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

Linear & Non Linear Analysis of Stepper Motor.

To Control the Motor's behaviour.

Let T_m = Motor torque produced in rotor N-m

J = Inertia of the rotor & load in kgm^2

ω = Angular velocity of rotor.

D = Damping coefficient (or) VFC

T_r = Frictional load Torque

θ_s = Step angle in radians.

f = Stepping rate in steps/sec (pulse per second) pps.

Frictional load torque $T_f = k\theta$

According to rotor dynamics

$$T_m = J\frac{d\omega}{dt} + D\omega + T_f \quad \text{---} (1)$$

Also $\theta_s = \omega t$ = step angle

$$\omega = \frac{\theta_s}{t} = \frac{1}{t}\theta_s = f\theta_s \quad \text{---} (2)$$

where $f = \frac{1}{t}$

Sub (2) in (1)

$$T_m = J\frac{d}{dt}(f\theta_s) + D(f\theta_s) + T_f \quad \text{---} (3)$$

Step angle $\theta_s = \frac{360}{mN_r}$

$$T_m = J\theta_s\frac{d}{dt}(f) + D\theta_s(f) + T_f \quad \text{---} (4)$$

The Viscous friction coefficient is neglected ∴ is linear one.

Linear Analysis. [$\because D \doteq 0$]

$$T_m = J\frac{d\omega}{dt} + T_f \quad \text{——} (5)$$

$$T_m - T_f = J\frac{d\omega}{dt}$$

$$\frac{T_m - T_f}{J} = \frac{d\omega}{dt}$$

$$d\omega = \left(\frac{T_m - T_f}{J}\right) dt \quad \text{——} (6)$$

Integrating the above eq.

$$\omega = \left(\frac{T_m - T_f}{J}\right) t + \omega_1 \quad \text{——} (7)$$

ω_1 = integration constant

$$\left.\begin{aligned} \omega &= \theta_s f \\ \omega_1 &= \theta_s f_1 \end{aligned}\right\} \quad \text{——} (8)$$

Sub eq (8) in (7)

$$\theta_s f = \left(\frac{T_m - T_f}{J}\right) t + \theta_s f_1 \quad \text{——} (9)$$

$\div \theta_s$

$$\frac{\theta_s f}{\theta_s} = \left(\frac{T_m - T_f}{J\theta_s}\right) t + \frac{\theta_s f_1}{\theta_s} \quad \text{——} (10)$$

$$\boxed{f = \left(\frac{T_m - T_f}{J\theta_s}\right) t + f_1} \quad \text{——} (11)$$

Stepping rate