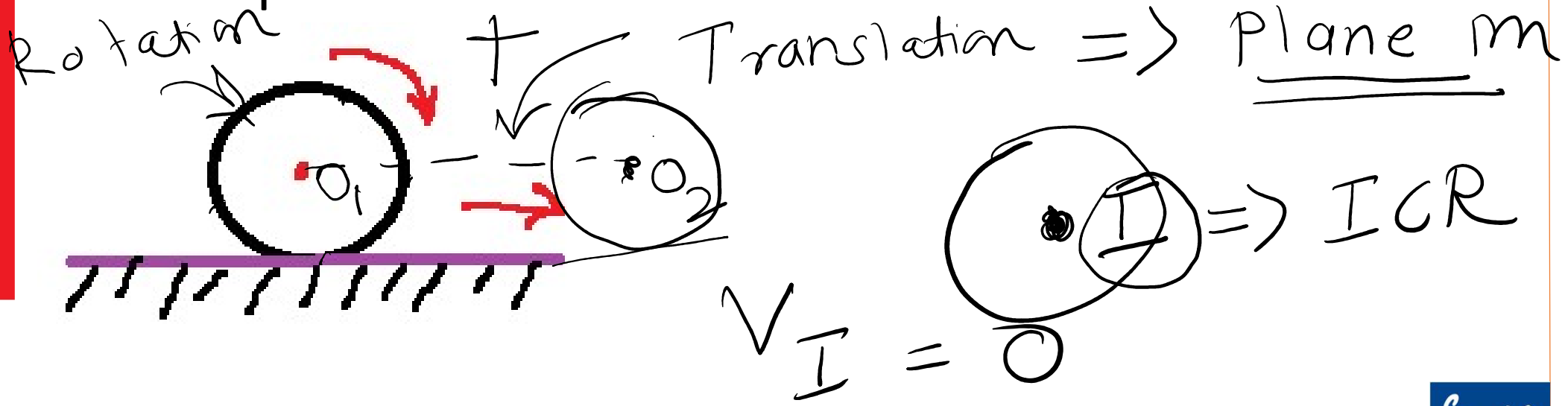
ICR (Instantaneous Centre of rotation)

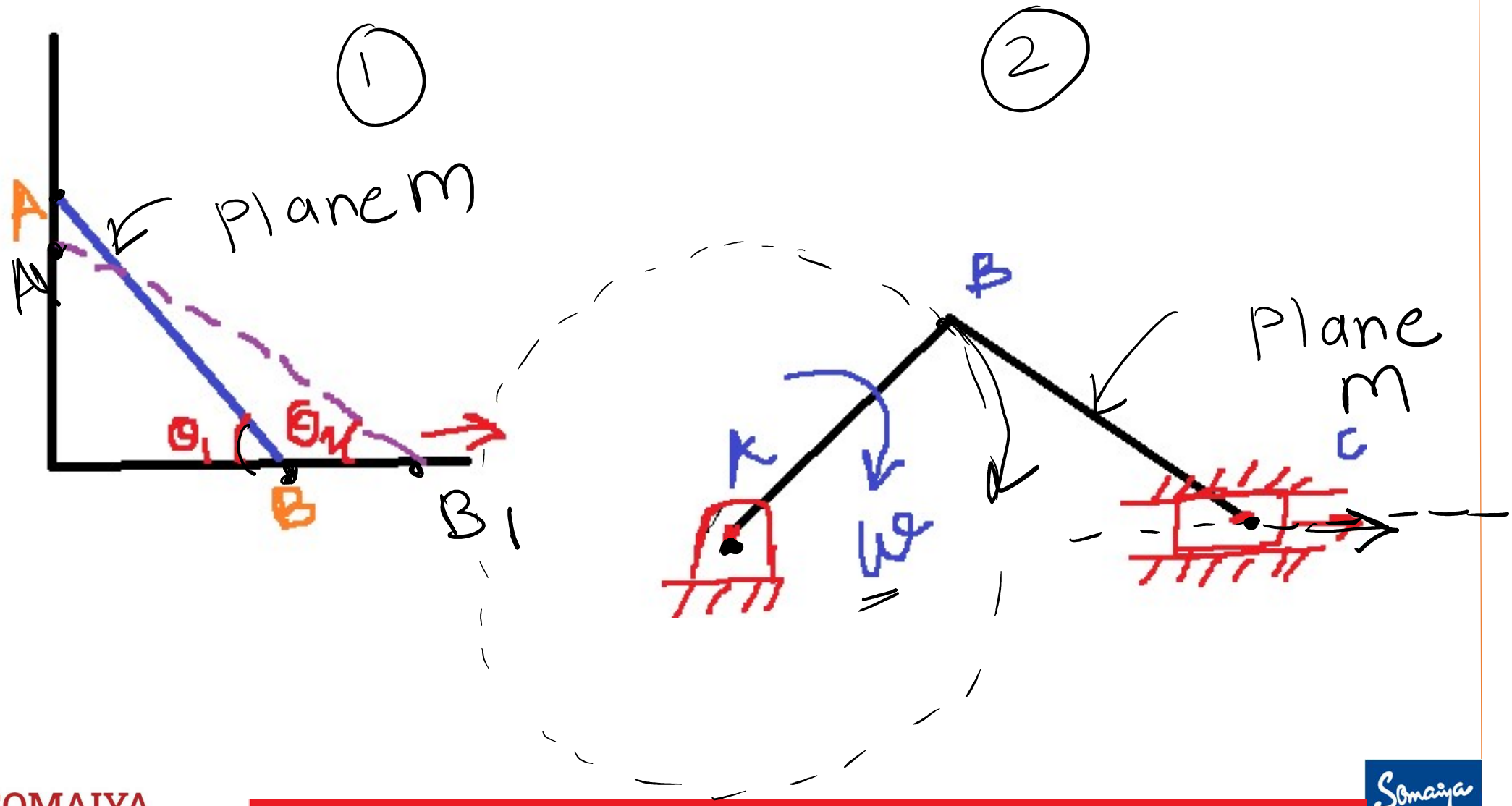
What is ICR?

Plane motion is the combination of rotation and translation. Such plane motion is converted into pure rotation about an arbitrary point . This point is called as ICR (Instantaneous Centre of rotation)

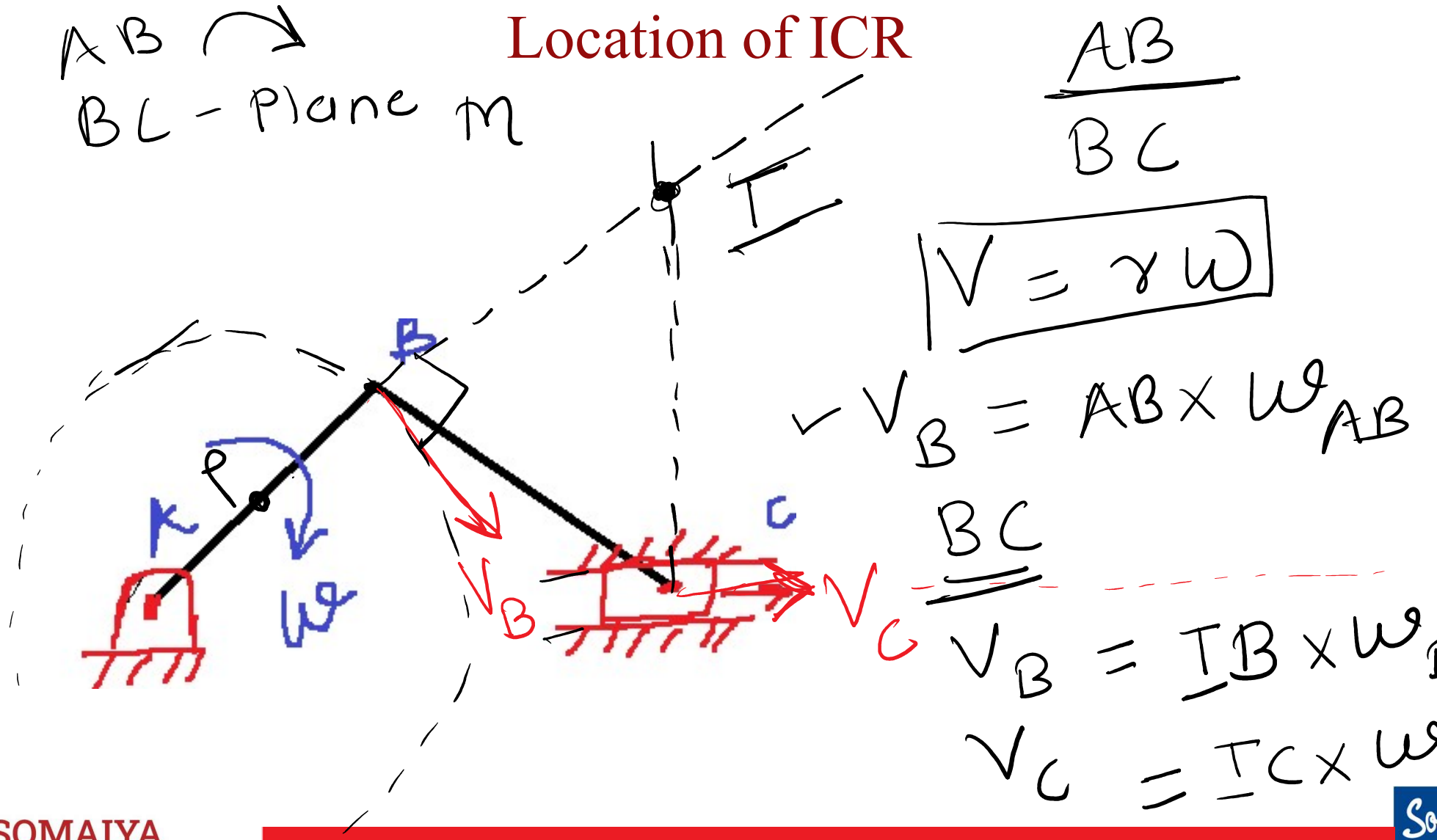
It is an imaginary point having zero velocity and its location is changing from instant to instant.

What is plane motion?

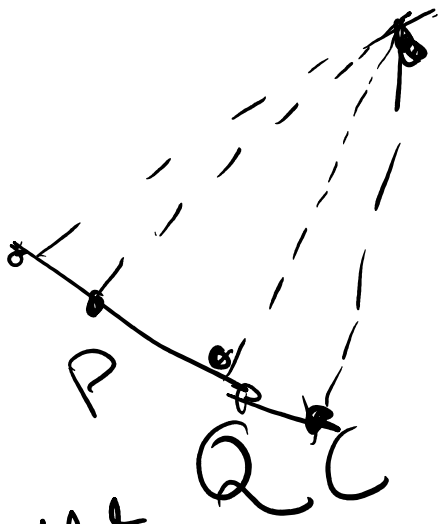



1
2
A
A'
Plane M
θ1
θM
B
B1
K
B
Plane
M
C
ω

Location of ICR



$V_Q = IQ \times \omega_{BC}$

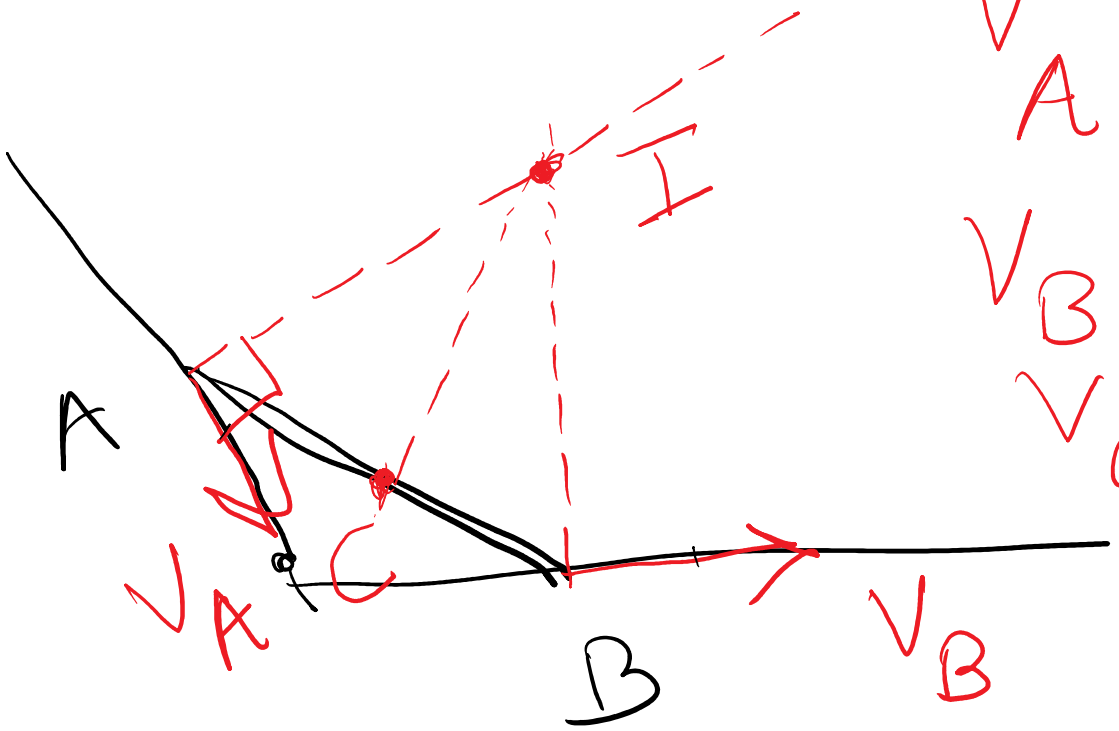


$V = r\omega$

$V_B = IB \times \omega_{BC}$

$V_C = IC \times \omega_{BC}$

$V_P = IP \times \omega_{BC}$

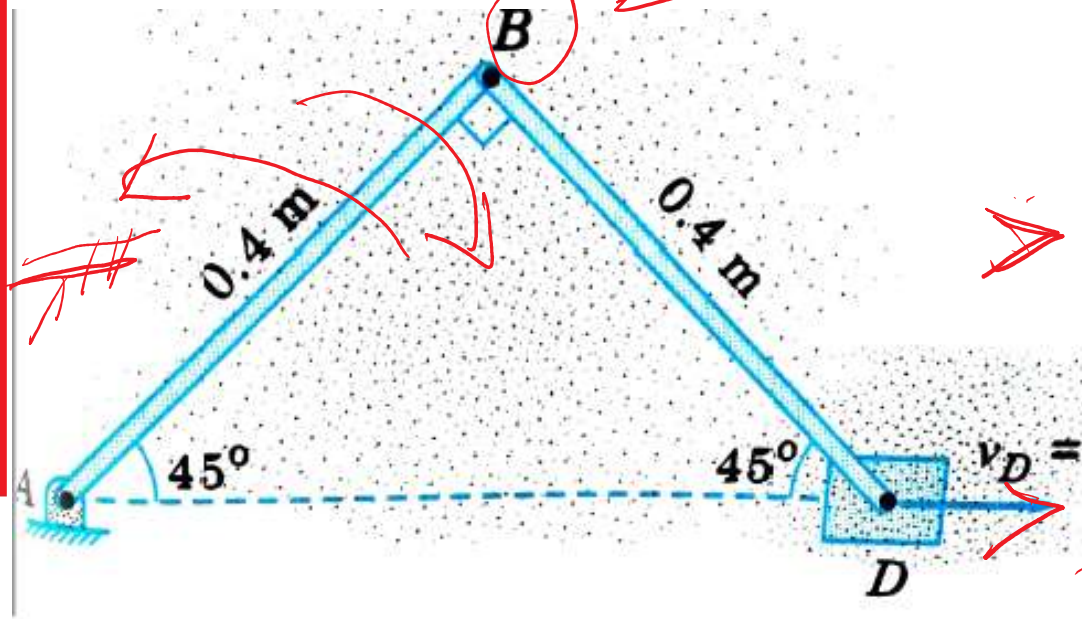


$$V_A = I_A \times \omega_{AB}$$

$$V_B = I_B \times \omega_{AB}$$

$$V_C = I_C \times \omega_{AB}$$

Determine the angular velocity of links AB and BD and velocity of point B at the instant shown



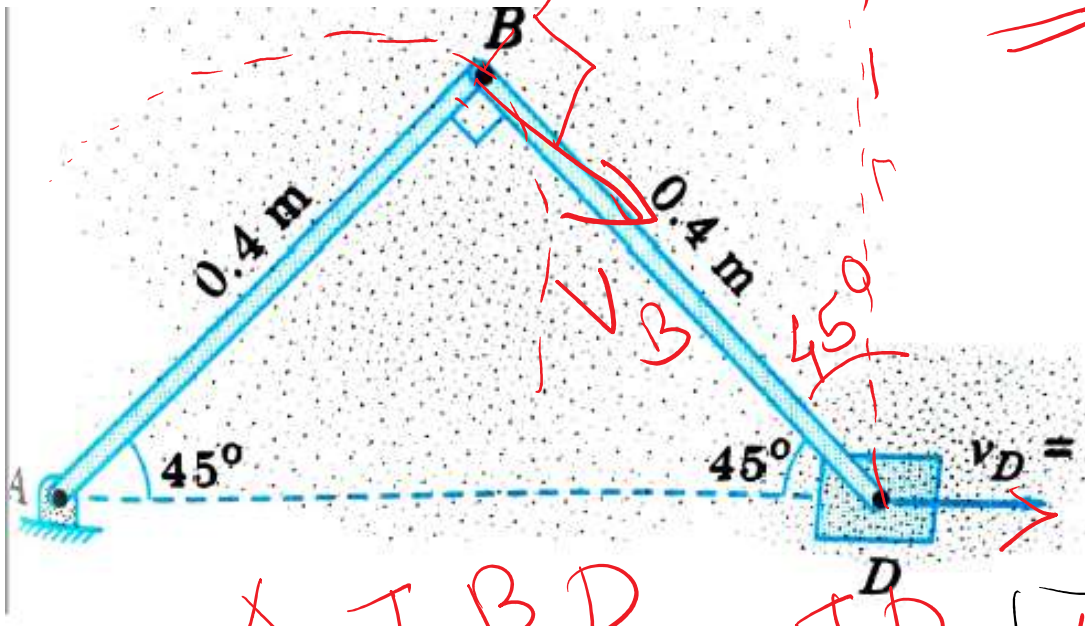
ω_{AB}, ω_{BD} = ?

Rotation

BD => plane M

=> AB => Rotation

translational



I_B, I_D

I

AB

BD

$\begin{cases} I_D = 0.565\,m \\ I_B = 0.4\,m \end{cases}$

BD $\Rightarrow v_B = I_B \times \omega_{BD}$

$\Rightarrow v_D = I_D \times \omega_{BD}$

$\omega_{BD} = 5.3\ rad/s$

$v_B = 2.124\ m/s$

$\triangle IBD$, I_D

link AB

$$\underline{V}_B = \underline{AB} \times \omega_{AB}$$

$$\omega_{AB} = 5.3 \text{ r/s}$$

Link EB in the mechanism has angular velocity of 4 rad/sec in CCW direction. Calculate – angular velocity of rod AD, velocity of collar D, velocity of point A

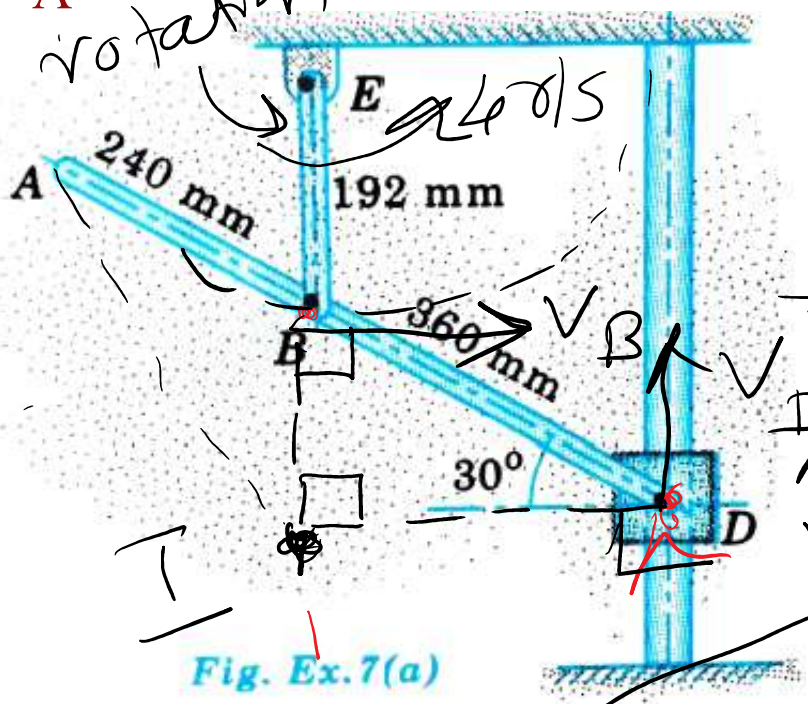


Fig. Ex.7(a)

rotation

$V_A = ?$ $V_D = ?$ $\omega_{AD} = ?$

EB $\Rightarrow V_B = EB \times \omega_{EB}$

$V_B = 0.768$ m/s

AD $\Rightarrow V_B = IB \times \omega_{AD}$

$IB = 0.18$m, $ID = 0.83$m

$\omega_{AD} = 4.26$ r/s

$\triangle IAD$

$$IA^2 = ID^2 + AD^2 - 2 IA \cdot AD \cos 30$$

$$IA = 0.365 m$$

$$V_A = IA \times \omega_{AD} = 1.556 \ m/s$$

$$V_D = ID \times \omega_{AD}$$

$$V_D = 1.33 \ m/s$$

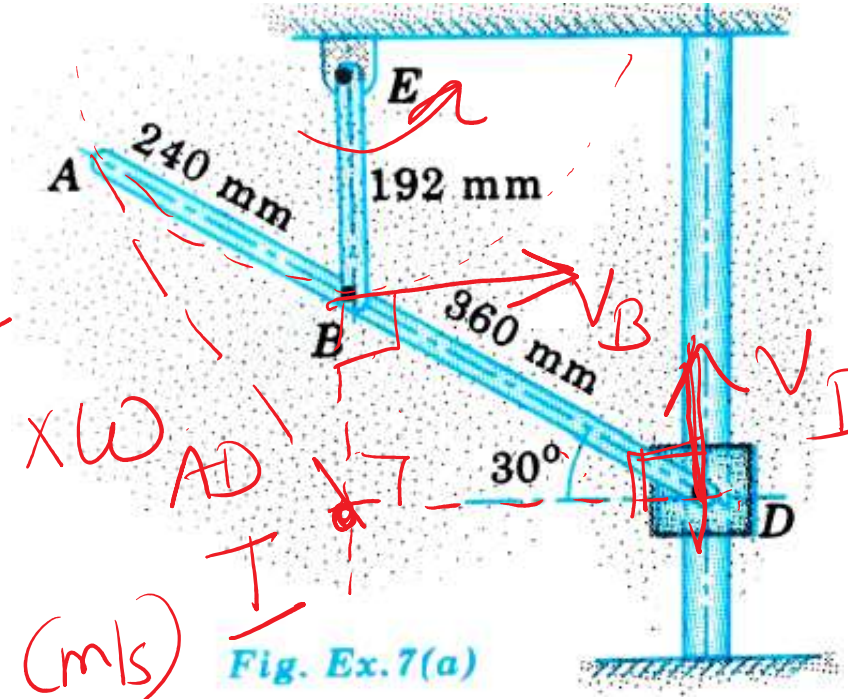


Fig. Ex.7(a)

EB $\Rightarrow V_B = EB \times \omega_{EB}$

$V_B = 192 \times 4$

$=$ mm/s

$V_A = IA \times \omega_{AD}$

$V_A =$ (m/s)

AD

$V_B = IB \times \omega_{AD}$

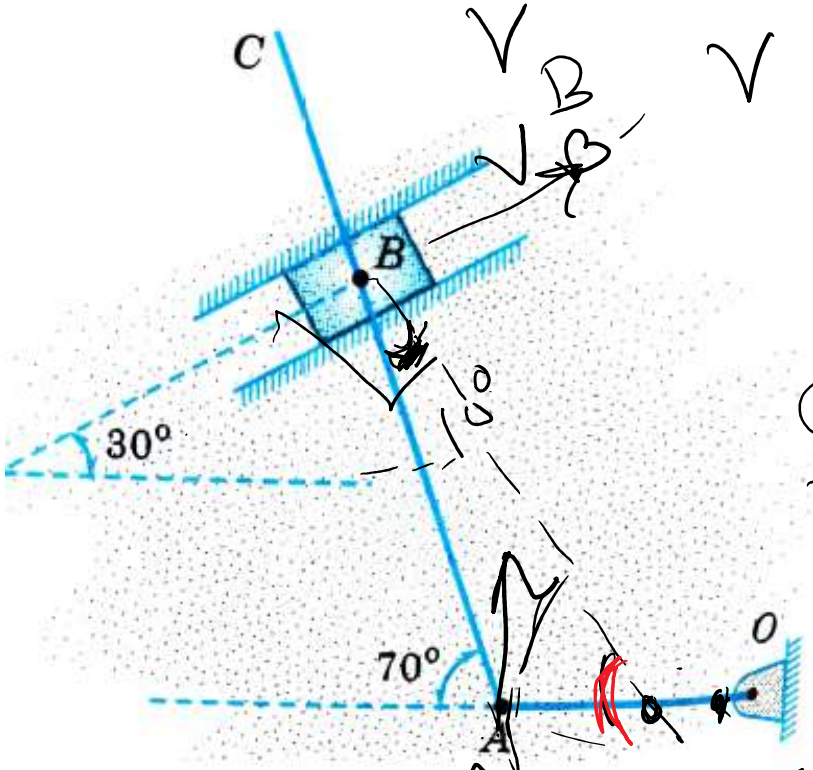
$\omega_{AD} =$ r/s

ΔIBD

$IB =$

$ID =$

Angular velocity of rod OA is 15 rad/sec CCW direction, length of OA = 200 mm, AB = 400 mm and BC = 150 mm. Locate ICR



V_B $V_C = ?$

$\omega_{OA} = 15$ rad/s

Δ IAB
AB
$\angle$ BAI

$V_A = OA \times \omega_{OA}$

$V_A = IA \times \omega_{ABC}$

$\frac{IA}{\sin 10} = \frac{IB}{\sin 110} = \frac{AB}{\sin 60}$

$V_A = 3\ m/s$

$I_A = 0.08\ m$

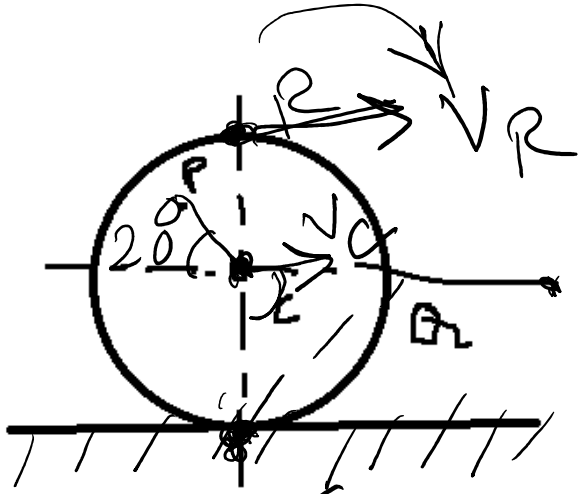
$I_B = 0.434\ m$

$V_B = I_B \times W_{ABC}$ ($W_{ABC} = 37.41$ rad/s)

$= 16.24\ m/s$

$V_C = I_C \times W_{ABC}$

$= 21.8\ m/s$

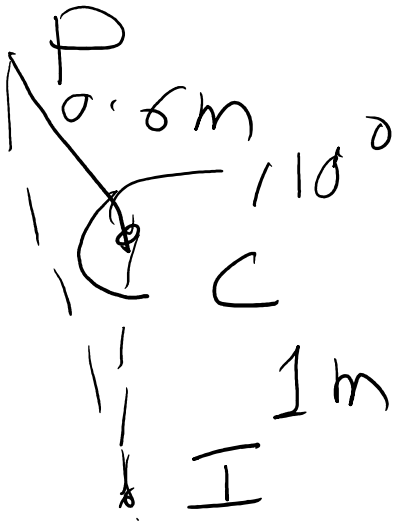


$\omega = ?$

V_R

$V = r\omega$

$\omega = \frac{V}{r}$



$\omega = \frac{V_C}{IC} = \frac{V_P}{IP} = \frac{V_Q}{IQ} = \frac{V_R}{IR}$

$IR = 2m$

$V_R = 8 m/s$

$\omega = \frac{4}{} = 4 rad/s$

$V_Q = 5.65 m/s$

$IQ = \ldots$

A ladder AB of 6 m long resting against a vertical wall at A and horizontal ground at B (with an inclination of 30^0 with horizontal) . If the end B of the ladder is pulled towards right with a constant velocity of 4 m/s, find: 1) ICR location, 2) angular velocity of ladder at this instant, 3) velocity of end A, 3) velocity components of midpoint of the ladder