Polar Curves in Cartesian Coordinates

Michael Penna, Indiana University – Purdue University, Indianapolis

Objective

To illustrate how Mathematica can be used to plot polar curves in Cartesian coordinates.

Narrative

The curve whose polar equation is $r = r(\theta), \theta \in [\alpha, \beta]$, can be plotted using the Cartesian coordinate parametrization

$$x = r\cos\theta = r(\theta)\cos\theta, \quad y = r\sin\theta = r(\theta)\sin\theta, \quad \theta \in [\alpha, \beta].$$

In this project we illustrate how this is done.

Tasks

1. a) Type the command lines below into Mathematica in the order in which they are listed. These commands plot the polar curve $r = 3\sin 2\theta, \theta \in [0, 2\pi]$.

```
In[1]:= (* Your name, today´s date *)
In[2]:= (* Polar Curves in Cartesian Coordinates *)
In[3]:= (* Task 1a *)
In[4]:= r[t_] := 3Sin[2t]
In[5]:= ParametricPlot[{r[t]Cos[t],r[t]Sin[t]}, {t,0,2Pi}, AspectRatio->1]}
```

b) Continue by typing the command lines below into Mathematica in the order in which they are listed. These commands plot the polar curve $r = 2\cos 3\theta, \theta \in [0, 2\pi]$.

```
In[6]:= (* Task 1b *)
In[7]:= r[t_] := 2Cos[3t]
In[8]:= ParametricPlot[{r[t]Cos[t],r[t]Sin[t]}, {t,0,2Pi}, AspectRatio->1]}
```

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

2. On the graphic you created in Task 1a:

a) plot and label by hand the points at which $t = 0, \pi/4, \pi/2, 3\pi/4, \pi, 5\pi/4, 3\pi/2, 7\pi/4, 2\pi$, and

b) along each loop, draw a small arrow in the direction increasing t.

3. On the graphic you created in Task 1b, label by hand:

a) the points at which $t = 0, \pi/6, \pi/3, \pi/2, 2\pi/3, 5\pi/6, \pi$, and

b) along each loop, draw a small arrow in the direction increasing t.

4. Draw the graph of a polar curve of your own choosing in Cartesian coordinates. (Be creative!)

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

Comments

Some other interesting curves you might like to investigate include curves defined parametrically by $x(t) = r(t)\cos kt$, $y(t) = r(t)\sin kt$ where $r = r(t)$ is a function as above, and k is a real constant.