RRB JE | SSE 2023

Foundation Batch

Analog Electronics

Day-10

> LIVE

2PM LAWRENCE Sir

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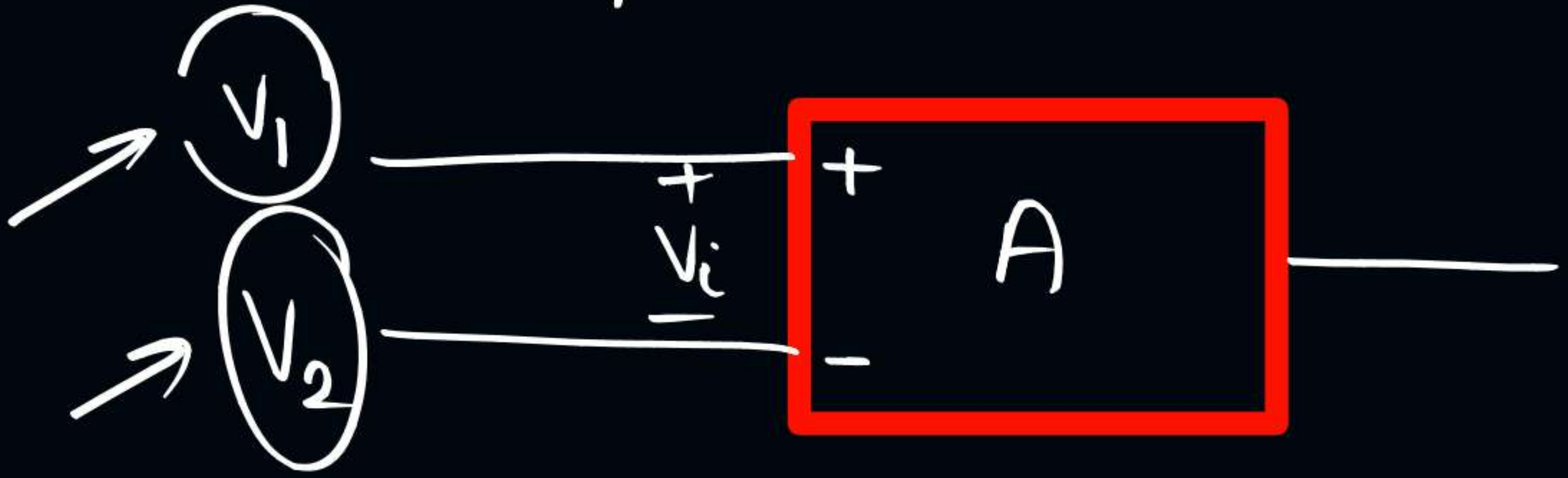
→ Differential Mode:

Input → both Terminal

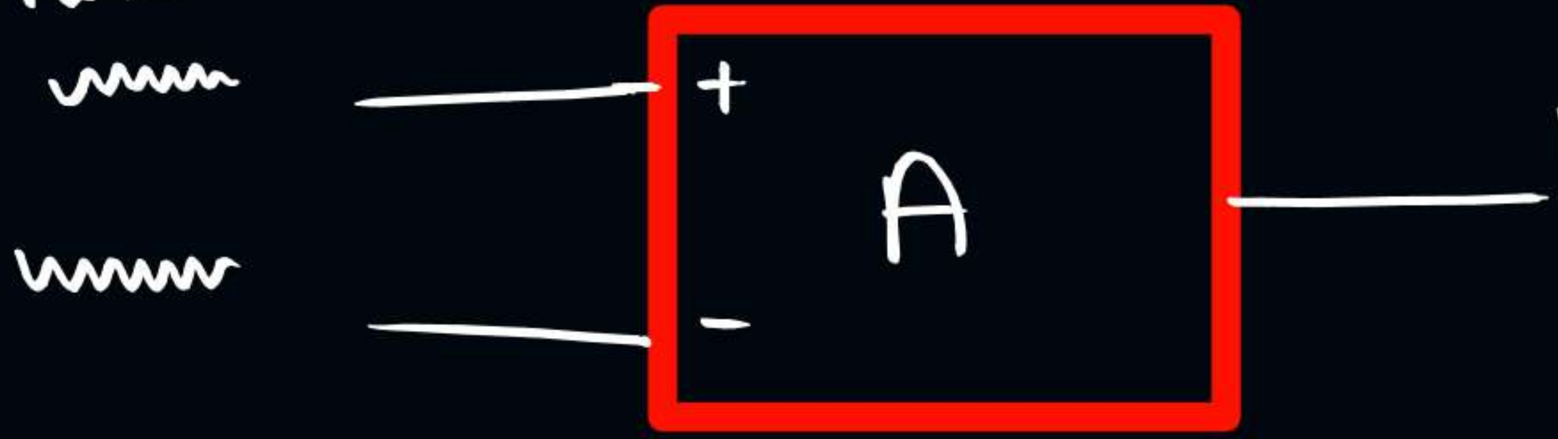
$V_i = V_1 - V_2$



$V_0 = A \cdot V_i$

$V_0 = A(V_1 - V_2)$

noise → 1 μvolt



$V_0 = 10^6 \times 1 \times 10^{-6}$

$= 1$ volt

$A_v \to 10^6$

$$V_o = A_d \cdot V_d + A_c \cdot V_c$$

$A_d \cdot V_d$ → Differential Output Voltage

A_d → differential gain

V_d → differential voltage

$$V_d = (V_1 - V_2)$$

$$V_o = A_d \cdot V_d + A_c \cdot V_c$$

$A_c \cdot V_c$ → Common mode output voltage → due to noise

A_c → Common mode gain → gain provided to noise

V_c → Common mode voltage

$$V_o = A_d \cdot V_d + A_c \cdot V_c$$

Q: What Should be the value of Common mode gain for Ideal Op-Amp?

Ideally:

$$A_c = 0$$

Practically:

$A_c \rightarrow$ v.v. low

Should be, $V_o = A(V_1 - V_2) = 0$

∵ ① $V_1 = V_2 = V_s$

If V_o = 1 volt → due to common mode

↓

$A_c \cdot V_c$

$V_0 = A_d \cdot V_d + A_c \cdot V_c$

A_d = differential gain

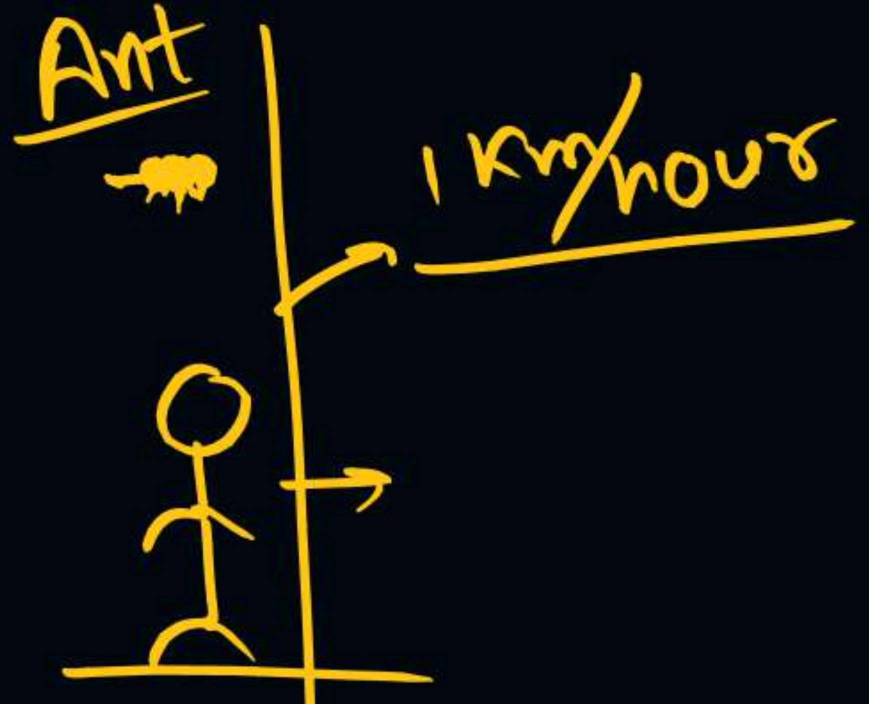
V_d → differential voltage → $V_d = V_1 - V_2$

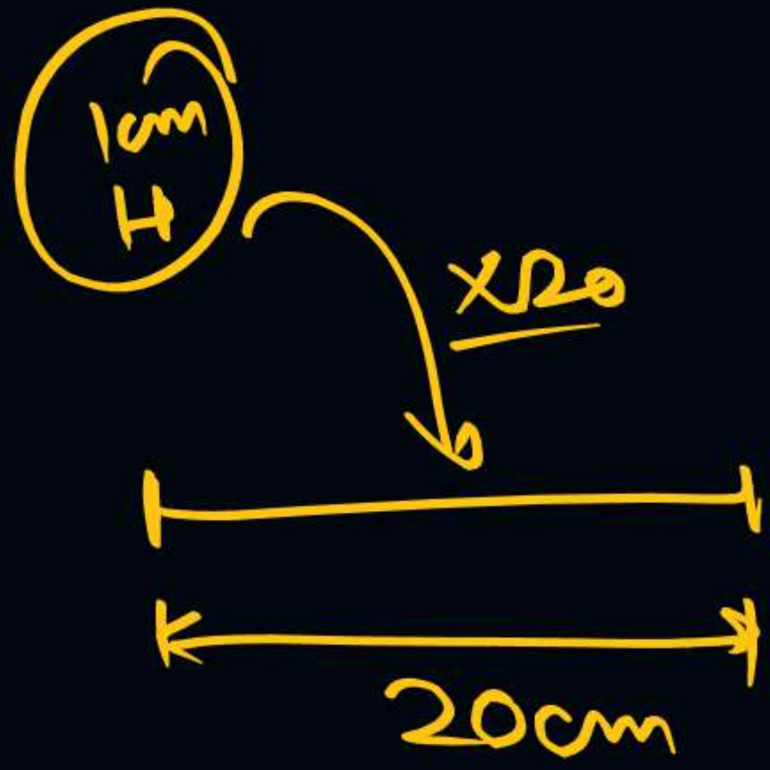
A_c → Common mode gain

V_c → Common mode Voltage → $V_c = \frac{V_1 + V_2}{2}$

$A_c \to 0$ → Common Mode Rejection Ratio (CMRR)

CMRR =





a) Slow
b) fast
c) normal

Amplifier:	Differential gain	Common Mode gain
①	10	2
②	5	1.5

① → better

Differential gain → high

Common Mode gain → low

Common Mode Rejection Ratio $= \frac{A_d}{A_c} =$ CMRR

↓

It is Ratio of differential gain to Common Mode gain

Q: What Should be the value of CMRR for Ideal Op-Amp?

a) 0

b) ∞

c) V. high

d) depends on char.

$$CMRR = \frac{A_d}{A_c}$$

Ideal: $A_c = 0$ $CMRR = \infty$

Practical: A_c = v. low, CMRR = v. high

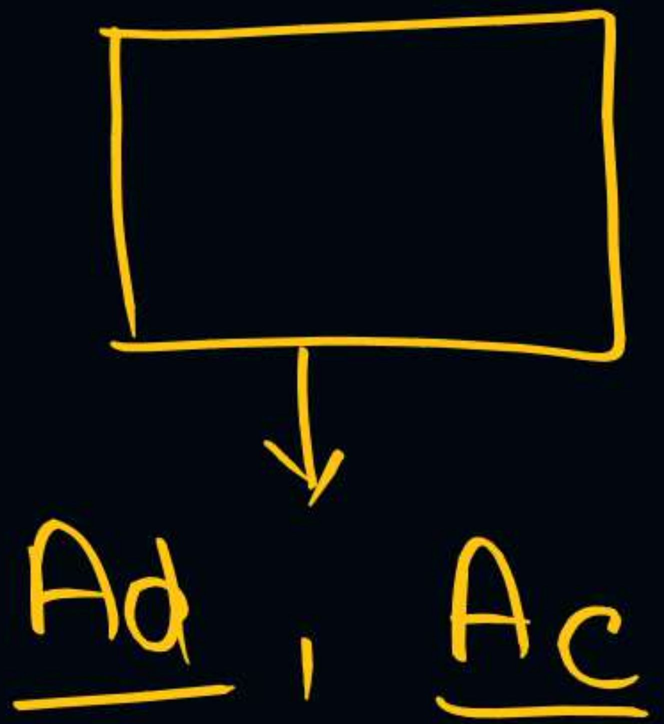
$$V_o = A_d \cdot V_d + A_c \cdot V_c$$

for A_d:

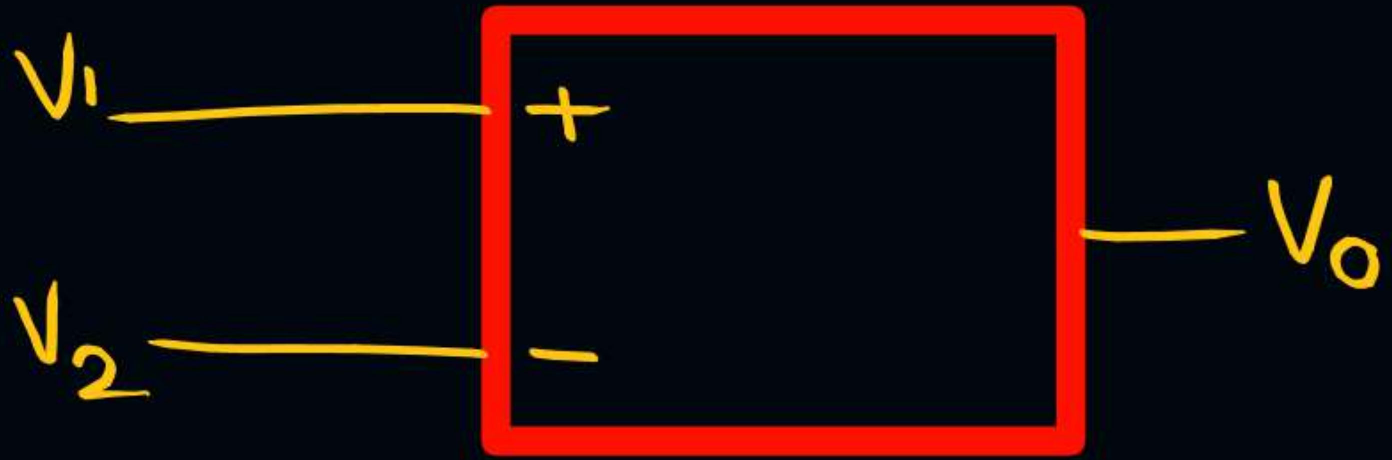
$$V_d = V_1 - V_2$$

$$V_c = \frac{V_1 + V_2}{2}$$

for A_c:



for Ac:



① $V_1 = V_s$

$V_2 = V_s$

$V_d = (V_1 - V_2)$

$V_d = 0$

$V_c = \frac{V_s + V_s}{2} = V_s$

$$V_o = A_d \cdot V_d + A_c \cdot V_c$$

$$V_o = A_d \cdot 0 + A_c \cdot V_s$$

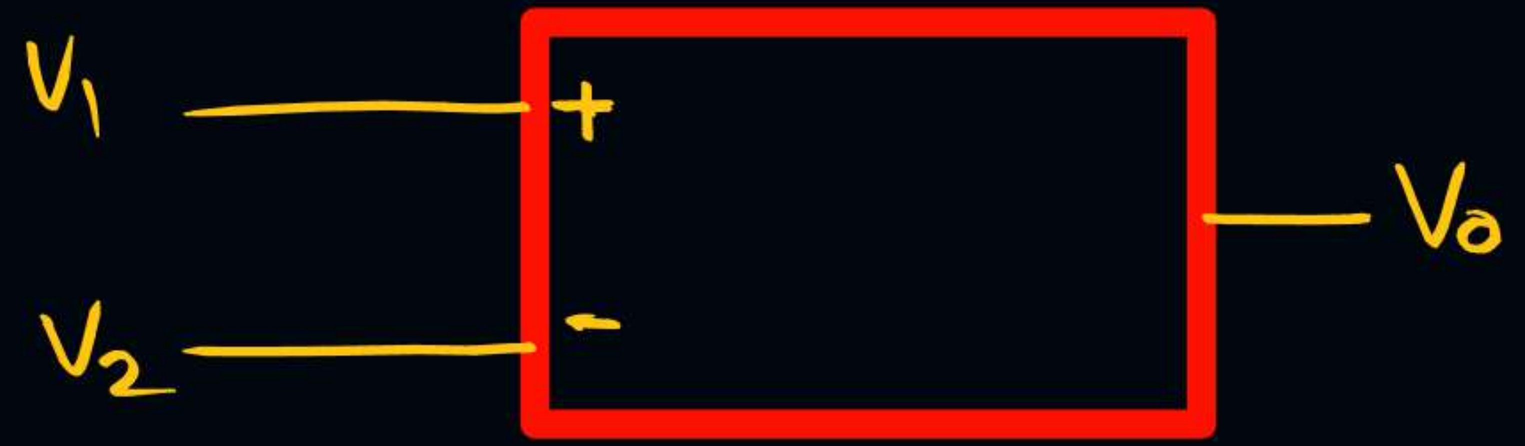
$$\boxed{A_c = \frac{V_o}{V_s}}$$ → Common Mode gain

$$A_c = \frac{V_o}{V_s}$$

For Ad:

$V_1 = V_s/2$

$V_2 = -V_s/2$

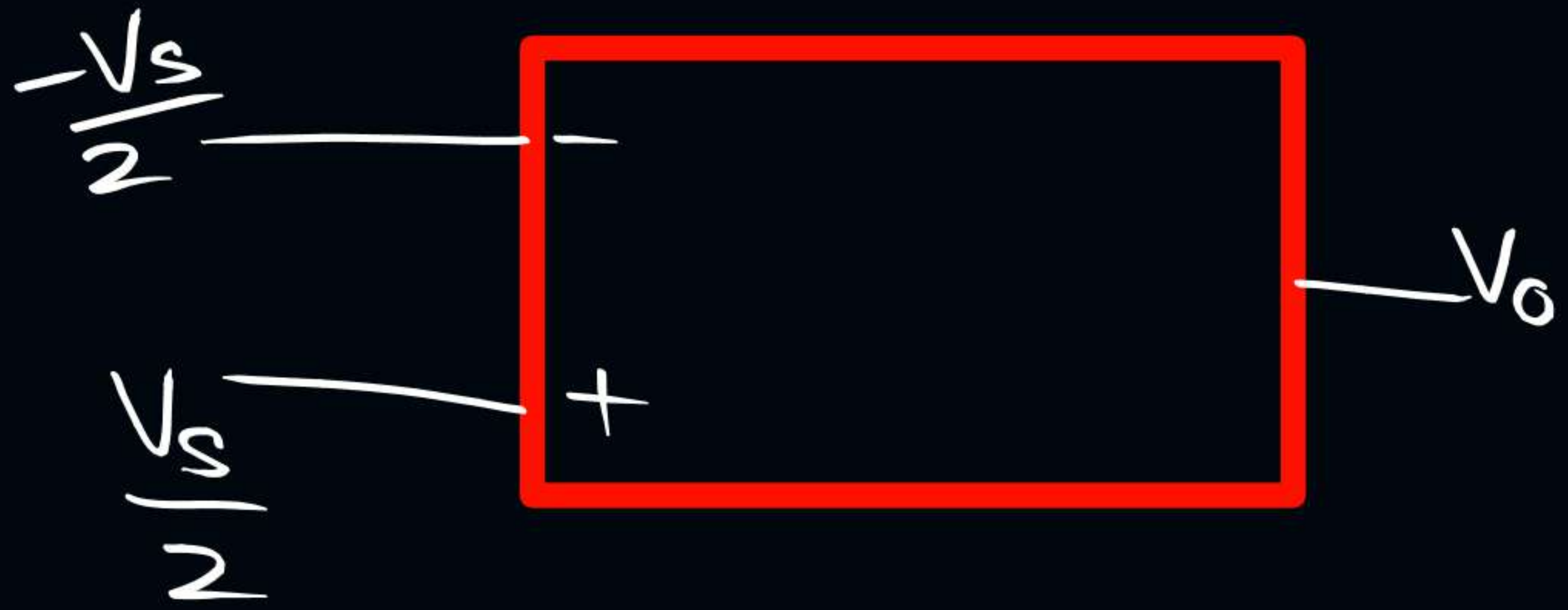


$$V_d = \frac{V_s}{2} - \left(-\frac{V_s}{2}\right) = V_s$$

$$V_c = \frac{\frac{V_s}{2} - \frac{V_s}{2}}{2} = 0$$

$$V_o = A_d \cdot V_s + 0$$

$$A_d = \frac{V_o}{V_s}$$



(If) → $V_1 = V_s$, $V_2 = -V_s$

$$V_d = V_s - (-V_s) = 2V_s$$

$$V_c = \frac{V_s - V_s}{2} = 0$$

$$V_0 = A_d \cdot (2V_s) + A_c(0)$$

$$\star \quad \boxed{A_d = \frac{V_0}{2V_s}}$$

$$CMRR = \frac{A_d}{A_c}$$

Ideally $A_c = 0$

$CMRR = \infty$

$A_c = $ v. v. low

$CMRR = $ v. v. high

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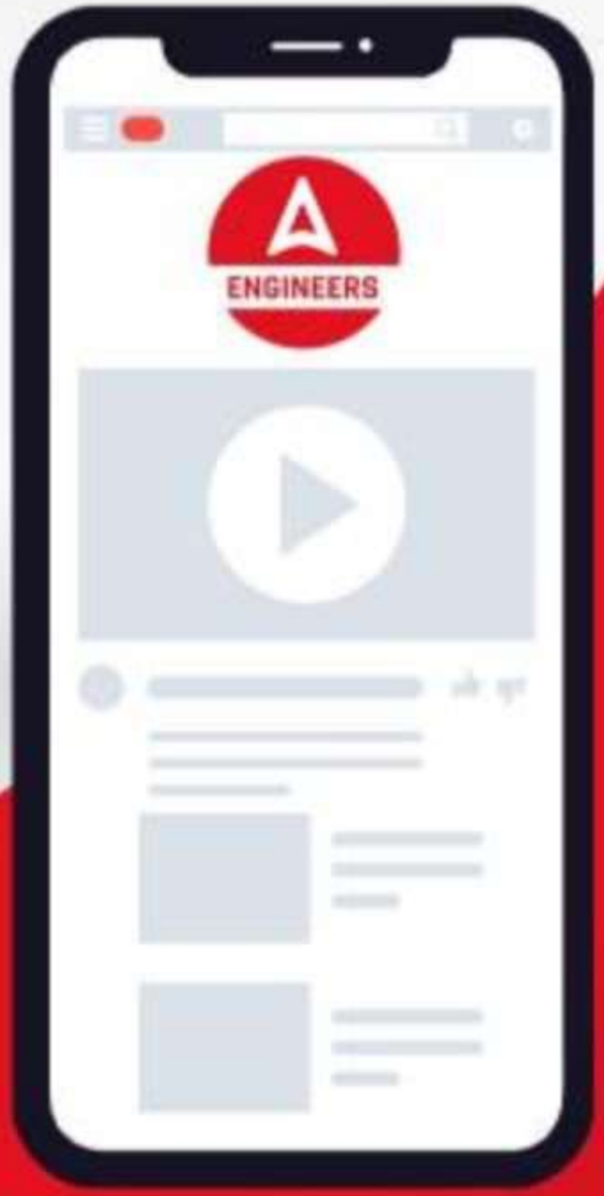
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