1.2 Equations governing motor load dynamics:

A motor generally drives a load (Machines) through some transmission system. While motor always rotates, the load may rotate or undergo a translational motion.

Load speed may be different from that of motor, and if the load has many parts, their speed may be different and while some parts rotate others may go through a translational motion.

Equivalent rotational system of motor and load is shown in the figure.

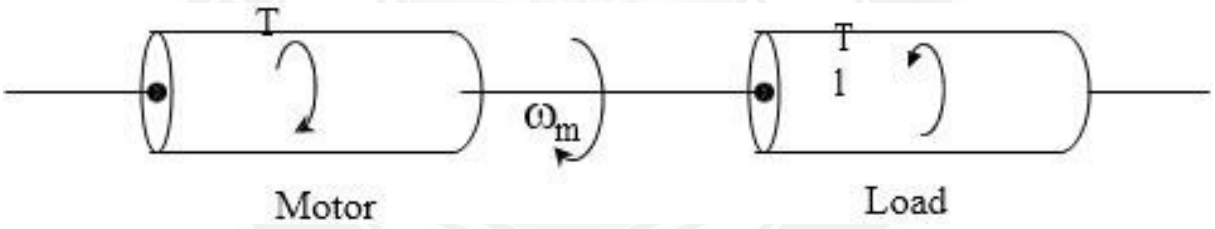

Figure 1.2.1 Motor Load System

(Source:"Fundamentals of Electrical Drives" by G.K.Dubey,page-11)

J = Moment of inertia of motor load system referred to the motor shaft kg / m^2

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

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

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

Load torque includes friction and wind age torque of motor. Motor-load system shown in figure can be described by the following fundamental torque equation.

$$T-T_l = d/dt\ (J\ \omega_m) = J\ d/dt\ (\omega_m) + \omega_m\ dJ/dt \qquad \ldots\ldots\ldots\ldots (1)$$

Equation (1) is applicable to variable inertia drives such as mine winders, reel drives, Industrial robots.

For drives with constant inertia

$$\frac{dJ}{dt}=0$$

$$T=T_1+J\, d/dt\,(\omega_m) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Equation (2) shows that torque developed by motor

Classification of Load Torques:

Various load torques can be classified into broad categories.

- ✓ Active load torques
- ✓ Passive load torques

Load torques which has the potential to drive the motor under equilibrium conditions are called active load torques. Such load torques usually retain their sign when the drive rotation is changed (reversed)

Eg:

- ✓ Torque due to force of gravity
- ✓ Torque due tension
- ✓ Torque due to compression and torsion etc

Load torques which always oppose the motion and change their sign on the reversal of motion are called passive load torques

Eg:

- ✓ Torque due to friction, cutting etc.

Components of Load Torques:

The load torque Tl can be further divided in to following components

✓ Friction Torque (TF):

Friction will be present at the motor shaft and also in various parts of the load. TF is the equivalent value of various friction torques referred to the motor shaft.

✓ Windage Torque (TW)

When motor runs, wind generates a torque opposing the motion. This is known as windage torque.

✓ Torque required to do useful mechanical work

Nature of this torque depends upon particular application. It may be constant and independent of speed. It may be some function of speed, it may be time invariant or time variant, its nature may also change with the load's mode of operation.

Friction at zero speed is called diction or static friction. In order to start the drive the motor should at least exceeds diction.

Friction torque can also be resolved into three components

Component T_V varies linearly with speed is called VISCOUS friction and is given by

$$T_V = B_m$$

Where B is viscous friction co-efficient.

Another component TC, which is independent of speed, is known as COULOMB friction. Third component Ts accounts for additional torque present at stand still. Since Ts is present only at stand still it is not taken into account in the dynamic analysis.