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M20550 Calculus III Tutorial
Worksheet 3

1. Imagine a wheel of unit radius rolling from left to right along the x-axis in the xy-plane with a constant angular velocity of $\frac{1rad}{sec}$. Let p be the point on the wheel that has coordinates $(0,0)$ at time $t=0$. Find a vector valued function that describes the position of p at time t. What if the wheel had radius a? (The curve traced out by the motion of this point is called a cycloid.)

2. Find an equation of the tangent line to the space curve $\mathbf{r}(t) = \langle 2t^3, 3t^2, 3t \rangle$ at the point $(-2,3,-3)$.

3. Find the distance from the point $(0,1,-1)$ to the space curve given by $\mathbf{r}(t) = \left\langle \sqrt{t}, 2t, -t \right\rangle$.

4. Find $\mathbf{r}(t)$ if $\mathbf{r}''(t) = e^t\mathbf{i}$, $\mathbf{r}(0) = 2\mathbf{i} + 3\mathbf{j} + 2\mathbf{k}$, and $\mathbf{r}'(0) = \mathbf{i} + \mathbf{j} + \mathbf{k}$.

5. Find the unit tangent vector, the principal unit normal vector, and the unit binormal vectors to the curve $\mathbf{r}(t) = \langle \sin 2t, \cos 2t, 3t^2 \rangle$ at $t = \pi$.

6. 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 $(-2, \pi, 0)$.

7. Find the length of the curve $\mathbf{r}(t) = \left\langle 2t, t^2, \frac{1}{3}t^3 \right\rangle$ from $(0,0,0)$ to $\left(2, 1, \frac{1}{3}\right)$.

8. A particle moves with position function $\mathbf{r}(t) = \langle \sin t, \cos t, \cos^2 t \rangle$. Find the tangential and normal components of acceleration when $t = \pi/4$.