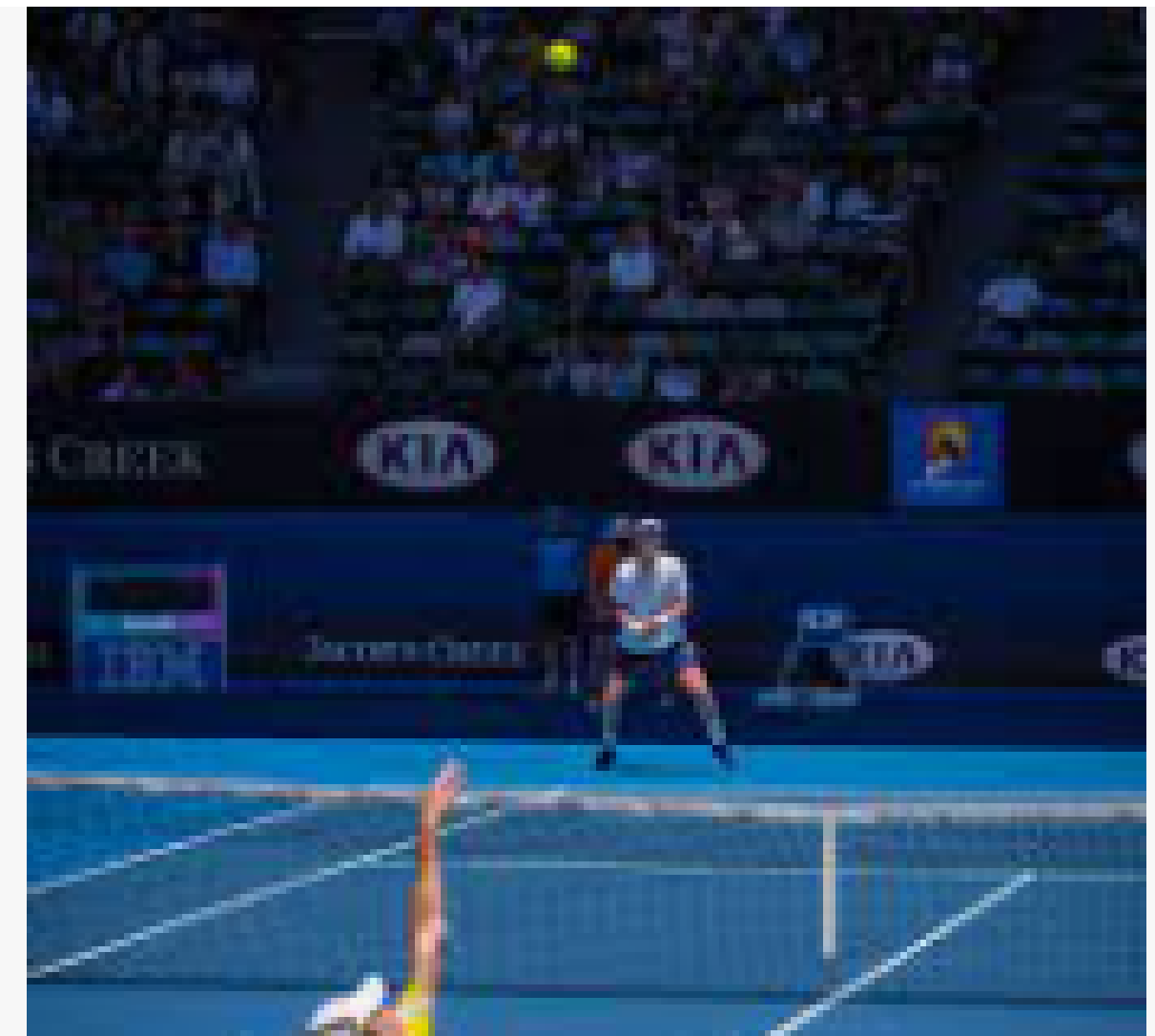




# ENGINEERING MECHANICS

## Lecture (P3)

Sheba Varghese  
Asst Professor  
Department of Mechanical  
Engg  
KJSCE



## Engineering Mechanics

Engineering Mechanics is the branch of Applied Science which deals with the laws and principles of Mechanics along with their applications to engineering problems.

Knowledge of engineering mechanics is very essential for an engineer in planning, designing and construction of various types of structures and machines.

Course Code	Course Title						
116U06C104	Engineering Mechanics						
	TH		P	TUT		Total	
Teaching Scheme(Hrs.)	03		--	--		03	
Credits Assigned	03		--	--		03	
Examination Scheme	Marks						
	CA		ESE	TW	O	P&O	Total
	ISE	IA					
	30	20					

**Course prerequisites**

- Basics of units and conversions
- Basics of Trigonometry
- Newton's Laws of Motion

**Course Objectives**

Engineering mechanics is the application of physics to solve problems involving common engineering elements. This course introduces system of forces and its effect on stationary and moving objects. The goal of this course is to expose students to problems in real-world scenarios and respond accordingly.

**Course Outcomes**

**At the end of successful completion of the course the student will be able to**

- CO1. Evaluate resultant and moment of a force system
- CO2. Analyze the concept of kinematics of particle and rigid body.
- CO3. Determine center of gravity of wires (rods), lamina and solids
- CO4. Analyze applications of equilibrium using free body diagram
- CO5. Analyze the dynamic system using D'Alembert, work energy and impulse momentum principle.

Module No.	Unit No.	Details	Hrs.	CO
1	<b>System of forces</b>		7	CO 1
	1.1	System of coplanar forces: Resultant of concurrent forces, parallel forces, non-concurrent non parallel system of forces, moment of force about a point, couples, Varignon's theorem, Principle of transmissibility of forces		
	1.2	Resultant of forces in space		
2	<b>Kinematics of Particles and Rigid Bodies</b>		11	CO 2
	2.1	Variable motion, motion curves (a-t, v-t, s-t) (acceleration curves restricted to linear acceleration only), motion along plane curved path, velocity & acceleration in terms of rectangular components, tangential & normal component of acceleration, relative velocities.		
	2.2	Introduction to general plane motion, problems based on ICR method for general plane motion of bodies (up to 2 linkage mechanism and no relative velocity method)		
3	<b>Centroid of Wires, Laminas and Solids</b>		5	CO 3
	3.1	Centroid of wires/rods Centroid of plane laminas: Plane lamina consisting of primitive geometrical shapes Center of gravity of solids: Solids consisting of primitive solids		

<b>4</b>	<b>Equilibrium of Force System and Friction</b>		<b>13</b>	<b>CO 4</b>
	<b>4.1</b>	Equilibrium of system of coplanar forces: Condition of equilibrium for concurrent forces, parallel forces and non-concurrent, non-parallel force system (general force system), Free body diagram.		
	<b>4.2</b>	Types of support, loads, beams, determination of reactions at supports for various types of loads on beams (excluding internal hinge problems)		
	<b>4.3</b>	Laws of friction, cone of friction, angle of repose, equilibrium of bodies on inclined plane, application to problems involving wedges and ladders		
<b>5</b>	<b>Kinetics of particle</b>		<b>9</b>	<b>CO5</b>
	<b>5.1</b>	Force and acceleration: Introduction to basic concepts, equations of dynamic equilibrium, Newton's second law of motion (only rectilinear motion)		
	<b>5.2</b>	Work energy principle		
	<b>5.3</b>	Impulse and Momentum: Principle of linear impulse and momentum, law of conservation of momentum, impact and collision, direct central and oblique central impact.		
<b>Total</b>			<b>45</b>	

## Text Books

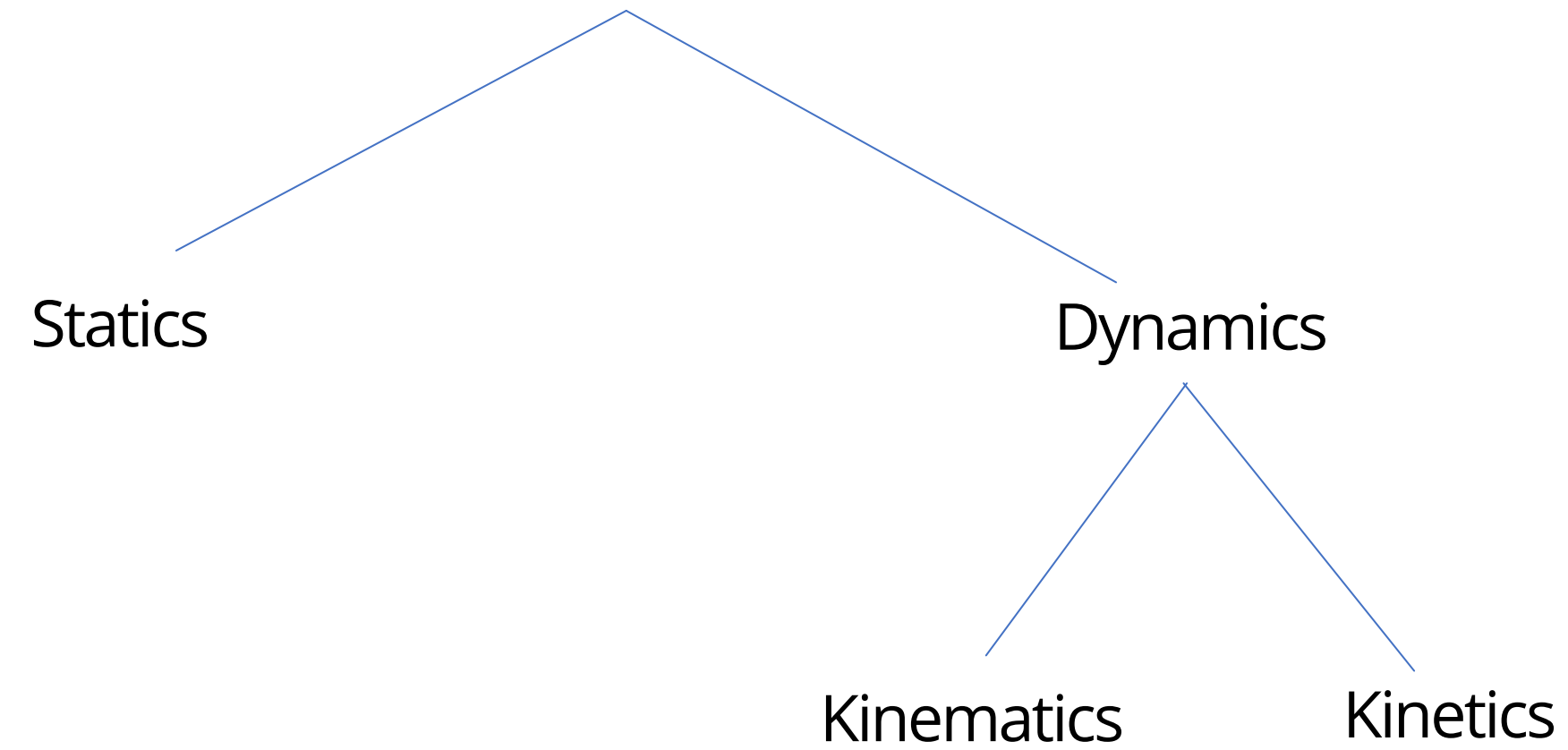
Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Tayal, A.K.	Engineering Mechanics, Statics and Dynamics	Universal Publication, India	14th Edition 2011
2.	Bhavikatti S. S.	Engineering Mechanics	New Age international, India	Revised Edition 2019

## Reference books:

Sr. No.	Name/s of Author/s	Title of Book	Name of Publisher with country	Edition and Year of Publication
1.	Hibbeler, H. C. and Gupta	Engineering Mechanics, Statics and Dynamics	Prentice Hall Private limited, India	Revised Edition 2017
2.	Bhattacharyya B.	Engineering Mechanics	Oxford University Press, India	2nd Edition 2014



# Engineering Mechanics



1	<b>System of forces</b>		<b>7</b>	<b>CO 1</b>
	<b>1.1</b>	System of coplanar forces: Resultant of concurrent forces, parallel forces, non-concurrent non parallel system of forces, moment of force about a point, couples, Varignon's theorem, Principle of transmissibility of forces		
	<b>1.2</b>	Resultant of forces in space		

## Force

- An external agency which changes or tends to change the state of rest or of uniform motion of a body upon which it acts.
- One Newton Force
  - force required to produce an acceleration of  $1 \text{ m/s}^2$  in a body of mass  $1 \text{ kg}$
- Characteristics of Force
  - Magnitude
  - Direction
  - Point of application

## Force

- Definition
- Types and Classifications
  1. According to the effect produced by the force
  2. According to the origin of force
  3. According to the nature of the force
  4. According to whether the force acts at a point or distributed over a large area
  5. According to whether the force acts at a distance or by contact

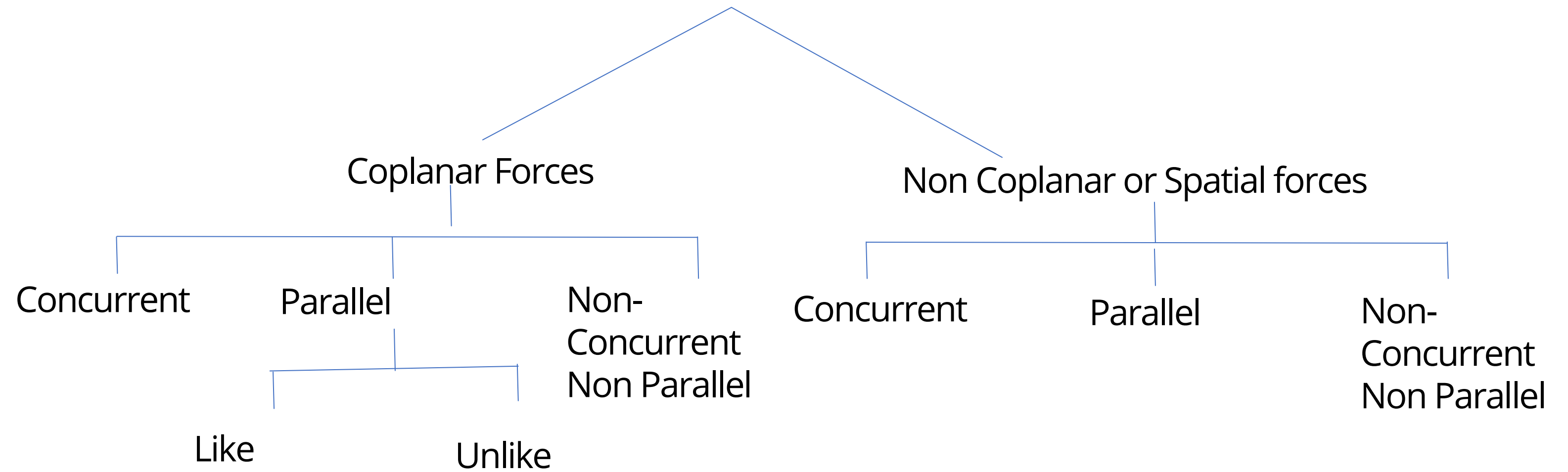
## Particle and Rigid Body

- Particle – A body infinitely small volume and is considered to be a concentrated point
- Rigid Body – A body which can retain its shape and size, even if subjected to some external forces.

### Principle of Transmissibility of Forces

- It states that the condition of equilibrium or uniform motion of rigid body will remain unchanged if the point of application of a force acting on a rigid body is transmitted to act at any other point along its line of action.
- i.e, If a force acts at any point on a rigid body, it may also be considered to act at any other point on its line of action, provided this point is rigidly connected with the body.

# Systems of Forces



## Composition of Forces

*The process of finding resultant of forces is called composition of forces.*

- **Parallelogram Law of Forces**
- **Triangle Law of Forces**
- **Polygon Law of Forces**

## Parallelogram law of forces – to find the Resultant of a force

*“If two forces, acting simultaneously on a particle, be represented in magnitude and direction by the two adjacent sides of a parallelogram, then their resultant may be represented in magnitude and direction by the diagonal of the parallelogram, which passes through their point of intersection.”*



## Triangle Law of Force (Corollary of parallelogram Law)

*"If two forces, acting simultaneously on a particle, be represented in magnitude and direction by the two sides of a triangle, taken in order; their resultant may be represented in magnitude and direction by the third side of the triangle, taken in opposite order."*

## Polygon Law of Force

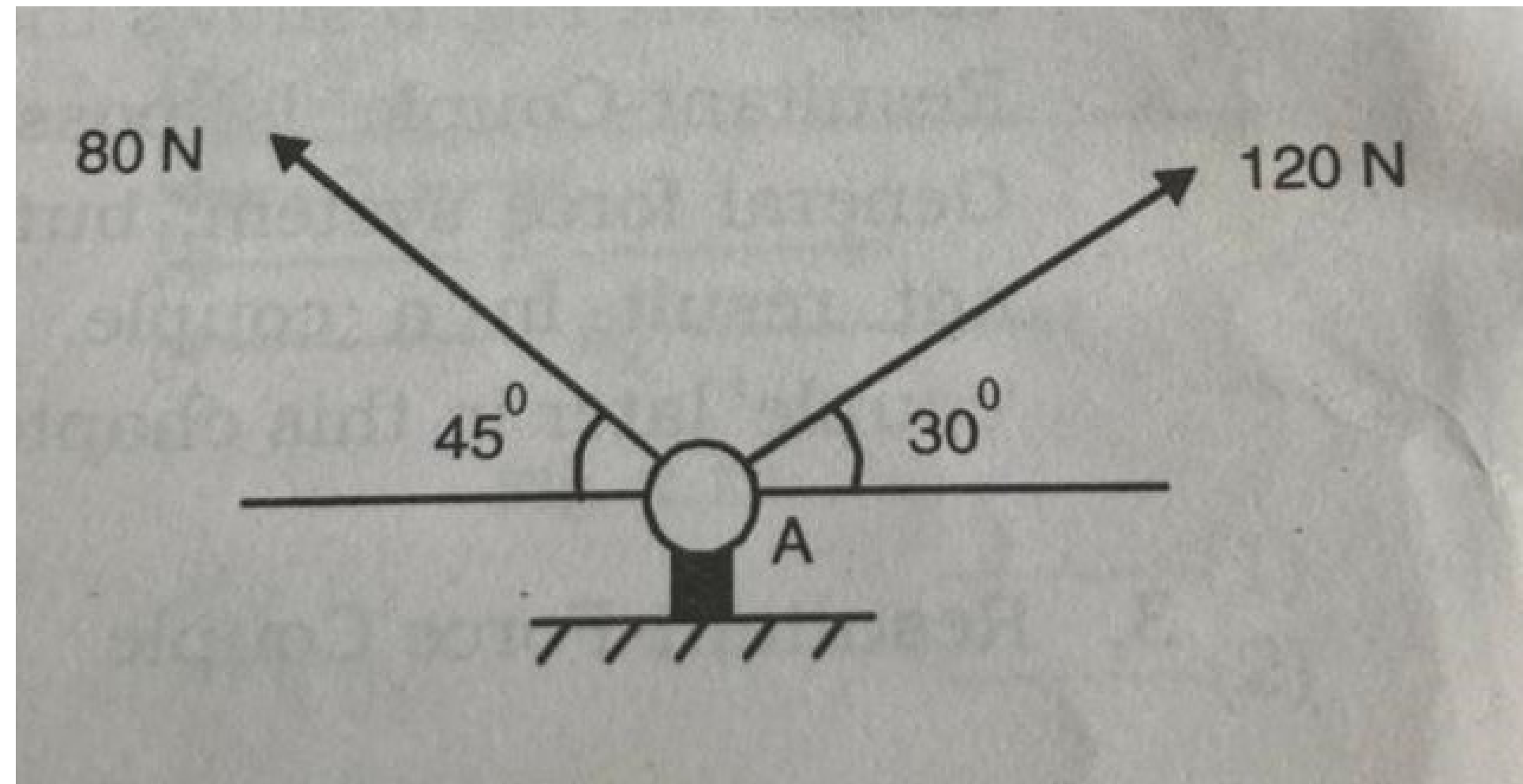
*"If a no : of forces, acting simultaneously on a particle, be represented in magnitude and direction by the sides of a polygon taken in order: then the resultant of all these forces may be represented, in magnitude and direction, by the closing side of the polygon, taken in opposite order."*

Two forces of 100N and 150N are acting simultaneously at a point. What is the resultant of these two forces if the angle between them is  $45^\circ$ ?

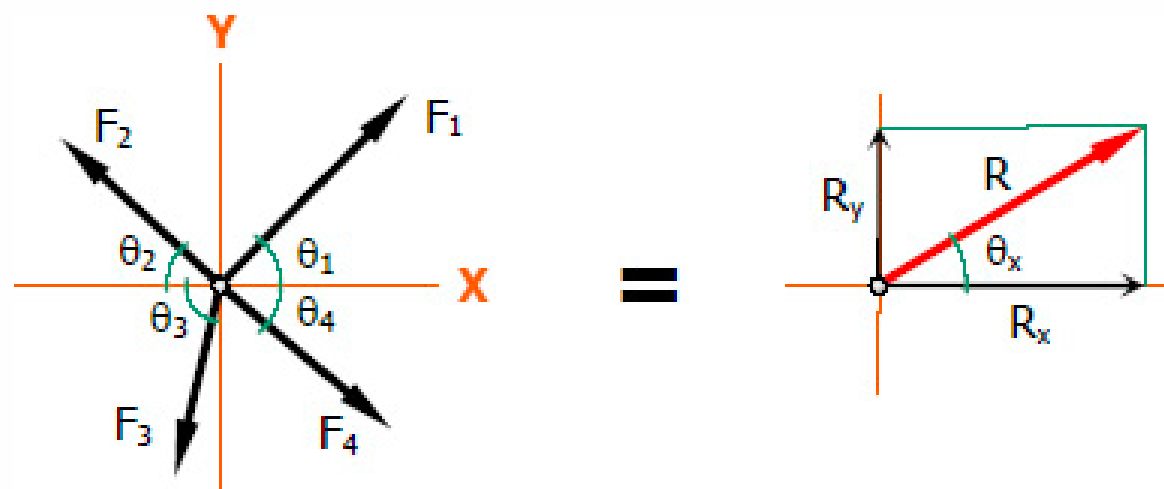
## Resolution of a Force into Component forces.

- The process of splitting up the given force into two components without changing its effect on the body is called **Resolution of a Force**.
- Force which is split into two parts is called the **resolved force** and the parts are called **component forces**.

**Q.** Two forces of 120 N and 80 N act on an eye bolt at A as shown. Determine the resultant of the two forces.



## Resultant of a Concurrent Force System



$$R_x = \Sigma F_x$$

$$R_y = \Sigma F_y$$

$$R = \sqrt{R_x^2 + R_y^2}$$

$$\tan \theta_x = \frac{R_y}{R_x}$$

Q. Find the resultant of the four concurrent forces acting on a particle P.

