Kinematics of Rigid Body (ICR)

1) $V = r \times w$

$V \rightarrow$ Velocity

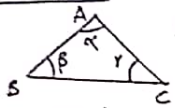
$r \rightarrow$ Distance between Fixed Point and moving point

$w \rightarrow$ Angular Velocity (rad/sec)

$w = \frac{2\pi N}{60}$

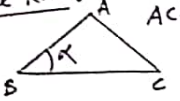
$N \rightarrow$ No. of Revolutions (RPM)

3) **Sine Rule:**



$$\frac{AB}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$$

4) **Cosine Rule:**



$$AC = \sqrt{AB^2 + BC^2 - 2AB \cdot BC\cos\alpha}$$

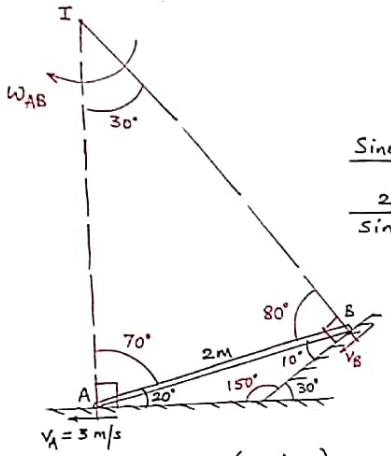
ICR

1) It is a fixed point i.e. zero Velocity Point
2) It is an img point
3) It may be lie within the body or outside the body.

Types of Link

- Rotating Link (ICR → Inside the body)
- Sliding Link (ICR → outside the body)

Type 1:- Sliding link



Link AB (Sliding)

pt I is an ICR

$V_A = AI \times w_{AB}$

$3 = 3.93 \times w_{AB}$

$\boxed{w_{AB} = 0.761 \text{ r/sec}}$

$V_B = BI \times w_{AB}$

$= 3.75 \times 0.761$

$\boxed{V_B = 2.86 \text{ m/s}}$

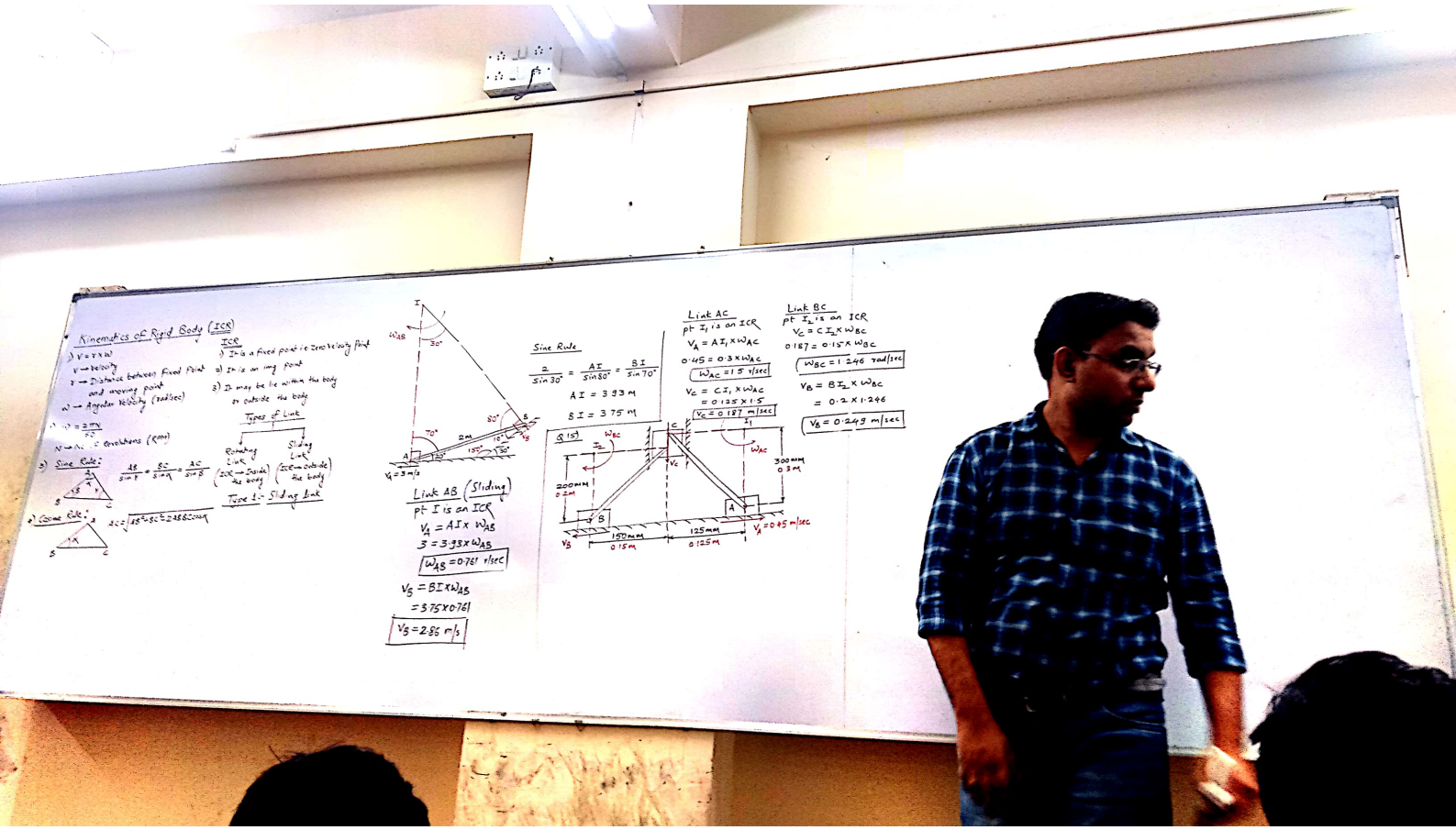
Sine Rule

$$\frac{2}{\sin 30^\circ} = \frac{AI}{\sin 80^\circ} = \frac{BI}{\sin 70^\circ}$$

$AI = 3.93$ m

$BI = 3.75$ m

Q 15)


Kinematics of Rigid Body (ICR)
ICR
Sine Rule
Link AB (Sliding)
Link AC
Link BC
Types of Link
Type 1:- Sliding Link
Sine Rule:
Cosine Rule:
Scanned by CamScanner

Kinematics of Rigid Body (ICR)

1) $V = r \times w$

$V \rightarrow$ Velocity

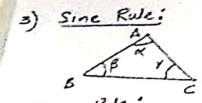
$r \rightarrow$ Distance between Fixed Point and moving point

$w \rightarrow$ Angular Velocity (rad/sec)

$\frac{2\pi N}{?}$

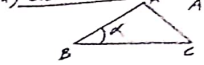
$N \rightarrow$ No of Revolutions (RPM)

3) **Sine Rule:**



$$\frac{AB}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$$

4) **Cosine Rule:**



$$AC = \sqrt{AB^2 + BC^2 - 2AB\,BC\cos\alpha}$$

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Types of Link

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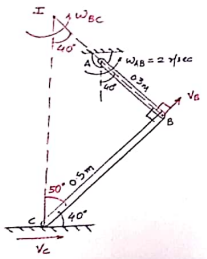
Type 3 :- One Sliding, One Rotating and one free end



Link AB (Rotating)

Pt A is an ICR

$V_A = 0$

$V_B = AB \times w_{AB}$

$= 0.3 \times 2$

$V_B = 0.6$ m/sec

Link BC (Sliding)

Pt I is an ICR

$V_B = BI \times w_{BC}$

$0.6 = 0.596 \times w_{BC}$

$w_{BC} = 1$ r/sec

$V_C = CI \times w_{BC}$

$= 0.778 \times 1$

$V_C = 0.778$ m/sec

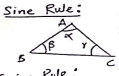
Kinematics of Rigid Body (ICR)

1) $V = r \times w$
   - V → Velocity
   - r → Distance between Fixed Point and moving point
   - w → Angular Velocity (rad/sec)

$\rightarrow \frac{2\pi N}{60}$

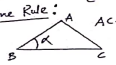
   - N → No of Revolutions (RPM)

3) **Sine Rule:**



$$\frac{AB}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$$

4) **Cosine Rule:**



$$AC = \sqrt{AB^2 + BC^2 - 2AB\,BC\cos\alpha}$$

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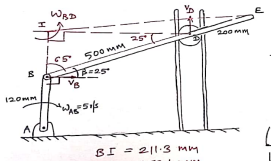


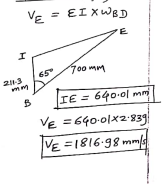
BI = 211.3 mm
DI = 453.1 mm

Link AB (Rotating)
pt A is an ICR
$V_A = 0$
$V_B = AB \times w_{AB}$
$= 120 \times 5$
$V_B = 600$ mm/sec

Link BD (Sliding)
pt I is an ICR
$V_B = BI \times w_{BD}$
$600 = 211.3 \times w_{BD}$
$w_{BD} = 2.839$ r/sec

$V_D = DI \times w_{BD}$
$= 453.1 \times 2.839$
$V_D = 1286.49$ mm/sec

Free end (E)
$V_E = EI \times w_{BD}$



$IE = 640.01$ mm
$V_E = 640.01 \times 2.839$
$V_E = 1816.98$ mm/s

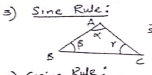
Kinematics of Rigid Body (ICR)

1) $V = r \times w$
   - V → Velocity
   - r → Distance between Fixed Point and moving point
   - w → Angular Velocity (rad/sec)

$w = \frac{2\pi N}{60}$

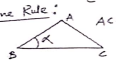
N → No of Revolutions (RPM)

3) **Sine Rule:**



$\frac{AB}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$

4) **Cosine Rule:**



$AC = \sqrt{AB^2 + BC^2 - 2AB\,BC\cos\alpha}$

ICR

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Types of Link

- Rotating Link (ICR → Inside the body)
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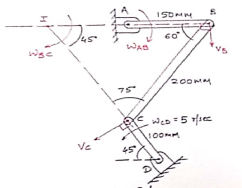
Type 1 :- Sliding Link

Type 2 :- One Sliding & One Rotating

Type 3 :- One Sliding, One Rotating and One Free end

Type 4: Two Rotating & one Sliding link

Find w_{AB}



Sine Rule

CI = 441.34 mm

BI = 273.21 mm

Link CD (Rotating)

pt D is an ICR

$V_D = 0$

$V_C = CD \times w_{CD}$

$V_C = 500$ mm/sec

Link AB (Rotating)

pt A is an ICR

$V_A = 0$

$V_B = AB \times w_{AB}$

$V_B = 150 \times w_{AB}$ —— (1)

Link BC (Sliding)

pt I is an ICR

$V_C = CI \times w_{BC}$

$500 = 244.34 \times w_{BC}$

$w_{BC} = 2.04$ r/sec

$V_B = BI \times w_{BC}$

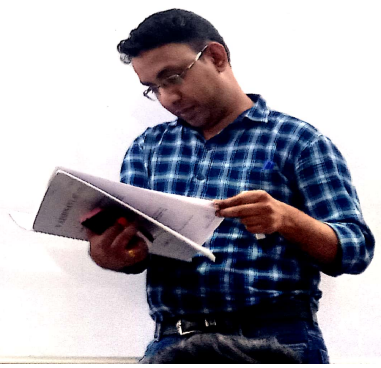
$= 273.21 \times 2.04$

$V_B = 557.34$ mm/sec

From eqn (1)

$557.34 = 150 \times w_{AB}$

$w_{AB} = 3.71$ r/sec



Kinematics of Rigid Body (ICR)

1) $V = r \times w$

V → velocity

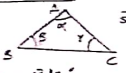
r → Distance between Fixed Point and moving point

w → Angular Velocity (rad/sec)

$= \frac{2\pi N}{60}$

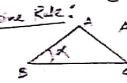
N → No of Revolutions (RPM)

2) **Sine Rule:**



$$\frac{AB}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$$

3) **Cosine Rule:**



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Types of Link

- Rotating Link (ICR → Inside the body)
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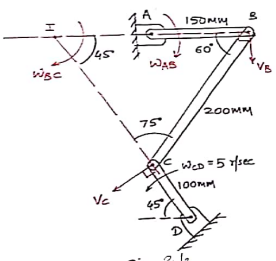
Type 1:- Sliding link

Type 2:- One Sliding & One Rotating

Type 3:- One Sliding, One Rotating and One free end

Type 4: Two Rotating & one Sliding link

Find w_{AB}



Sine Rule

CI = 244.94 mm

BI = 273.21 mm

Link CD (Rotating)

pt D is an ICR

$V_D = 0$

$V_C = CD \times w_{CD}$

$V_C = 500$ mm/sec

Link AB (Rotating)

pt A is an ICR

$V_A = 0$

$V_B = AB \times w_{AB}$

$V_B = 150 \times w_{AB}$ —①

Link BC (Sliding)

pt I is an ICR

$V_C = CI \times w_{BC}$

$500 = 244.94 \times w_{BC}$

$w_{BC} = 2.04$ r/sec

$V_B = BI \times w_{BC}$

$= 273.21 \times 2.04$

$V_B = 557.34$ mm/sec

From eqn ①

$557.34 = 150 \times w_{AB}$

$w_{AB} = 3.71$ r/sec

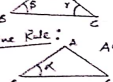
Kinematics of Rigid Body (ICR)

1) $V = r \times w$
   - V → velocity
   - r → Distance between Fixed Point and moving point
   - w → Angular Velocity (rad/sec)

$= \frac{2\pi N}{60}$

N → No of Revolutions (RPM)

2) **Sine Rule:**



$$\frac{AB}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$$

3) **Cosine Rule:**

$$AC = \sqrt{AB^2 + BC^2 - 2AB \cdot BC\cos\alpha}$$

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Types of Link

- Rotating Link (ICR → Inside the body)
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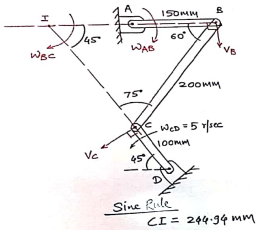
Type 1 :- Sliding Link

Type 2 :- One Sliding & One Rotating

Type 3 :- One Sliding, One Rotating and one free end

Type 4 : Two Rotating & one Sliding link

Find W_{AB}



Sine Rule

CI = 294.94 mm

BI = 273.21 mm

Link CD (Rotating)

pt D is an ICR

$V_D = 0$

$V_C = CD \times W_{CD}$

$V_C = 500$ mm/sec

Link AB (Rotating)

pt A is an ICR

$V_A = 0$

$V_B = AB \times W_{AB}$

$V_B = 150 \times W_{AB}$ —— ①

Link BC (Sliding)

pt I is an ICR

$V_C = CI \times W_{BC}$

$500 = 294.94 \times W_{BC}$

$W_{BC} = 2.04$ r/sec

$V_B = BI \times W_{BC}$

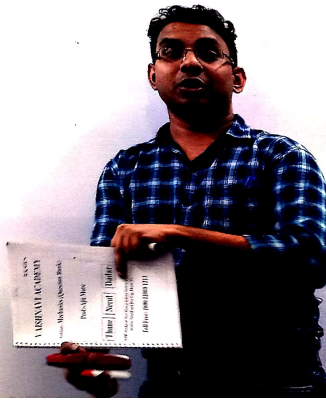
$= 273.21 \times 2.04$

$V_B = 557.34$ mm/sec

From eqn ①

$557.34 = 150 \times W_{AB}$

$W_{AB} = 3.71$ r/sec



Kinematics of Rigid Body (ICR)

1) $V = r \times w$

V → Velocity

r → Distance between Fixed Point and moving point

w → Angular Velocity (rad/sec)

$N = \frac{2\pi N}{60}$

N → Revolutions (RPM)

a) Sine Rule:

$\frac{AB}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$

b) Cosine Rule:

$AC = \sqrt{AB^2 + BC^2 - 2AB\,BC\cos\alpha}$

ICR

1) It is a fixed point i.e Zero Velocity Point
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Types of Link

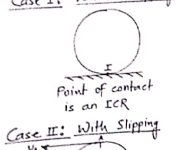
- Rotating Link
  - (ICR → Inside the body)
  - Type 1:- Sliding Link
  - Type 2:- One Sliding & One Rotating
  - Type 3:- One Sliding, One Rotating and One Free end
- Sliding Link (ICR → outside the body)

Type 4: Two Rotating & one Sliding link

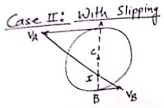
Type 5: Circular Body

Circular Body

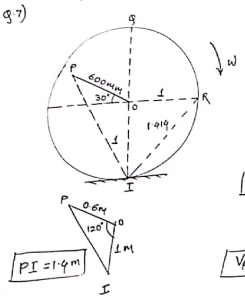
Case I:- Without Slipping



Case II:- With Slipping



Q7) dia = 2m, r = 1m, V_o = 4 m/s



PI = 1.4 m

$V_o = OI \times w$

$4 = 1 \times w$

$w = 4$ rad/sec

$V_g = QI \times w$

$= 2 \times 4$

$V_g = 8$ m/sec

$V_R = RI \times w$

$= 1.414 \times 4$

$V_R = 5.65$ m/s

$V_p = PI \times w$

$= 1.4 \times 4$

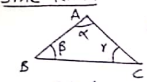
$V_p = 5.6$ m/s

Kinematics of Rigid Body (ICR)

1) $V = r \times w$
   - $V \rightarrow$ Velocity
   - $r \rightarrow$ Distance between Fixed Point and moving point
   - $w \rightarrow$ Angular Velocity (rad/sec)

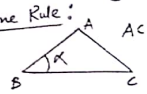
2) $w = \frac{2\pi N}{60}$
   - N → No. of Revolutions (RPM)

3) **Sine Rule:**



$$\frac{AB}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$$

4) **Cosine Rule:**



$$AC = \sqrt{AB^2 + BC^2 - 2AB\,BC\cos\alpha}$$

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1) It is a fixed point i.e Zero Velocity Point
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- Rotating Link (ICR → Inside the body)
- Sliding Link (ICR → outside the body)

Type 1 :- Sliding Link

Type 2 :- One Sliding & One Rotating

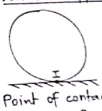
Type 3 :- One Sliding, One Rotating and one free end

Type 4 :- Two Rotating & one Sliding link

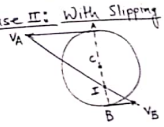
Type 5 : Circular Body

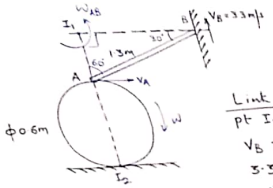
Circular Body

Case I :- Without Slipping



Case II : With Slipping





Sine Rule

$BI_1 = 1.12$ m

$AI_1 = 0.65$ m

Link AB (Sliding)

pt I_1 is an ICR

$V_B = BI_1 \times w_{AB}$

$3.3 = 1.12 \times w_{AB}$

$\boxed{w_{AB} = 2.94 \text{ r/sec}}$

$V_A = AI_1 \times w_{AB}$

$= 0.65 \times 2.94$

$\boxed{V_A = 1.91 \text{ m/sec}}$

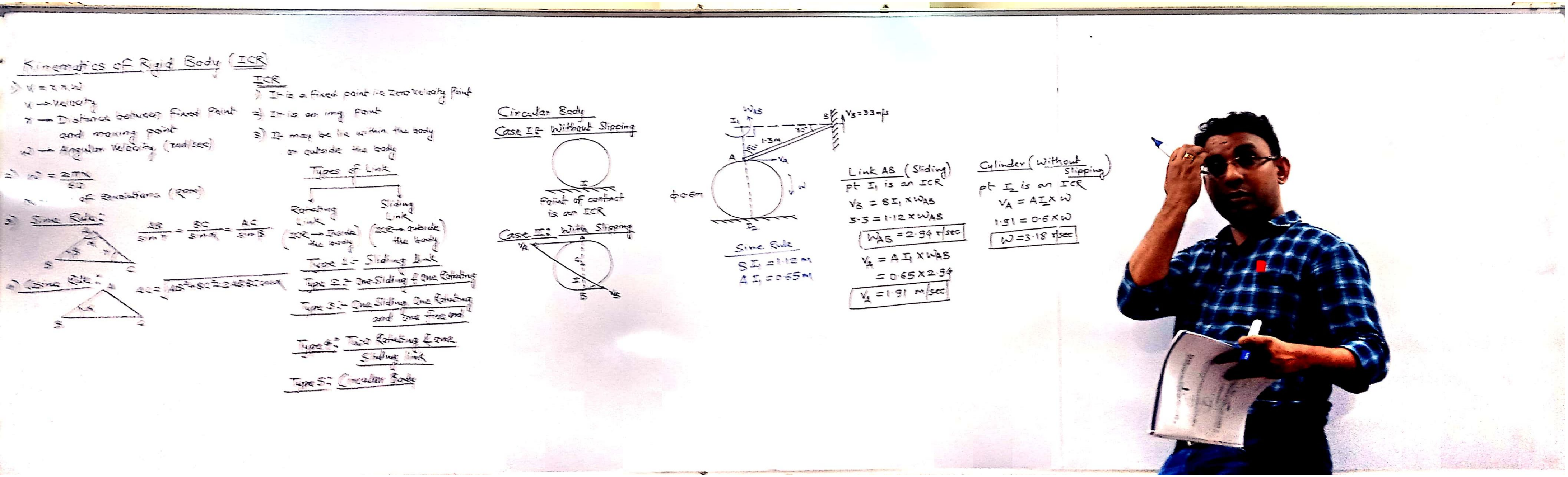
Cylinder (Without Slipping)

pt I_2 is an ICR

$V_A = AI_2 \times w$

$1.91 = 0.6 \times w$

$\boxed{w = 3.18 \text{ r/sec}}$



...es of Rigid Body (ICR)

...e between Fixed Point
...ving point
...Velocity (rad/sec)

...utions (RPM)

$\frac{AR}{\sin\gamma} = \frac{BC}{\sin\alpha} = \frac{AC}{\sin\beta}$

$c = \sqrt{AB^2+BC^2-2AB\,BC\cos\alpha}$

ICR

1) It is a fixed point i.e Zero Velocity Point
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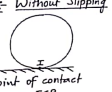
- Sliding Link (ICR → outside the body)

Type 1 :- Sliding Link
Type 2 :- One Sliding & One Rotating
Type 3 :- One Sliding, One Rotating and One Free end
Type 4 :- Two Rotating & one Sliding link
Type 5 :- Circular Body

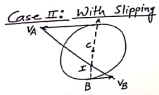
Circular Body

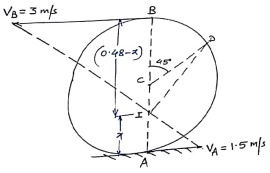
Case I:- Without Slipping



Point of contact is an ICR

Case II:- With Slipping





$V_A = AI \times \omega$

$1.5 = x \times \omega$ — (i)

$V_B = BI \times \omega$

$3 = (0.48-x) \times \omega$ — (ii)

eqn (i) ÷ (ii)

$\frac{1.5}{3} = \frac{x \times \omega}{(0.48-x)\times\omega}$

$x = 0.16$ m

From eqn (i)

$1.5 = 0.16 \times \omega$

$\omega = 9.37$ r/s

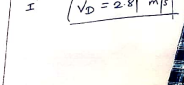
$V_C = CI \times \omega$

$CI = CA - AI = 0.08$ m

$V_C = 0.08 \times 9.37$

$V_C = 0.75$ m/sec

$V_D = DI \times \omega$



$DI = 0.3$ m

$V_D = 0.3 \times 9.37$

$V_D = 2.81$ m/s