



SNS COLLEGE OF ENGINEERING

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AN AUTONOMOUS INSTITUTION



Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

POWER SYSTEM ANALYSIS

UNIT - III

STEPPER MOTOR

Non-linear Analysis

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

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

The above eq. is \div by $J\theta_s$

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

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

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

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

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 $y = f$; $p = \frac{D}{J}$;
 $x = t$; $Q = \frac{T_m - T_f}{J\theta_s} = \text{Constant}$

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

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

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

$C = \text{Integration constant.}$

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

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

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

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

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

Sub eq (15) in (14)

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

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

$\leftarrow (16)$

