1. Describe the volume being integrated over, and compute the iterated integral.

(a) \[ \int_0^5 \int_0^{\sqrt{25-x^2}} \int_0^{\sqrt{x^2+y^2}} z \, dz \, dy \, dx \]

(b) \[ \int_0^{2\pi} \int_0^{1+\sin(x)} \int_0^{1+\sin(x)} 2z \, dz \, dy \, dx \]

2. Sketch the region of integration for the iterated integral \[ \int_0^1 \int_x^1 \int_0^{1-x} f \, dz \, dy \, dx \], and express it in the five other possible orders of integration.

Suggestions: (1) The region being integrated over is a tetrahedron, and it may help to work out its vertices. (2) Besides a 3D sketch, it will also be helpful to sketch the projection of the region on the xy-, xz-, and yz-planes.

3. For each of the following surfaces, find a parameterization, and compute the tangent vectors and normal vectors in terms of that parameterization:

(a) The graph of \( f(x, y) = 9 - xy \) over the circle \( x^2 + y^2 \leq 9 \).

(b) The part of the sphere \( x^2 + y^2 + z^2 = 4 \) above the plane \( z = 1 \) (i.e., with \( z \geq 1 \)).

(c) The surface obtained by rotating the line segment connecting \( (1, 0, 2) \) to \( (4, 0, 0) \) about the \( z \)-axis.

4. Let \( S \) be the helicoid parameterized by \( (v \cos(\theta), v \sin(\theta), \theta) \) with \( (\theta, v) \in [0, 4\pi] \times [0, 1] \). A picture of the helicoid is shown at right.

(a) Find the area of \( S \) (equivalently, find \( \iint_S 1 \, dS \)).

(b) Find the average value of the function \( f(x, y, z) = yz \) over \( S \).

The antiderivative \( \int \sqrt{1 + u^2} \, du = \frac{1}{2} \left(u \sqrt{1 + u^2} + \ln \left(u + \sqrt{1 + u^2}\right)\right) \) may be useful in this question.

5. Fix a radius \( r > 0 \) and two angles \( \varphi_1 \) and \( \varphi_2 \), with \(-\frac{\pi}{2} \leq \varphi_1 \leq \varphi_2 \leq \frac{\pi}{2}\). Find the surface area of the portion of the sphere of radius \( r \) with latitudes between \( \varphi_1 \) and \( \varphi_2 \).