University of Delaware
Department of Mathematical Sciences

MATH-243 – Analytical Geometry and Calculus C
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Fall 2012

Homework 4

Due date: September 25, 2012

Problems

Taken or adapted from Sections 12.6–13.2 the book *Calculus: Early Transcendentals* 7th edition by J. Stewart.

You need to study Section 12.6 in order to solve some of the following problems.

1. Reduce the equation $x^2 = 2y^2 + 3z^2$ to one of the standard forms, classify the surface and sketch it.
2. Reduce the equation $4x - y^2 + 4z^2 = 0$ to one of the standard forms, classify the surface and sketch it.
3. Reduce the equation $4y^2 + z^2 - x - 16y - 4z + 20 = 0$ to one of the standard forms, classify the surface and sketch it.
4. Reduce the equation $x^2 - y^2 + z^2 - 2x + 2y + 4z + 2$ to one of the standard forms, classify the surface and sketch it.
5. Show that the space curve described by $\vec{r}(t) = \langle t^2, 1-3t, 1+t^3 \rangle$ passes through the points $(1, 4, 0)$ and $(9, -8, 28)$, but not through the point $(4, 7, -6)$.
6. If two objects travel through space along two different curves, it is often important to know whether they will collide. The curves might intersect, but we need to know whether the objects are in the same position *at the same time*. Suppose the trajectories of two particles are given by the vector functions

$$\vec{r}_1(t) = \langle t, t^2, t^3 \rangle \qquad \vec{r}_2(t) = \langle 1 + 2t, 1 + 6t, 1 + 14t \rangle$$

   Do the particles collide? Do their paths intersect?
7. Find the unit tangent vector $\vec{T}(t)$ to the space curve $\vec{r}(t) = \langle 2\cos(t), 2\cos(t), \tan(t) \rangle$ at $t = \pi/4$.

8. If $\vec{r}(t) = \langle e^{2t}, e^{-2t}, te^{2t} \rangle$, find $\vec{T}(0)$, $\vec{r}\,''(0)$, and $\vec{r}\,'(t) \cdot \vec{r}\,''(t)$.

9. Find the parametric equations for the tangent line to the curve given by $\vec{r}(t) = \langle t, e^{-t}, 2t - t^2 \rangle$, at the point $(0, 1, 0)$. Hint: The direction vector of the tangent line at a point A, is equal to the unit tangent vector at that same point.

10. Find the parametric equations for the tangent line to the curve given by $\vec{r}(t) = \langle t\cos(t), t, t\sin(t) \rangle$, at the point $(-\pi, \pi, 0)$.