Linear Variable Differential Transformer (LVDT).

→ Modified version of plunger type sensors

→ arranged with two sets of coils, one as the primary and the other set as secondary having two coils connected differentially for providing the o/p.

→ The coupling between primary and secondaries varies with the core plunger moving linearly.

→ An alternating supply V_i and frequency f is impressed across the primary coil and depending on the position of the core w.r.to primary and two secondaries, an o/p voltage V_o' is obtained from the secondaries.

→ The induction in one secondary coil, the law is according to the

$$V_{os} = -\frac{n\,d\phi}{dt} = -M\frac{di_p}{dt} \quad -①$$

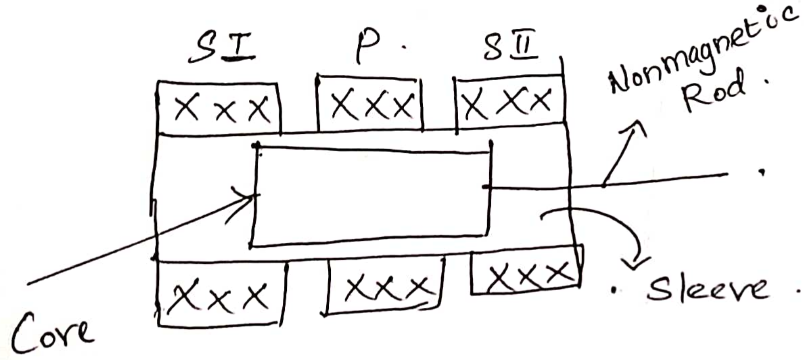
n → no of turns in the coil of secondary

ϕ → magnetic flux

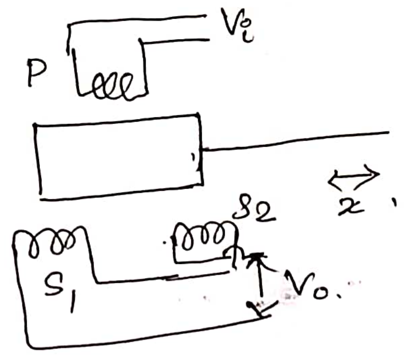
M → Mutual Inductance b/w primary & secondary

i_p → primary current.

Scheme of an LVDT



equivalent model



For the two coils differentially connected,

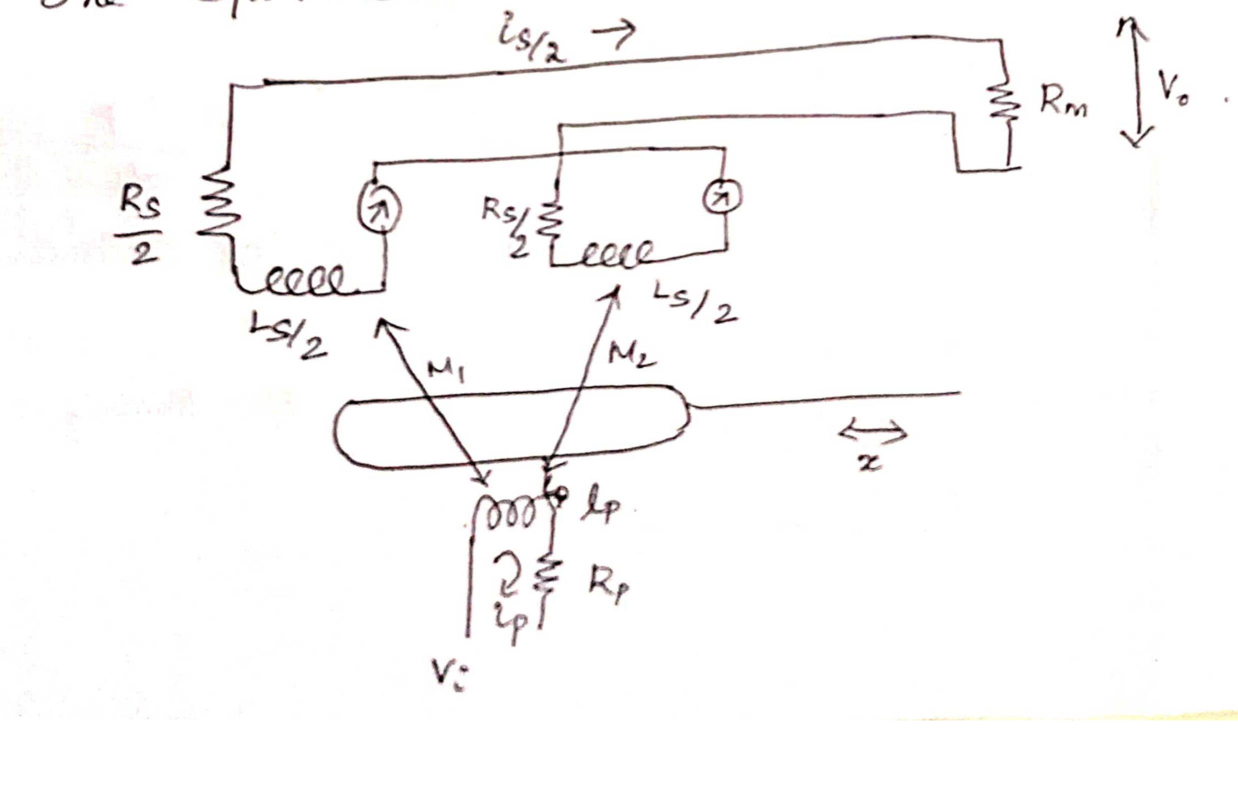
$$V_o = V_{os1} - V_{os2} = (M_1 - M_2)\frac{di_p}{dt} \quad — (2)$$

Both M_1 & M_2 being functions of x, $M_1 - M_2 = M(x)$. If the function is linear over a certain range, $M(x) = kx$ so that

$$x = \frac{V_o}{k\left(\frac{di_p}{dt}\right)} \quad — (3)$$

Loss components are to be considered for obtaining o/p V_o per unit displacement of the core. ~~The~~ When arranged in a bridge in a differential manner, loss components be compensated by appropriate circuit components.

The equivalent circuit of LVDT is



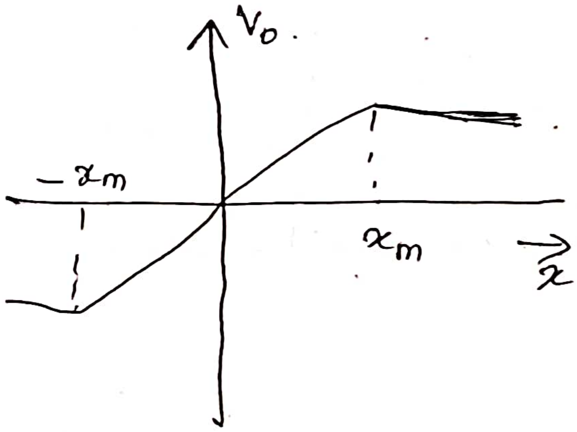
Solving for the magnitude ratio per unit displacement $\left|\frac{V_o}{V_i}\right| / x$, angle by which the o/p voltage V_o, lags the i/p voltage V_i at $f = \frac{\omega}{2\pi}$ and if the meter load is R_m, we get.

$$\left|\frac{V_o}{V_i}\right| \frac{1}{x} = \frac{K \omega R_m / \{(R_s + R_m) R_p\}}{\sqrt{[\{1 - \omega^2(\tau_m^2 + \tau_p \tau_s)\}^2 + \omega^2(\tau_p + \tau_s)^2]}}.$$

$$\phi = 90^\circ - \tan^{-1} \frac{\omega(\tau_p + \tau_s)}{1 - \omega^2(\tau_m^2 + \tau_p \tau_s)}$$

Where $\tau_m = \frac{M_1 - M_2}{\sqrt{(R_s + R_m) R_p}}$ $\tau_p = \frac{L_p}{R_p}$ $\tau_s = \frac{L_s}{R_s + R_m}$

The phase rectified secondary o/p voltage V_0 with x is shown in fig.



For a given V_i, linear range limits is are indicated by $\pm x_m$. This limitation is inherent in all differential systems.