

ENGINEERING MECHANICS**CHAPTER 2: COPLANAR CONCURRENT FORCES**

Lecture 1:

2.1 Force, Units, Types, Effect of a force on a body

Force: Force is defined as an agent which produces or tends to produce, destroys or tends to destroy motion.

For Example: A horse applies force to pull a cart and to set it in motion. Sometimes, the applied force may not be sufficient to move a body, *e.g.*, if we try to lift a stone weighing 2 or 3 quintals, we fail to do so. In this case we exert a force, no doubt, but no motion is produced. This shows that a force may not necessarily produce a motion in a body ; but it may, simply, tend to do so. In a tug-of-war the two parties, when balanced, neutralize each other's force. But the moment one party gets weaker, the other party pulls off, in spite of first party's best effort to destroy motion.

Units: In M.K.S (Metre-Kilogram-Second) system, the unit of force is kilogram force (kgf).

In C.G.S (Centimetre-Gram-Second) system, the unit of force is dyne, which is defined as the force acting on a mass of one gram and producing an acceleration of one centimetre per second square.

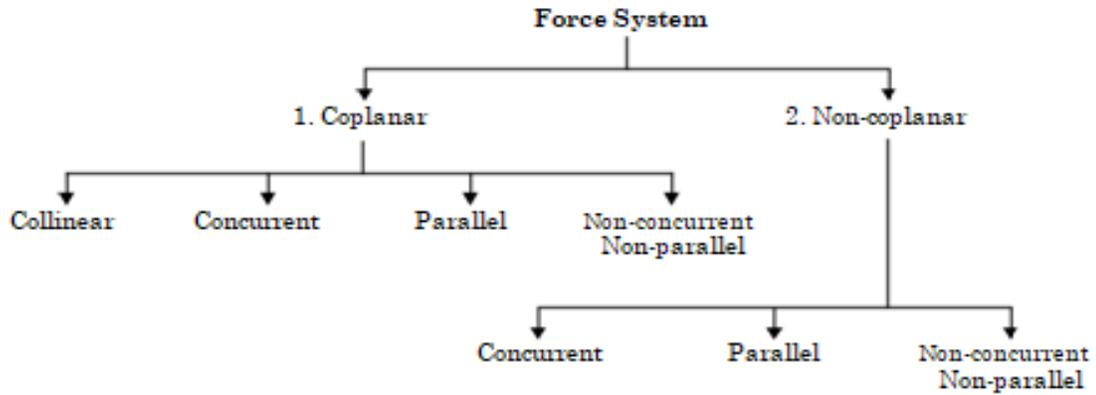
In S.I (International System of units), the unit of force is Newton (N) which is the force acting on a mass of one kilogram and producing an acceleration of one metre per second square.

The relation between Newton (N) and dyne is $1\text{N}=10^5$ dyne , which is obtained as

$$\begin{aligned} \text{One Newton} &= \text{One kilogram mass} \times \frac{\text{One metre}}{\text{s}^2} \\ &= 1000 \text{ gm} \times \frac{100 \text{ cm}}{\text{s}^2} \\ &= 1000 \times 100 \times \frac{\text{gm} \times \text{cm}}{\text{s}^2} \\ &= 10^5 \text{ dyne} \end{aligned}$$

The relation between Newton (N) and kilogram force (kgf) is $1 \text{ kgf} = 9.81 \text{ N}$

Types: A force system may be coplanar or non-coplanar. If in a system all the forces lie in the same plane then the force system is known as coplanar. But if in a system all the forces lie in different planes, then the force system is known as non-coplanar.

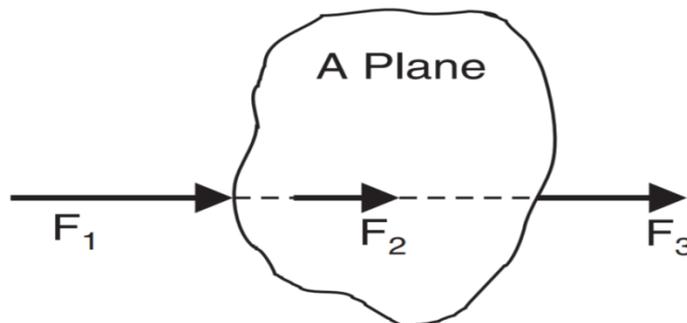


NOTE: The word collinear stands for the forces which are having common lines of action whereas the word concurrent stands for the forces which intersect at a common point. When several forces act on a body, then they are called a force system or a system of forces.

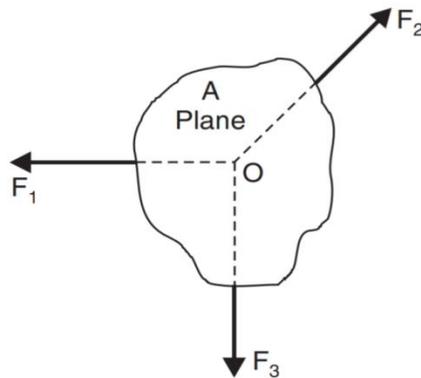
In this chapter, we shall discuss only coplanar force system, in which the forces may be:

- (i) Collinear
- (ii) Concurrent
- (iii) Parallel
- (iv) Non-concurrent, Non-parallel (or General system of forces).

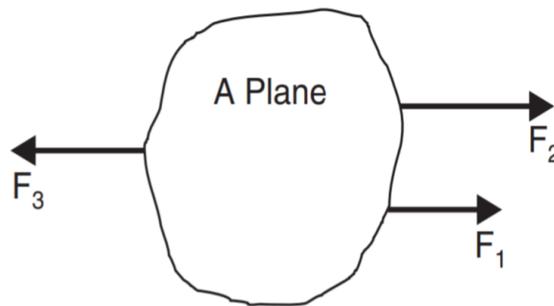
1. Coplanar Collinear : Figure shows three forces F_1 , F_2 and F_3 acting in a plane. These three forces are in the same line, *i.e.*, these three forces are having a common line of action. This system of forces is known as coplanar collinear force system.



2. Coplanar Concurrent: Figure shows three forces F_1 , F_2 and F_3 acting in a plane and these forces intersect or meet at a common point O . This system of forces is known as coplanar concurrent force system.



3. Coplanar Parallel: Figure shows three forces F_1 , F_2 and F_3 acting in a plane and these forces are parallel. This system of forces is known as coplanar parallel force system.



4. Coplanar Non-Concurrent Non- Parallel: Figure shows four forces F_1 , F_2 , F_3 and F_4 acting in a plane. The lines of action of these forces lie in the same plane but they are neither parallel nor meet or intersect at a common point. This system of forces is known as coplanar non-concurrent non-parallel force system. This force system is also known as general system of forces.

