**Parametric Curves**

\[ x = f(t) \quad y = g(t) \quad a \leq t \leq b \]

**Parametric Tangents**

\[
\frac{dy}{dx} = \frac{dy/dt}{dx/dt} \quad \frac{d^2y}{dx^2} = \frac{d}{dt} \left( \frac{dy}{dx} \right)
\]

**Parametric Area**

\[
A = \int_{a}^{b} y \, dx = \int_{a}^{b} g(t) f'(t) \, dt
\]

**Parametric Arc Length**

\[
L = \int_{a}^{b} \sqrt{\left( \frac{dx}{dt} \right)^2 + \left( \frac{dy}{dt} \right)^2} \, dt
\]

**Polar Curves**

\[ r = f(\theta) \]

\[ x = r \cos \theta \]

\[ y = r \sin \theta \]

**Polar Tangents**

\[
\frac{dy}{dx} = \frac{dy/d\theta}{dx/d\theta} = \frac{r \cos \theta + \sin \theta \frac{dr}{d\theta}}{-r \sin \theta + \cos \theta \frac{dr}{d\theta}}
\]

**Polar Area and Arc Length**

\[
A = \int_{a}^{b} \frac{1}{2} r^2 \, d\theta \quad L = \int_{a}^{b} \sqrt{r^2 + \left( \frac{dr}{d\theta} \right)^2} \, d\theta
\]

**Conic Sections**

**Parabola**

\[ x^2 = 4py \quad \text{focus} (0, p), \text{directrix } y = -p \]

**Circle**

\[(x - h)^2 + (y - k)^2 = r^2 \quad \text{radius } r, \text{ center } (h, k)\]

**Ellipse**

\[ \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \quad \text{or} \quad \frac{x^2}{b^2} + \frac{y^2}{a^2} = 1 \quad a > b \]

vertices \((\pm a, 0)\) or \((0, \pm a)\)

foci \((\pm c, 0)\) or \((0, \pm c)\), \(c^2 = a^2 - b^2\)

**Hyperbola**

\[ \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \quad \text{or} \quad \frac{y^2}{a^2} - \frac{x^2}{b^2} = 1 \]

vertices \((\pm a, 0)\) or \((0, \pm a)\)

foci \((\pm c, 0)\) or \((0, \pm c)\), \(c^2 = a^2 + b^2\)

asymptotes \(y = \pm \frac{b}{a} x\) or \(y = \pm \frac{a}{b} x\)

This study guide is a summary of the material that has been covered since the third exam. Note that it is not a complete list of topics that may appear on the comprehensive final exam.