



SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

19EET301 / POWER ELECTRONICS AND DRIVES

III YEAR / V SEMESTER

UNIT – IV : Part A - INTRODUCTION TO ELECTRIC DRIVES



**DYNAMICS , LOAD TORQUE AND
MODES OF OPERATION**



TOPIC OUTLINE



What we'll
discuss?



Dynamics of Motor load system

Classification of load torque

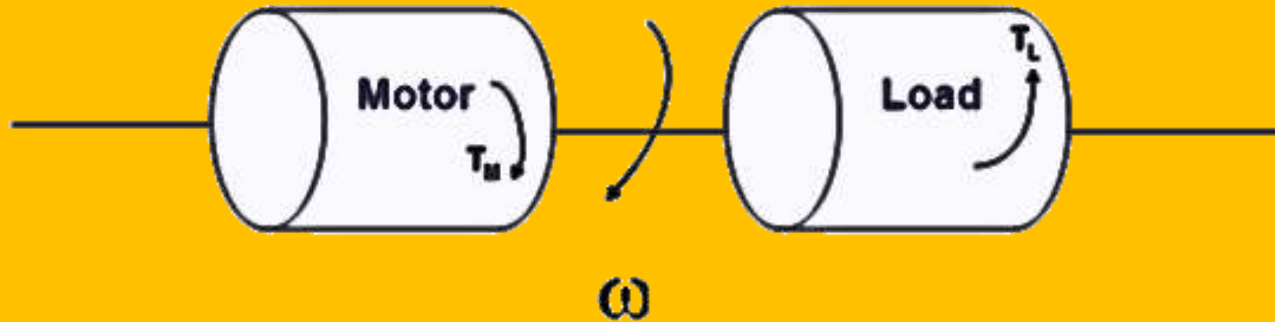
Components of load torque

Modes of operation

Speed transition



DYNAMICS OF MOTOR LOAD SYSTEM



J = Moment of inertia of motor load system referred to the motor shaft kg / sq.m

ω_m = Instantaneous angular velocity of motor shaft, rad/sec.

T_m = Instantaneous value of developed motor torque, N-m

T_L = Instantaneous value of load torque, referred to the motor shaft N-m



(a) General Torque Equation



Translational (linear) motion:

$$F = M \frac{dv}{dt}$$

F : Force (Nm)

M : Mass (Kg)

v : velocity (m/s)

Rotational motion:

$$T = J \frac{d\omega}{dt}$$

T : Torque (Nm)

J : Moment of Inertia (Kgm²)

w : angular velocity (rad/s)



(b) Torque Equation: Motor drives



$$T_m = T_L + J \frac{d\omega}{dt} \quad \text{or} \quad T_m - T_L = J \frac{d\omega}{dt}$$

T_m : Motor torque (Nm) T_L : Load torque (Nm)

$$T_m - T_L > 0 \quad \text{Acceleration}$$

$$T_m - T_L < 0 \quad \text{Deceleration}$$

$$T_m - T_L = 0 \quad \text{Constant speed}$$

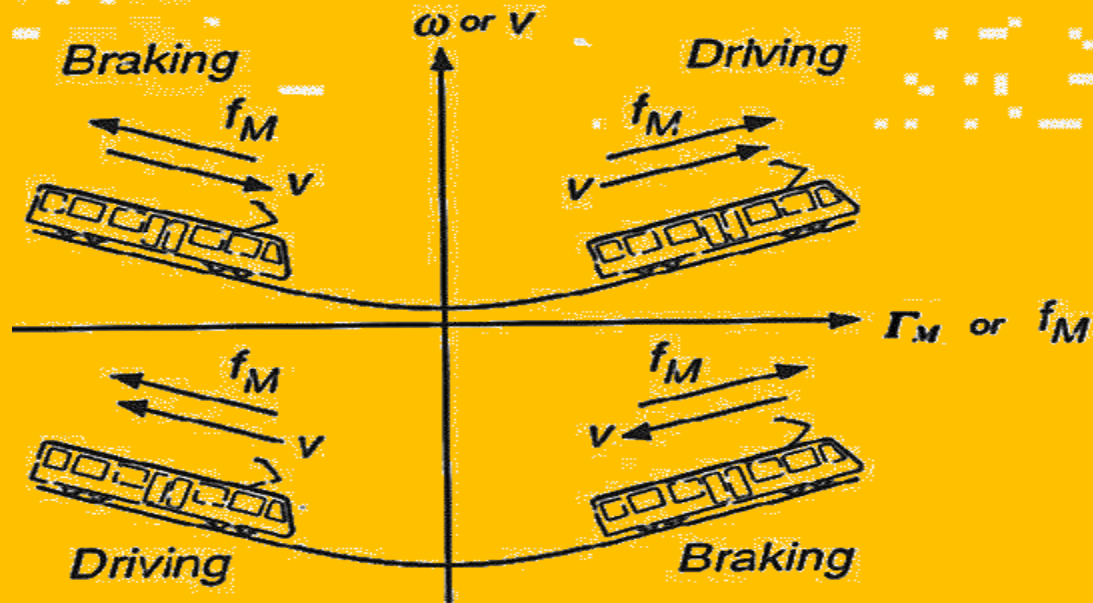


DYNAMICS conti..



Γ_M = Motor torque
 Γ_L = Load torque

ω = Angular speed
 f_M = Linear force
 v = Linear speed





CLASSIFICATION OF LOAD TORQUE



1. Active load torque : Load torques usually retain their sign when the drive rotation is reversed

Eg:

- Torque due to force of gravity
- Torque due tension
- Torque due to compression



2. Passive load torque : Load torques which always oppose the motion and change their sign on the reversal of motion

Eg:

- Torque due to friction, cutting etc.



COMPONENTS OF LOAD TORQUE



1. Friction Torque (T_f)

- Friction will be present at the motor shaft and also in various parts of the load.

2. Windage Torque (T_w)

- When motor runs, wind generates a torque opposing the motion.

3. Torque required to do useful mechanical work (T_m)

Nature of this torque depends upon particular application.

- Constant and independent of speed
- Time invariant or time variant
- Depends on mode of operation.



MODES OF OPERATION

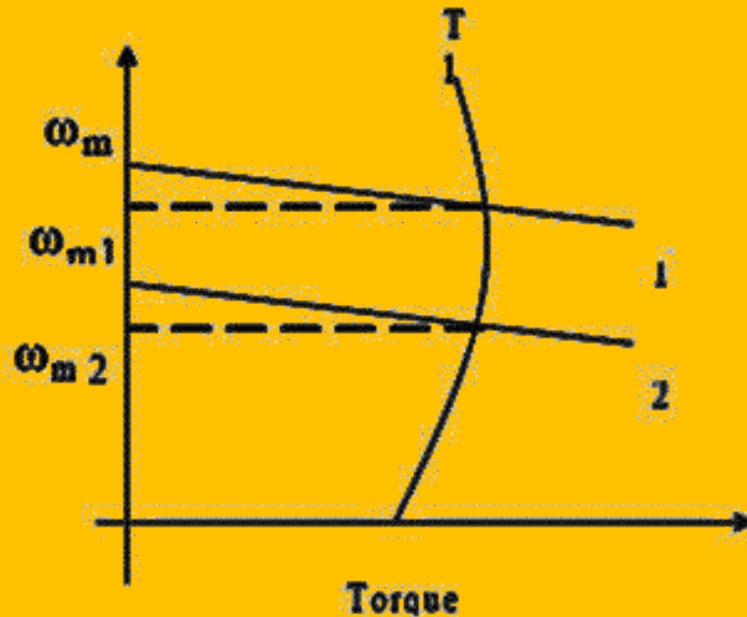


An electrical drive operates in three modes

1. Steady state
2. Acceleration including Starting
3. Deceleration including Stopping



(a) PRINCIPLE OF SPEED CONTROL



Speed Vs Torque Ch.

- **Steady state :**

Motor torque = Load torque

- **Acceleration : $T_m > T_L$**

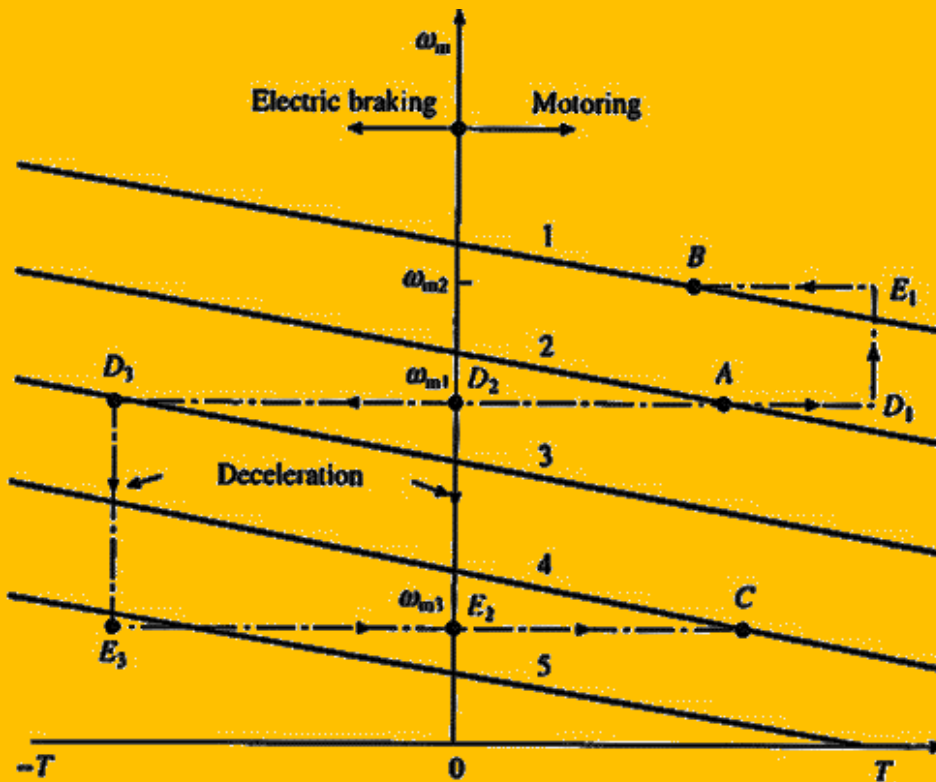
Quad I or III

- **Deceleration : $T_m < T_L$**

Quad II or IV



(b) SPEED TRANSITION PATH



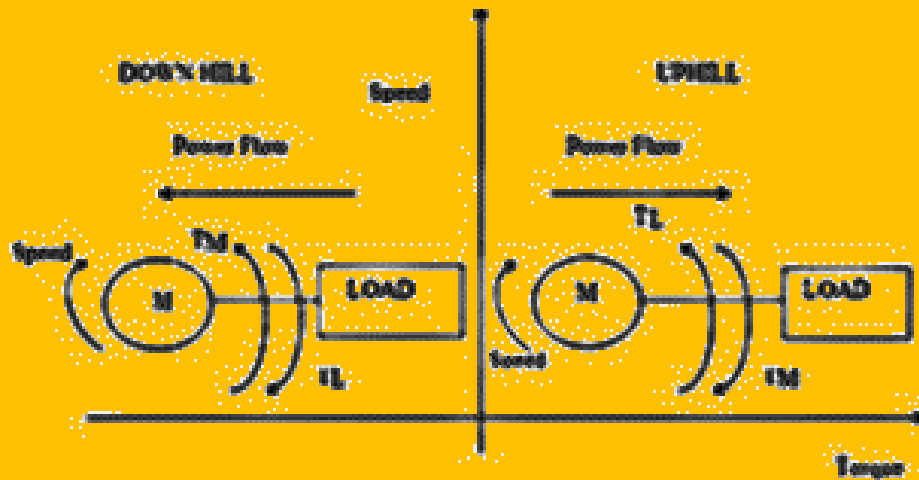
- A to B – Acceleration
- A to C - Deceleration



DISCUSSION



- Questions from this diagram...



Thank you