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FACULTY OF ENGINEERING &  
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## **Actually, no perfectly frictionless surface exists. For two surfaces**

in contact, tangential forces, called friction forces, will develop if one attempts to move one relative to the other. However, the friction forces are limited in magnitude and will not prevent motion if sufficiently large forces are applied. The distinction between frictionless and rough is, therefore, a matter of degree.

- There are two types of friction: dry or Coulomb friction and fluid friction.

## **The Laws of Dry Friction. Coefficients of Friction**

- Block of weight  $W$  placed on horizontal surface. Forces acting on block are its weight and reaction of surface  $N$ .
- Small horizontal force  $P$  applied to block. For block to remain stationary, in equilibrium, a horizontal component  $F$  of the surface reaction is required.  $F$  is a *static-friction force*.
- As  $P$  increases, the static-friction force  $F$  increases as well until it reaches a maximum value  $F_m$ .  $F_m = m_s N$
- Further increase in  $P$  causes the block to begin to move as  $F$  drops to a smaller *kinetic-friction force*  $F_k$ .

$$F_k = m_k N$$



## Friction

- Maximum static-friction force:  $F_m = \mu_s N$

Kinetic-friction force:  $F_k = \mu_k N$

- Maximum static-friction force and kinetic friction force are:

- proportional to normal force
- dependent on type and condition of contact surfaces independent of contact area

**Brakes, Clutches and Flywheel,**

## Types of Friction

**1.Static friction.**It is the friction, experienced by a body, when at rest.

**2.Dynamic friction.** It is the friction, experienced by a body, when in motion. The dynamic friction is also called kinetic friction and is less than the static friction. It is of the following three types :

(a) Sliding friction. It is the friction, experienced by a body, when it slides over another body.

(b) Rolling friction.It is the friction, experienced between the surfaces which has balls or roller sinterposed between them.

(c) Pivot friction. It is the friction, experienced by a body, due to the motion of rotation as in case of foot step bearings.

The friction may further be classified as :

1. Friction between unlubricated surfaces, and
2. Friction between lubricated surfaces.

### Friction Between Unlubricated Surfaces

The friction experienced between two dry and unlubricated surfaces in contact is known as dry or solid friction. It is due to the surface roughness.

## Friction Between Lubricated Surfaces

When lubricant (i.e. oil or grease) is applied between two surfaces in contact, then the friction may be classified into the following two types depending upon the thickness of layer of a lubricant.

### 1. Boundary friction (or greasy friction or non-viscous friction).

It is the friction, experienced between the rubbing surfaces, when the surfaces have a very thin layer of lubricant.

The thickness of this very thin layer is of the molecular dimension. In this type of friction, a thin layer of lubricant forms a bond between the two rubbing surfaces. The lubricant is absorbed on the surfaces and forms a thin film.

This thin film of the lubricant results in less friction between them. The boundary friction follows the laws of solid friction.

### 2. Fluid friction (or film friction or viscous friction).

It is the friction, experienced between the rubbing surfaces, when the surfaces have a thick layer of the lubricant.

In this case, the actual surfaces do not come in contact and thus do not rub against each other. It is thus obvious that fluid friction is not due to the surfaces in contact but it is due to the viscosity and oiliness of the lubricant.

## Laws of Static Friction

Following are the laws of static friction :

1. The force of friction always acts in a direction, opposite to that in which the body tends to move.
2. The magnitude of the force of friction is exactly equal to the force, which tends the body to move.