Winplot III: Polar and Vector Equations
Presented by Lin McMullin

Where to get Winplot:

- http://math.exeter.edu/rparris for Winplot and other good programs. **FREE**
- http://math.exeter.edu/rparris/winplot.html for the latest version directly
- Or just Google Winplot which will also give you links to instruction sites
- My web site: www.LinMcMullin.net/Winplot has the files demonstrated today and several others. You may download any and all.

Winplot has many built in features to help teaching and learning calculus. In this session we will look at those features and then learn how to make and animate polar graphs, parametric graphs and the how to animate parametric graphs and add vectors to them.

The notes here are to help you find the features you need and give you some information about the syntax and methods to set up your own illustrations and animations.

Syntax note:

- The Characteristic function: $chi(a,b,x) = \begin{cases} 1 & a \le x \le b \\ 0 & else \end{cases}$

Polar graphs

- Basic graph $r(t) = 3\cos(2t)$
- Moving point (Use Equa > point > (r,t)) (r,t) = (3cos(2a),a)
- Graph follows moving point r = 3cos(2t)chi(0,a,t); 0.000000 <= t <= 6.283190
- Add radius vector (Use Equa > Segment > (r,t))
  - r = 3cos(2t)chi(0,a,t); 0.000000 <= t <= 6.283190
  - (r,t) = (3cos(2a),a)
  - polar seg (0,0) to (3cos(2a),a)

Parametric Graphs

- Basic entry use Equa > parametric
- Adding vectors Use Equa > segment > (x,y)

- **Example 1: Ellipse – simple vector function** – then add velocity vector

  seg (0,0) to (2cos(a),0)
  seg (0,0) to (0,-3sin(a))
  seg (0,0) to (2cos(a),-3sin(a))
  hidden: xx/4+yy/9=1
  seg (0,-3sin(a)) to (2cos(a),-3sin(a))
  seg (2cos(a),0) to (2cos(a),-3sin(a))
  (x,y) = (2cos(t)chi(0,a,t)sqrt(sgn(a-t)),-3sin(t)chi(0,a,t)sqrt(sgn(a-t))); 0.000000 <= t <= 6.283190
  seg (2cos(a),-3sin(a)) to (2cos(a)+(-2sin(a)),-3sin(a)+(-3cos(a)))

- **Example 2: Cycloid**

  (x,y) = ((t-Asin(t))chi(0,u,t)sqrt(sgn(u-t)),(1-Acos(t))chi(0,u,t)sqrt(sgn(u-t))); 0.000000 <= t <= 30.000000
  (x,y) = (u+cos(t),sin(t)+1); 0.000000 <= t <= 6.283190
  (x,y) = (u-Asin(u),1-Acos(u))
  seg (u,1) to (u-Asin(u),1-Acos(u))
  (x,y) = (u,1)
  seg (0,0) to (u,0)
  seg (u,0) to (u,1)
  seg (u,1) to (u-Asin(u),1)
  seg (u-Asin(u),1) to (u-Asin(u),1-Acos(u))
  seg (0,0) to (u-Asin(u),1-Acos(u))
  seg (u-Asin(u),1-acos(u)) to (u-Asin(u)+1-Acos(u),1-Acos(u)+Asin(u))

- **Example 3: AP Exam example – 1999 BC 1** – class work (graph, show moving point, show velocity vector)