Strength of Materials - GATE

Kulasekaran

February 8, 2023

Contents

Chapter 1

Composition, Resolution and Equilibrium of Forces

1.1 Force

- It is the action of one body on another that changes the state of being (rest/uniform motion) of the object on which it is being applied
- 3 things are needed to define a force: Magnitude, direction, Point of application
- According to Newton's first law: $\boxed{Force = Mass * Acceleration}$

1.2 Force systems

- **Coplanar** - 2D system
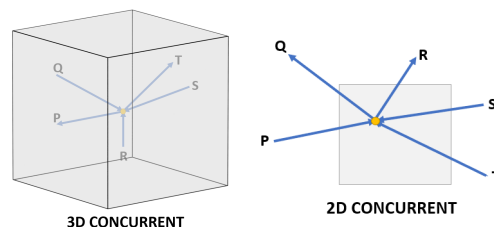- **Non-Coplanar** - 3D system

1.2.1 Collinear

- Two are more forces whose line of action is same
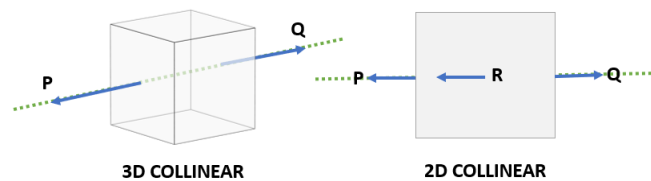
1.2.2 Concurrent

- Two are more forces which meet at a common point

1.2.3 Coplanar

- Forces that are on the same plane

1.2.4 Coplanar Concurrent

- Forces that are on the same plane and meet at a common point as well

1.2.5 Non-Coplanar Concurrent

- Forces are not on the same plane but meet at a common point
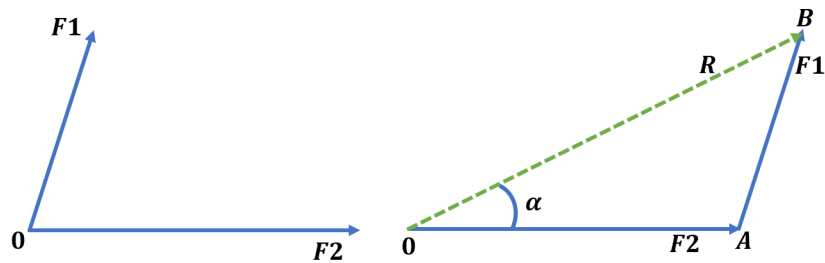
1.2.6 Coplanar Non-Concurrent

- Forces are on the same plane but don't meet at a common point

1.2.7 Non-Coplanar Non-Concurrent

- Forces are neither on the same plane nor meet at a common point

---
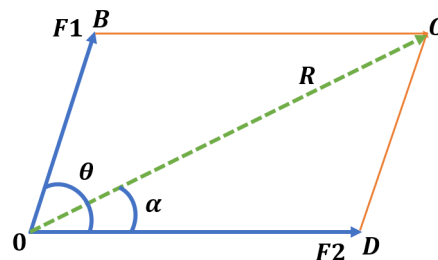
1.3 Triangular Law of forces

- *Two concurrent forces acting on a body is represented in magnitude and direction by two sides of a triangle taken in order, then their third side will represent the resultant of two forces in the direction and magnitude taken in opposite order*

$$R = \sqrt{F_1^2 + F_2^2}$$ $$\alpha = \cos^{-1}\left(\frac{F_1}{R}\right) = \sin^{-1}\left(\frac{F_2}{R}\right)$$
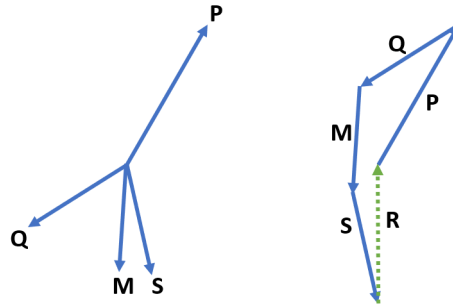

1.4 Parallelogram Law of forces

- *If two concurrent forces are represented in magnitude as the two sides of a parallelogram, then the resultant of these two forces is the diagonal of the parallelogram*

$$R = \sqrt{F_1^2 + 2F_1 F_2 \cos\theta + F_2^2}$$

1.5   Polygon Law of forces

- The triangular law can be extended to the polygon law. *If a number of coplanar concurrent forces are represented in magnitude and direction by the sides of a polygon, taken in order, then their resultant can be represented by the closing side of the polygon*

1.6   Resolution of Forces

- The concept of replacing a single force at some angle with two of its component in the vertical and horizontal direction is called Resolution of forces.
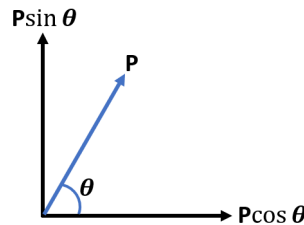
1.7   Equilibrium state

- A body is said to be in equilibrium if it is at rest or moving with uniform velocity. **Under equilibrium state, the resultant of the force system will be zero.**

1.8   Lami's Theorem
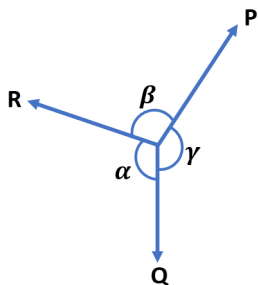
If 3 coplanar concurrent forces are in equilibrium, then each force is proportional to the sine of the angle between the other two sides

$$\frac{P}{\sin \alpha} = \frac{Q}{\sin \beta} = \frac{R}{\sin \gamma}$$

Chapter 2

Analysis of Simple trusses

-

Chapter 3

Friction

-

Chapter 4

Work and Energy

-

Chapter 5

Virtual work

-

Chapter 6

Center of Gravity and Moment of Inertia

•

Chapter 7

Impulse and Momentum

-

Chapter 8

Lagrangian Equation

-