# Problem Sheet 3 for the Tutorial, October 13.

(Vector-Valued Functions and Motion in Space.)

**Problem 1.** Find the length of the curve $\mathbf{r}(t) = (\sqrt{2}t)\mathbf{i} + (\sqrt{2}t)\mathbf{j} + (1 - t^2)\mathbf{k}$ from $(0, 0, 1)$ to $(\sqrt{2}, \sqrt{2}, 0)$.

**Solution:**

**Problem 2.** Find $\mathbf{T}$, $\mathbf{N}$, and $\kappa$ for the space curves defined by position vector $\mathbf{r}(t) = (\cos^3 t)\mathbf{i} + (\sin^3 t)\mathbf{j}$, $0 < t < \pi/2$.

**Solution:**

**Problem 3.** Show that a moving particle will move in a straight line if the normal component of its acceleration is zero.

**Solution:**

**Problem 4.** Find parametric equations for the line that is tangent to the curve $\mathbf{r}(t) = e^t\mathbf{i} + (\sin t)\mathbf{j} + \ln(1-t)\mathbf{k}$ at $t = 0$.

**Solution:**

**Problem 5.** Evaluate the integrals:

$$\int_0^1 \left[ t^3\mathbf{i} + 7\mathbf{j} + (t+1)\mathbf{k} \right] dt$$

$$\int_0^1 \left[ te^{t^2}\,\mathbf{i} + e^{-t}\,\mathbf{j} + \mathbf{k} \right] dt$$

**Solution:**