DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

POWER SYSTEM ANALYSIS
UNIT – III
STEPPER MOTOR

Non - linear Analysis

$$T_m = J\theta_s \frac{df}{dt} + D\theta_s f + T_f \quad \text{---(1)}$$

$$T_m - T_f = J\theta_s \frac{df}{dt} + D\theta_s f$$

The above eq. is ÷ by $J\theta_s$

$$\frac{T_m - T_f}{J\theta_s} = \frac{J\theta_s \frac{df}{dt}}{J\theta_s} + \frac{D\theta_s f}{J\theta_s}$$

$$\frac{T_m - T_f}{J\theta_s} = \frac{df}{dt} + \frac{Df}{J}$$

$$\frac{T_m - T_f}{J\theta_s} = \frac{df}{dt} + \left(\frac{D}{J}\right) f$$

$$\frac{df}{dt} + \left(\frac{D}{J}\right) f = \frac{T_m - T_f}{J\theta_s} \quad \text{---(13)}$$

The above eq. is in the form of

$$\frac{dy}{dx} + Py = Q$$

The solution of above equation

$$y e^{\int P dx} = \int Q e^{\int P dx} + C$$

Here $y = f$; $P = \frac{D}{J}$;

$x = t$; $Q = \frac{T_m - T_f}{J\theta_s}$ = Constant

$$f e^{\int D/J \, dt} = \int \left(\frac{T_m - T_f}{J\theta_s}\right) e^{\int \frac{D}{J} dt} + C$$

$$f e^{D/J \, dt} = \left(\frac{T_m - T_f}{J\theta_s}\right) \int e^{D/J \, t} + C$$

$$f e^{D/J \, t} = \left(\frac{T_m - T_f}{J\theta_s}\right) \frac{e^{D/J \, t}}{D/J} + C \quad \text{---(14)}$$

C = Integration constant.

$t = 0$; $f = f(0) = f_1$

$$f_1 e^0 = \left(\frac{T_m - T_f}{J\theta_s}\right)\frac{1}{D/J} + c$$

$$f_1 = \frac{T_m - T_f}{J\theta_s} \times \frac{J}{D} + c$$

$$f_1 = \frac{T_m - T_f}{D\theta_s} + c$$

$$c = f_1 - \left(\frac{T_m - T_f}{D\theta_s}\right) \longrightarrow (15)$$

Sub eq (15) in (14)

$\therefore e^{D/J t}$

$$f = \frac{T_m - T_f}{D\theta_s} + \left(f_1 - \frac{T_m - T_f}{D\theta_s}\right) e^{-D/J t}$$