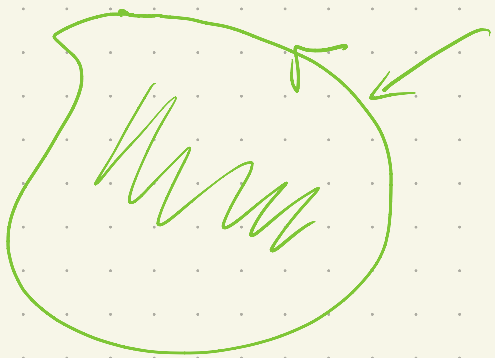
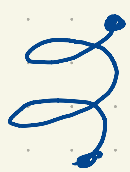


$$\boxed{\vec{r}(t) = \langle \cos(2t), \sin(2t), t \rangle \qquad 0 \le t \le 2\pi}$$



$\leftarrow t = 2\pi \quad (z = 2\pi)$

$\leftarrow t = 0 \quad (z = 0)$

$$\boxed{\vec{q}(s) = \langle \cos(s), \sin(s), s/2 \rangle \qquad 0 \le s \le 4\pi}$$

$$\vec{r}(u,v) = \langle x(u,v), y(u,v), z(u,v) \rangle$$

"parameterized surface"

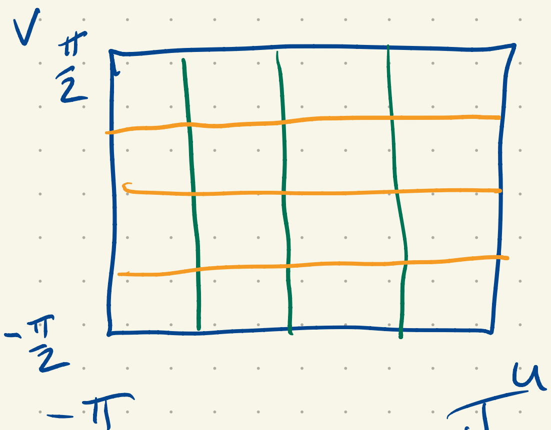
$$\vec{r}(u,v) = \langle \underbrace{\cos u \cos v}_{x(u,v)}, \sin u \cos v, \sin v \rangle$$

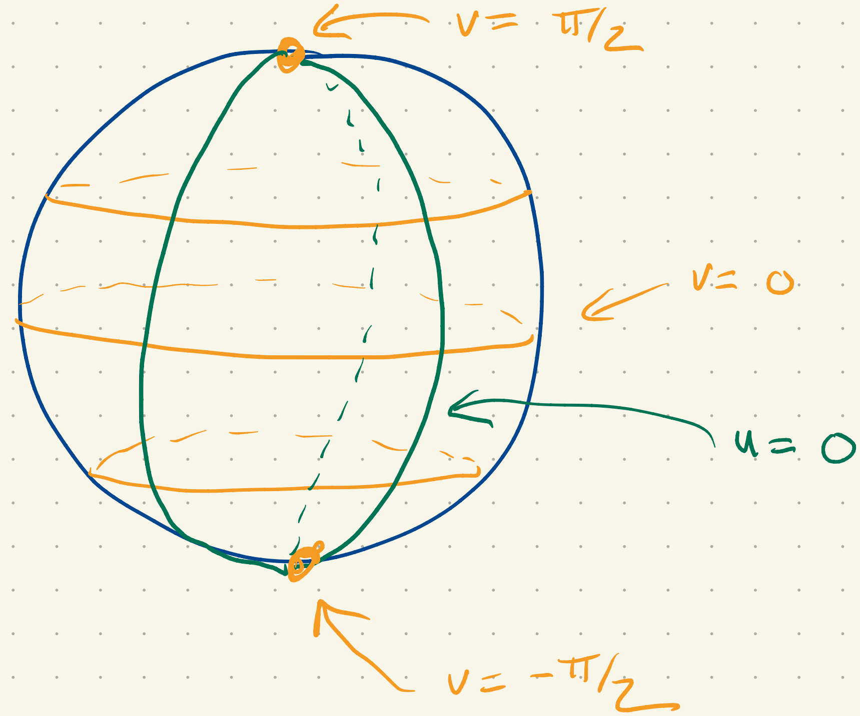
$$\langle \cos v, 0, \sin v \rangle$$

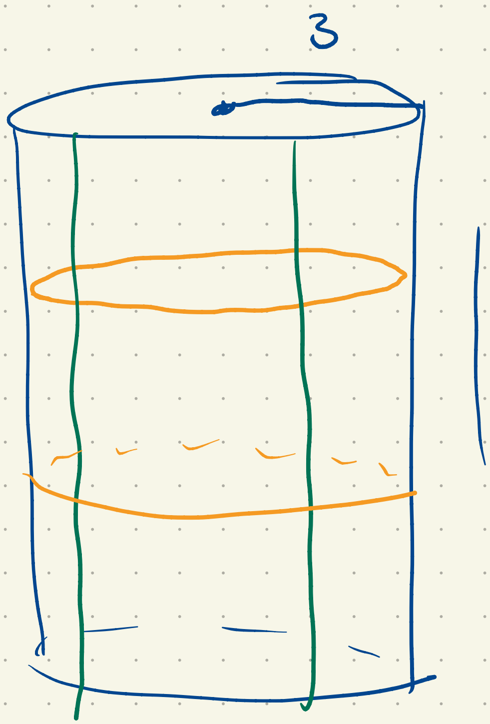
$$x^2 + y^2 = \cos^2 u \cos^2 v + \sin^2 u \cos^2 v$$

$$= \cos^2 v$$

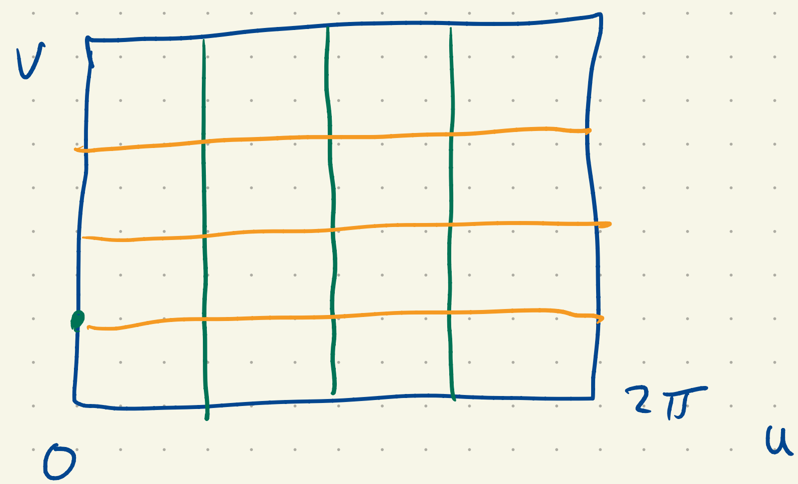
$$x^2 + y^2 + z^2 = \cos^2 v + \sin^2 v = 1$$



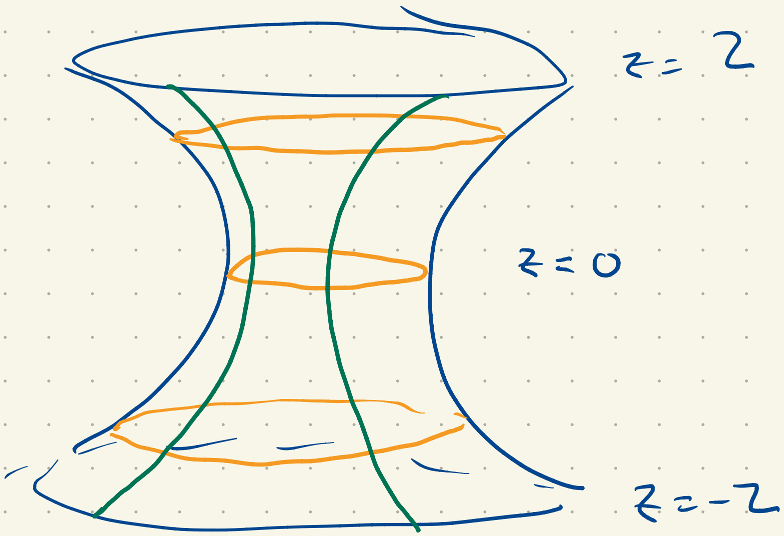




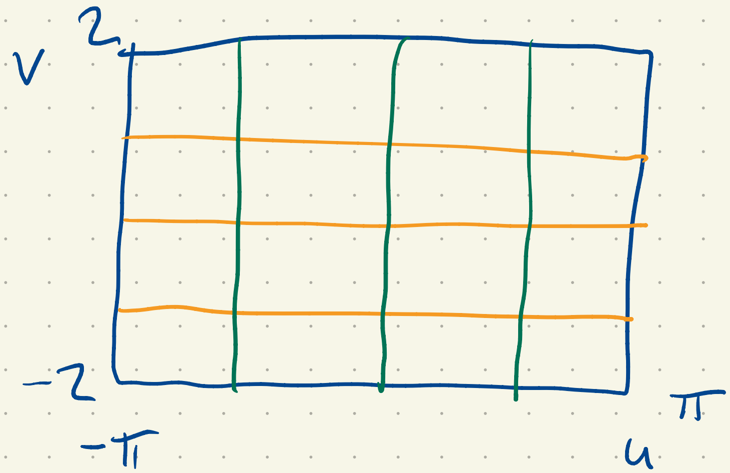
$$x^2 + y^2 = 9$$



$$\vec{r}(u,v) = \langle 3\cos(u),\ 3\sin(u),\ v \rangle$$



$$x^2 + y^2 = z^2 + 1 \qquad r = \sqrt{z^2+1}$$



$$\vec{r}(u,v) = \langle r\cos u,\ r\sin u,\ v \rangle$$

$$\int_{-2}^{2}\int_{-\pi}^{\pi} \bigcirc \, du\, dv$$

$$= \langle \sqrt{v^2+1}\cos u,\ \sqrt{v^2+1}\sin u,\ v \rangle$$

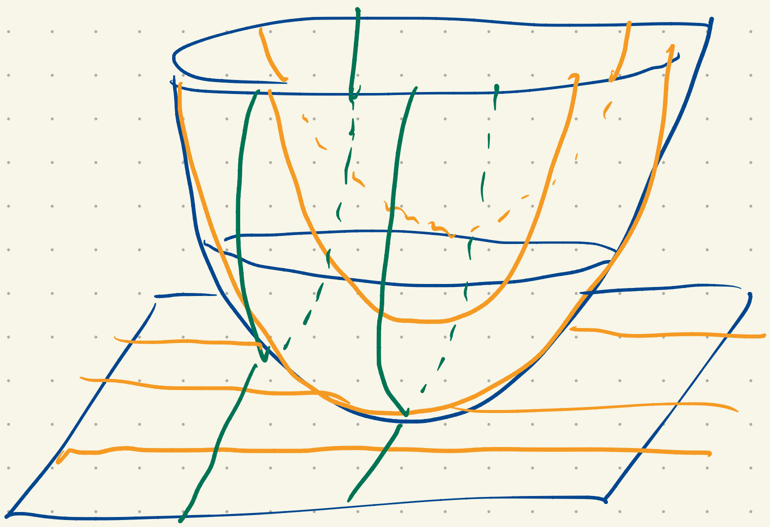
$$x^2 + y^2 = (v^2+1)\cos^2 u + (v^2+1)\sin^2 u = v^2 + 1$$

$$z^2 + 1 = v^2 + 1$$

$= \checkmark$

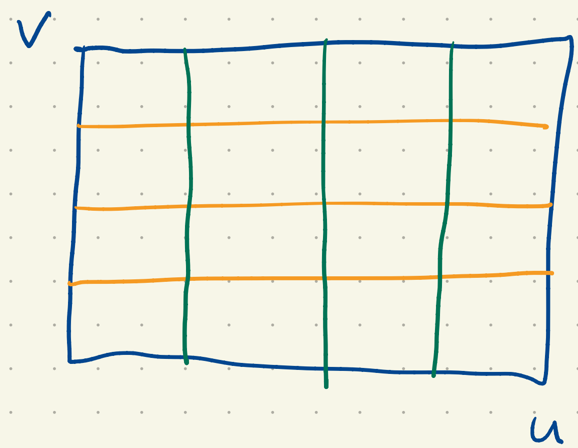
$z = f(x,y)$

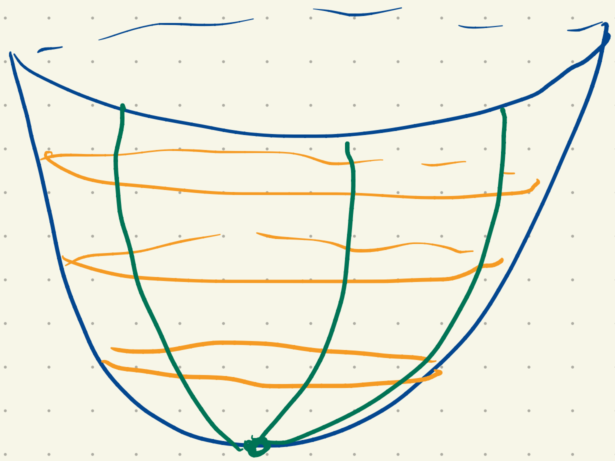
$z = x^2 + y^2$



$\vec{r}(u,v) = \langle u, v, f(u,v) \rangle$

$\vec{r}(u,v) = \langle u, v, u^2 + v^2 \rangle$

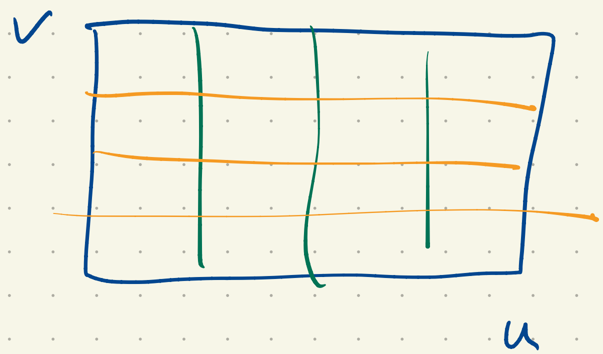




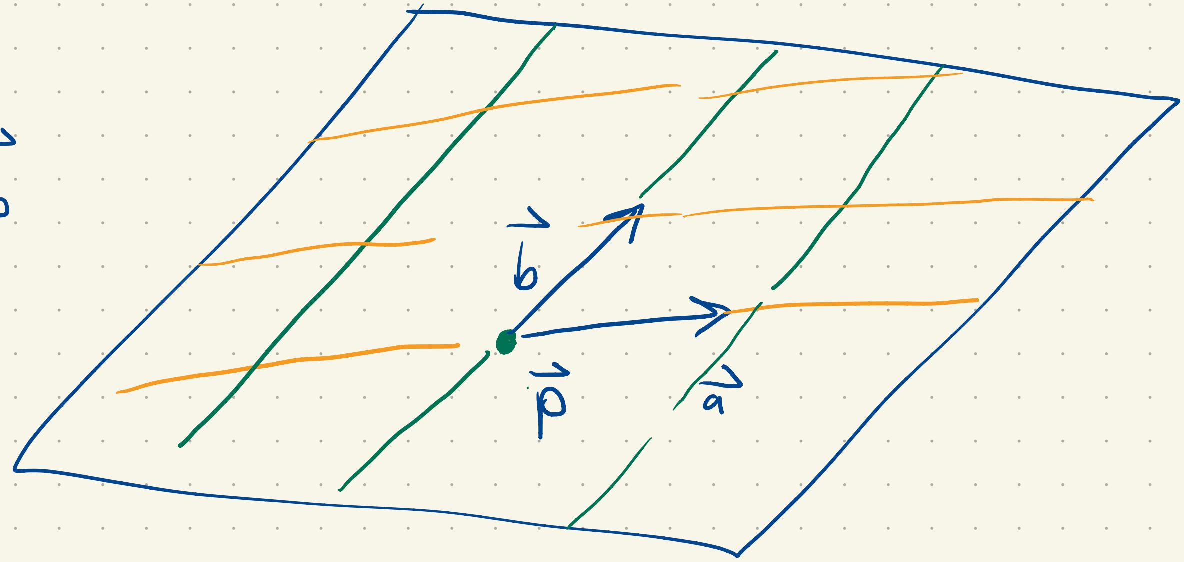
$$z = x^2+y^2$$

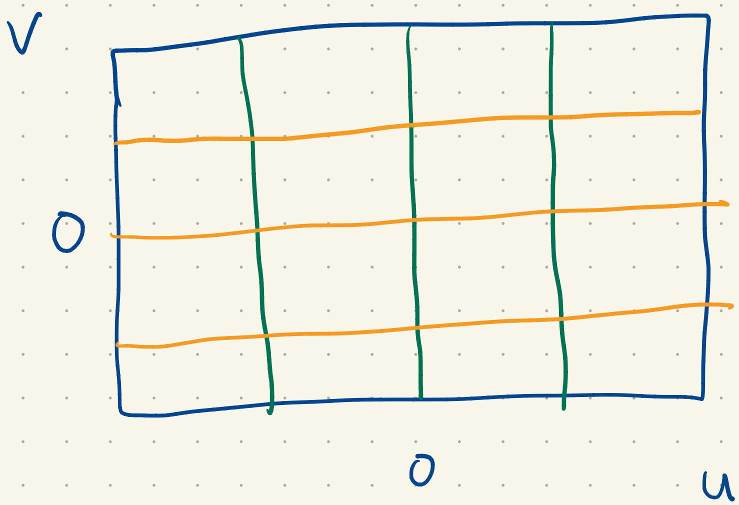
$$\vec{r}(u,v) = \langle \sqrt{v}\cos u, \sqrt{v}\sin u, v \rangle$$

$$x^2+y^2 = v\cos^2 u + v\sin^2 u = v = z \checkmark$$



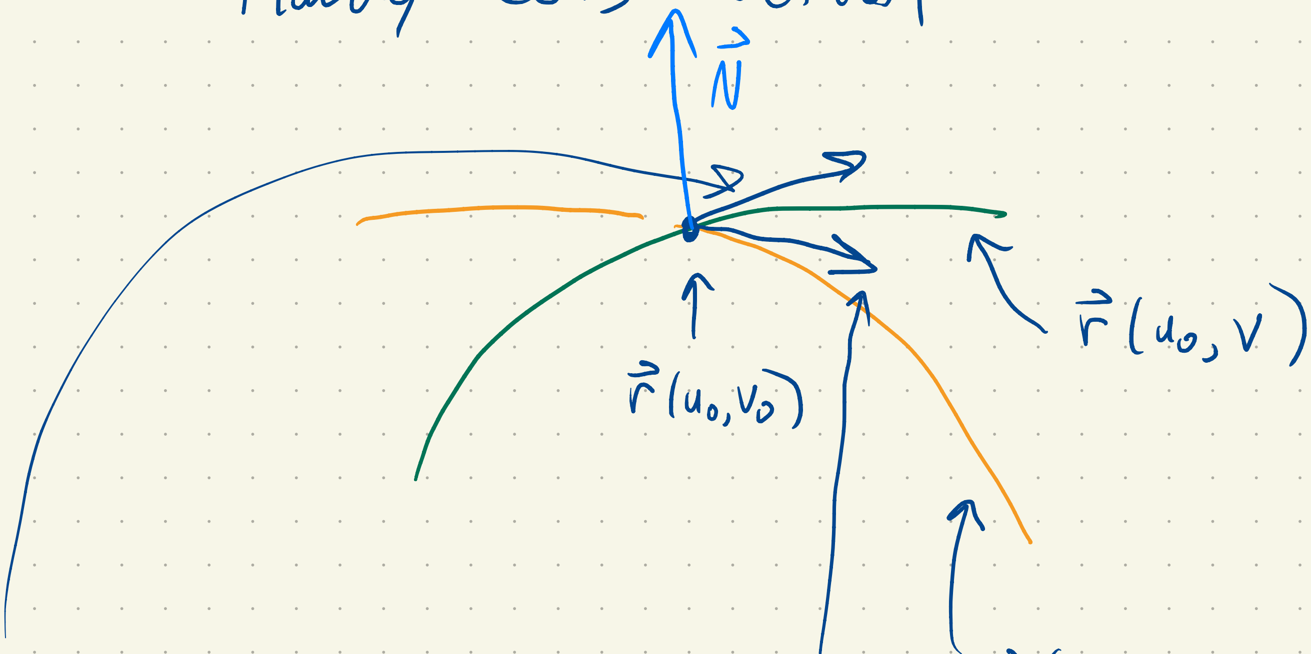
$$\vec{r}(u,v) = \vec{p} + u\vec{a} + v\vec{b}$$

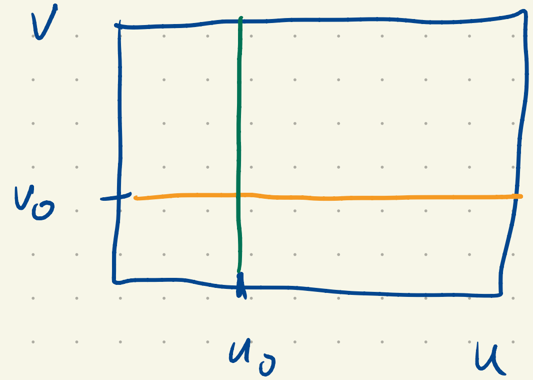




$$\vec{r}(t) = \vec{p} + t\vec{v}$$

Handy Construction





$$\frac{\partial \vec{r}}{\partial v}(u_0, v_0)$$

$$\frac{\partial \vec{r}}{\partial u}(u_0, v_0)$$

$$\frac{\partial x}{\partial u}(u_0, v_0)$$

$$\longrightarrow \left\langle \frac{\partial x}{\partial u}, \frac{\partial y}{\partial u}, \frac{\partial z}{\partial u} \right\rangle$$

$$\vec{N} = \frac{\partial \vec{r}}{\partial u} \times \frac{\partial \vec{r}}{\partial v}$$

$$\vec{r}(u,v) = \langle \cos u, \sin u, v \rangle$$

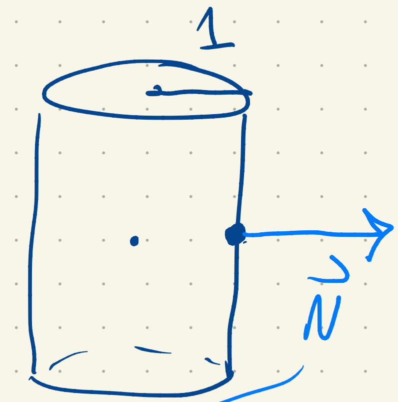
$$\frac{\partial \vec{r}}{\partial u} = \langle -\sin u, \cos u, 0 \rangle$$

$$\frac{\partial \vec{r}}{\partial v} = \langle 0, 0, 1 \rangle$$

$$\vec{N} = \frac{\partial \vec{r}}{\partial u} \times \frac{\partial \vec{r}}{\partial v} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -\sin u & \cos u & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

$$= \langle \cos u, \sin u, 0 \rangle$$

$$\vec{N}(0,0) = \langle 1, 0, 0 \rangle$$



$u=0, v=0$

$\langle 1, 0, 0 \rangle$

parallel to $\langle 1, 0, 0 \rangle$