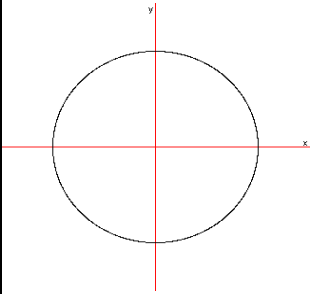


## TYPICAL POLAR GRAPHS

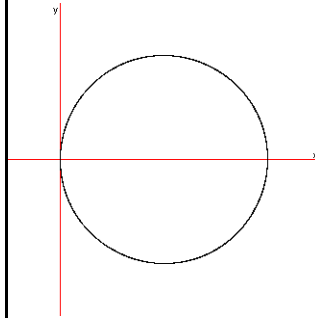
**Line**  $\theta = \alpha$

### CIRCLES

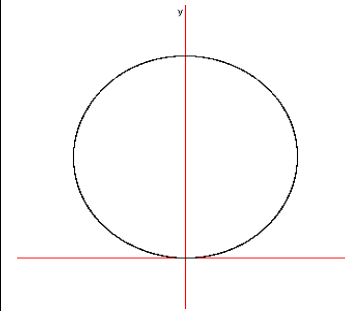
$r = a$   
Center at  $(0, 0)$   
Radius =  $a$



$r = a \cos(\theta)$   
Center at  $(\frac{a}{2}, 0)$   
Radius =  $\frac{a}{2}$



$r = a \sin(\theta)$   
Center at  $(0, \frac{a}{2})$   
Radius =  $\frac{a}{2}$



### ROSES $r = a \cos(n\theta)$ or $r = a \sin(n\theta)$

*If n is odd: n-leaf rose*

$r = 4 \cos(3\theta)$

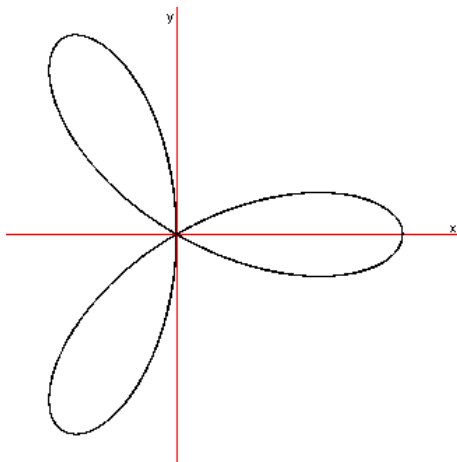
*First Leaf*

$-\frac{\pi}{6} \leq \theta \leq \frac{\pi}{6}$

*Angle b/w the*

*centers of leaves*  $= \frac{2\pi}{n}$

$= \frac{2\pi}{3}$



*If n is even: 2n-leaf rose*

$r = 4 \sin(2\theta)$

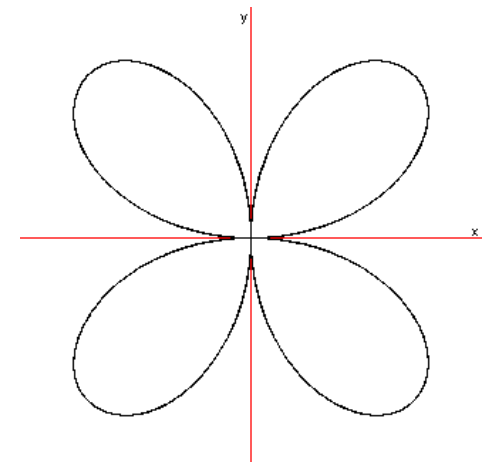
*First Leaf*

$0 \leq \theta \leq \frac{\pi}{2}$

*Angle b/w the*

*centers of leaves*  $= \frac{2\pi}{2n}$

$= \frac{\pi}{2}$



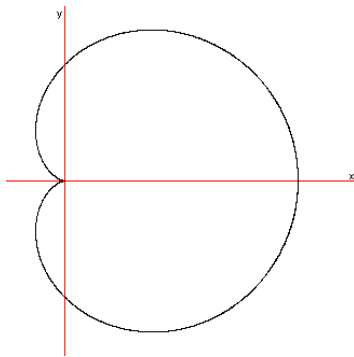
## TYPICAL POLAR GRAPHS

### CARDIOIDS $r = a + b \cos(\theta)$ or $r = a + b \sin(\theta)$

if  $|a| = |b|$

*CUSP*

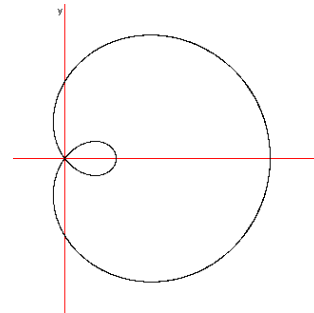
$$r = 2 + 2 \cos(\theta)$$



if  $|a| < |b|$

*re-entrant loop*

$$r = 1.5 + 2.5 \cos(\theta)$$

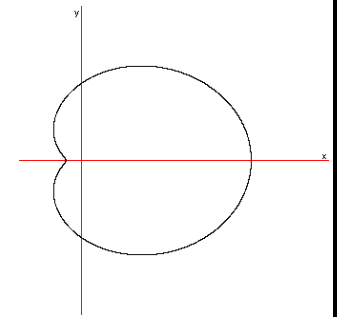


if  $|a| > |b|$

*no cusp or*

*re-entrant loop*

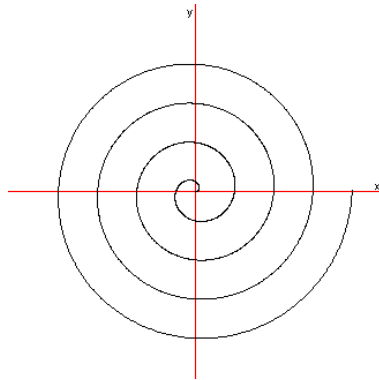
$$r = 2.5 + 1.5 \cos(\theta)$$



### SPIRAL $r = a\theta$

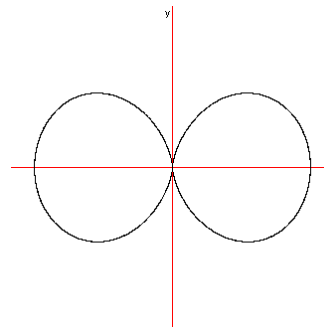
$$r = 0.1 \theta ;$$

$$0 \leq \theta \leq 8\pi$$

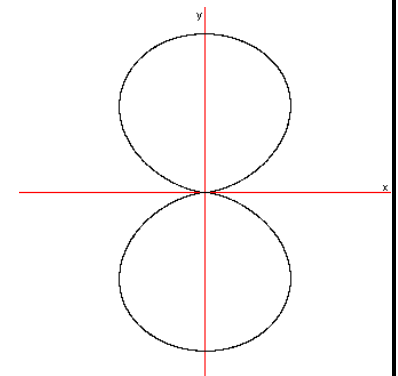


### INFINITY

$$r = a \cos^2(\theta)$$



$$r = a \sin^2(\theta)$$



*Majid Kashi*