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All objects considered here are in the plane $\mathbb{E}^2$.

1. Determine parametric equations for the line ℓ in the following cases:

a) ℓ contains the point $A(1,2)$ and is parallel to the vector $\mathbf{a}(3,-1)$,

b) ℓ contains the origin and is parallel to $\mathbf{b}(4,5)$,

c) ℓ contains the point $M(1,7)$ and is parallel to Oy,

d) ℓ contains the points $M(2,4)$ and $N(2,-5)$.

2. For the lines ℓ in the previous exercise

a) give a Cartesian equation for ℓ,

b) describe all direction vectors for ℓ.

3. Determine a Cartesian equations for the line ℓ in the following cases:

a) ℓ has slope -5 and contains the point $A(1,-2)$,

b) ℓ has slope 1 and is at distance 2 from the origin,

c) ℓ contains the point $A(-2,3)$ and has an angle of $60°$ with the Ox-axis,

d) ℓ contains the point $B(1,7)$ and is orthogonal to $\mathbf{n}(4,3)$.

4. For the lines ℓ in the previous exercise

a) give parametric equations for ℓ,

b) describe all normal vectors for ℓ.

5. Consider a line ℓ. Show that

c) if $\mathbf{v}(v_1,v_2)$ is a direction vector for ℓ then $\mathbf{n}(v_2,-v_1)$ is a normal vector for ℓ,

d) if $\mathbf{n}(n_1,n_2)$ is a normal vector for ℓ then $\mathbf{v}(n_2,-n_1)$ is a direction vector for ℓ.

6. Consider the points $A(1,2)$, $B(-2,3)$ and $C(4,7)$. Determine the medians of the triangle ABC.

7. Let $M_1(1,2)$, $M_2(3,4)$ and $M_3(5,-1)$ be the midpoints of the sides of a triangle. Determine Cartesian equations and parametric equations for the lines containing the sides of the triangle.

8. Let $A(1,3)$, $B(-4,3)$ and $C(2,9)$ be the vertices of a triangle. Determine

a) the length of the altitude from A,

b) the line containing the altitude from A.

9. Determine the circumcenter of the triangle with vertices $A(1,2)$, $B(3,-2)$, $C(5,6)$.

10. Determine the angle between the lines $\ell_1 : y = 2x + 1$ and $\ell_2 : y = -x + 2$.

11. Let $A(1,-2)$, $B(5,4)$ and $C(-2,0)$ be the vertices of a triangle. Determine the equations of the angle bisectors for the angle $\measuredangle A$.

12. Let A' be the orthogonal reflection of $A(10,10)$ in the line $\ell : 3x + 4y - 20 = 0$. Determine the coordinates of A'.

13. Determine Cartesian equations for the lines passing through $A(-2,5)$ which intersect the coordinate axes in congruent segments.

14. Determine Cartesian equations for the lines situated at distance 4 from the line $12x-5y-15 = 0$.

15. Determine the values k for which the distance from the point $(2,3)$ to the line $8x + 15y + k = 0$ equals 5.

16. Consider the points $A(3,-1)$, $B(9,1)$ and $C(-5,5)$. For each pair of these three points, determine the line which is equidistant from them.

17. The point $A(3,-2)$ is the vertex of a square and $M(1,1)$ is the intersection point of its diagonals. Determine Cartesian equations for the sides of the square.

18. Determine a point on the line $5x-4y-4 = 0$ which is equidistant to the points $A(1,0)$ and $B(-2,1)$.

19. The point $A(2,0)$ is the vertex of an equilateral triangle. The side opposite to A lies on the line $x + y - 1 = 0$. Determine Cartesian equations for the lines containing the other two sides.