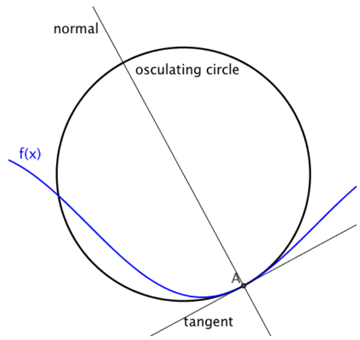
# The osculating circle

The "osculating circle" to a curve $C$ at a point $A$ on the curve is the circle tangent to the curve at point $A$ whose center is in the direction of the unit normal vector $\hat{\mathbf{N}}$ to the curve at point $A$ and whose curvature equals to the curvature $\kappa$ of the curve at the point $A$ (see the diagram below). Recalling that the curvature of a circle




of radius $r$ is $\kappa = \frac{1}{r}$, find:

1. The equation of the osculating circle to the graph of $f(x) = x^2$ at the point $(0, 0)$. Note: We can parameterize a function $f(x)$ as $\boldsymbol{r}(x) = \langle x, f(x) \rangle$.
2. The equation of the osculating circle to the graph of $f(x) = x^2$ at the point $(-1, 1)$.
3. The equation of the osculating circle to the graph of $f(x) = \sin(x)$ at the point $(\pi/2, 1)$.