

**M20550 Calculus III Tutorial
Practice Problems**

1. Find the unit tangent, the (principal) unit normal, and the binormal vectors to the curve $\mathbf{r}(t) = \langle \sin 2t, \cos 2t, 3t^2 \rangle$ at $t = \pi$.
2. Find the equation for the normal and osculating planes to the curve $\mathbf{r}(t) = 2 \cos(3t)\mathbf{i} + t\mathbf{j} + 2 \sin(3t)\mathbf{k}$ at the point $(-2, \pi, 0)$.
3. A particle moves with position function $\mathbf{r}(t) = \langle \cos t, \sin t, \cos^2 t \rangle$. Find the tangential and normal components of acceleration when $t = \pi/4$.
4. Find the arc length of the curve $\mathbf{r}(t) = \langle 2t, t^2, \frac{1}{3}t^3 \rangle$, $0 \leq t \leq 1$.