Nishant Jindal

OPTICAL INSTRUMENT

MICROSCOPE

- Simple Microscope
- Compound Microscope

TELESCOPE

- Astronomical telescope (Refracting type)

Nishant Jindal

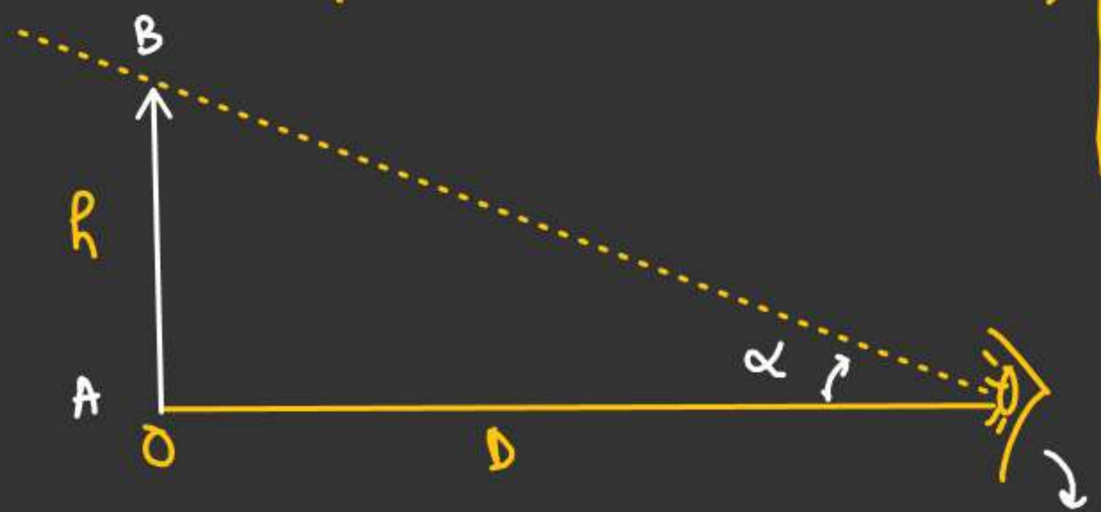
MICROSCOPE

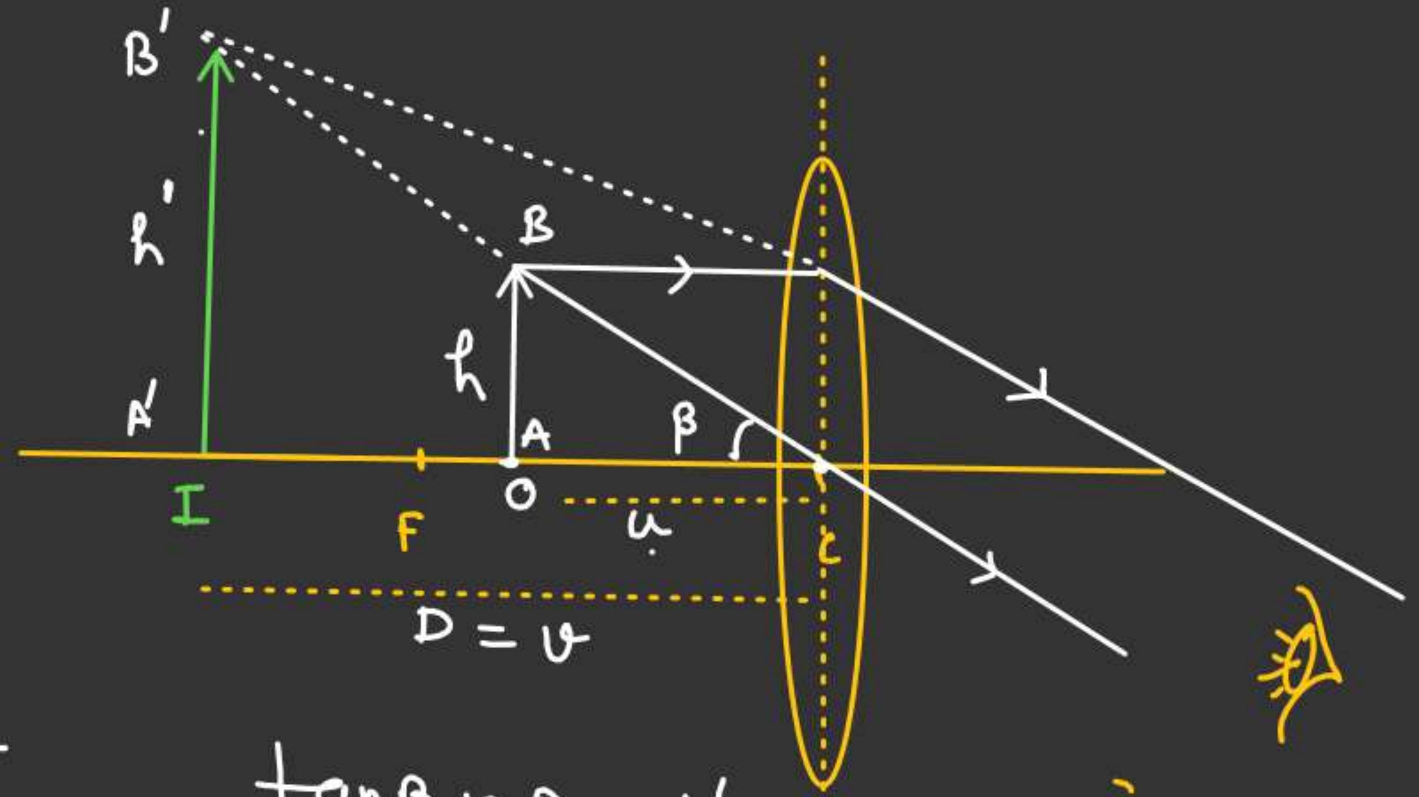
☆☆ **Magnification of a Microscope** = $\left[\dfrac{\text{Angle Subtended by final image at eye } (\beta)}{\text{Angle Subtended by object at Unaided eye. } (\alpha)} \right]$

Nishant Jindal

OPTICAL INSTRUMENT [JEE MAINS ONLY]

SIMPLE MICROSCOPE ⇒ [A Convex lens with Small focal length]





D = Least distance of distinct vision

$$\boxed{D = 25cm}$$

$$\tan\alpha \simeq \alpha = \frac{h}{D}.$$

$$m = \frac{\beta}{\alpha}$$

$$\tan\beta \simeq \beta = \frac{h'}{D} = \frac{h}{u}.$$

$$m = \frac{h/u}{h/D} = \frac{D}{u}$$

$$\underline{m = \frac{D}{u}} \checkmark$$

$\triangle B'IC$ is smiliar to $\triangle BOC$

$$\left(\frac{h'}{D} = \frac{h}{u}\right)$$

Nishant Jindal

Case-1 Final image at D.

$$\left(m = \frac{D}{u}\right)$$

By lens formula.

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{(-D)} - \frac{1}{(-u)} = \frac{1}{f}$$

$$\frac{1}{u} = \frac{1}{D} + \frac{1}{f}$$

$$\frac{1}{u} = \frac{1}{D}\left(1 + D/f\right)$$

$$\frac{D}{u} = \left(1 + D/f\right)$$

$$\boxed{m = \left(1 + \frac{D}{f}\right)}$$

$D = 25\,cm$.

Nishant Jindal

OPTICAL INSTRUMENT

Simple Microscope

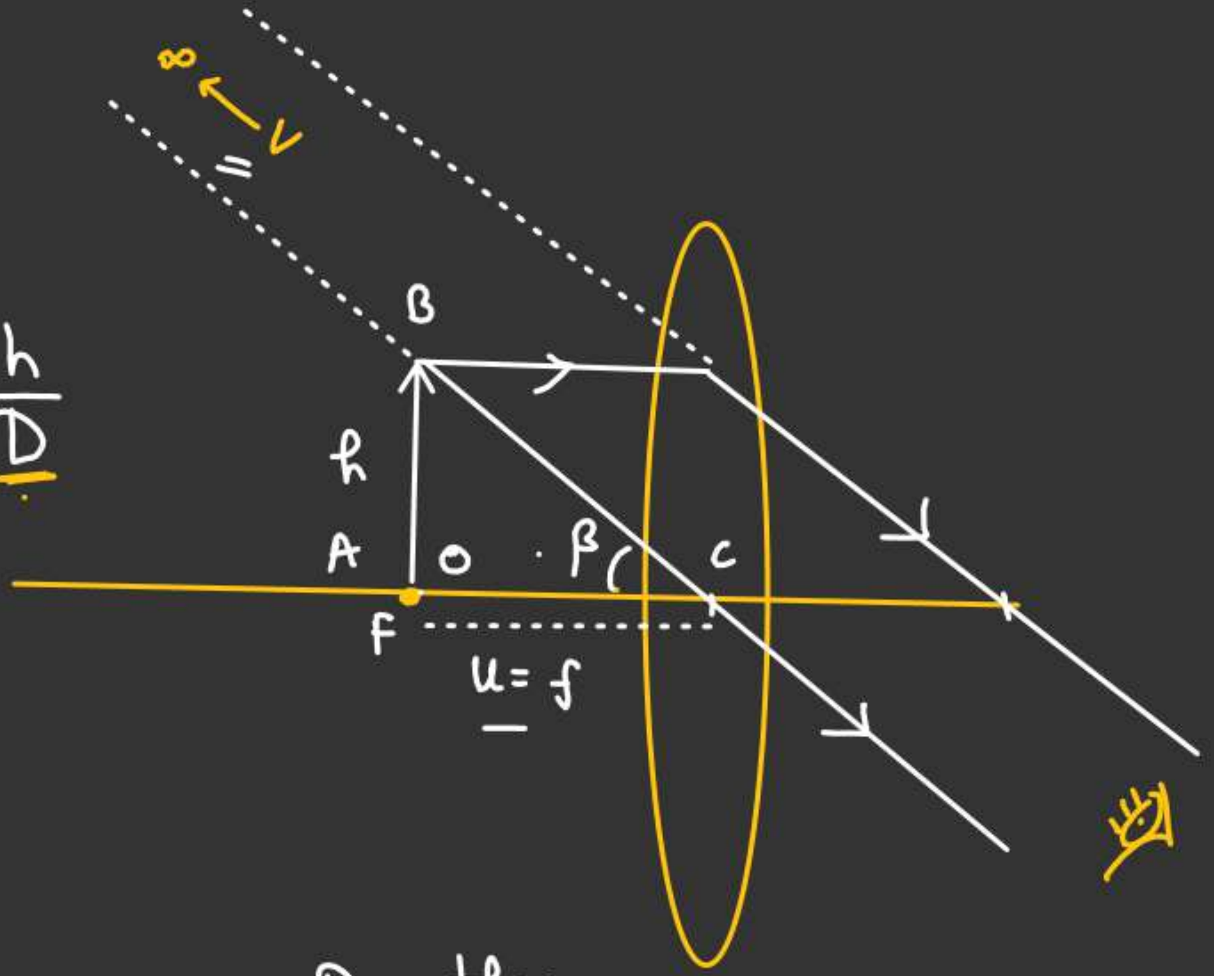
Case-2 :- Image at infinity (Normal adjustment)

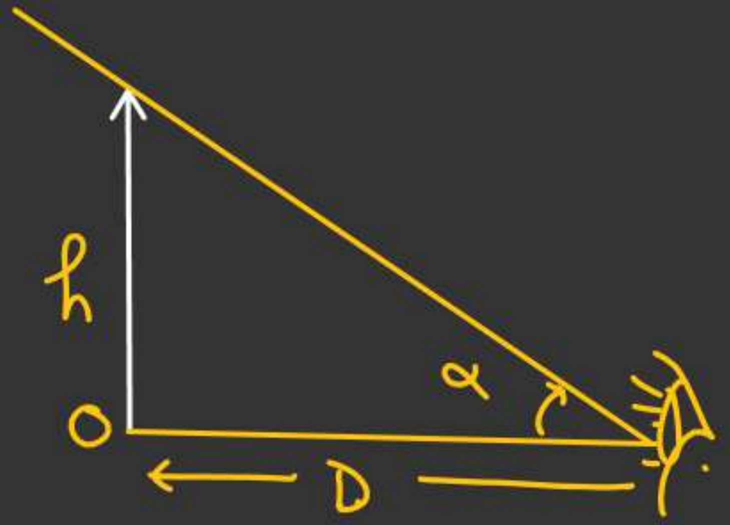
(Eye at relaxe position)

$$m = \frac{\beta}{\alpha} = \left(\frac{D}{f}\right)$$

$$\tan\alpha \simeq \alpha = \frac{h}{D}$$

$$\tan\beta \simeq \beta = \frac{h}{f}$$





$$\boxed{m = \frac{D}{f}}$$

$$m = \frac{D}{u}$$ Here $u = f$

Nishant Jindal

OPTICAL INSTRUMENT

COMPOUND MICROSCOPE

$f_e >> f_o$

f_o = Focal length of objective

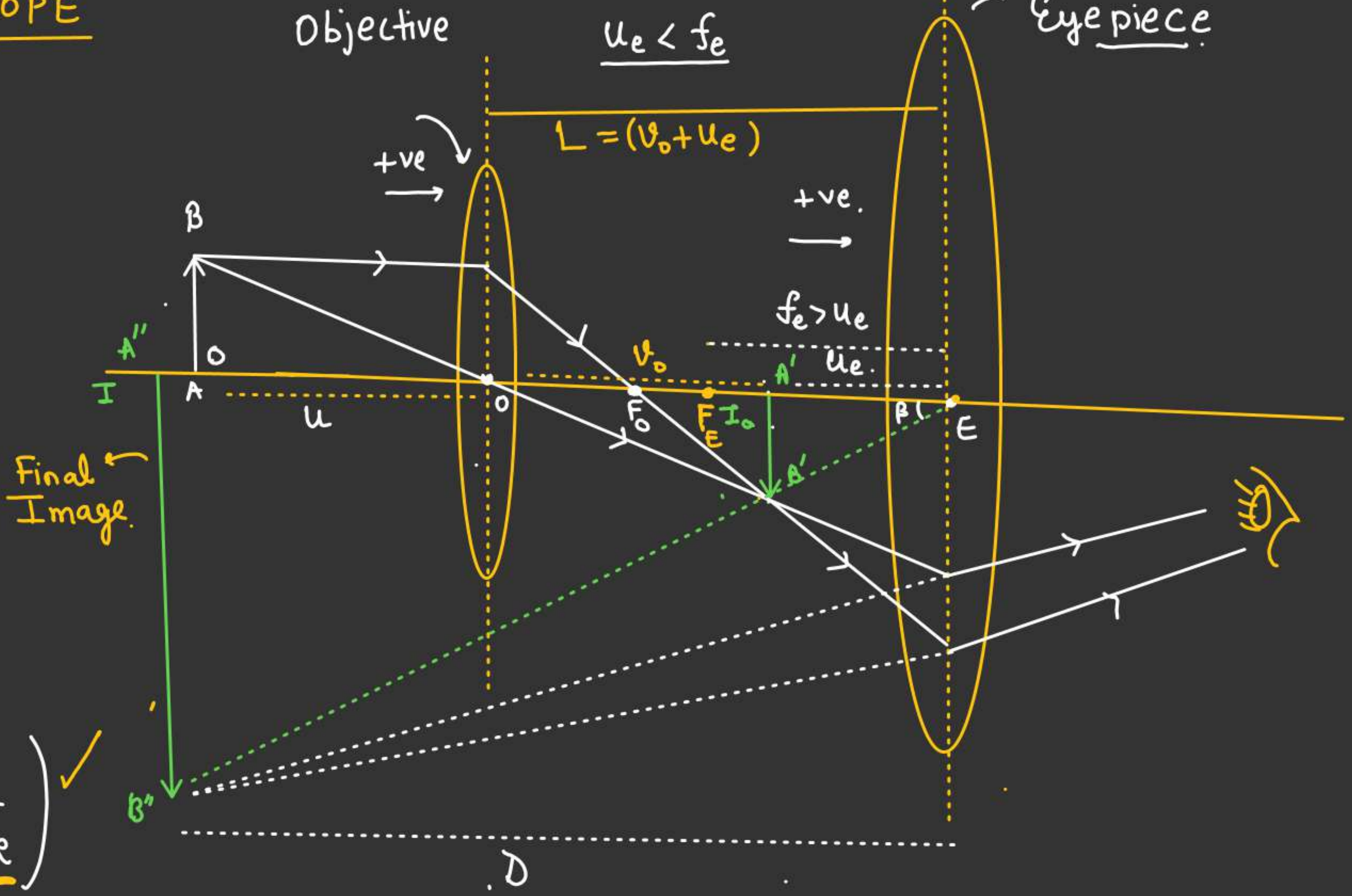
f_e = Focal length of eye piece.

$m = \frac{\beta}{\alpha}$

$\beta \simeq \tan\beta = \left(\frac{A''B''}{D}\right) = \left(\frac{A'B'}{u_e}\right)$

$\alpha \simeq \tan\alpha = \frac{AB}{D}$

$m = \left(\frac{A'B'}{AB} \times \frac{D}{u_e}\right)$ ✓



Nishant Jindal

$$m = \left(\frac{A'B'}{AB}\right)\times\left(\frac{D}{u_e}\right)$$

$\frac{A'B'}{AB} \to m_o$; $\frac{D}{u_e} \to m_e$.

$$\frac{A'B'}{AB} = (\text{Magnification of objective})$$

$$m_o = \frac{V_o}{(-u_o)} = \left(-\frac{V_o}{u_o}\right)$$

For eye piece

$$\frac{1}{(-D)} - \frac{1}{(-u_e)} = \frac{1}{f_e}$$

$$\frac{1}{u_e} = \frac{1}{f_e} + \frac{1}{D}$$

$$\frac{1}{u_e} = \frac{1}{D}\left(1 + D/f_e\right)$$

$$\frac{D}{u_e} = \left(1 + \frac{D}{f_e}\right)$$

At $v = D$

$$\boxed{m = \left(-\right)\left(\frac{V_o}{u_o}\right)\left(1 + \frac{D}{f_e}\right)}$$

$(-)$: Final image inverted

$\frac{V_o}{u_o}$: $m_o \Rightarrow$ Magnification of objective

$\left(1 + \frac{D}{f_e}\right)$: $m_e \Rightarrow$ Magnification of eye piece.

For Numerical use.

$$\boxed{|m| = \frac{v_o}{|u_o|}\left(1 + D/f_e\right)}$$

Nishant Jindal

OPTICAL INSTRUMENT

COMPOUND MICROSCOPE

Case-2 :- (Normal Adjustment)
$(V \to \infty)$

$$\beta \simeq \tan\beta = \left(\frac{A'B'}{f_e}\right)$$

$$\alpha \simeq \tan\alpha = \left(\frac{AB}{D}\right)$$

$$m = \frac{\beta}{\alpha} = \left(\frac{A'B'}{AD}\right) \times \frac{D}{f_e}$$

$$\Downarrow \qquad \Downarrow$$

$$m_o \times m_e$$

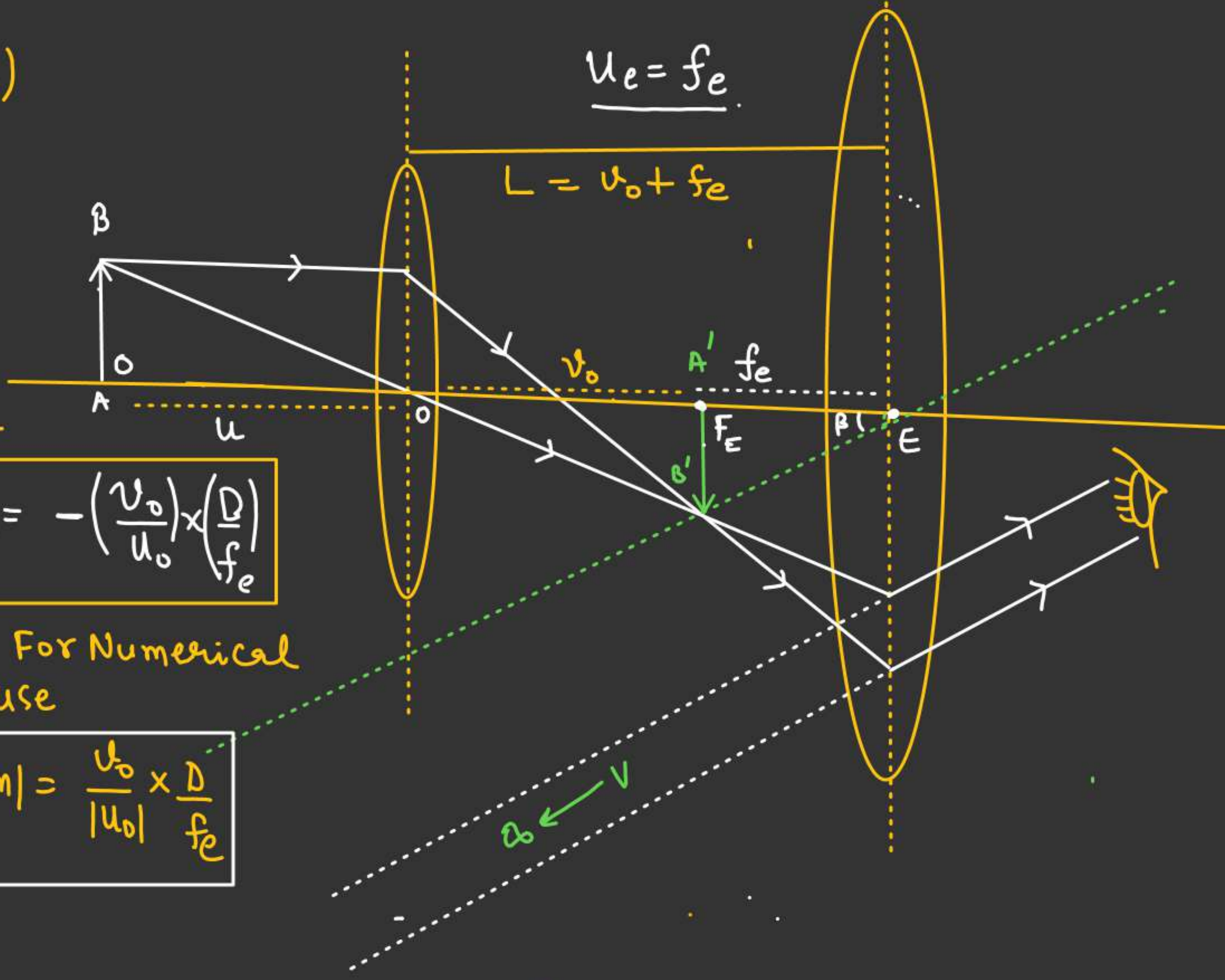
$$m = \left(\frac{v_o}{-u_o}\right) \times \frac{D}{f_e}$$

**

$$\boxed{m = -\left(\frac{v_o}{u_o}\right) \times \left(\frac{D}{f_e}\right)}$$

For Numerical use

$$\boxed{|m| = \frac{v_o}{|u_o|} \times \frac{D}{f_e}}$$



Nishant Jindal

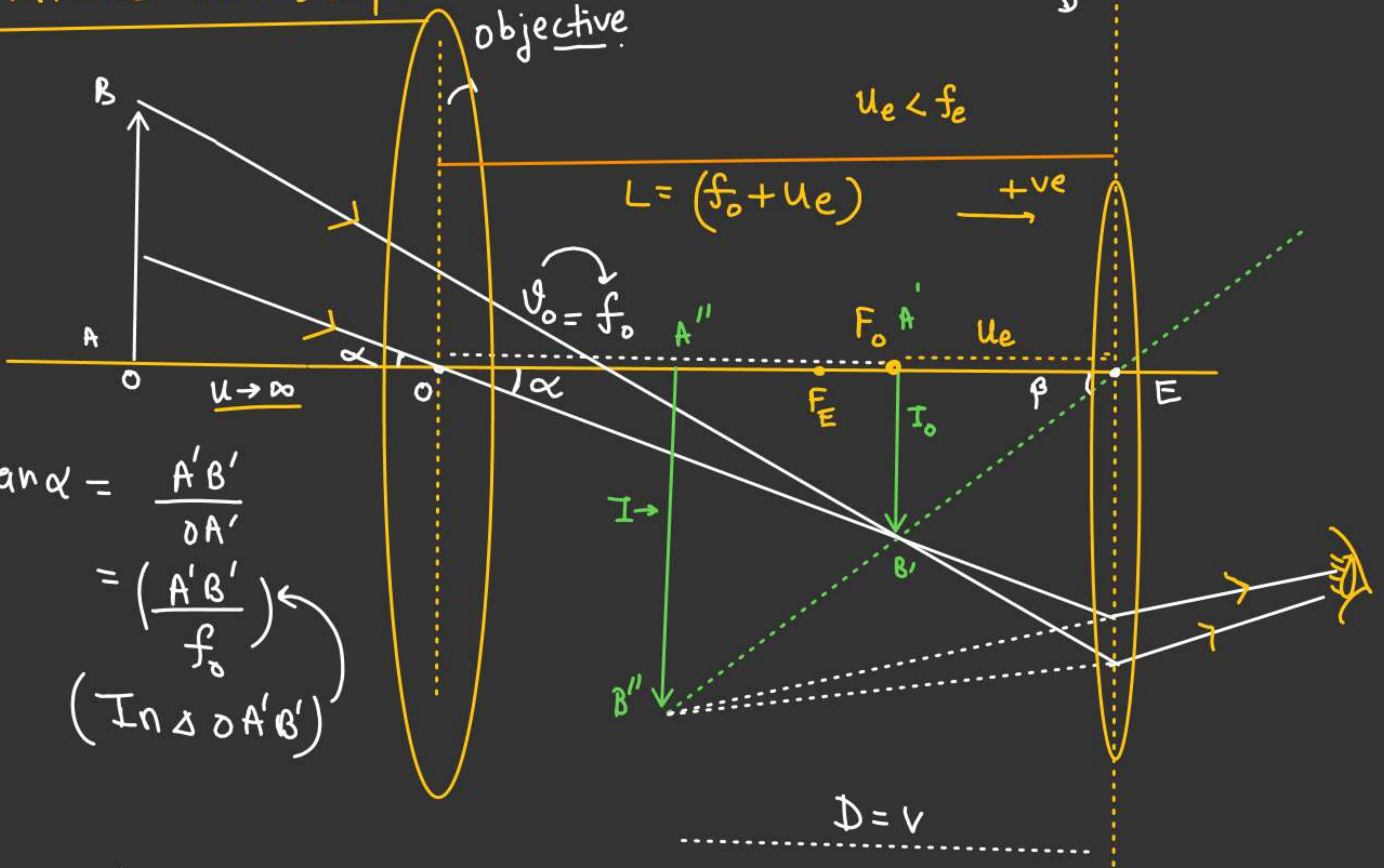
TELESCOPE

** Refracting astronomical telescope

Case-1 :– Final image at D

For Astronomical telescope object alway at ∞.

$u \to \infty$



$$m = \frac{\beta}{\alpha}$$

$$\tan\beta \simeq \beta = \frac{A'B'}{u_e}$$

$$\tan\alpha = \frac{A'B'}{OA'} = \left(\frac{A'B'}{f_o}\right)$$

(In $\triangle OA'B'$)

Nishant Jindal

$$m = \frac{\beta}{\alpha} = \frac{A'B'}{-u_e} \times \frac{f_o}{A'B'}$$

$$m = \left(\frac{f_o}{-u_e}\right)$$

For Eye piece.

$$\frac{1}{-D} - \frac{1}{(-u_e)} = \frac{1}{f_e}$$

$$\frac{1}{u_e} = \frac{1}{f_e} + \frac{1}{D}$$

$$\frac{1}{u_e} = \left(\frac{D+f_e}{Df_e}\right) ✓$$

$$m = \frac{-f_o}{f_e D}\left(D+f_e\right)$$

$$\boxed{m = \frac{-f_o}{f_e}\left(1+\frac{f_e}{D}\right)}$$ ★★

Case when Image at D.

For Numerical

$$\boxed{|m| = \frac{f_o}{f_e}\left(1+\frac{f_e}{D}\right)}$$

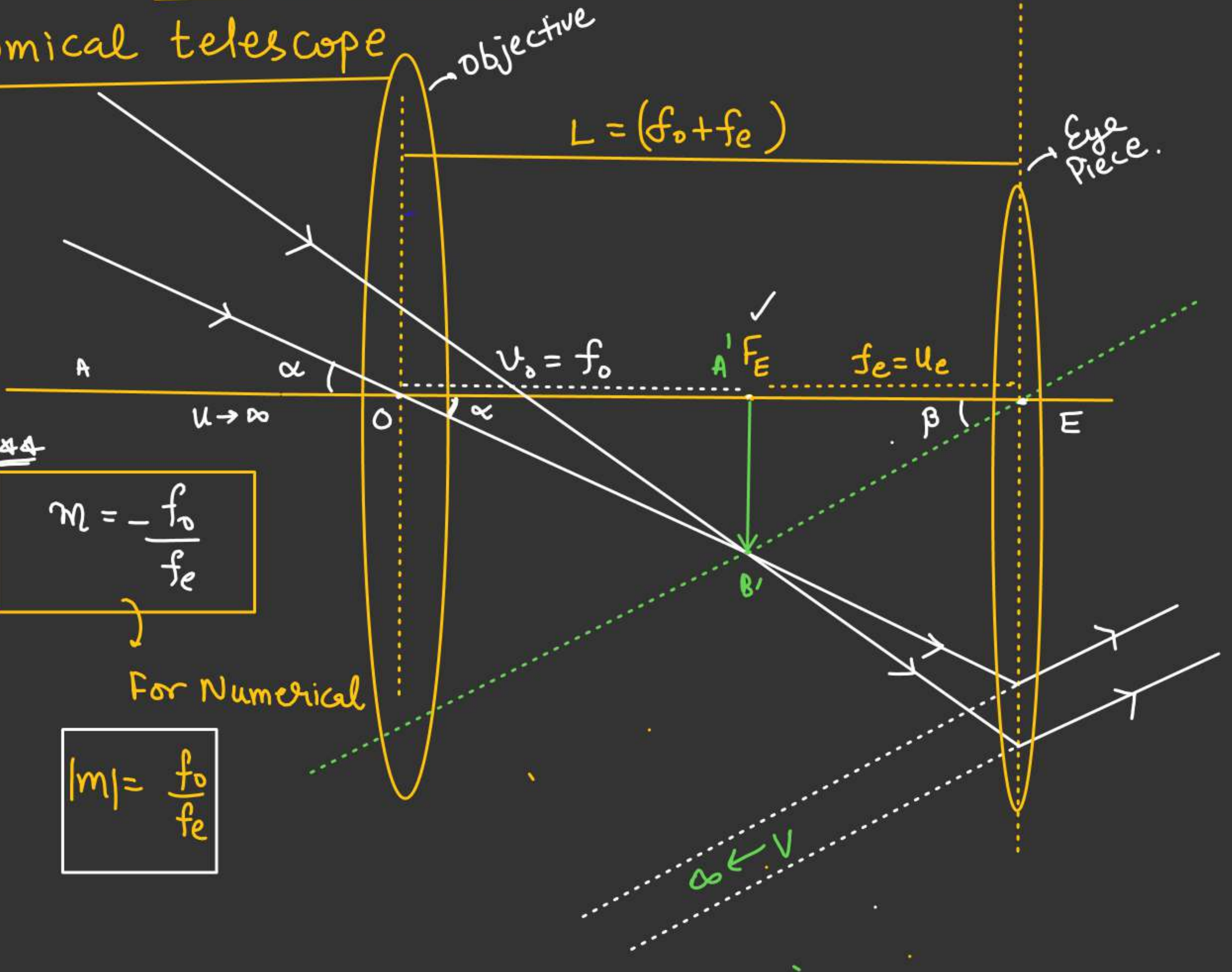
Nishant Jindal

TELESCOPE

** Refracting astronomical telescope

Case-2 :- Normal Adjustment.

[Final image at ∞]



$$m=\frac{\tan\beta}{\tan\alpha}\simeq\frac{\beta}{\alpha}$$

$$\tan\beta=\frac{A'B'}{(-f_e)}$$

$$\tan\alpha=\frac{A'B'}{v_o}=\frac{A'B'}{f_o}$$

$$m=\ominus\frac{f_o}{f_e}$$

**

$$\boxed{m=-\frac{f_o}{f_e}}$$

For Numerical

$$\boxed{|m|=\frac{f_o}{f_e}}$$

Nishant Jindal

H.W.

OPTICAL INSTRUMENT

① Compound Miscroscope

$f_o = 0.95\text{cm}$

$f_e = 5\text{cm}$

Distance b/w objective & eyepiece = 20cm

last image is formed at 25cm from the eye piece.

Calculate position of object & total magnification

Ans. $u = -\frac{95}{94}\text{cm}$, $m = -94$

$|m| = 94$

Nishant Jindal

OPTICAL INSTRUMENT

H.W

② Compound Miscroscope.

$f_o = 4cm$

$f_e = 10cm$

$u_o = 6cm$

Calculate 1) $m = ?$ 7 Ans

2) $L = ?$ 19.14 cm

Nishant Jindal

OPTICAL INSTRUMENT

H.W

\# 3. Compound Miscroscope

$$f_o = 2\,cm$$

$$f_e = 6.25\,cm$$

Distance b/w objective & eyepiece = 15cm

How far from the objective object is placed in Order to obtained the final image at

a) u_D

b) ∞

c) Find m in each Case.

Ans a) $u_o = -2.5\,cm$, $|M| = 20$

b) $u_o = -2.59\,cm$, $|M| = 13.5$