1. Contours, open and closed sets

1. Determine contours and domains of the following functions.

$$f_1(x,y) = x + \sqrt{y}, \qquad f_2(x,y) = \frac{y}{x}, \qquad f_3(x,y) = x^2 + y^2,$$
$$f_4(x,y) = x^2 - y^2, \qquad f_5(x,y) = \sqrt{xy},$$
$$f_6(x,y) = \sqrt{1 - x^2 - y^2}, \qquad f_7(x,y) = \frac{1}{\sqrt{x^2 + y^2 - 1}},$$
$$f_8(x,y) = \sqrt{(x^2 + y^2 - 1)(4 - x^2 - y^2)}, \qquad f_9(x,y) = \sqrt{\sin(x^2 + y^2)},$$
$$f_{10}(x,y) = \operatorname{sgn}(\sin x \cdot \sin y), \qquad f_{11}(x,y) = |x| + y.$$

2. Decide whether the following sets are open or closed, determine their interior, closure and boundary.

$$A_1 = \mathbb{Q}, \qquad A_2 = \mathbb{N}, \qquad A_3 = \{1/n;\ n \in \mathbb{N}\},$$
$$A_4 = \{[x,y] \in \mathbb{R}^2;\ x > 0,\ y \leq 0\}, \qquad A_5 = \{[x,y] \in \mathbb{R}^2;\ x^2 + y^2 < 1\},$$
$$A_6 = \{[x,y] \in \mathbb{R}^2;\ x^2 + y^2 \geq 1\}, \qquad A_7 = \{[x,y] \in \mathbb{R}^2;\ x^2 + e^y > 17\},$$
$$A_8 = \{[x,y] \in \mathbb{R}^2;\ x^2 + y^2 + 2xy = 5\},$$
$$A_9 = \{[x,y,z] \in \mathbb{R}^3;\ x \geq 0, y > 0, x + y = 2, z \leq 0\}.$$

3. Determine closure, boundary and interior of the set $M = \{(x,y) \in \mathbb{R}^2;\ |x+y| - x - y > 0\}$.