Problem 1: Describe Region
For all the region:
1. Sketch the region $D$;
2. Write the iterated integral on this region.

1. The region bounded by $z = x^2 + y^2$ and $z = 4$;
2. The region in the first octant bounded by $x + y + z = 9$, $2x + 3y = 18$ and $x + 3y = 9$.
3. The region bounded by $x^2 + y^2 = 1$ and $z = 0$, $z = 5$.
4. The region in the first octant bounded by $x^2 + y^2 = a^2$, and $z = x + y$.
5. The region in the first octant bounded by $x^2 + y^2 + z^2 = 1$.
6. The region bounded by $x^2 + y^2 + z^2 = 2$ and $z = \sqrt{x^2 + y^2}$.

Problem 2: Cylinder Coordinate
For the following region $D$, write the integral with cylinder coordinate.
1. Problem 1.1
2. Problem 1.3
3. Problem 1.4
4. Problem 1.6
Problem 3: Sphere Coordinate
For the following region $D$, write the integral with sphere coordinate.

1. Problem 1.5
2. Problem 1.6
1. Projection to $xy$-plane:

\[ z = x^2 + y^2 \rightarrow x^2 + y^2 = 4 \]

2. Projection to $xy$-plane:

The shape is $ABCD$, like a wedge.

\[ \int\int_{-2}^{2} f(2-x^2-y^2) \, dx \, dy \]

3. Projection:

A cylinder

\[ \int\int_{-1}^{1} \int_{-\sqrt{1-x^2}}^{\sqrt{1-x^2}} f(z, y, x) \, dz \, dy \, dx \]

4. Projection:

\[ x^2 + y^2 \leq a^2 \]

\[ \int\int_{-a}^{a} \int_{-\sqrt{a^2-x^2}}^{\sqrt{a^2-x^2}} f(z, y, x) \, dz \, dy \, dx \]
5. \[ \int \int \int_{D} f \cdot dV = \int \int_{D} f \cdot dz \, dy \, dx \]

6. \[ \int \int \int_{D} f \cdot dV = \int \int_{D} f \cdot dz \, dy \, dx \]

Projection
\[ \begin{cases} x^2 + y^2 + z^2 = 2 \\ z = \sqrt{x^2 + y^2} \end{cases} \Rightarrow x^2 + y^2 = 1 \]

Cylinder:
1. \[ \int_{0}^{2\pi} \int_{0}^{2} \int_{r}^{4} f \cdot r \, dz \, dr \, d\theta \]
2. \[ \int_{0}^{2\pi} \int_{0}^{1} \int_{0}^{5} f \cdot r \, dz \, dr \, d\theta \]
3. \[ \int_{0}^{\pi} \int_{0}^{\alpha} \int_{r\cos \theta + r\sin \theta}^{r} f \cdot r \, dz \, dr \, d\theta \]
4. \[ \int_{0}^{2\pi} \int_{0}^{1} \int_{0}^{2-r^2} f \cdot r \, dz \, dr \, d\theta \]
Sphere: 

1. \[ \int_0^1 \int_0^{2\pi} \int_0^\pi f(\rho \sin \phi) \, \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta \]

2. \[ \int_0^{\sqrt{2}} \int_0^{2\pi} \int_{\pi/4}^{\pi/2} f(\rho \sin \phi) \, \rho^2 \sin \phi \, d\rho \, d\phi \, d\theta \]