1. Write a Maple procedure that takes as an argument a chart **x**, two parameter names (e.g. u v, an initial point (in (u,v) coordinates) and an initial velocity (u',v') and returns a procedure that gives a curve (in your choice of (u,v) or (x,y,z) coordinates) that represents the corresponding geodesic. You will want to use Maple's dsolve command with the numeric option here.

2. Use Maple to generate plots of geodesics on the one-sheeted hyperboloid $x^2 - z^2 = 1$ with angular velocities $\Omega = 0.5, 0.8, 1$ (both kinds), 1.2, and 2.

3. Use the Clairaut relation to give a qualitative description of all the geodesics on the torus. Be sure to discuss all cases of values of the angular momentum.

4. A chart into the pseudosphere is given by

$$\mathbf{x}(u,v) = \left[\frac{1}{u}\cos(v), \frac{1}{u}\sin(v), \sqrt{1-\frac{1}{u^2}} - \operatorname{arccosh}(u)\right]$$

where $u > 1$ and $-\pi < v < \pi$. (The constraint on v can be relaxed, but the constraint on u is required for smoothness).

   a) Show (by hand or otherwise) that for this chart $E = F = 1/w^2$ and $G = 0$.

   b) Show that every geodesic in local coordinates is either contained in a line $v = v_0$ or satisfies
   $$(v - v_0)^2 + u^2 = \frac{1}{\Omega^2}$$
   where Ω is the angular momentum of the geodesic.

   c) Draw what geodesics look like in local coordinates, and use Maple to generate plots of some corresponding geodesics on the pseudosphere.

5. Oprea 5.2.14