Taibah University – Yanbu Branch
College of Engineering at Yanbu
Mechanical Engineering Department

ME 341
Mechanics of Machines
Lecture 5

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Coordinate system

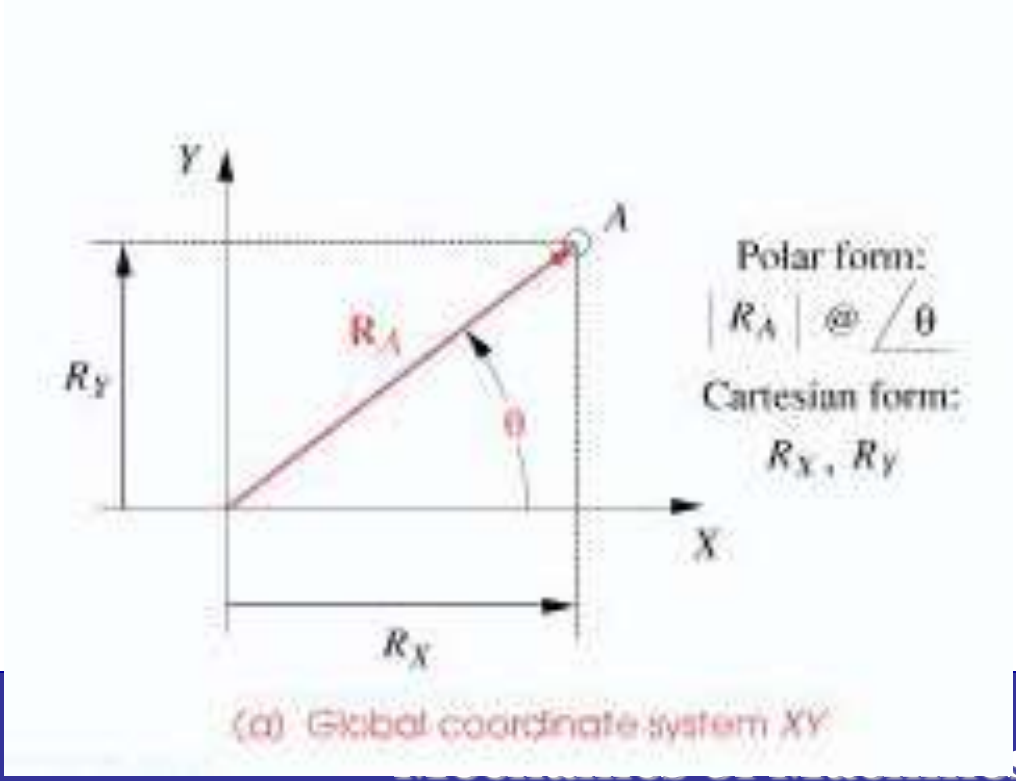
- Global coordinate system: often taken to be attached to Earth, though it could as well be attached to another ground plane such as the frame of an automobile (GCS – X, Y). Also called as the absolute coordinate system
- Local coordinate system are typically attached to a link to some point of interest. This might be a pin joint, a centre of gravity, or a line of centres of a link (LCS – x, y)

Position

- A position of a point in the plane can be defined by the use of position vector
- The choice of reference axis is arbitrary and is selected to suit the observer
- A two dimensional vector has two attributes, which can be expressed in either polar or Cartesian coordinates
- The polar form provides the magnitude and angle of the vector
- The Cartesian form provides the X and Y component of the vector

Relationship between polar and Cartesian

$$R_A = \sqrt{R_X^2 + R_Y^2} \qquad \theta = \arctan\left(\frac{R_Y}{R_X}\right)$$

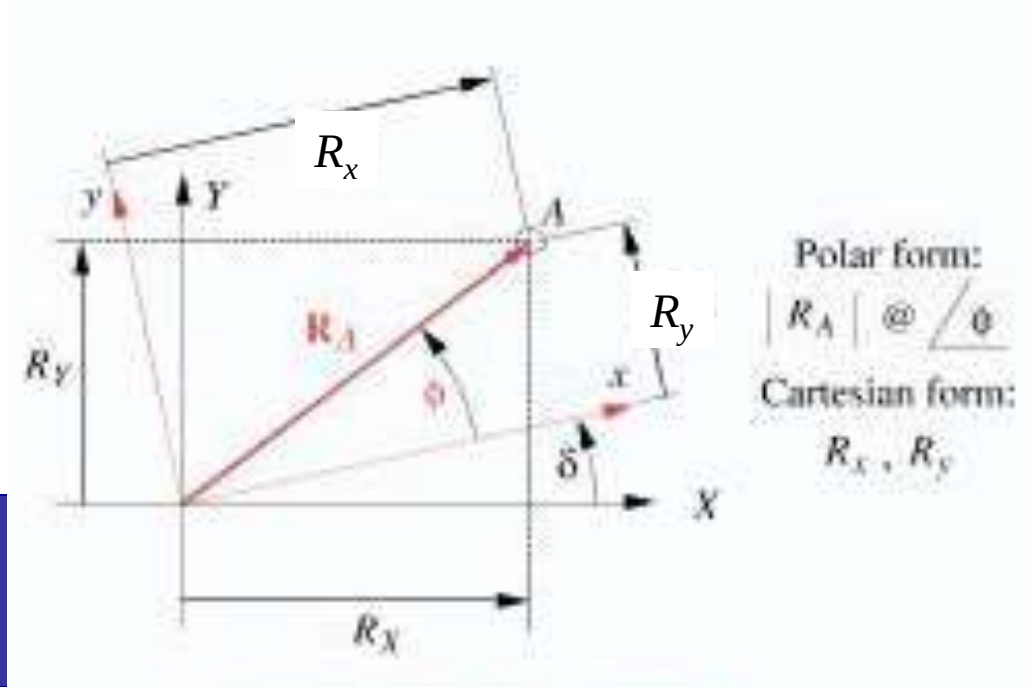


Coordinate Transformation

- It is often necessary to transform the coordinates of a point defined in one coordinate system to coordinate system in another
- If the position of point A is expressed in the local xy system as R_x, R_y and it is desired to transform its coordinated to R_X, R_Y in the global XY system, the equations are:

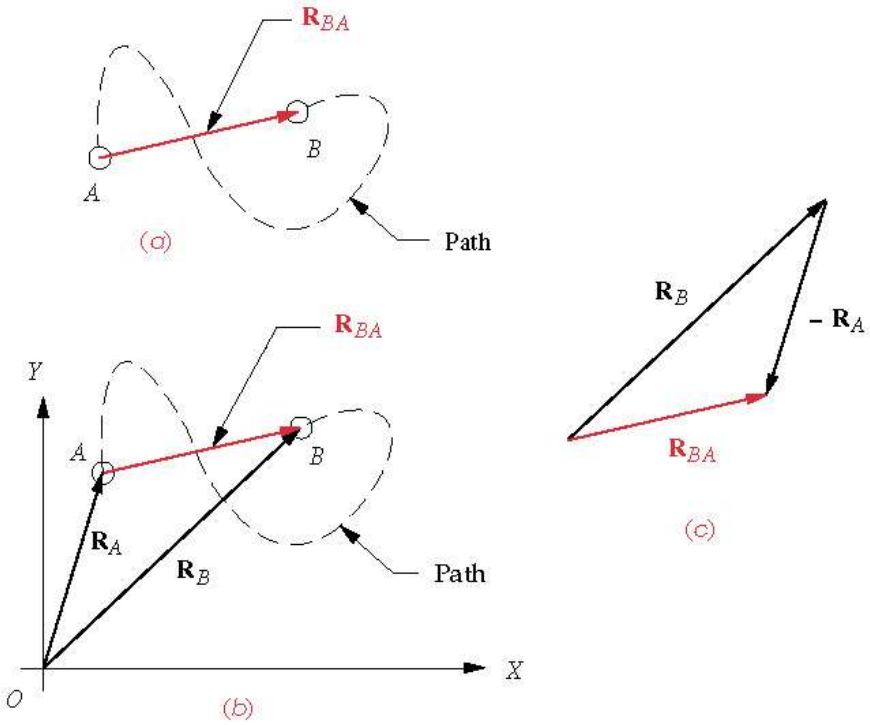
$$R_X = R_x \cos\delta - R_y \sin\delta$$

$$R_Y = R_x \sin\delta + R_y \cos\delta$$



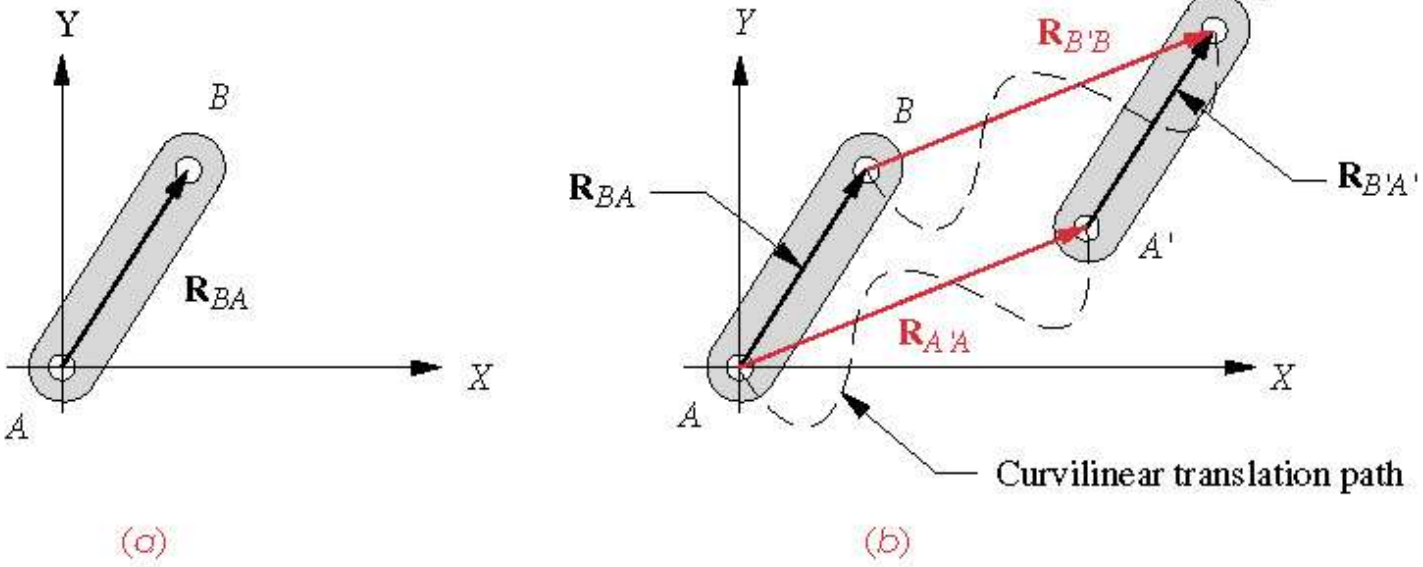
Displacement

- Displacement of a point is the change in its position and can be defined as the straight line distance between the initial and final position of a point which has moved in the reference frame
- The position of B with respect to A is equal to the (absolute) position of B minus the (absolute) position of A, where absolute means with respect to global reference frame
- $R_{BA} = R_B - R_A$
- $R_{BA} = R_{BO} - R_{AO}$



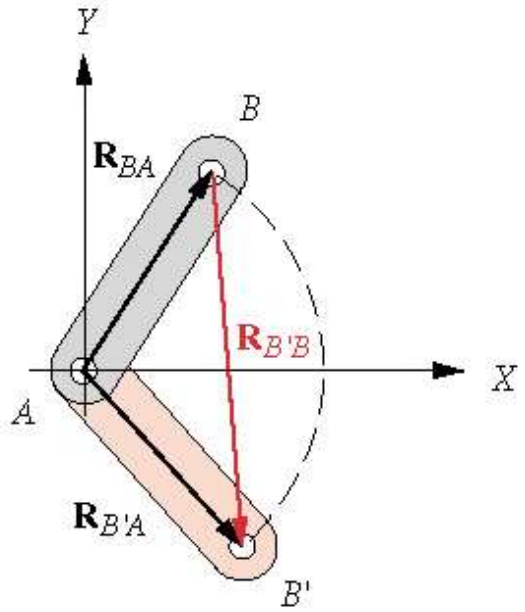
Translation

- All points on the body have the same displacement
- Note that translation need not be along a straight path
- If the path happens to be a straight line then its called the rectilinear translation, otherwise it is the curvilinear translation



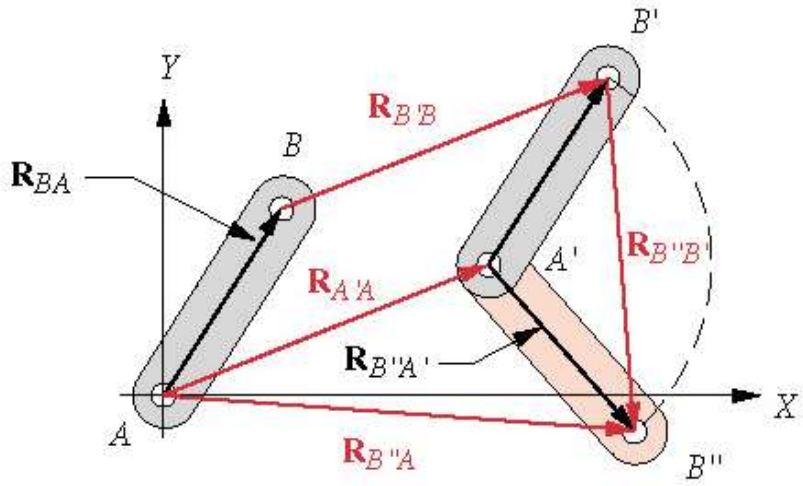
Rotation

- Different points in the body undergo different displacements and thus there is a displacement difference between any two points chosen



Complex motion

- Sum of translation and rotation components
- Total displacement = translation component + rotation component



Theorems

- Euler's theorem:
  - The general displacement of a rigid body with one point fixed is a rotation about some axis
- Chasles' theorem:
  - Any displacement of a rigid body is equivalent to the sum of a translation of any one point on that body and a rotation of the body about an axis through that point

Position Analysis Methods

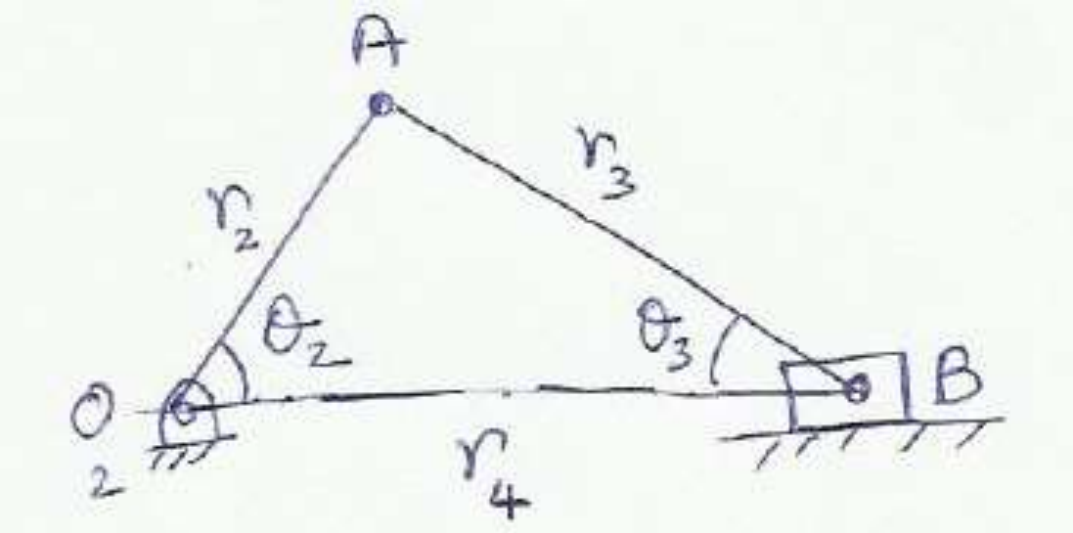
- Algebraic
- Graphical
- Vectors
- Complex Numbers

We will start with Algebraic Method and solve some examples on the white board

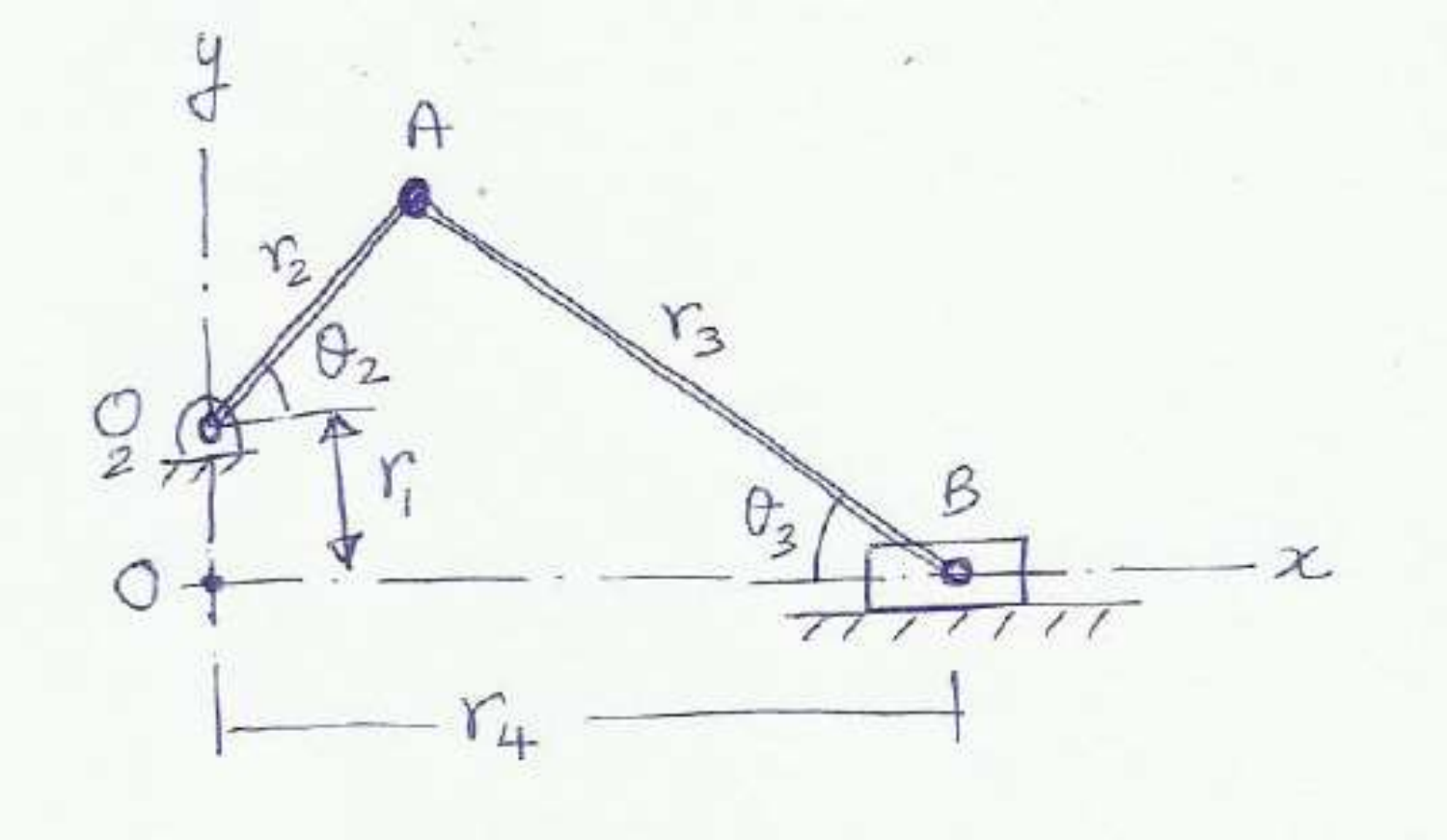
Position Analysis of Planner Mechanisms

We will consider planner mechanism with pin joints and sliding joint

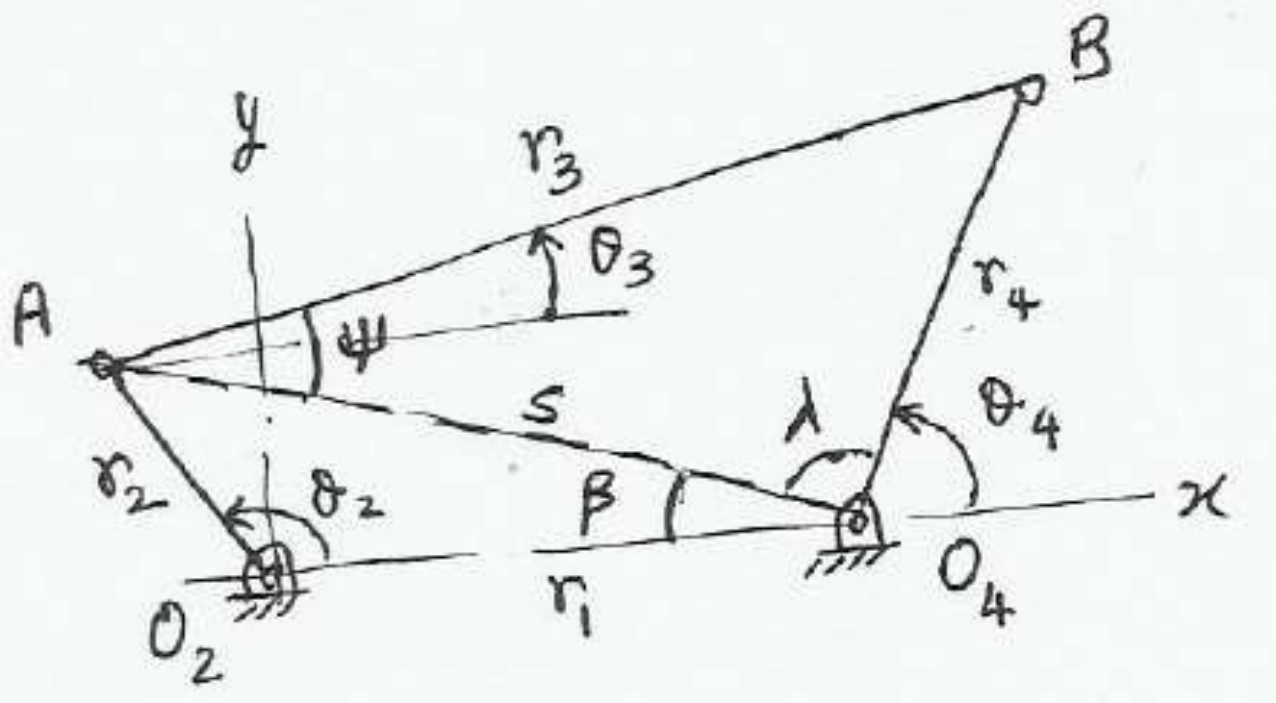
Slider Crank Mechanism –Position Analysis



Slider Crank Mechanism with an offset – Position Analysis



Position Analysis 4 Bar Mechanism



Graphical Methods

- Use some of the drawing tools