This exam will replace your lowest exam score. Period. If your grade on this exam is lower than your lowest score, it will still replace your lowest score. There are 5 problems on this exam. There are a total of 100 points possible. 

You must show all of your work for credit.

**Problem 1:** (20 points) Consider the conic section \(4y^2 - x^2 - 8y - 4x - 16 = 0\)

a) Name the conic section represented by this equation. 

b) Put the conic section in standard form. Show your work here.

c) Identify each of the following that applies to this conic section. Center, vertices, foci, directrix, endpoints of minor axes, and asymptotes. Tell me what the values are for this conic section.

d) Sketch the graph, showing all relevant values you found in part c).

**Problem 2:** (20 points) Consider the curve \(r = 2 \sin(3\theta)\).

a) Sketch the curve on the graph below.

b) Find the area inside one petal of the rose. Show all of your work for credit. Tell me how you determined the endpoints of integration.

**Problem 3:** (20 points) Consider the parametric equations \(x = t^2, \ y = 2t^2 + 1\).

a) Find \(\frac{dy}{dx}\) and \(\frac{d^2y}{dx^2}\).

b) Evaluate the first and second derivatives at the point \(t = 2\).

c) Find the equation of the tangent line at \(t = 2\).

d) Eliminate the parameter to find the corresponding rectangular equation.

**Problem 4:** (20 points) Find the arc length of the curve given by \(r = \theta, \ 0 \leq \theta \leq \pi\).

**Problem 5:** (20 points) Answer each of the following.

a) Find two polar representations. Include a sketch. \((x,y) = (2\sqrt{3}, -2)\)

b) Find the rectangular coordinates for the point \((r,\theta) = (-3, \frac{\pi}{3})\).

Include a sketch.

c) Convert the polar equation \(r = 2\sin \theta\) to rectangular form. Simplify.

d) Convert the rectangular equation \(x^2 = 3y\) to polar form. Put in the \(r = f(\theta)\) form.