Practical 2: Surveying and geodesy. Coordinate systems. Orthogonal and polar coordinates. Conversion between orthogonal and polar coordinates

Accessories to be used:

1 scientific calculator for each student

Contents:

Refreshing elementary coordinate geometry calculations

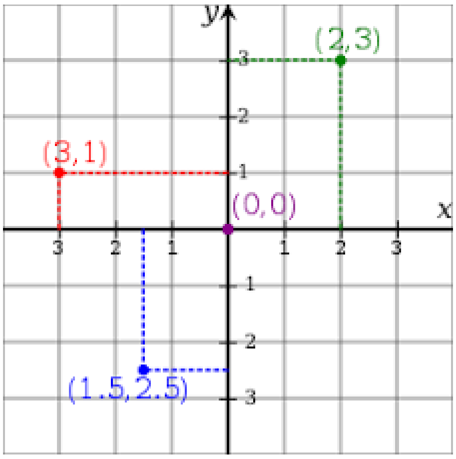
Coordinate systems used in surveying

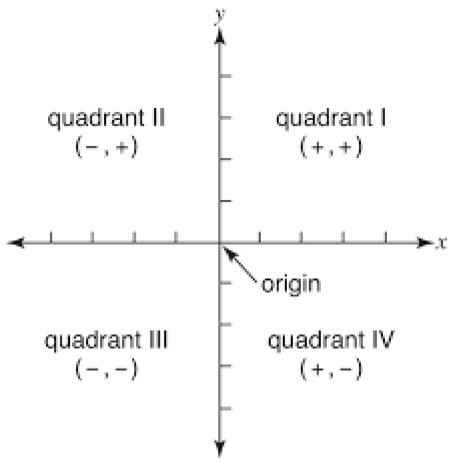
Coordinate systems used in matematics

Position of points on the plain are defined by coordinates. We need a coordinate reference system for this. Two types of coordinate systems are used generally:

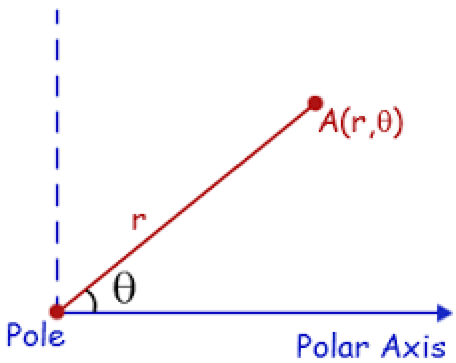
- Cartesian (orthogonal) coordinate system
- polar coordinate system

Cartesian coordinate system:
To define the coordinate system first the origin have to be set up, the intersection point of the two perpendicular coordinate axises. The horizontal axis is called **x** axis. The positive rotation is counter clockwise. The other, **y** axis is got rotating **x** axis by +90°.
The axises divide the plan into four quadrants.

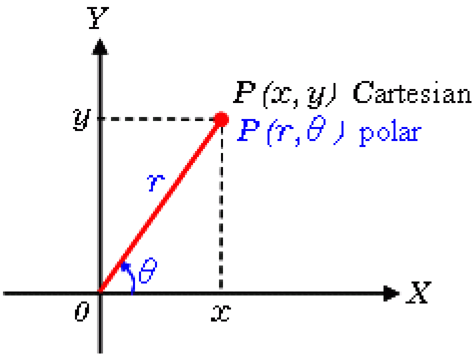




Polar coordinate system:
A point is also chosen here as the pole (origin) and a ray from this point is taken as the polar axis, which is usually horizontal in mathematics. A point is defined on the plain by the counterclockwise angle from the polar axis and the distance from the pole.



If the origin of a Cartesian coordinate system and the x axis are identical to the pole and polar axis of a polar coordinate system, exchange between x, y coordinates and r, Θ can be done.



$$x = r \cdot \cos(\theta)$$
$$y = r \cdot \sin(\theta)$$
$$r = \sqrt{x^2 + y^2}$$
$$\alpha = \arctan\left|\frac{y}{x}\right|$$

Quadrant	x	y	Θ
I	+	+	$\theta = \alpha$
II	-	+	$\theta = 180^o - \alpha$
III	-	-	$\theta = 180^o + \alpha$
IV	+	-	$\theta = 360^o - \alpha$

Polar to Cartesian

Exercise 1:

$r_A = \sqrt{2} \qquad \theta = 45$
$x_A = 1 \qquad y_A = 1$

Exercise 2:

$r_A = 10.45 \qquad \theta = 122 - 52 - 43$
$x_A = -5.67 \qquad y_A = 8.78$

Cartesian to polar

Exercise 3:

$x_A = 1 \qquad y_A = 1$
$r_A = \sqrt{2} \qquad \alpha = \theta = 45^o$

Exercise 4:

$x_A = -1 \qquad y_A = 1$
$r_A = \sqrt{2} \qquad \alpha = 45^o \qquad \theta = 180^o - \alpha = 135^o$

Exercise 5:

$x_A = -1 \qquad y_A = -1$
$r_A = \sqrt{2} \qquad \alpha = 45^o \qquad \theta = 180^o + \alpha = 225^o$

Exercise 6:

$x_A=1 \quad y_A=-1$
$r_A=\sqrt{2} \quad \alpha=45^o \quad \theta=360^o-\alpha=315^o$

Exercise 7:

$x_A=-5.67 \quad y_A=8.78$
$r_A=10.45 \quad \alpha=57-08-46 \quad \theta=122-51-14$

Using scientific calculator

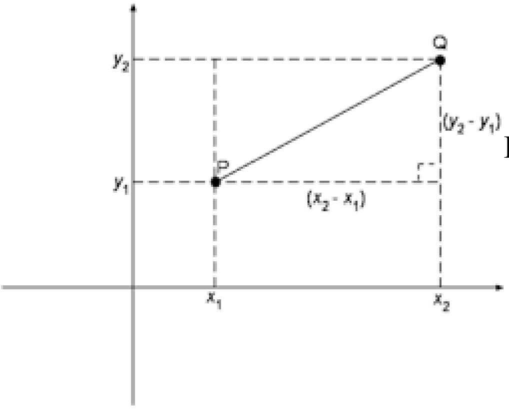
Polar to Cartesian:

Rect(	r_A	,	θ_A	=	x_A	RCL	F	y_A

Cartesian to polar

Pol(	x_A	,	y_A	=	r_A	RCL	F	θ_A

Distance of two points



$$d_{PQ}=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$

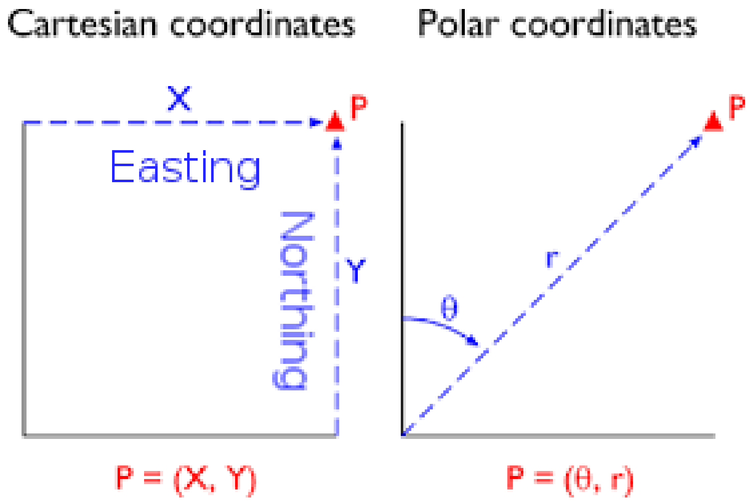
Exercise 8:

$x_A=87.59 \quad y_A=-32.14$
$x_B=11.42 \quad y_B=15.89$
$d_{AB}=90.05$

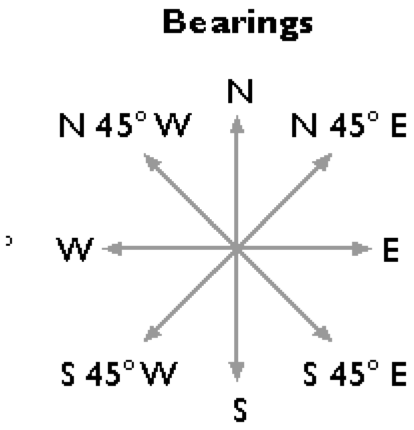
Equation of a line

Coordinate systems used in surveying

There are differences between mathematical and surveyor's coordinate systems. The x axis is often called Easting (E) and the y axis is often called Northing (N). The polar axis is going to North and the positive angles are measured clockwise and called bearing.



Bearing



Whole circle bearing

Quadrant in which bearing lies	*Conversion relation*
NE	$\alpha = \theta$
SE	$\alpha = 180° - \theta$
SW	$\alpha = \theta - 180°$
NW	$\alpha = 360° - \theta$

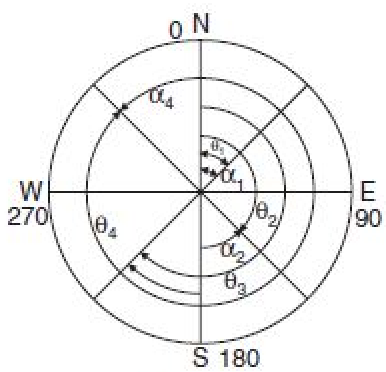


Fig. 13.4

Calculation of coordinates from a known point and relative polar coordinates.

$$E_B = E_A + d_{AB} \cdot \sin(WCB_{AB})$$
$$N_B = N_A + d_{AB} \cdot \cos(WCB_{AB})$$