Math 3202

- 1. Let trajectory be given by vector function  $\vec{r}(t) = (t \cos(2t), t \sin(2t), 0)$ . Find velocity vector  $\vec{v}(t) = \vec{r}'$ , angular momentum vector  $\vec{L}(t) = \vec{r} \times \vec{v}$ , acceleration vector  $\vec{a}(t) = \vec{r}''$  and torque vector  $\vec{\tau}(t) = \vec{r} \times \vec{a}$ . Is there a moment of time where vectors  $\vec{r}$  and  $\vec{v}$  are perpendicular?
- 2. Let trajectory be given by vector function  $\vec{r}(t) = (\cos(2t), \sin(2t), t)$ . Find velocity vector  $\vec{v}(t) = \vec{r'}$ , angular momentum vector  $\vec{L}(t) = \vec{r} \times \vec{v}$ , acceleration vector  $\vec{a}(t) = \vec{r'}$  and torque vector  $\vec{\tau}(t) = \vec{r} \times \vec{a}$ .
- 3. (a) Is the curve  $\vec{r}(t) = (t^3, t^2, t)$  smooth?
  - (b) Is it true of false that the curve given by  $\vec{r}(t) = (f(t), g(t), t)$  is smooth regardless of what the functions f(t) and g(t) are, as long as they are differentiable?
- 4. Use definition of the cross product and the product rule for differentiation to show that

$$(\vec{x} \times \vec{y})' = \vec{x}' \times \vec{y} + \vec{x} \times \vec{y}'.$$

- 5. Find the length of the curve
  - (a)  $\vec{r} = (3t^2, 12t, 8t^{3/2})$  where  $0 \le t \le 2$ .
  - (b)  $\vec{r} = (3t, 4\sin t, 4\cos t)$  where  $-1 \le t \le 10$
- 6. Find the curvature and normal and binormal vectors at given point
  - (a)  $\vec{r}(t) = (t, t^3, 0)$  at (1, 1, 0)
  - (b)  $\vec{r}(t) = (e^t, e^t \sin t, e^t \cos t)$  at (1, 0, 1)
- 7. Find and graph the osculating circle of the hyperbola y = 2/x at point (1, 2).