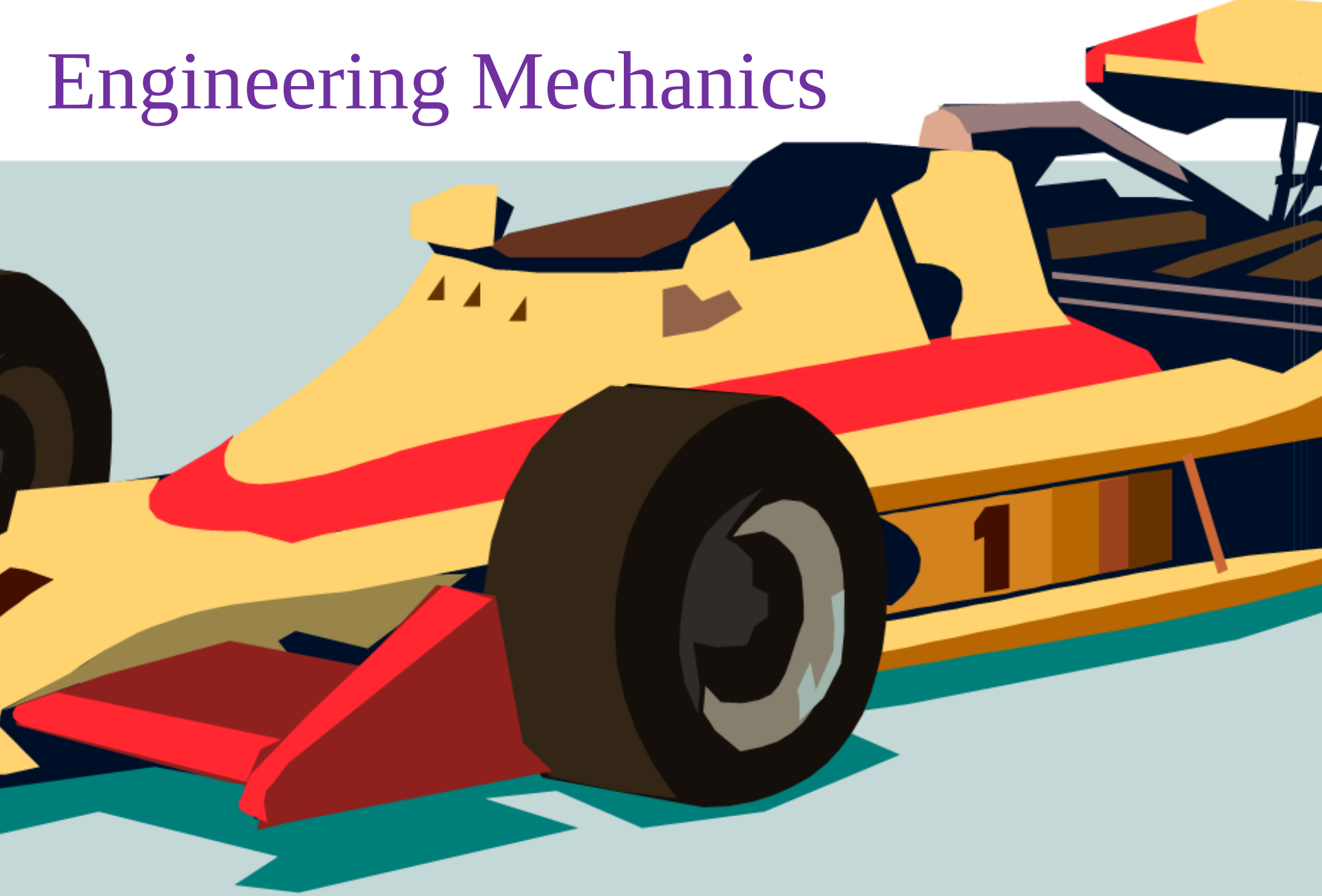
Engineering Mechanics



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Engineering?

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The Profession that puts scientific knowledge to practical use.

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Why do we need to study Engineering Mechanics?

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The primary purpose of the study of engineering mechanics is to develop the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering.

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Mechanics

The study of behavior of matter under the

action of applied forces is known as mechanics.

Engineering Mechanics

It is the branch of mechanics which deals with the study of behavior of rigid bodies under the action of applied forces when they are at rest or in motion.

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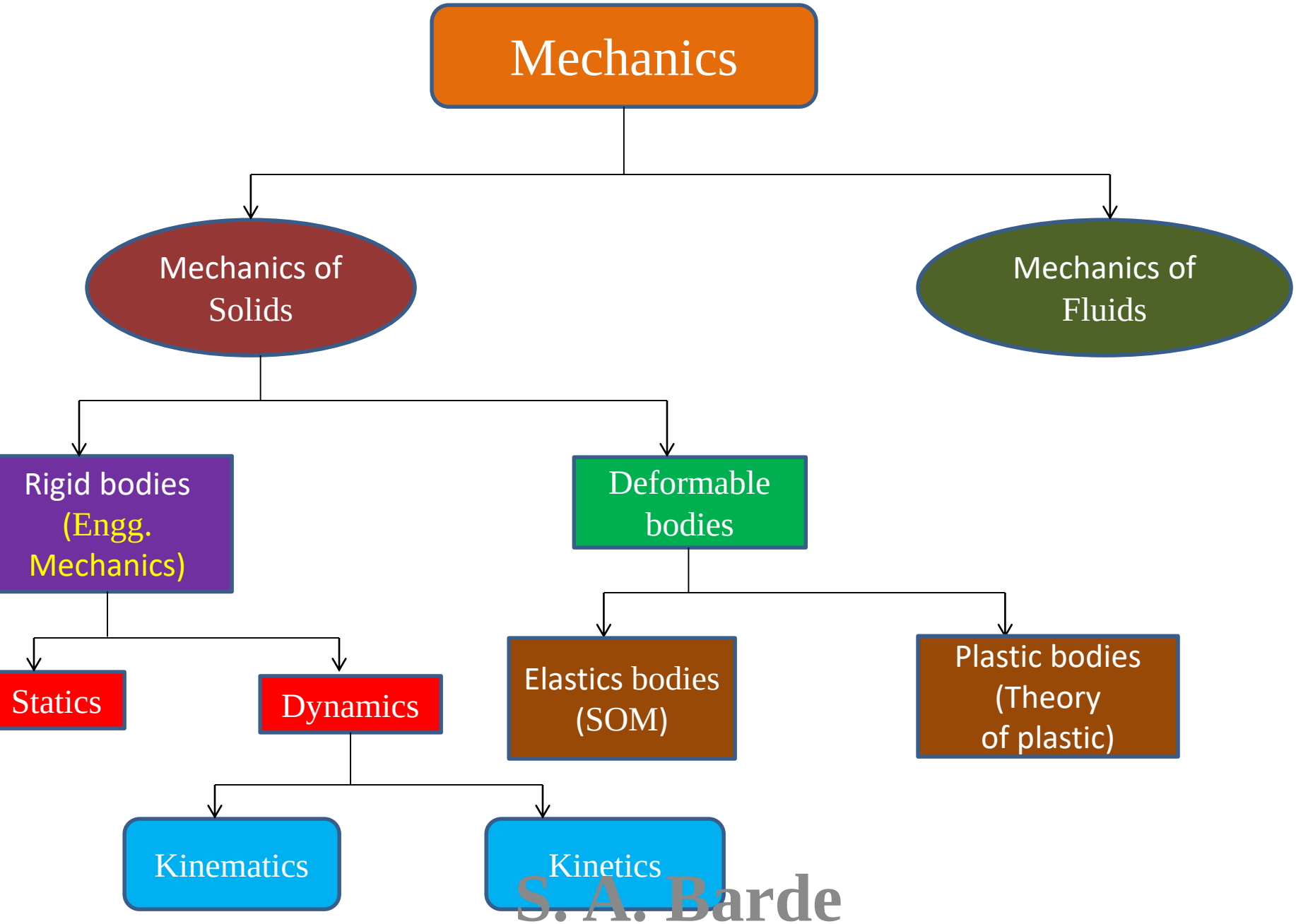
Mechanics
Mechanics of Solids
Mechanics of Fluids
Rigid bodies (Engg. Mechanics)
Deformable bodies
Statics
Dynamics
Elastics bodies (SOM)
Plastic bodies (Theory of plastic)
Kinematics
Kinetics

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Difference between Kinematics and Kinetics

Kinematics

1.Branch of dynamics which deals with the bodies in motion without considering the forces acting.

2. It deals with position, velocity, displacement, acceleration and time.

Kinetics

1.Branch of dynamics which deals with the bodies in motion by considering the forces causing the motion.

2. It deals with position, velocity, acceleration ,time and force.

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Idealized Concepts In Engineering Mechanics

1. Particle
2. Rigid body
3. Point of application of force
4. Point force OR concentrated force
5. Idealized truss
6. 2- Dimensional body
7. 1- Dimensional body

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Basic Concepts

Particle

1. It is a body whose dimensions can be neglected.

2.Rotation of the body is neglected.

3.It occupies point in space.

4. No size and shape

5.Idealized concept

Body

1. A matter which is limited in all direction.
2. Rotation is considered
3. It occupies volume in space.
4. Definite size and shape
5. Real concept

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Basic Concepts

Rigid body

1. Distance between the particles constituting the body does not change under the action of external force.

2.Idealized concept

Deformable body

1. If there is a considerable change in the distance between the particles of the body under the action of forces so that overall dimensions of the body are affected or if it has significant effect on the motion or equilibrium of the body.

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Basic Concepts

1-Dimensional body

1. If any one of it's dimension(length) out of three is considerably large as compared to other two dimensions.

2.Idealized concept

3. eg. Rods,wires,ropes,cables

2-Dimensional body

1. If any one dimension is considerably small as compared to other two dimensions.

2.Idealized concept

3.eg. Metal sheet, plate

Basic Concepts

3-Dimensional body

If all three dimensions are considerable and the effects are considered in all 3 directions under the action of forces

eg. Building, Machine

Basic Concepts

Mass

1. Mass is the quantity of matter contained in a body

2.It is a scalar quantity

3.SI unit of mass is kg.

4. Mass of a body remains constant at all places i.e. on the earth, moon and sun

Weight

1. Weight of a body is the force with which the body is attracted by the earth towards its Centre.
2. It is a vector quantity
3. SI unit of weight is "N"(Newton)
4. Weight of a body changes from place to place

$W\ (Newton) = m\ (kg)\ \boldsymbol{X}\ g\ (m/sec^2)$

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Basic Concepts

Force

An external agency either push or pull which changes or tends to change the state of rest or of uniform motion of a body, upon which it acts.

SI Unit

SI unit of force = SI unit of mass X SI unit of acceleration

Newton = kg X m/sec^2

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Basic Concepts

Force

1 kN (1 kilonewton) = 10^3 N

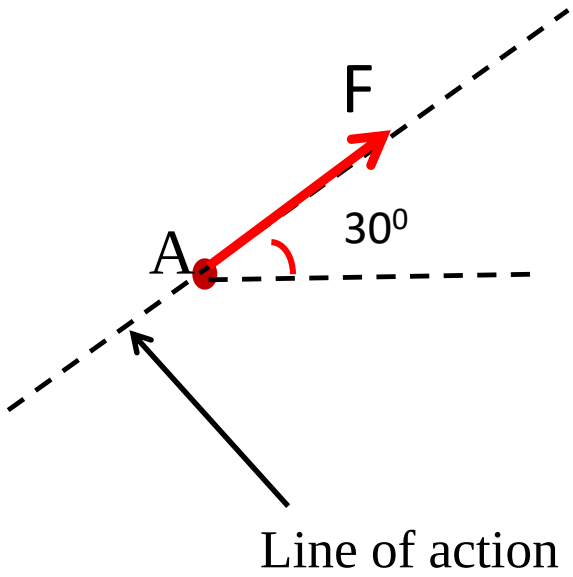
1 MN (1 Meganewton) = 10^6 N

1 GN (1 Geganewton) = 10^9 N

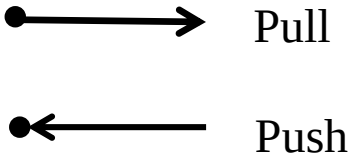
Basic Concepts

Characteristics of a Force

1. Magnitude = 50 N
2. Direction(Line of action) = 30^0 wrt horizontal
3. Point of application = A



4. Nature OR Sence = Away from point of application i.e. Pull



Basic Concepts

Force System

When two or more forces act on a body, they are said to form a system of forces.

Basic Concepts

Force System

1. Coplanar Force System

2. Non-coplanar Force System

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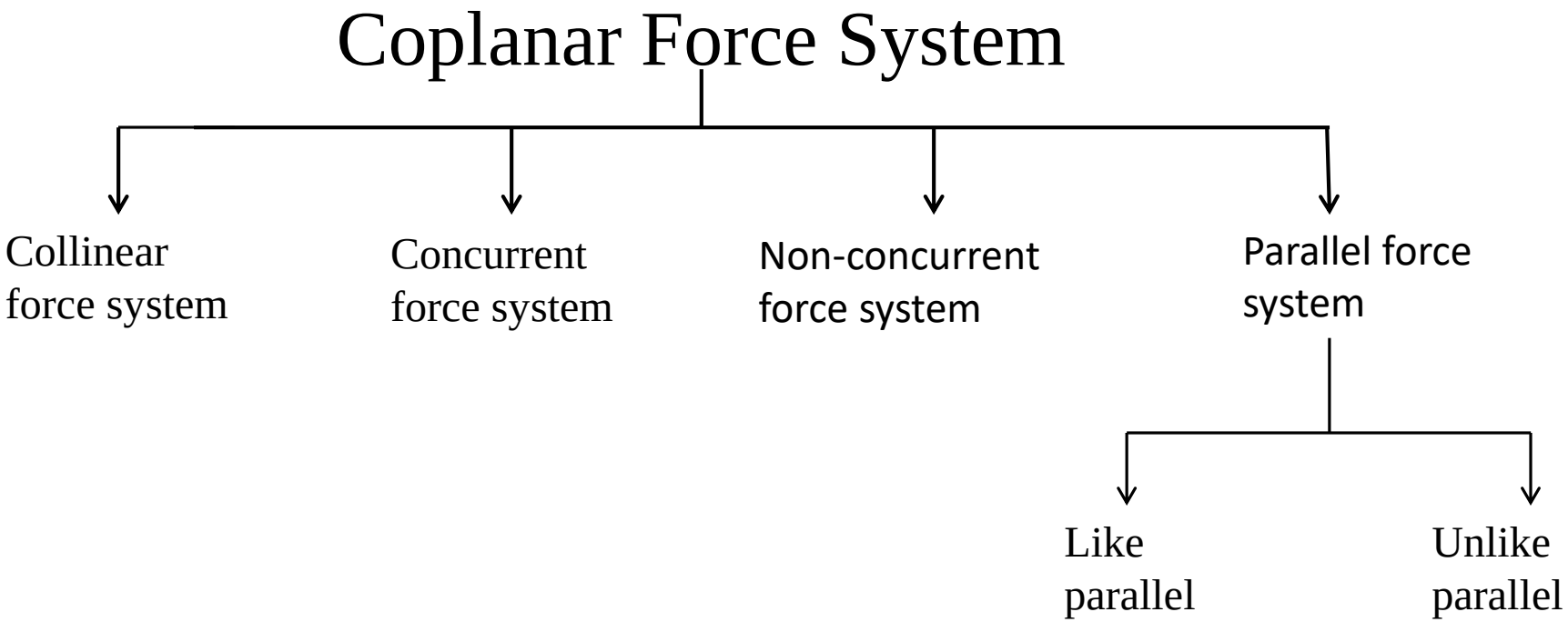
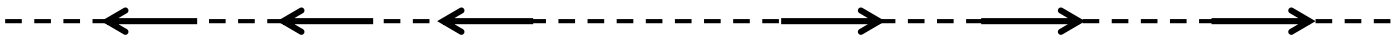
Basic Concepts



Basic Concepts

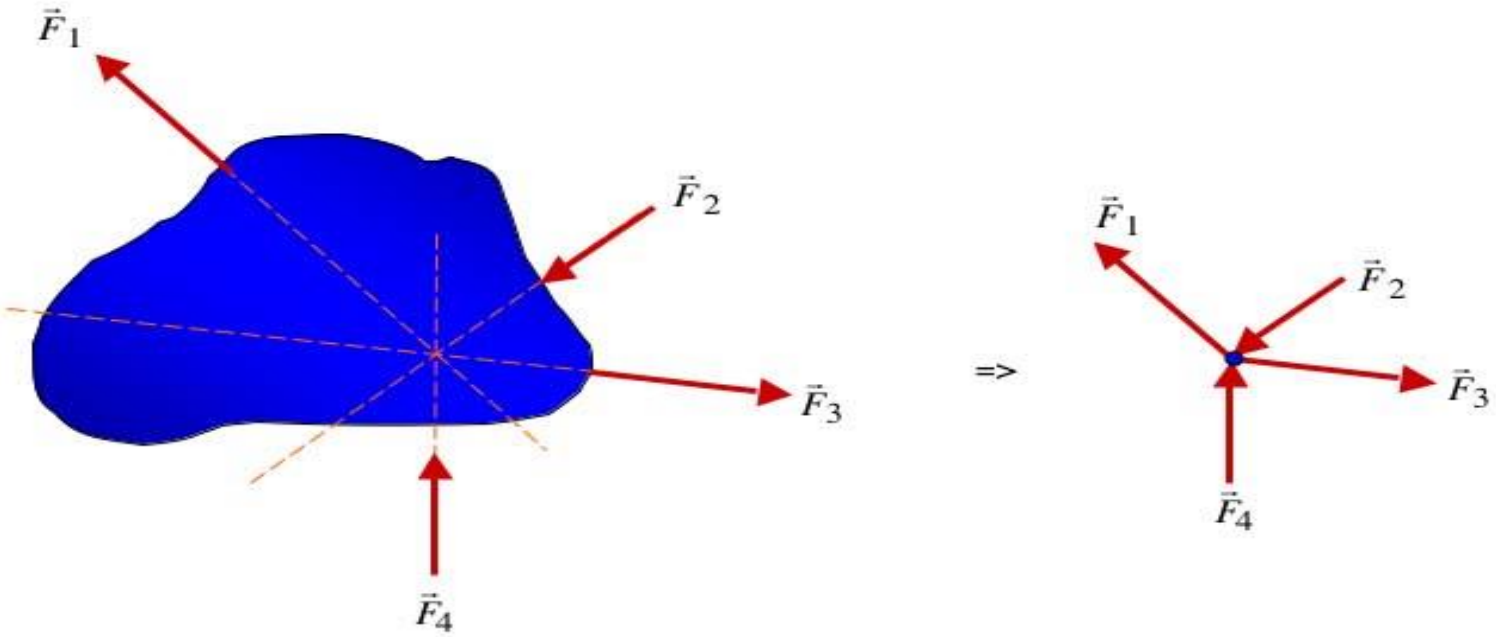
Collinear force system – The forces acting along the same line of action

Eg. Tug of war



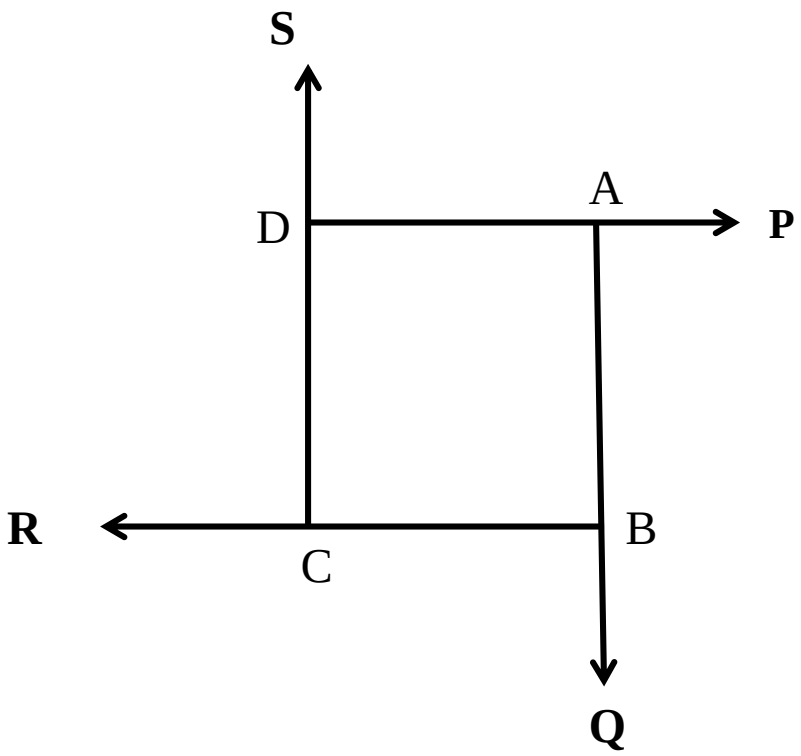
Basic Concepts

Concurrent force system – The forces which meet at a point



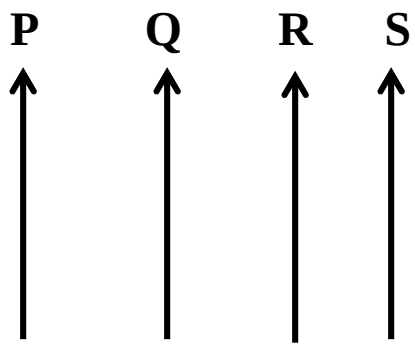
Basic Concepts

Non-concurrent force system – The forces which act at different points

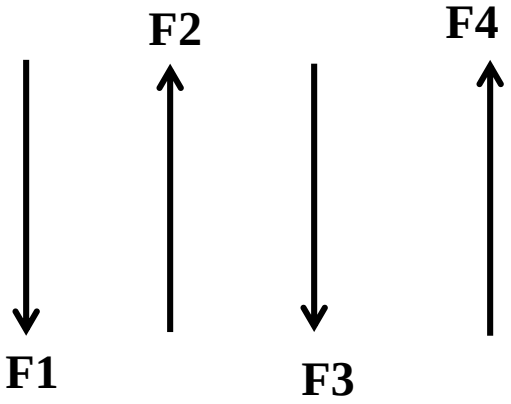


Basic Concepts

Parallel force system – The forces whose line of action are parallel to each other

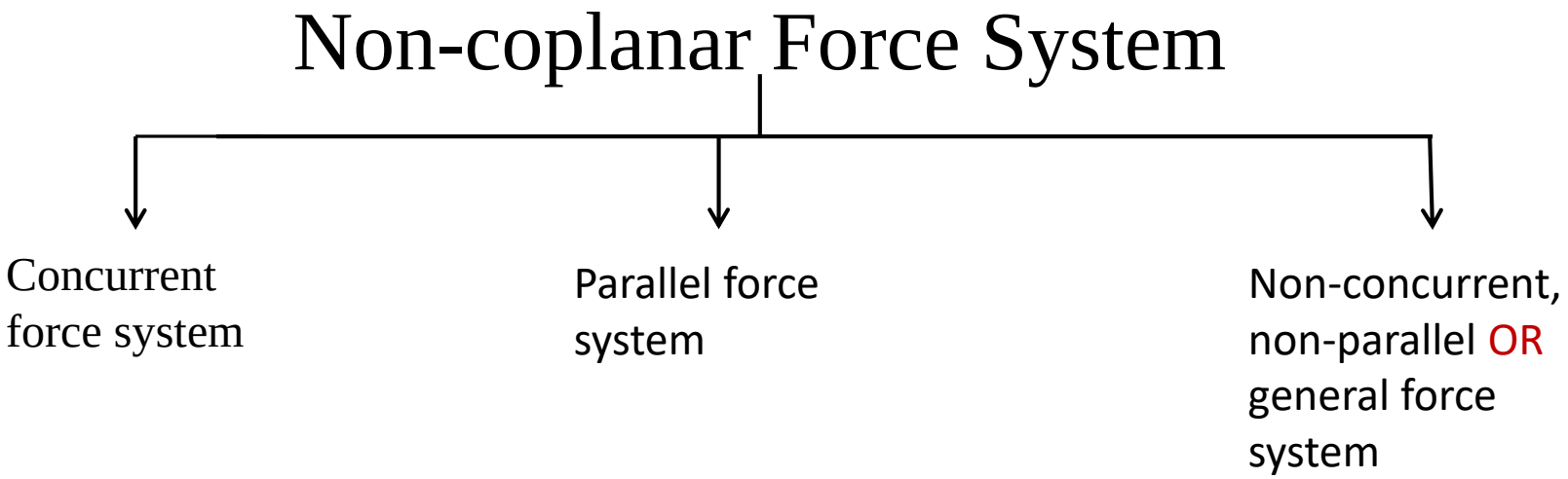


Like parallel forces



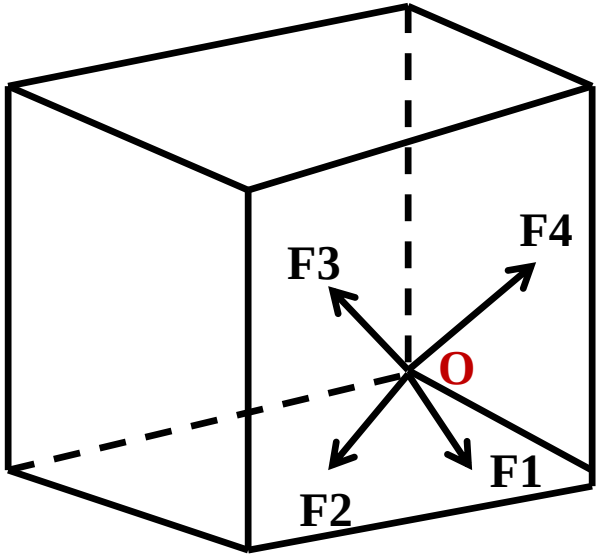
Unlike parallel forces

Basic Concepts



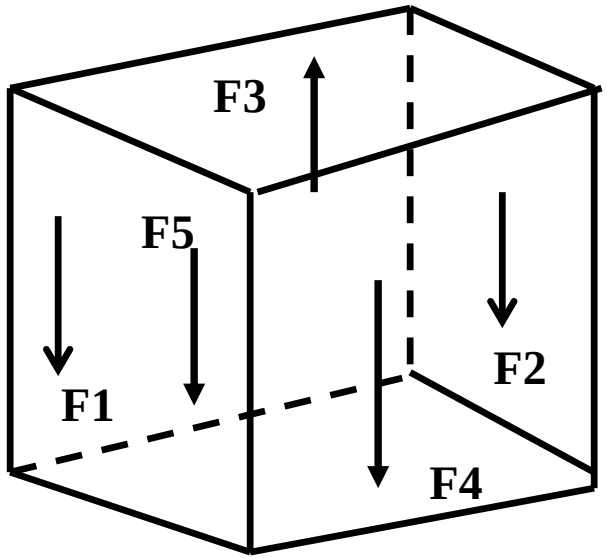
Basic Concepts

Non-coplanar concurrent force system – These forces exist in different planes but possess a common point of concurrency.



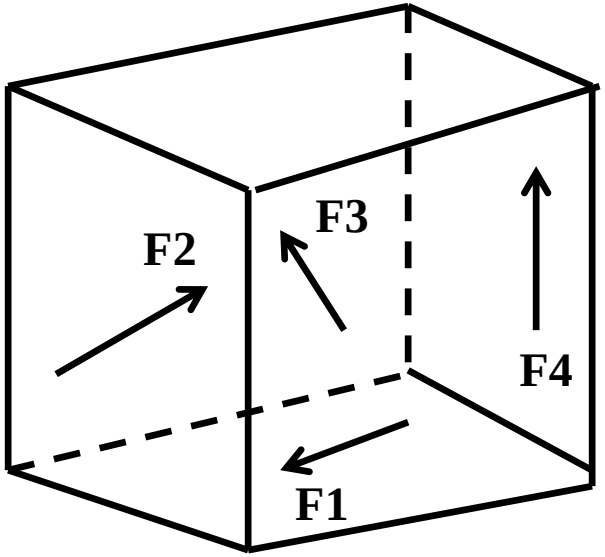
Basic Concepts

Non-coplanar parallel force system – These forces exist in different planes but are parallel to each other.



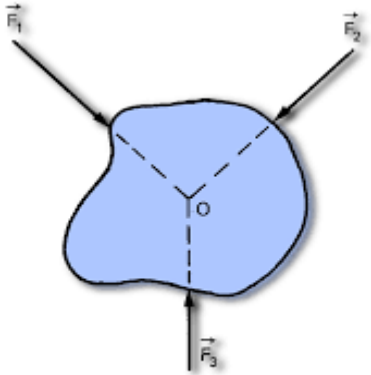
Basic Concepts

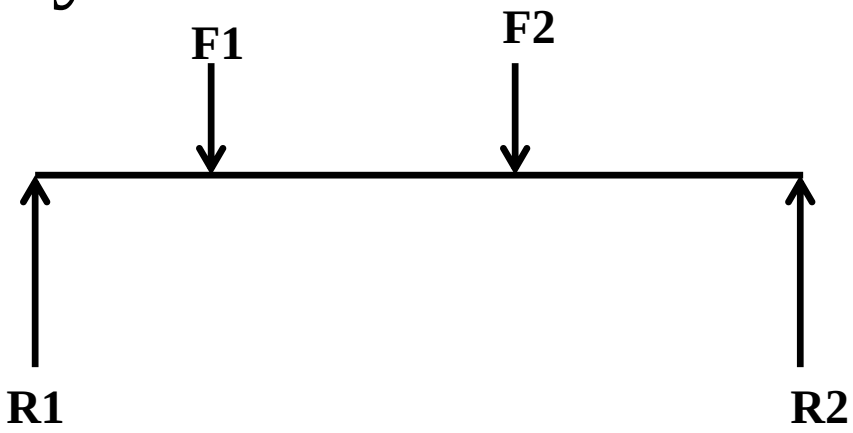
Non-coplanar general force system – These forces act in different planes and they do not possess one single point of concurrency.

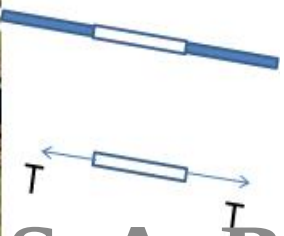


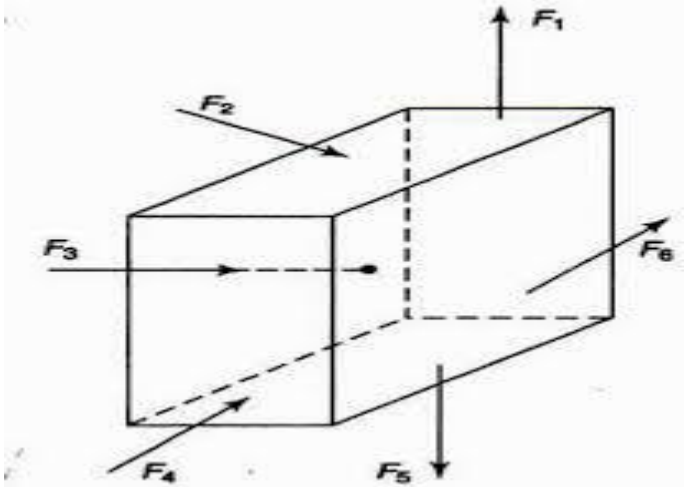
Basic Concepts

Just Identify Force System









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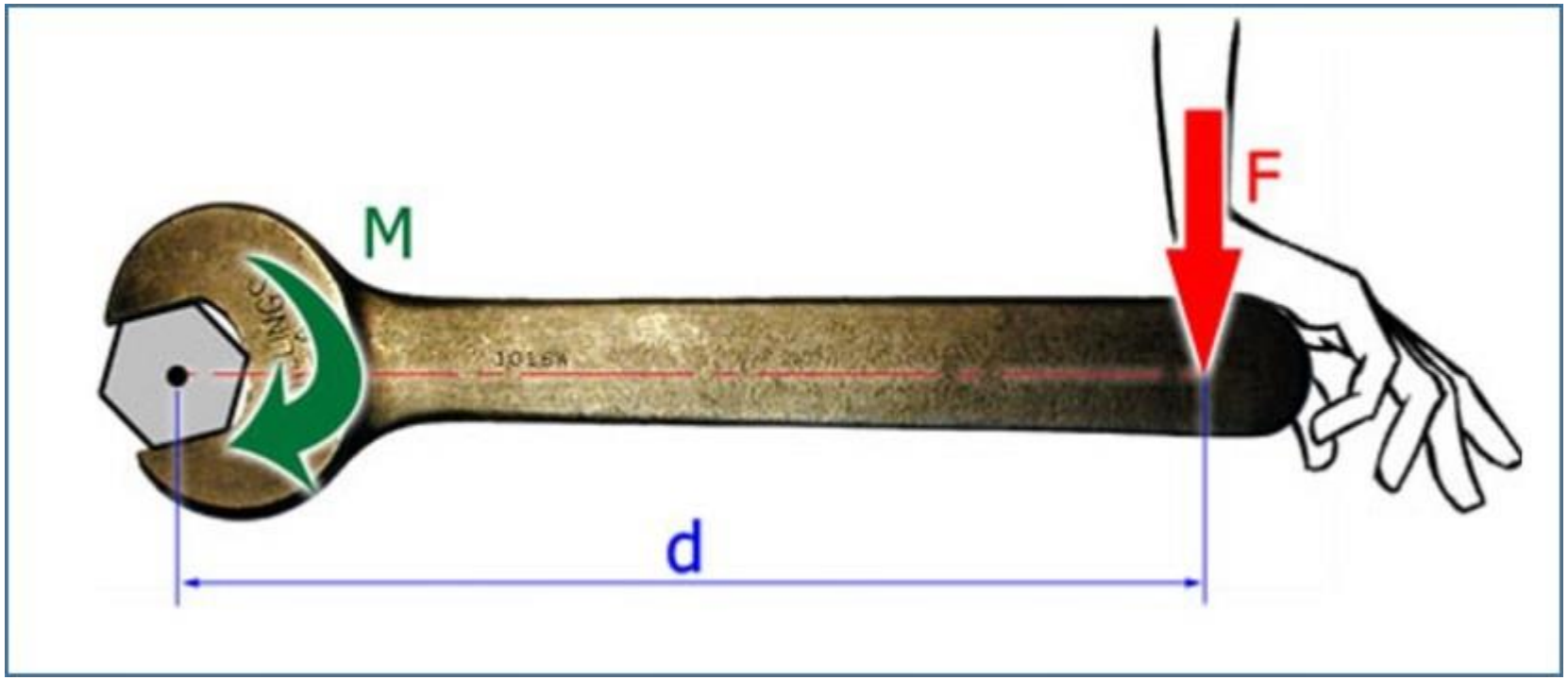
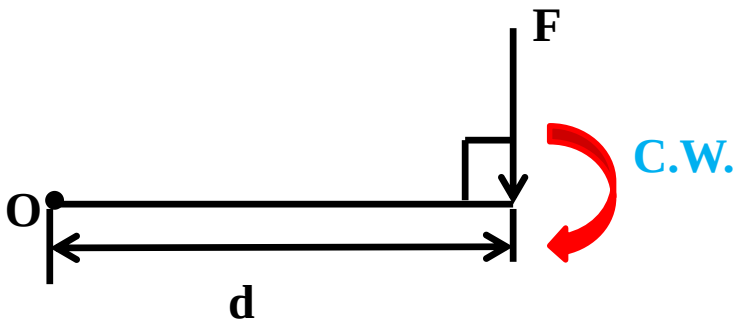
Basic Concepts

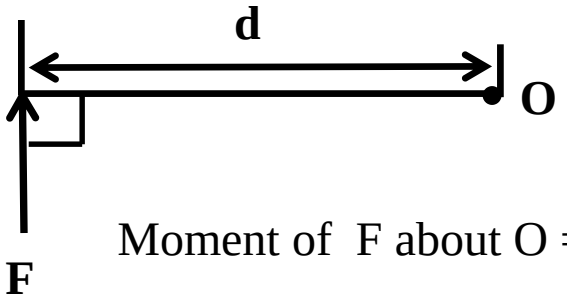
Moment of force– The turning effect produced by a force on the body.



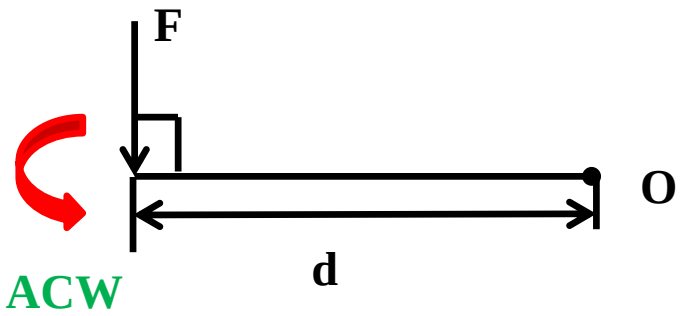
Basic Concepts



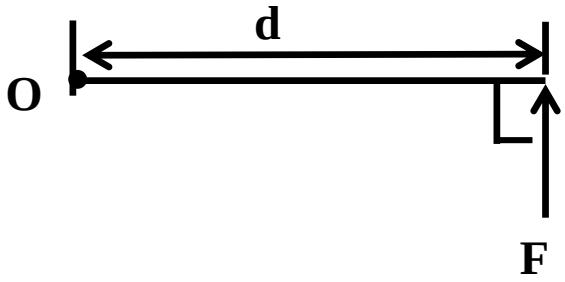
Moment of F about O = F X d



Moment of F about O = F X d



Moment of F about O = F X d



Moment of F about O = F X d

Sign Convention : - CW moment **positive** and **ACW** moment **negative**

SI Unit :- **N-m** (kN-m, kN-mm, N-mm)

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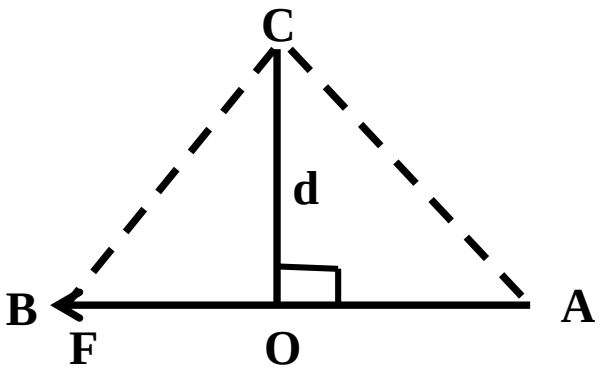
Basic Concepts

Geometrical meaning of moment of a force

The moment of a force about any point is equal to twice the area of a triangle whose base is the line which represents the force and whose vertex is the point about which the moment is to be taken.



Moment of F about C = F X d

= AB X OC

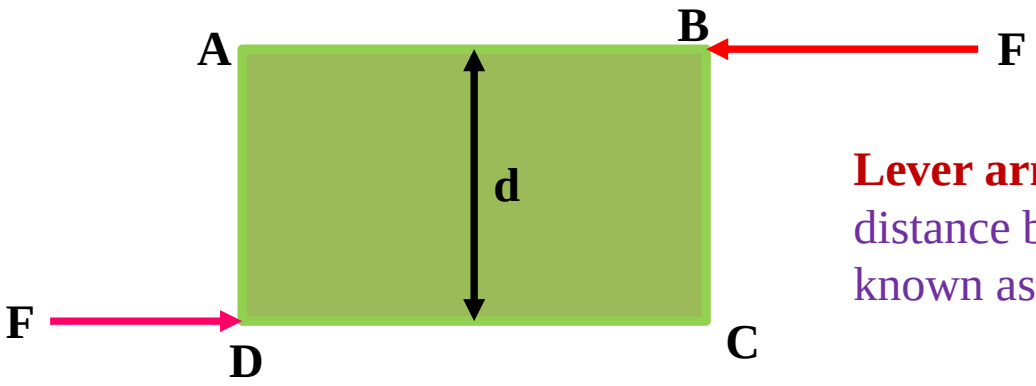
= 2 [1/2(AB X OC)]

= 2 [Area of triangle ABC]

Basic Concepts

Couple

Two equal, unlike, parallel, non-collinear forces form a couple.

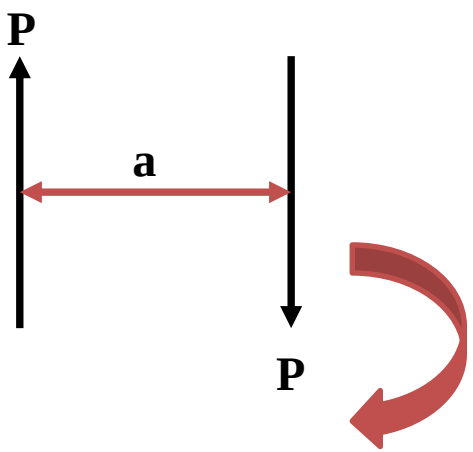


Lever arm OR arm of the couple: -The distance between two forces of couple is known as lever arm.

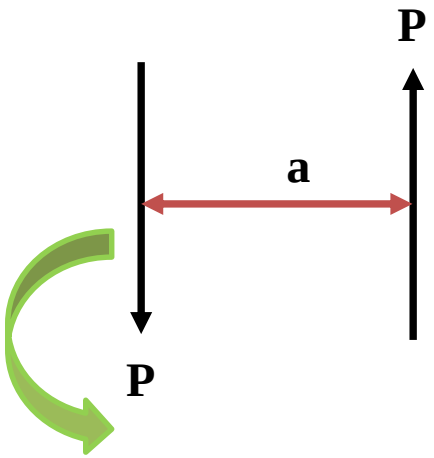
Basic Concepts

Unit of Couple :- N-m (kN-m, kN-mm)

Types of Couple



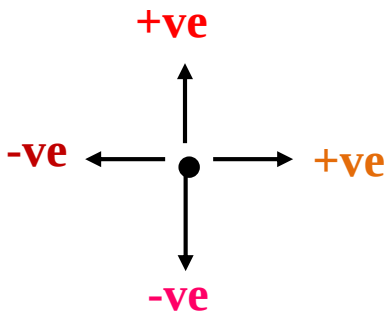
Clockwise couple



Anticlockwise couple

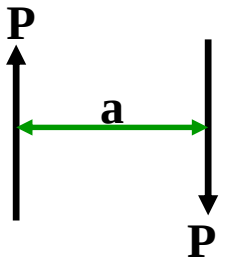
Basic Concepts

Properties of a Couple



1. The couple does not translate a body but tends to rotate it.

2. **The resultant** of the forces of a couple is **zero** i.e. **R= P-P = 0**

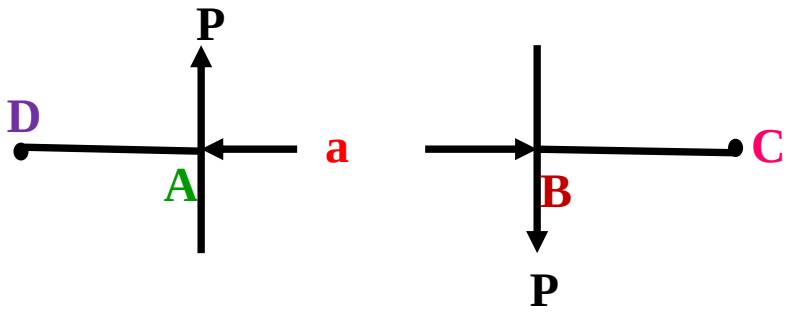


3. The moment of a couple is equal to the product of one of the forces and arm of the couple. i.e. **M = P X a**

Basic Concepts

Properties of a Couple

4. Moment of the couple is independent of the distance of the point about which moments are taken i.e. moment of a couple is always constant.



Moment of a couple = P X a

Moment of a couple about 'C'

= P X AC – P X BC

= P (AB + BC) – P X BC

= P(AB) + P(BC) –P(BC)

= P (AB) = P X a ------ (1)

Moment of a couple about 'D' = -P X AD + P X BD = -P X AD + P X (AD + AB)

= -P(AD) + P(AD) + P(AB)

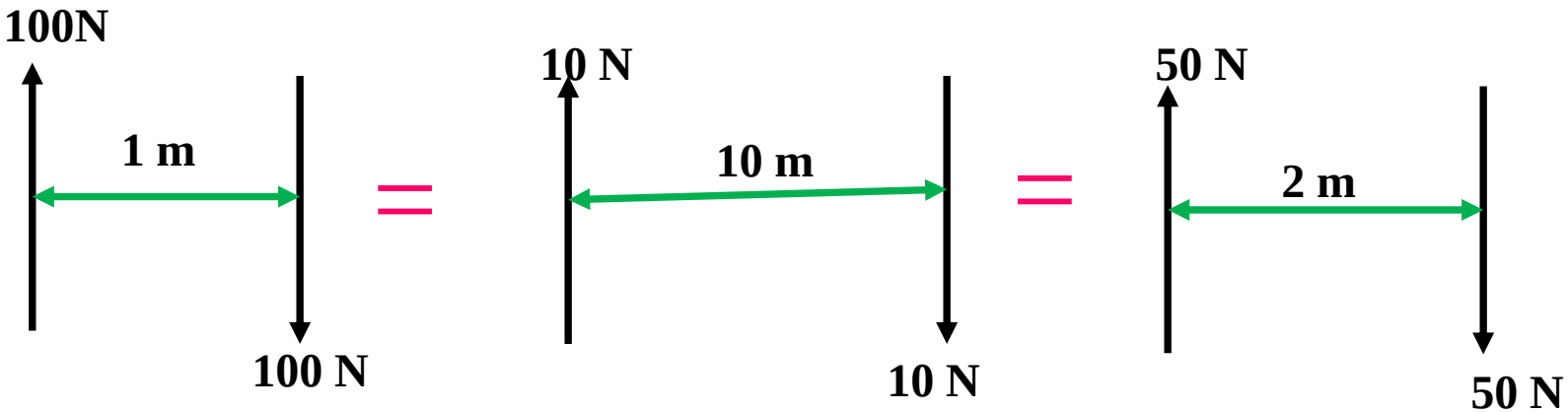
= P(AB) = P X a ----------(2)

From (1) and (2) moment of couple about any point is constant.

Basic Concepts

Properties of a Couple

5. Two or more couples are said to be equal when they have same sense(clockwise or anticlockwise) and moment.



Moment = 100 X 1
= 100 N.m

Moment = 10 X 10
= 100 N.m

Moment = 50 X 2
= 100 N.m

Basic Concepts

Resultant

If any number of forces acting upon a body are replaced by a single force which has the same effect as that of the forces together, then this single force is called the "resultant force"

Resultant → Resultant force

Resultant → Resultant moment

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Basic Concepts

Equilibrium

A body is said to be in equilibrium when the resultant force and the resultant moment about any point on the body is zero.

Equilibrium → Resultant force = 0

Equilibrium → Resultant moment = 0

Basic Concepts

Equilibrant

A force which when applied to a system of forces produces a resultant equal to zero, is known as an Equilibrant

Equilibrant has same magnitude but opposite direction, as that of the resultant.

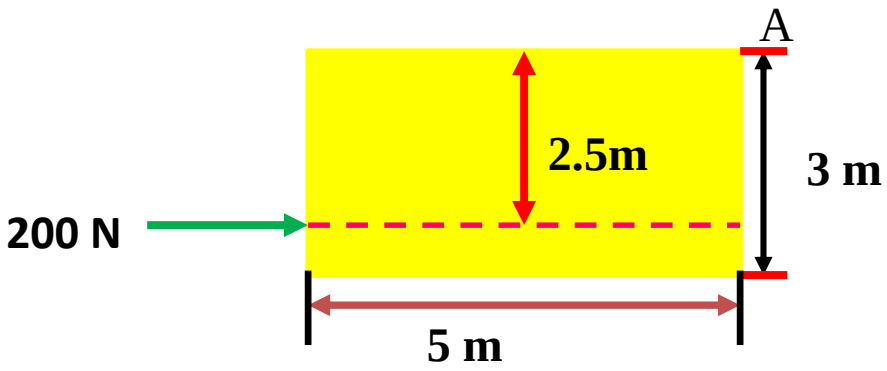
Basic Concepts

Lets revised

1.Define force and types of force system.

2. Define moment of a force.

3.Find the moment of a 200 N force about point A.



Ans : - 500 N-m

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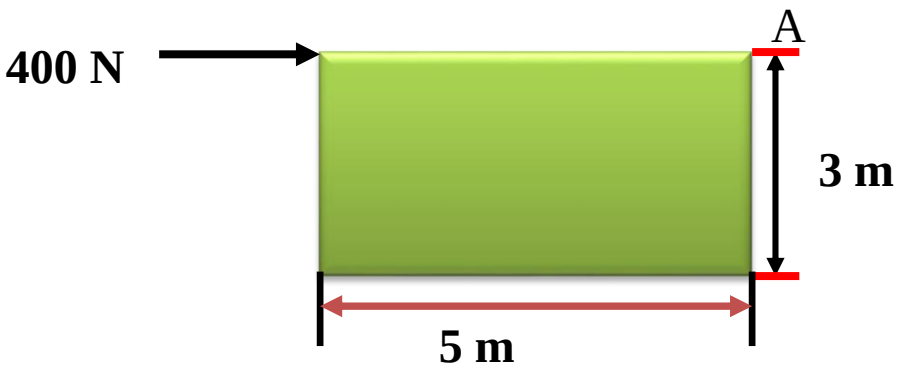
Basic Concepts

Lets revised

4. Define couple and states its properties.

5. Define resultant.

6.Find the moment of a 400 N force about point A.



Ans :- Zero