

Polar Curves

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Objective

To investigate curves whose equations are of the form $r = f(\theta)$.

Narrative

The graph of an equation of the form $r = f(\theta)$ in polar coordinates, is a polar curve. In addition to being important, polar curves are both beautiful and unusual for anyone whose graphing experience has been limited to curves in rectangular coordinates. In this project we investigate polar curves.

Tasks

1. Type the command lines below into Mathematica in the order in which they are listed. These commands illustrate how we can use Mathematica's **PolarPlot** command first to graph the circle whose equation in polar coordinates is $r = 1$, and then to graph the circles whose equations in polar coordinates are $r = 1$, $r = 1/2$, $r = 1/4$, and $r = 1/8$.

```
In[1] := (* Your name, today's date *)
```

```
In[2] := (* Polar Plots *)
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In[3] := <<Graphics`Graphics`
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In[4] := (* Task 1 *)
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In[5] := PolarPlot[1, {t, 0, 2Pi}]
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In[6] := PolarPlot[{1, 1/2, 1/4, 1/8}, {t, 0, 2Pi}]
```

2. a) Use the **PolarPlot** command to draw in one graphic the graphs of the equations $r = 1 + k \cos \theta$ in polar coordinates, where $\theta \in [0, 2\pi]$ and $k = 0, 0.25, 0.5, 0.75$, and 1 .

b) Use the **PolarPlot** command to draw in one graphic the graphs of the equations $r = 1 + k \cos \theta$ in polar coordinates, where $\theta \in [0, 2\pi]$ and $k = 1, 1.25, 1.5, 1.75$, and 2 .

3. Use the **PolarPlot** command to draw (in *different* graphics):

a) the graph of the equation $r = \cos 2\theta$ in polar coordinates, where $\theta \in [0, 2\pi]$,

b) the graph of the equation $r = \cos 2\theta$ in polar coordinates, where $\theta \in [0, \pi]$,

c) the graph of the equation $r = \cos 3\theta$ in polar coordinates, where $\theta \in [0, 2\pi]$, and

d) the graph of the equation $r = \cos 3\theta$ in polar coordinates, where $\theta \in [0, \pi]$.

Observe the effects of changing the range of θ values when graphing $r = \cos n\theta$, and the effects of changing n when graphing $r = \cos n\theta$, $\theta \in [0, 2\pi]$.

At this time, make a hard-copy of your typed input and Mathematica's responses. Then:

4. Highlight each curve you drew in Tasks 1 and 2 in a different color, and label each graph with its equation. (You may use the same colors more than once, just not more than once in a single graphic.)

5. Plot and label the points in the graphics you produced in Task 2 that correspond to the beginning parameter value $\theta = 0$ and the ending parameter value $\theta = \pi$ or $\theta = 2\pi$, and label each loop and partial loop with a small arrow indicating the direction of increasing values of θ .

Your lab report will be a hard-copy of your typed input and Mathematica's responses (both text and hand-labeled graphics).