# Problem 1

1. *(10 points)* Let $\boldsymbol{r_1}$ be the line passing through the point $P = (1, 0, 1)$ and with direction $(1, -1, 0)$. Write the equation of the line in parametric and symmetric form.
2. *(10 points)* Find the equation of the line $\boldsymbol{r_2}$ obtained by intersecting the planes $x + y - z = 2$ and $2x + 2y + z = 3$.
3. *(10 points)* Find the equation of the plane passing through $\boldsymbol{r_1}$ and the line $\boldsymbol{r_3}(t) = (t, -t, 0)$.
4. *(5 points)* Consider the line intersecting $\boldsymbol{r_1}$ in $P$ and with direction $(1, 1, 1)$. What is the angle of this line with $\boldsymbol{r_1}$? Is this line orthogonal to the plane you found in part 3?

# Problem 2

Consider the function $f : D \subset \mathbb{R}^2 \to \mathbb{R}$ given by $f(x, y) = \sqrt{x^2 - y^2}$.

1. *(15 points)* Find and sketch the domain $D$ and the level curves of $f$ in $\mathbb{R}^2$.
2. *(15 points)* Consider the point $P = (1, 0)$. Find the unitary directions $\vec{v}$ along which the partial derivative of $f$ in $P$ has value $\frac{1}{2}$. What are the lowest and highest values of the directional derivatives of $f$ in $P$?
3. *(5 points)* Is $f$ differentiable at the origin?
4. *(5 points)* Let $A = \{(x, y) | x^2 + y^2 - 6x \leq 10\}$. Find the absolute maximum and minimum of $f$ in $A$.

# Problem 3

1. *(10 points)* Find the volume of the solid inside the cylinder $(x - 1)^2 + (y - 1)^2 = 1$ and below the paraboloid $z = 30 - 3x^2 - y^2$.
2. *(10 points)* Find the volume of the solid inside the sphere $x^2 + y^2 + z^2 = 1$ and outside the cone $z = \sqrt{x^2 + y^2}$.
3. *(10 points)* Use cylindrical coordinates to find the volume of the solid inside the sphere $x^2 + y^2 + z^2 = 1$ and below the plane $z = \frac{\sqrt{2}}{2}$.
4. *(5 points)* Set up the integral from part 3 in spherical coordinates.