$$e_0 = \frac{K \cancel{R_p}}{\cancel{R_p}} * e_i$$

$$\therefore e_0 = K e_i \longrightarrow (i)$$

$$e_0 = \frac{x_i}{x_t} e_i \longrightarrow (ii)$$

$$\frac{e_0}{x_i} = \frac{e_i}{x_t} = \text{const.} \longrightarrow (iii)$$

26th Dec

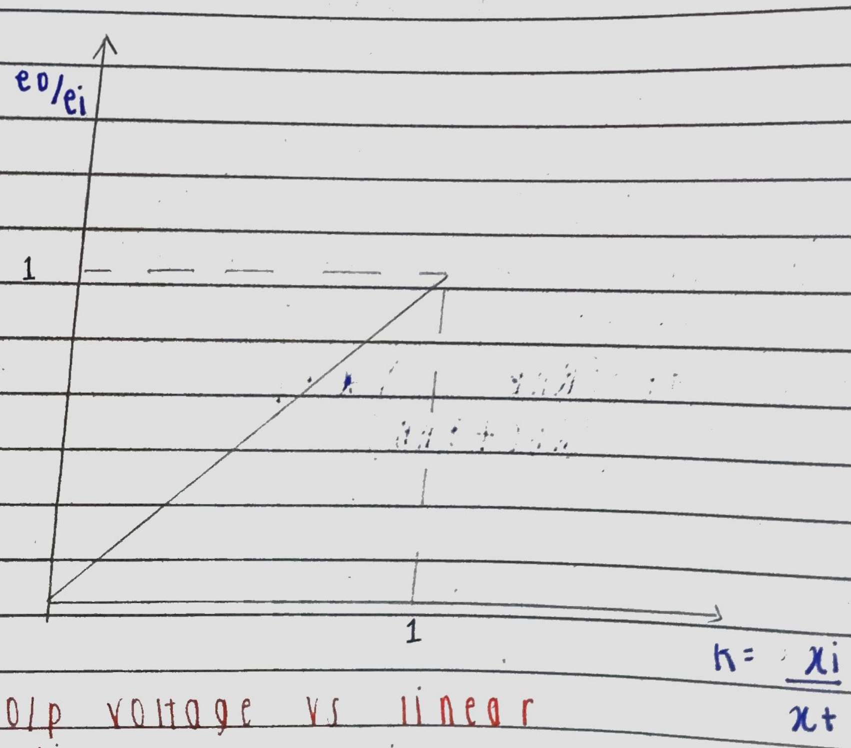

Fig: O/P voltage vs linear displacement in POT

From eq^n (i), (ii) & (iii) we conclude that there exists a linear rel^n bet^n o/p voltage & i/p voltage.

so,

sensitivity $\xrightarrow{is}$ constant

as shown in fig above

$$S = \frac{\text{mag. of o/p}}{\text{mag. of i/p}}$$

$$\therefore S = \frac{e_o}{x_i} = \frac{e_i}{x_t} = K \text{ (constant)} \quad \text{(iv)}$$

$x_i \to \theta_i$, $x_t \to \theta_t$

Eq^n (i) – (iv) are also applicable to rotatory POT if we replace

$x_i \longrightarrow \theta_i$

&

$x_t \longrightarrow \theta_t$

so,

eq^{n}s becomes

$$e_o = K e_i$$

$$e_o = \frac{\theta_i}{\theta_t} e_i$$

$$\frac{e_0}{e_i} = \frac{\theta_i}{\theta_t} = k$$

$$\frac{e_0}{\theta_i} = \frac{e_i}{\theta_t} = \text{constant}$$

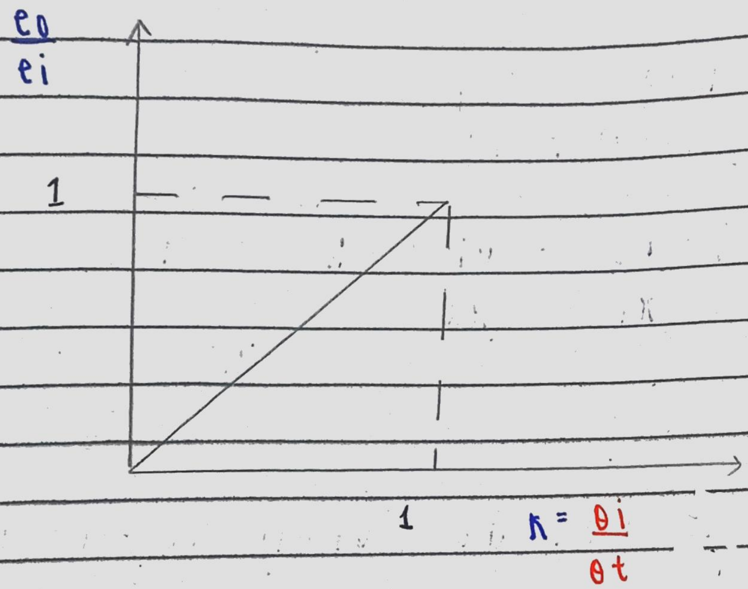

Fig: O/P voltage vs. Rotational displacement in POT

Loading Effect in POT

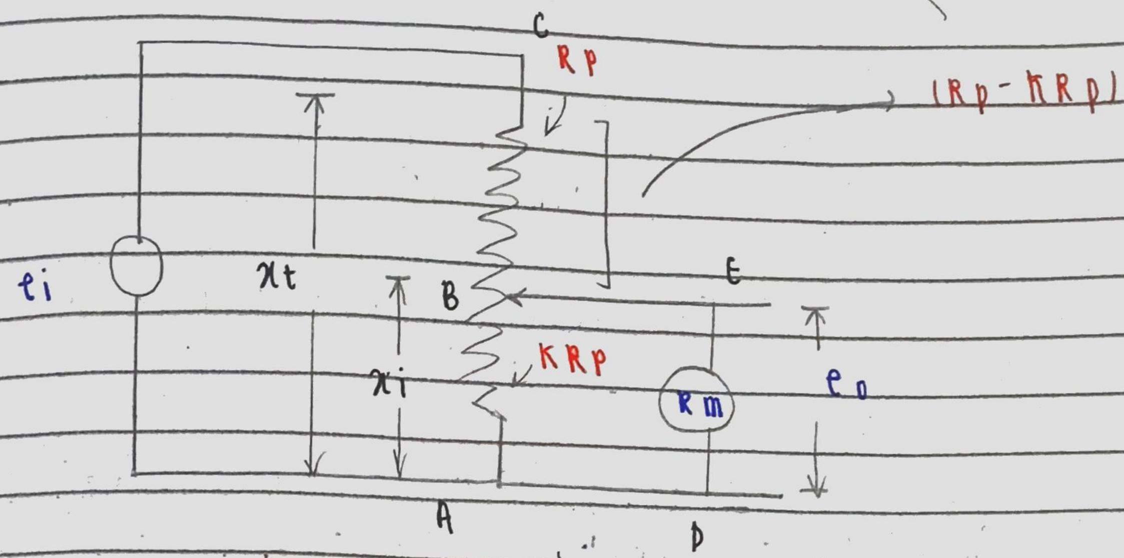

Fig: loaded POT

If R of voltmeter ⟶ ∞,

we get linear relⁿ betⁿ o/p & i/p voltage.

given by

$$e_0 = Ke_i = \frac{x_i}{x_t} e_i \quad \text{(i)}$$

In actual practice, the i/p or internal resistance (Rm) of voltmeter is ⟶ finite.

So,

the reading indicated by voltmeter will always be ↓ than value given by eqⁿ (i)

This effect is known as loading effect

&

there exists an error known as
loading error

• due to internal resistance / impedance of
o/p device.

Due to loading effect there exists a
non-linear relⁿ betⁿ o/p & i/p voltage.

Here,
the resistance across R_{AB}
$= KR_p \parallel R_m$

$$R_{AB} = \frac{KR_p R_m}{KR_p + R_m}$$

The o/p voltage due to loading effect
is given by

$$e_0 = \frac{R_{AB}}{(R_{AB} + R_{BC})} * e_i$$

not Rp!!

Don't forget as R_{AB} is not KR_p *

yo dunta add gara Rp X aaune vayena aaba

As voltmeter jodesi equivalent R arxai aairakyo. Tara $R_p \rightarrow$ same

so,

$$R_{BC} = R_p - KR_p$$

Thus,

$$e_0 = \frac{\frac{KR_pR_m}{KR_p + R_m}}{\frac{KR_pR_m}{KR_p+R_m} + (R_p - KR_p)} * e_i$$

$$= \frac{\frac{KR_pR_m}{KR_p+R_m}}{\frac{\cancel{KR_pR_m} + KR_p^2 - K^2R_p^2 + R_mR_p - \cancel{KR_pR_m}}{KR_p + R_m}} * e_i$$

$$= \frac{KR_pR_m}{KR_p^2 - K^2R_p^2 + R_pR_m} * e_i$$

Dividing both by R_pR_m

$$= \frac{K}{K\frac{R_p}{R_m} - K^2\frac{R_p}{R_m} + 1} * e_i$$

put $\frac{R_m}{R_p} = \alpha$

$$\Rightarrow \frac{K}{\frac{K}{\alpha} - \frac{K^2}{\alpha} + 1} * e_i$$

$$\therefore \; e_0 = \frac{\alpha K}{\alpha + K(1-K)} * e_i$$ (iii)

If

ideal voltmeter

$R_m \to \infty$ then $\alpha \to \infty$

&

eq^n (iii) becomes

$$e_0 = K e_i$$ (iv)

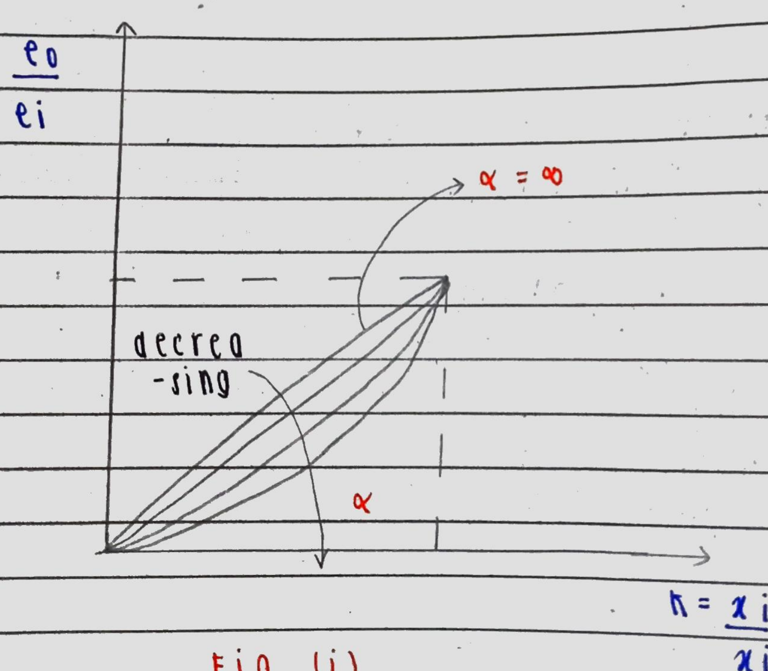

Fig (i)

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$\exists$

Eqⁿ (iii) shows that there exists a non-linear relⁿ betⁿ o/p & i/p due to the loading effect

graphically shown in fig (i)

Loading Error

① Relative Error

② absolute Error

① Relative Error [Er]

$$Er = \frac{\text{o/p voltage w/o loading} - \text{o/p voltage w. loading}}{\text{o/p voltage w/o loading}}$$

$$= \frac{Kei - \frac{\alpha Kei}{\alpha + K(1-K)}}{Kei}$$

$$= 1 - \frac{\alpha}{\alpha + K(1-K)}$$

$$= \frac{\alpha + K(1-K) - \alpha}{\alpha + K(1-K)}$$

$$Er = \frac{K(1-K)}{\alpha + K(1-K)} \quad \text{(*)}$$

Er depends upon:

- value of K

&

- practical value of α

- To find K at which Er is max.

We have,

$$\frac{d}{dK}(Er) = 0$$

$$\Rightarrow \frac{d}{dK}\left[\frac{K(1-K)}{\alpha + K(1-K)}\right] = 0$$

$$\Rightarrow \left[\frac{\{\alpha + K(1-K)\}(1-2K) - \{K(1-K)\}(1-2K)}{(\alpha + K(1-K))^2}\right] = 0$$

$$\Rightarrow \alpha + \cancel{K(1-K)} - 2\alpha K - \cancel{2K^2(1-K)} - \cancel{K(1-K)} + \cancel{2K^2(1-K)} = 0$$

$$\Rightarrow \alpha - 2\alpha K = 0$$

$$\Rightarrow \boxed{(1-2K)\alpha = 0}$$

$$\downarrow$$

$$\alpha \neq 0$$

$$\because \alpha = \frac{Rm}{Rp} \quad \& \quad Rm >> Rp$$

beti̲ⁿ 0 to 1 — k choi

So, $1-2k=0$

$\therefore k=\frac{1}{2}$

When $k=\frac{1}{2}$, Er will be maximum

i.e. when the wiper $\xrightarrow{\text{is at}}$ mid-point of pot

Now, let us plot the variation of Er w_i r.t. k for diff. value of α.

- For $\alpha = 1$

k	Er
0	0
0·1	0·0826
0·2	0·1379
0·3	0·1736
0·4	0·1935
0·5	0·2
0·6	0·1935
0·7	0·1736
0·8	0·1379
0·9	0·0826
1·0	0

- For $\alpha = 10$

k	Er
0	0
0·1	0·0089
0·2	0·0157
0·3	0·0206
0·4	0·0234
0·5	0·0244
0·6	0·0234
0·7	0·0206
0·8	0·0157
0·9	0·0089
1·0	0

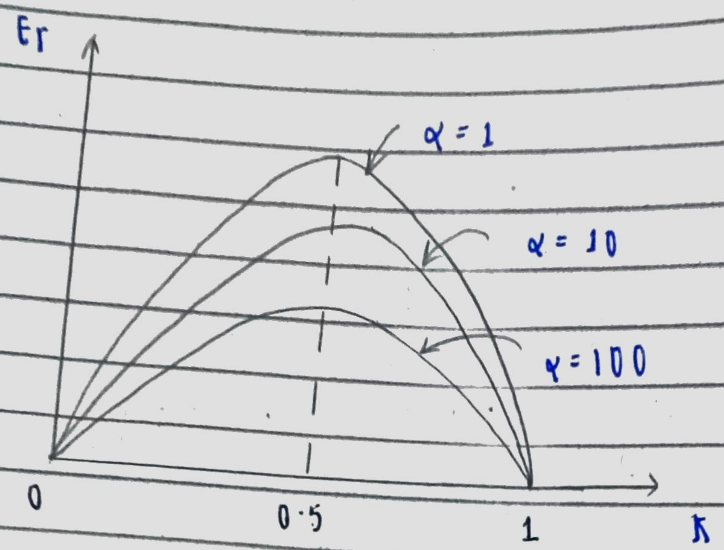

Fig (iii) variation of Er w.r.t. K acc. to α

From graph, we can see that

• Er ↓ w. ↑ in α