DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

POWER SYSTEM ANALYSIS
UNIT – III
STEPPER MOTOR

The case of Constant Permeabilities.

L = Coil inductance

ψ = flux linkages.

$$\psi = LI$$

The magnetic energy.

$$W_m = \frac{1}{2} L I^2 \quad \text{——} \quad (18)$$

emf induced in the coil

$$e = \frac{-\Delta\psi}{\Delta t}$$

$$= \frac{-\Delta (LI)}{\Delta t} \quad \text{——} \quad (19)$$

$$e = -I \frac{\Delta L}{\Delta t} \quad \text{——} \quad (20)$$

Work done ΔP_i

$$\Delta P_i = I\,|e|\,\Delta t$$

$$= I\left|-I\frac{\Delta L}{\Delta t}\right|\Delta t$$

$$= I^2 \Delta L \quad \text{——} \quad (21)$$

$$\Delta W_m = \frac{1}{2}\Delta P_i$$

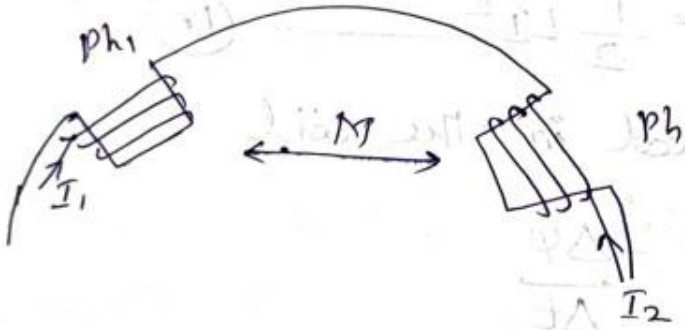
$$= \frac{1}{2} I^2 \Delta L \quad \text{——} \quad (22)$$

$$\Delta W_m = f\,\Delta x$$

$$f\Delta x = \frac{1}{2} I^2 \Delta L \quad \text{——} \quad (23)$$

$$\boxed{f = \frac{1}{2} I^2 \frac{\Delta L}{\Delta x}} \quad \text{——} \quad (24)$$

Effects of Mutual induction



The induced voltages at each phase are

$$e_1 = -I_1 \frac{\Delta L_1}{\Delta t} - I_2 \frac{\Delta M}{\Delta t} \quad \text{—— (25)}$$

$$e_2 = -I_2 \frac{\Delta L_2}{\Delta t} - I_1 \frac{\Delta M}{\Delta t} \quad \text{—— (26)}$$

e_1 = Induced voltages of phase 1

e_2 = " " " " 2.

L_1 = Inductance of phase 1.

L_2 = " " " 2.

M - Mutual inductance between the two phases.

$$\Delta P_i = (-e_1 I_1 + e_2 I_2)\Delta t$$

$$= I_1^2 \Delta L_1 + I_2^2 \Delta L_2 + 2 I_1 I_2 \Delta M \quad \text{---(21)}$$

$$\Delta W_m = \frac{1}{2}(I_1^2 \Delta L_1 + I_2^2 \Delta L_2) + I_1 I_2 \Delta M$$

$$(\Delta W_m)\Delta P_o = T \Delta\theta$$

$$T\Delta\theta = \frac{1}{2}(I_1^2 \Delta L_1 + I_2^2 \Delta L_2) + I_1 I_2 \Delta M.$$

$$T = \frac{1}{2} I_1^2 \frac{\partial L_1}{\partial\theta} + \frac{1}{2} I_2^2 \frac{\partial L_2}{\partial\theta} + I_1 I_2 \frac{\partial M}{\partial\theta} \quad \text{---(22)}$$