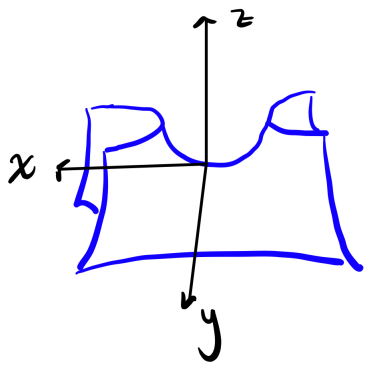
Instructions. Show all work, with clear logical steps. No work or hard-to-follow work will lose points.

1.) (5 points) Classify and sketch the surface given by $z = x^2 - y^2$.

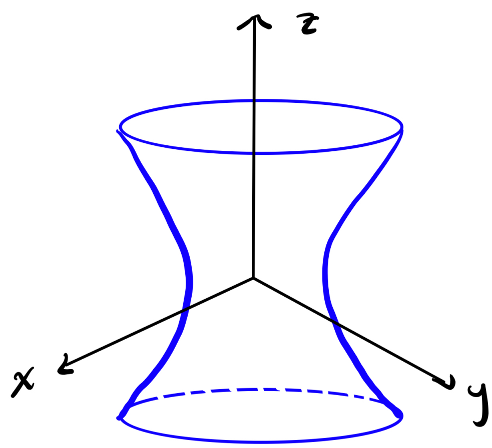
Solution. Hyperbolic paraboloid.



$\square$

2.) (5 points) Classify and sketch the surface given by $x^2 + y^2 = 1 + z^2$.

Solution. Hyperboloid of one sheet; axis of symmetry is z-axis.



$\square$

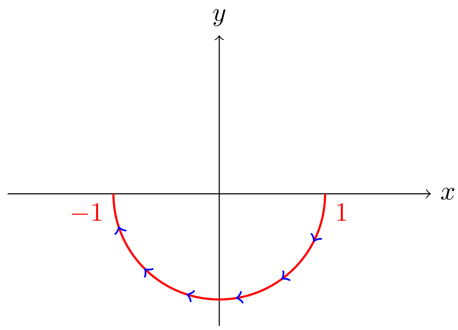
3.) (5 points) Graph the curve and indicate the direction of positive orientation of the function

$$\mathbf{r}(t) = \langle \cos \pi t, -\sin \pi t \rangle, \quad 0 \le t \le 1.$$

Solution. We know $\mathbf{r}(t) = \langle \cos \pi t, \sin \pi t \rangle$, with $0 \le t \le 2$ describes a circle oriented counter-clockwise. So

$$\mathbf{r}(-t) = \langle \cos(-\pi t), \sin(-\pi t) \rangle = \langle \cos \pi t, -\sin \pi t \rangle$$

describes a circle oriented clockwise. Since here we have $0 \le t \le 1$, it's just the lower half-circle.



□

4.) (5 points) Find the domain of the following function.

$$\mathbf{r}(t) = \left\langle \frac{1}{t}, \sqrt{1+t} \right\rangle$$

Solution. In the first component, we need $t \neq 0$, and in the second component we need $t \geq -1$. So the domain is $\{t : t \in [-1, 0) \cup (0, \infty]\}$. □