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3) $x = \cos t + t\sin t$
$y = \sin t - t\cos t$

$$\frac{dy}{dx} = \frac{dy}{dt} \div \frac{dx}{dt}$$

$$\frac{dy}{dt} = -\sin t + (t\cos t + (1)\sin t)$$

$$\frac{dy}{dt} = -\sin t + t\cos t + \sin t$$

$$\frac{dx}{dt} = t\cos t$$

$$\frac{dy}{dx} = \cos t\ (-t\sin t + (1)\cos t)$$

$$\frac{dy}{dt} = \cos t - t\sin t + \cos t$$

$$\frac{dy}{dt} = 2\cos t - t\sin t$$

$$\frac{dy}{dx} = \frac{2\cos t - t\sin t}{t\cos t} = \frac{2\cos t}{t\cos t} - \frac{t\sin t}{t\cos t}$$

$$\frac{dy}{dx} \quad \frac{2}{t} - \frac{\sin t}{\cos t} = \frac{2}{t} - \tan t$$

$$2t^{-1} - \tan t$$

$$\frac{d^2y}{dx^2} = -2t^{-2} - \sec^2 t$$

$$\frac{d^2y}{dx^2} = \frac{d\left(\frac{dy}{dx}\right)}{dt} \times \frac{dt}{dx} \quad = \frac{d^2y}{dx^2}$$

$$\frac{d^2y}{dx^2} = \frac{2t^{-2} - \sec^2 t}{t\cos t}$$

Since $\sec t = \frac{1}{\cos t}$, $\sec^2 t = \left(\frac{1}{\cos t}\right)^2$

$$\frac{d^2y}{dx^2} = \frac{-2t^{-2} - \left(\frac{1}{\cos t}\right)^2}{t\cos t}$$

$$\frac{d^2y}{dx^2} = \frac{-2t^{-2}}{t\cos t} - \frac{1/\cos^2 t}{t\cos t}$$

$$\frac{d^2y}{dy^2} = 2t^{-2x(-1)} - \frac{1/\cos^2 t}{t\cos t}$$

$$\frac{d^2y}{dy^2} = \left(\frac{-2t^{-3}}{\cos t} - \frac{1}{t\cos^3 t}\right) = \frac{2t^{-3}}{\cos t} + \frac{1}{t\cos^3 t}$$

$$R = \frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}}{d^2y/dx^2}$$

$$R = \frac{\left[\left(1 + \frac{1}{t} - \tan t\right)^2\right]^{3/2}}{\left(\frac{2t^{-3}}{\cos t} + \frac{1}{t\cos^3 t}\right)}$$

ii $x - R\sin\theta = H$

$y + R\cos\theta = K$

$\cos t + t\sin t - R\sin\theta = H$

$\sin t + t\cos t - R\cos\theta = K$

$$h = \cos t + t\sin t - \left[\frac{\left[(1+2t - t\tan t)^2\right]^{3/2}}{\frac{2t^{-3}}{\cos t} + \frac{1}{t\cos^3 t}}\right] \sin\left(\tan^{-1}\left(\frac{\sin t + \cos t}{\cos t + t\sin t}\right)\right)$$

$\frac{dx}{dt} = -\sin$

1) Radius of Curvature (R)

$$R = \frac{\left(1 + \left(\frac{dy}{dx}\right)^2\right)^{3/2}}{\frac{d^2y}{dx^2}}$$

$$R = \left(1 + \left(\frac{dy}{dx}\right)^2\right)^{3/2} \times \frac{dx^2}{d^2y}$$

$$R = \left(1 + \left(\frac{\sin t}{\cos t}\right)^2\right)^{3/2} \times t\cos^2 t$$

$$R = \left(1 + \frac{\sin^2 t}{\cos^2 t}\right)^{3/2} \times t\cos^2 t$$

$$R = \left(1 + \frac{\sin^2 t}{\cos^2 t}\right)^{3/2} \times t\cos^2 t$$

From trig we know $\sin^2 x + \cos^2 x = 1$

$$R = \sqrt{\left(\frac{1}{\cos^2 t}\right)^3} \times t\cos^2 t$$

$$R = \frac{1}{\sqrt{(\cos^2 t)^3}} \times t\cos^2 t$$

$$R = \frac{1}{\cos^2 t \times \sqrt{\cos^2 t}} \times t\cos^2 t$$

$$R = \frac{1}{\cos^2 t} \times t\cos^2 t$$

$R = t$

$\frac{\sin t + \cos t}{\cos t + \tan t}$

Coordinate of centre of Curvature (h,k)

$h = x_1 - r\sin\theta$

$k = y_1 + r\cos\theta$

$x_1 = \cos t + t\sin t$ $\qquad r = t$

$y_1 = \sin t - t\cos t$ $\qquad \theta = t$

$h = \cos t + t\sin t - t\sin t$

$h = \cos t$

$k = \sin t - t\cos t + t\cos t$

$k = \sin t$

$\therefore (h,k) = (\cos t, \sin t)$