MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION

Federal State Autonomous Educational Institution of Higher Education "National Research Technological University".
"MISIS branch in Almalyk, Republic of Uzbekistan

TEACHING PACKAGE
in the discipline of "Mining Geometry"

Direction preparations:	**21.05.04 - "Mining Engineering"**

Almalyk - 2024.

UDC 622.1(07)

Contributor:

Mamazhanov M.M., Associate Professor, Mining Engineering Department, Ph.

Educational and methodical complex for the discipline "Mining Engineering" is compiled in accordance with the requirements of educational standards of NUSTU "MISIS" on the basis of curricula for the relevant areas of training and is a presentation of issues "Subject and tasks, the concept of the shape of the deposit, the image of the toposurface, surveyor plans and sections, types of projection, problems solved by plans and sections", etc.

For university students of mining and metallurgical, geological and land cadastre specialities.

Most of the topics presented in the study work are basic for the course. Therefore, it can also be useful for students of other specialities.

1. General Provisions

1.1. Discipline Objectives.

The Model Regulations on Departmental Surveying and Geological Services, as well as the "Regulations on Geological and Surveying Provision of Industrial Safety and Subsoil Protection", oblige surveyors to geometrize mineral deposits in order to ensure rational planning of mining and exploration works, as well as rational use and protection of subsoil.

During the study of the discipline "Mining Geometry" the student learns the following disciplinary competences in the direction 21.05.04 "Mining Engineering", specialisation "Surveying":

- *readiness to assess the structure, chemical and mineral composition of the Earth's crust, morphological features and genetic types of solid mineral deposits from a natural science perspective when solving problems on rational and integrated development of the georesource potential of subsurface resources (PC-1);*
- *readiness to use scientific laws and methods in geological and industrial assessment of solid mineral deposits and mining allotments (PC-2);*
- *ability to selectand develop the provision of integrated technological systems of operational exploration, mining and processing of solid minerals, as well as enterprises for construction and operation of underground facilities with technical means with a high level of control automation (PC-5);*
- *ability to determine the spatial and geometric position of objects, carry out the necessary geodetic and surveying measurements, process and interpret their results (PC-13);*
- *ability to study scientific and technical information in the field of operational exploration, mining, processing of minerals, construction and operation of underground facilities (PSCV-4-2);*
- *readiness to justify and use methods of geometrization and forecasting of field indicators location in space (PSC-4-4).*

1.2 Discipline Objectives:

The task of studying the discipline is to acquire knowledge, skills and abilities to solve mining and geometric problems in the exploration and development of mineral deposits in accordance with the state educational standard for the direction 130400 "Mining Engineering".

1.3 The subject of mastering the discipline is the following objects:

(a) Methods and types of geometrization of the forms, conditions of occurrence, properties of the deposit and processes occurring in the subsurface during mining operations;

b) projections used in subsurface geometrization;

c) methods of mathematical and graphical modelling of mineral deposits;

d) quantitative assessment of the variability of deposit parameters and the complexity of the geological structure of the field;

e) methods of estimating mineral reserves and managing the movement of reserves during their development;

(e) Surveying records of production, losses and dilution and recovery of minerals from the subsoil;

ж) solution geometrically methods problems mining, geological exploration, subsoil protection and rational subsoil use.

1.4 Place of the discipline in the structure of professional training of graduates.

The discipline "Mining Geometry" belongs to the basic part of the cycle of mathematical and natural-scientific disciplines and is compulsory for mastering the specialised educational programme " Mining Engineering" (qualification (degree) "specialist), specialisation " Surveying";

Subsoil geometry is a scientific and technical discipline that studies the methods of observations, measurements, calculations and graphical works, which make it possible to obtain a geometric expression of the geological structure of mineral deposits and on this basis to solve the problems of mining production. In this regard, the discipline of subsurface geometry is closely related to the disciplines of the geological cycle, mining and surveying.

After studying the discipline, the student must master parts of the competences specified in paragraph 1.1 and demonstrate the following results:

to know:

-methods of building models of mineral deposits;

be able to:

-justify and use existing methods of geometrization and forecasting of field indicators location in space;

-produce geometrization deposits mineral of different types of mineral deposits;

-manage control movement stock, keep record losses and dilution of minerals during extraction;

Possess:

-Methods of working with spatial geometric data; methods of studying and analysing mining and geological conditions of occurrence mineral deposits for their effective industrial development;

-methods of construction of mining geometric drawings;

-methods for quantitative assessment of variability of deposit parameters and complexity of their geological structure;

-mountain-geometric methods solutions problems mining geological and geological exploration, subsoil protection and rational subsoil use.

Table 1.1 summarises the preceding and following disciplines aimed at the formation of competences stated in paragraph 1.1.

Table 1.1 - Disciplines aimed at the formation of competences

Code	**Name of competence**	**Previous disciplines**	**Subsequent disciplines (groups of disciplines)**
Professional competences			
PC-1	readiness to assess the structure, chemical and mineral composition of the Earth's crust, morphological features and genetic types of solid mineral deposits from a natural science perspective, while solving tasks on rational and integrated development of the geo-resource potential of subsurface resources	Economic theory, chemistry, Geology,	Rational use and protection of subsoil, geotechnology, Development of submarine shelves,
PC-2	readiness Use scientific laws and methods in geological and industrial assessment of deposits geological and industrial evaluation of deposits solid minerals and mining allotments	Economic theory, physics, chemistry, geology, thermodynamics, hydromechanics	
PK-5	ability to select and/or develop support for integrated technological systems of operational exploration, mining and processing of solid minerals, as well as enterprises for construction and operation of underground facilities by technical means with a high level of control automation.	Economic theory, maths, Geology, Electrical engineering, Hydromechanics, PI enrichment, Software and hardware in surveying	Geotechnology,

PC-13	Ability to determine the spatial and geometric stipulation facilities, carry out the necessary geodetic and surveying measurements, process и interpret th eir results	Mathematics, computer science, geodesy, MORI, descriptive geometry and engineering graphics, accuracy analysis of mine surveying works, surveying instruments, software and hardware in surveying, technologies of processing and storage of surveying information, mathematical statistics in mining and petroleum engineering,	mine surveying planning, geomechanics, mine surveying for underground construction, higher geodesy, remote sensing methods and photogrammetry, mine surveying for open-pit mining, GIS-based solution of mining geometric problems, mine surveying for oil and gas field development, mine safety.
pskv -4-2	ability analyse scientific and technical information in the field of operational exploration, extraction, mineral processing minerals, construction and operation of underground facilities	chemistry, geology, theoretical mechanics, applied mechanics, resistance of materials, electrical engineering, thermodynamics, open-pit mining, mining aerology, PI beneficiation, surveying, Geotechnology,	WRC
psk 4-4	readiness to justify and use methods of geometrization and forecasting of field indicators location in space	Mathematics, geology, rock physics, computer modelling of PI deposits,	Geomechanics, Remote sensing methods and photogrammetry, Mathematical statistics in mining and petroleum engineering, Solution of mining geometric problems on the basis of GIS, VKR

2. Requirements to the results of mastering the academic discipline

The academic discipline provides formation of part of competences PC-1, PC-2, PC-5, PC-13, PSCV-4-2, PSC-4-4.

2.1 Disciplinary map of competence PC-1

Code	Competency Statement:
PC-1	*Willingness to evaluate the structure from a natural science point of view, chemical and mineral composition of the Earth's crust, morphological features and genetic types of solid mineral deposits* *The following are some of the key elements of a sustainable and integrated fossil resource management programme* *development of the geo-resource potential of the subsoil.*

Code	Formulation of the disciplinary part of the competence:
PC-1 **SZ.B.9.1**	*Willingness to assess the shape, occurrence conditions and qualitative composition* *The following table summarises the results of the mining and geometric techniques mining documentation.*

Requirements for the component composition of competence PC-1

List of components	Types of training work	Means of assessment
He does: methods of building models of mineral deposits.	*Lectures* *Practical work* *Independent work*	*Calculating and graphic works Coursework work*
Skills: justify and use existing methods of geometrization and forecasting of field indicators location in space.	*Lectures* *Practical work* *Independent work*	*Calculation and graphical works* *Coursework*
Owned by: methods of working with spatial geometric data.	*Lectures* *Practical work* *Independent work*	*Calculating and graphic works Coursework work*

2.2 Disciplinary map of competence PC-2

Code	Competency Statement:
PC-2	*Willingness to use scientific laws and methods in geological-industrial evaluation of solid mineral deposits and mining claims*
Code	**Formulation of the disciplinary part of the competence:**
PC-2 **SZ.Ъ.9.1**	*Willingness to use methods of geometrization of PI deposits in the geological and industrial evaluation of hard rock deposits minerals.*

Requirements for the component composition of competence PC-2.

List of components	Types of training work	Means of assessment
Skills: geometriise deposits minerals of various types.	*Lectures* *Independent work* *Practical labours*	*Calculated graphic works* *Coursework*
Owned by: -methods of construction of mining geometry blueprints; -quantitative evaluation methods variability of deposit parameters and complexity of their geological structure.	*Lectures* *Independent work* *Practical labours*	*Calculated graphic works* *Coursework*

2.3 Disciplinary map of competence PC-5

Code	Competency Statement:
PK-5	*ability to select and (or) develop security integrated technological systems for operational exploration, production and processing of solid minerals, as well as enterprises for construction and operation of underground facilities with technical means with a high level of automation administrations*
Code	**Formulation of the disciplinary part of the competence:**
PK-5 **SZ.B.9.1**	*Ability to select and use automated complexes (software tools) for processing geological and exploration data information*

Requirements to the component composition of competence PC-5.

List of components	Types of training work	Means of assessment
He does: software for processing geological and exploration information, automated construction of mining geometric charts.	*Independent work* *Practical work*	*Calculating and graphic works Coursework work*
Skills: use software to process mining and geological information and build mining and geometric charts.	*Independent work* *Practical work*	*Calculating and graphic works Coursework work*
Owned by: -methods of construction of mining geometric drawings; -methods for quantitative assessment of variability of deposit parameters and complexity of their geological structure on the basis of PA.	*Independent work* *Practical work*	*Calculating and graphic works Coursework work*

2.4 Disciplinary map of competence PC-13

Code	Competency Statement:
PC-13	*Ability to determine the spatial and geometric position of the The following activities are carried out in the field of geodesy and surveying Measurements, process and interpret their results*

Code	Formulation of the disciplinary part of the competence:
PC-13 SZ.B.9.1	*Ability to determine the spatial and geometric position of the of objects, process and interpret measurement results in the form of mining geometric charts.*

Requirements for the component composition of competence PC-13

List of components	Types of training work	Means of assessment
Skills: geometrization of mineral deposits of various types.	*Lectures* *Independent work* *Practical work*	*Calculating and graphic works Coursework work*
Owned by: mining and geometric methods of solving problems of mining and geological exploration, subsoil protection and rational subsoil use.	*Practical work* *Independent work*	*Calculating and graphic works Coursework work*

2.5 Disciplinary map of the competence HSCP-4-2

Code	Competency Statement:
PSKV-4-2	*ability research scientific information в in the field of operational exploration, extraction, processing of mineral resources.* *The Company's operations in the field of mining, construction and exploitation of underground facilities*

Code	Formulation of the disciplinary part of the competence:
PSKV-4-2 SZ.B.9.1	*Ability to study data in the field of operational exploration in the exploitation of underground facilities*

Requirements for the component composition of the competence HSCP-4-2

List of components	Types of training work	Means of assessment
He does: statistical methods of geological exploration information processing.	*Lectures* *Independent work* *Practical work*	*Calculation and graphical works* *Coursework*
Skills: find the relationship between qualitative and quantitative indicators of the field.	*Lectures* *Independent work* *Practical work*	*Calculating and graphic works Coursework work*
Owned by: mining and geometric methods of solving problems of mining and geological exploration, s ubsoil protection a nd rational subsoil use.	*Practical work* *Independent work*	*Calculating and graphic works Coursework work*

2.6 Disciplinary map of competence PSK-4-4

Code	Competency Statement:
PSK-4-4	*readiness to justify and use methods of geometrization and forecasting the location of field indicators in the spaces*

Code	Formulation of the disciplinary part of the competence:
PSK-4-4 SZ.B.9.1	*readiness to justify and use methods of geometrization and forecasting the location of field indicators in the spaces*

Requirements for the component composition of competence PSK-4-4

List of components	Types of training work	Means of assessment
He does: methods of building field models minerals.	*Lectures* *Independent work* *Practical work*	*Calculated graphic works* *Coursework*
Skills: -justify and utilise existing geometricisation and forecasting techniques placement of field indicators in space; -geometrization of mineral deposits of various types; -manage the movement of reserves, keep records of losses and dilution of minerals during extraction.	*Independent work* *Practical labours*	*Calculated graphic works* *Coursework*
Owned by: -methods work c spatially with geometric data; -Methods of studying and analysing mining and geological conditions occurrence of mineral deposits for their effective industrial development; -methods of construction of mining-geometric drawings; -methods quantitative evaluation of variability of deposit parameters and complexity of their geological structure; -mining and geometric methods of solving problems of mining and geological exploration, subsoil protection and rational subsoil use.	*Lectures* *Independent work* *Practical labours*	*Calculated graphic works* *Coursework*

3. Structure of the academic discipline by types and forms of academic work

3.1. The structure of the discipline contains the distribution of the types of classroom work (ARM) and independent work of students (AWS) with the indication of labour intensity and forms of presentation of the results of the types of academic work.

3.2. The main types of classroom work in the discipline are:

- lectures (LC);
- practical training (PT).

3.3. The main types of independent work on the discipline are:

- independent study of theoretical material (ITM);
- execution of graphical calculations (RGD) on the topics of practical classes (RGPD);
- fulfilment of a term paper (CR).

3.4. The structure of the discipline by types and forms is given in Table 3.1. Table 3.1 - Volume and types of academic work

No. of p.p.s.	Types of training work	Labour intensity "ч		
		semester by semester		total
1	2	3	4	5
1	**Classroom work**	**44**		**44**
	-including in interactive form			
	- lectures (L)	18		18
	-including in interactive form			
	- practical exercises			
	-including in interactive form	26		26
2	**Control of independent work** (CEB)	**2**		**2**
3	**Independent work of students** (SRS)	**62**		**62**
	- study of theoretical material (ITM)	12		12
	- calculating and graphical works (CGRS)	20		20
	- term paper	30		30
4	**Final certification on the discipline (exam):**	**36**		**36**
5	**Labour intensity of the discipline, total:** **in hours (h)** **in credit units (CU)**	**144** **4**		**144** **4**

4. Content of the academic discipline

4.1 Modular thematic plan

Table 4.1 - Thematic plan by modules of the academic discipline

Module number	Discipline section number	Subject number DISCIPLES. Н ы	Number of hours (full-time education)									Labour-intensive h / H E
			classroom work				independent work				Etc. At.	
			total	Л	PR	CEB	all go	ytm	WG R pz	CR	Eck.	
1	2	3	4	5	6	7	8	9	10	И		12
1	Introduction		**5**	**1**	**4**		**3**			**3**		**8/0.23**
	1	1	6	2	4		7		4	3		
		2	6	2	4		5		2	3		
		3	7	2	4	1	5		2	3		
	Total for the section:		**19**	**6**	**12**	**1**	**17**		**8**	**9**		**36/1**
	2	4	2	1	1		7	2	2	3		
		5	3	2	1		7	2	2	3		
		6	3	1	2		7	2	2	3		
		7	4	2	2		7	2	2	3		
		8	4	2	2		7	2	2	3		
		9	5	2	2	1	7	2	2	3		
	Total for the section:		**21**	**10**	**10**	**1**	**42**	**12**	**12**	**18**		**63/1.77**
	Conclusion		**1**	**1**								
	Final certification (exam)										**36**	**36/1**
Bottom line:			**46**	**18**	**26**	**2**	**62**	**12**	**20**	**30**	**36**	**144/4**

4.2 Content of sections and topics of the academic

discipline Introduction. LK-1 hour, PR-4 , SRS-3

Subject, content and objectives of the discipline, its importance in the practical activity of the surveyor-geological service. Standard Regulations on departmental surveying service, Rules of subsoil protection.

Geometry of subsoil as a basis for studying the form, location of properties and processes occurring in the subsoil, construction of models of the studied indicators with the use of computers, used to solve a wide range of geological exploration, mining and economic problems at all stages of study and development of subsoil.

History of formation and development of geometry and geometrization of subsurface. Connection of subsurface geometry with other disciplines.

Section 1: Method of projections in rock geometry. LK-6 hours, PR-16 , CPC-17, CSR-1

Topic 1: Application of projections with numerical marks in geometrization of subsurface resources

Requirements to graphic images: accuracy, easy to measure, dynamism, visibility, simplicity of construction, convenience of their compilation.

The essence and meaning of the method of projections with numerical marks. Setting and representation of a point, line and plane. Interval, embedding, section and slope of a straight line. Methods of grading a straight line. Mutual position in space and in projections of a point and a line, two lines and two planes between each other, as well as the plane with a line and a point.

The essence of the method of superposition and change of the plane of projection. The use of these methods in determining the true values of angular and linear quantities between points, lines and planes.

Theme 2: Application of visual projections in depicting mining and geological objects

Affine projections. The essence of affine projections. Mathematical foundations of affine transformations. Affine coordinates, affinity axis and affine projection direction. Construction of affine images of geological bodies and mine workings. Solution of metric problems by images in affine projections. Affinographs.

Stereographic projections. Essence and basic properties of stereographicprojections. Types of stereographic grids and their construction. Determination of angles between straight lines, line and plane, between planes in space and in any plane section with the help of stereographic grids. Transition from stereographic projection of planes to the plan in projections with numerical marks.

Topic 3: Functions of topographic order. Topographic surfaces and methods of their construction and mathematical operations with their graphical expressions

Topographic surface and its representation in projection with numerical marks. Properties of topographic surface and its isolines. Methods of construction of topographic surface isolines. Justification of the section size when constructing topographic surface. Mutual position of a point, line, plane and surface with a topographic surface.

Advantages, disadvantages and scope of application of numerical mark projections.

Arithmetic operations with topofunctions: subtraction, addition, division, multiplication. Other algebraic operations with topofunctions.

The practical significance of mathematical operations with surfaces of topographic order.

Section 2. Geometrization of deposits. LK-10 hours, PR-10 , SRS-42, CSR-1

Topic 4: Geometric parameters of the deposit, methods of their determination

Modern concept of the structure of a mineral deposit and its geometric elements. Formulation of the basic concepts of geometric elements of a mineral deposit.

Graphical documentation showing the conditions of occurrence and position of the deposit in the subsurface. Direct and indirect methods of determining geometric elements of the deposit.

Topic 5: Geometrization of the field structure, occurrence conditions, deposit shape and its position in the subsurface

Geometrization of the deposit shape. The essence and tasks of geometrization of the shape of the deposit. Selection of the projection plane, scale and height of the surface section. Geological sections, profiles and hypsometric plans of surfaces of the hanging and lying side of the deposit. Methods of construction of geological sections, hypsometric plans and other graphs depicting the surface of the soil and roof of the deposit. Practical significance of geological sections and hypsometric plans.

The contact surface of disseminated rocks and its geometrization.

The thickness of the deposit and host rocks. Determination of deposit thickness in outcrops and mine workings. The concept of normal, apparent, horizontal and vertical thicknesses, the relationship between them. Transition from normal thickness to thickness along a given direction.

Isocapacity of the deposit, direct and indirect methods of their construction. Practical significance of power isoline diagrams. Contouring by minimum industrial capacity.

Depth of occurrence of a mineral deposit and methods of determination. Depositional isodepths, methods of their construction and practical significance. Determination of mineral body exit to the earth surface, under the sediment, to the working and projected horizons.

The importance of graphic documentation reflecting the shape and conditions of the deposit for the rational use of subsoil, in the integrated mechanisation of field development, planning the development of mining operations and mining.

Topic 6: Geometrization of folded rock structures

Tectonic stress fields and their manifestation. Fold, discontinuity and fracture tectonics of rock massifs and the relationship between them.

Folded forms of occurrence. General information. Geometrical elements, parameters, forms of folds and their classification. Definition of geometric elements of folds. Methods of depicting folds.

Topic 7: Geometrization of discontinuous rock structures

Rupture disorders (dislocations, disjunctivities). General information. Signs and methods of detecting discontinuities. Geometric elements of tectonic rupture: displacement, wings, line of intersection (cut-off) of the deposit, angle of displacement, amplitude of displacement of wings and direction of displacement. Definition of angular and linear values characterising the elements and position of the rupture. Classification of discontinuities. Geological and surveying documentation of discontinuities. Methods of modelling and geometrization of discontinuities.
Fracture prediction, prospecting and exploration of the displaced part of the deposit. Solution of practical problems in exploration and exploitation of disturbed fields. Assessment of tectonic disturbance of a particular field.

Prediction of tectonic disturbance to adjacent areas and horizons.

Topic 8: Geometrization of rock mass fracturing

Cracking of rock massif and its importance in underground construction and development of mineral deposits.

Classification of fractures. Geometric indicators of fracturing Intensity of rock fracturing and its quantitative expression. In-situ observations and documentation of fracturing. Methods and devices for determining the parameters of fracturing of the rock massif. Methods of observation processing. Construction of structural diagrams.

Dependence of intensity and orientation of fracturing on geometrical parameters of folds and discontinuities. Consideration of rock mass fracturing when solving mining engineering problems at different stages of field development.

Topic 9: Geometrization of physical, chemical and geomechanical properties of mineral deposits and rock massifs

Input materials for qualitative characterisation of a deposit. Direct and indirect methods of determining deposit properties. Primary geological and surveying documentation and sampling plans.

Methods of constructing curves of variability of the studied indicator along the line. Practical significance. Methods of finding the probable (average) location curve of the studied indicator on the basis of smoothing representative realisations.

Determination of the average value of the indicator based on the constructed curve of its location. Construction of isolines of average values of the indicator for the whole thickness of the mineral or for its separate layers. Smoothing by area. Selection of the smoothing window size.

Plans of isolines of the studied indicator location by separate horizons, layers, strata, etc.; methods of their construction and practical importance. Contouring of the field areas taking into account the established conditions.

Variability and study of the location of deposit indicators. Natural and observed, random and regular variability. Quantitative expression of variability along the line and area of the site. Statistical and geometric indicators of variability. Use of variability indicators in exploration and exploitation of deposits.

Conclusion LC-1 hour

4.3 List of practical training topics

Table 4.2 - Topics of practical works

№ p.p.s.	Name of the topic of practical work
1	3
1	Solution of mountain-geometric problems in projection with numerical marks
2	Solving problems to determine the mutual position of two straight lines.
3	Solving problems on construction of mine workings up to the formation, along the formation.
4	Solving problems on the mutual position of a line and a plane.
5	Solving problems on the method of matching.
6	Solving problems on conical, cylindrical surfaces.
7	Solving topographic surface problems.
8	Construction of a hypsometric plan of the reservoir.
9	Construction of vertical cross-sections along the strike and along the strike of the deposit.
10	Construction of the hypsometric plan of the fold.

Practical work Practical work No. 1

Topic: Solution of mountain-geometric problems in projection with numerical marks.

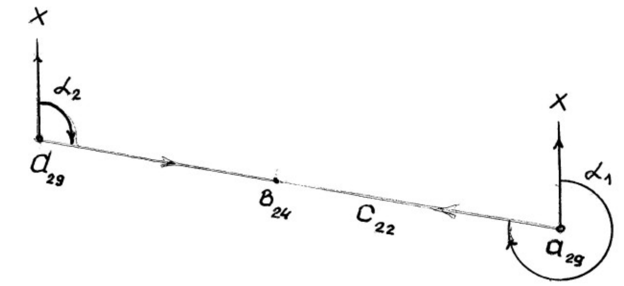
Purpose: To learn to determine the elements of straight lines.

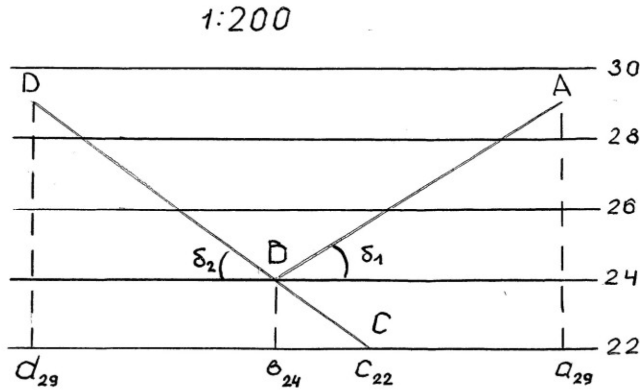
Number of hours - 2 hours.

Sample Problem Solving.

Task 1

Determine the point of intersection of two lines lying in the same vertical plane M 1:200. Show the elements of occurrence of lines αo; δo





Answer: the point of intersection of t. B (X;Y;24)

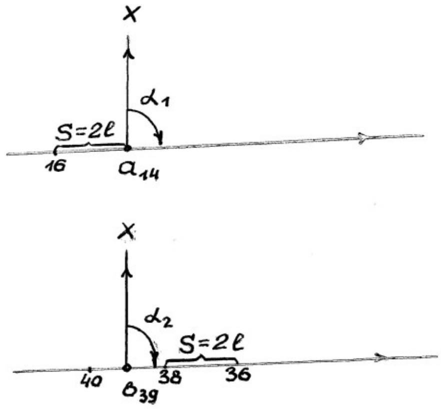
Practical work No. 2

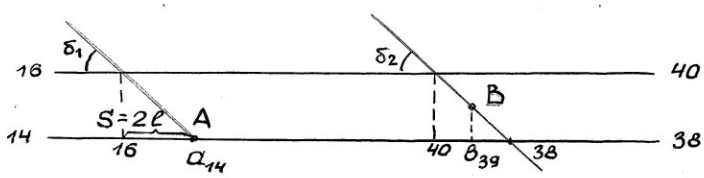
Topic: Solving problems to determine the mutual position of two lines.
Purpose: To learn to determine the mutual position of straight lines and elements of their occurrence.

Number of hours - 4 hours.

Sample Problem Solving.

Task 1
Two parallel lines A (X;Y;14), $\alpha o1 = 88^{o}$, $\delta o1 = 45^{o}$; B (X;Y;39) $\alpha o2 = 88^{o}$, $\delta o2 = 45^{o}$
, M 1:200 are given.
Draw straight lines





Task for practical work No. 1 and No. 2

Option 1

Task 1
A (X;U;18.0), $\alpha o = 148^{o}$, $\delta o = 36^{o}$M 1:100. Through the point (X;U; 150) construct aline parallel to the given line, prograde the line with S= 3 ℓ

Task 2
Coordinates of the slant wellhead: A (X;Y;27.5)
Well bottom hole coordinates B(X;Y;33.4), M 1:500. Determine the vertical well depth (h), inclination angle (δo), strike angle αo, well length ℓ graphically and record the answer.

Task 3
A (X;Y;8.0), B(X;Y;16.0).At point B draw a line perpendicular to the given line and lying with it in the same vertical plane,

M 1:200. Determine the elements of perpendicular occurrence.

Task 4
A line is given: AB: A (2,4,10), B(6,7,12), At the point K (X;U;14) lying on the given line construct a line intersecting AB with the elements of occurrence α_o = 40°, δ_o = 45° M 1:200.

Task 5
Determine the mutual position of lines AB and CD. Select the scale.
The straight line AB: A(X;Y;8), B(X;Y;13), SD: C(X;Y;10), D(X;Y;12) is given. The straight lines on the plan intersect.

Option 2

Task 1
The line AB is given: A (X;Y;106.2), B(X;Y; 101.4). Through the point C(X;U;2) Construct a line parallel to the given line. Prograde the line with S= 2ℓ
Show α_o, δ_o and the true length of M 1:200.

Task 2
A (X;Y;23.2), α_o = 60°, δ_o = 30° . At the point B (X;U;25), lying on the given line, draw a line perpendicular to the given line and lying with it in the same vertical plane M 1:100. Determine the elements of the perpendicular line.

Task 3
Coordinates of the inclined wellhead: A (X;Y;20), True length of the well ℓ =20m.
Angle of strike α_o = 120°, angle of inclination δ_o = 45°, M 1:500.
Determine well bottom hole coordinates, vertical depth.

Task 4
Coordinates of the directional wellhead: A (2,4,6). Wellhead coordinates B (7,8,12), M 1:200.
Determine the vertical well depth (h), inclination angle (δ_o), strike angle (α_o), and well length (ℓ) graphically and record the answer.

Task 5
Determine the mutual position of the lines given by the coordinate of point A (X;Y;20), the angle of line extension α_1= 60°, the angle of inclination δ_1 = 45 .°
The coordinate of point B is (X;Y;15), α_2= 110°; δ_2= 30°
. On the plan, the straight lines intersect. Scale to choose.

Practical work No. 3

Topic: Solving problems on the construction of mine workings to the formation, along the formation.
Purpose: To learn to determine the coordinates of meeting points of boreholes, pits, cuvettes with the formation.

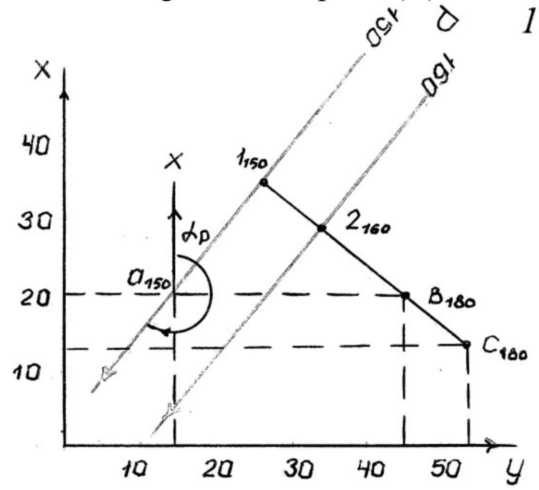
Sample Problem Solving.

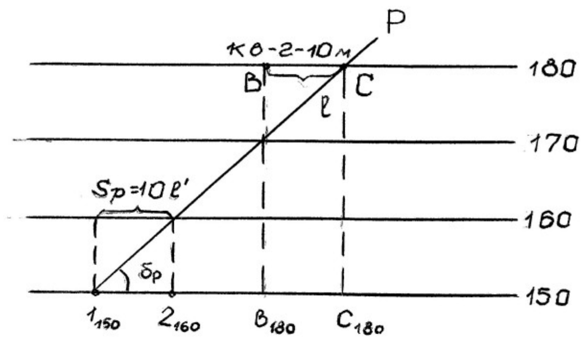
Task 1

Given: The plane P is given by point A (20;15;150), the angle of the plane strike: $\alpha r = 220^{o}$, the angle of the formation dip $_{\delta r} = 45^{o}$ .From point B (20;45;180) the quadrangle is passed. Scale M 1:1000.

Determine: length of the capstan (ℓ), coordinates of the meeting point with the formation.

1:1000





Practical work No. 4

Topic: Solving problems on the mutual position of a line and a plane.
Purpose: To learn to determine the coordinates of meeting points of boreholes, pits, cuvettes with the formation.

Task for practical work No. 3 and No. 4 Variant 1

Task 1
The line AB is given: A (X;Y;20), B(X;Y; 30). Through the point C(X;Y;26)
To draw a line parallel to the given line, through parallel lines to draw a plane with a section of horizontals equal to 5 m and to define elements of its occurrence M 1:1000
Task 2
The following planes P1 are set: A (X;U;230), $\alpha_{p1} = 270^o$, $\delta_{p1} = 40^o$
P2: B (X;Y;210), $\alpha_{p2} = 100^o$, $\delta_{p2} = 30^o$
Draw the line of intersection of planes and determine the elements of its occurrence M 1:1000 Task 3
A formation P: A (X;Y;40), $\alpha_{p1} = 90^o$, $\delta_{p1} = 45^o$. From the point B(X;U;30), a vertical well is drilled. Determine the coordinates of the meeting point of the well with the reservoir, the length of the well M 1:1000. Find out the solution from the plan, using a vertical section.
Task 4
The following planes P1 are set: A (X;U;70), $\alpha_{p1} = 30^o$, $\delta_{p1} = 45^o$
P2: B (X;Y;80), $\alpha_{p2} = 120^o$, $\delta_{p2} = 45^o$
Draw the line of intersection of planes and determine the elements of its occurrence M 1:1000
Task 5
A formation P: A (X;Y;200), $\alpha_p = 220^o$, $\delta_p = 30^o$. From the point B(X;U;240), a well perpendicular to the formation is drilled. M 1:1000 Determine the coordinates of the meeting point of the well with the formation, the length of the well, the inclination angle and the strike angle.

Option 2

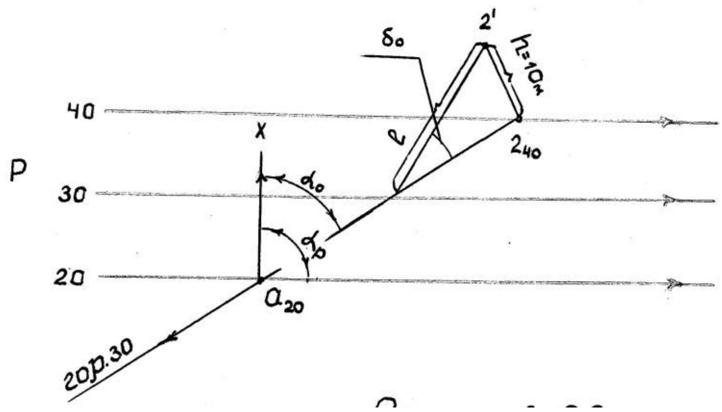
Task 1
The following planes P1 are set: A (X;Y;45), $\alpha_{p1} = 290^o$, $\delta_{p1} = 45^o$
P2: B (X;Y;30), $\alpha_{p2} = 100^o$, $\delta_{p2} = 45^o$
Determine the elements of occurrence of the line of intersection of planes M 1:1000 Task 2
A formation P: A (X;Y;110), $\alpha_p = 70^o$, $\delta_p = 45^o$. From the point B(X;U;80), drilled
The well having $\alpha_o = 240^o$, $\delta_o = 45^o$ M 1:1000. Determine the length of the well and the coordinates of the point where it meets the reservoir.
Task 3

A formation P: A (X;Y;20), $\alpha_p = 90^o$, $\delta_p = 45^o$. From the point B(X;U;40) a corschlag is passed. Determine the length and coordinates of the point of its meeting with the formation M 1:1000.
The solution should be carried out according to the plan and using a vertical
section. Task 4
Formation P is intersected by three vertical wells not lying on the same line at points A(X;Y;15), B(X;Y; 18). C(X;Y;17) M 1:100. Draw the plane P and determine the elements of its occurrence.
Task 5
Planes P_1: A (X;U;20), $\alpha_{r1} = 90^o$, $\delta_{r1} = 45^o$ P_2: B (X;U;40), $\alpha_{r2} = 180^o$, $\delta_{r2} = 30^o$ Construct the line of intersection of planes and determine the elements of its occurrence M 1:1000.

Practical work No. 5
Topic: Solving problems on the method of matching.
Purpose: To learn to determine the true value of lengths, angles by matching method.

Sample Problem Solving:

Task1
Formation P has elements of occurrence $\alpha_r = 90^o$, $\delta_r = 45^o$. From the point A (X;U;20), between horizons 30,40 it is necessary to design a rising diagonal excavation with the angle of strike $\alpha_o = 30^o$ M 1:1000. Determine the inclination angle (δ_o) and the length (ℓ) of the excavation



Answer ℓ = 22 m

Task for practical work No. 5 Variant 1

Task 1
Formation P has elements of occurrence $\alpha_r = 170^o$, $\delta_r = 42^o$. From point A (X;U;70), between horizons 70,90 it is necessary to design an upward diagonal excavation having a strike angle $\alpha_o = 120^o$. Determine the inclination angle and the length of the excavation M 1:1000.
Task 2
Given formation P: A (X;Y;120), $\alpha_r = 260^o$, $\delta_r = 45^o$. Through the point B(X;Y;30), draw a mine perpendicular to the formation. Determine the elements of excavation occurrence M 1:1000.
Task 3
From point A (X;U;220), a slope with the elements of occurrence aclone = 44°, δ slope = 40° and a pumping drift with a strike angle $\alpha_{sh} = 121^o$ is traversed along the formation soil.
Determine bedding elements M 1:1000.
Task 4
Formation P: C (X;U;70), $\alpha_r = 300^o$, $\delta_r = 45^o$and well AB: A (X;U;140), (X;U;150).M 1:1000 are given. Determine the angle between the reservoir plane P and well AB.
Task 5
The formation P is given: A (X;Y;50), αp = 110°, $\delta_p = 60^o$. From the point B(X;U;70) a corschlag is passed. Determine the coordinates of the point of meeting of the cuvette with the formation, its length M 1:1000.

Option 2

Task 1

The line AB is given: A (X;Y;20), B(X;Y; 30) M 1:1000. Through the point C(X;U;150) draw the plane P perpendicular to AB. Determine αr, δr.

Task 2

The following planes P_1 are set: A (X;U;10), $\alpha p1=30^o$, $\delta p1 = 45^o$

P_2: B (X;Y;30), $\alpha p2 = 190^o$, $\delta p2 = 30^o$ M 1:1000

Determine the angle between P_1 and P_2.

Problem 3

Determine the shortest distance from the point C to the line AB. AV:

A (X;Y;90), B(X;Y; 80), C(X;Y;70) M 1:1000.

Task 4

Soil of formation P is undercut by vertical well A (2;2;10) and

Vertical shaft B (6;6;14). From the borehole an inclined excavation BC is made along the formation soil. Coordinates of the point C(X;Y;16) M 1:200. Determine the elements of bedding of the formation.

Task 5

Given formation P: A (X;Y;170), $\alpha r = 170^o$, $\delta r = 45^o$. Through the point B(X;Y;80), draw a mine perpendicular to the formation. Determine the elements of excavation occurrence M 1:1000.

Practical work No. 6

Topic: Solving problems on conic, cylindrical surfaces.

Purpose: To learn how to construct surfaces in isolines and solve problems with surfaces.

- projections used in surveying
- *methods of drawing cylindrical, conical, topographic surfaces in projection with numerical marks;*
- *forms of deposits, elements of formation occurrence and methods of their determination;*

Practical work No. 7

Topic: Solving problems on the topographic surface.

Purpose: To learn how to build topographic surfaces in isolines and solve problems with surfaces.

Equipment: drawing materials. Number of hours - 4 hours.

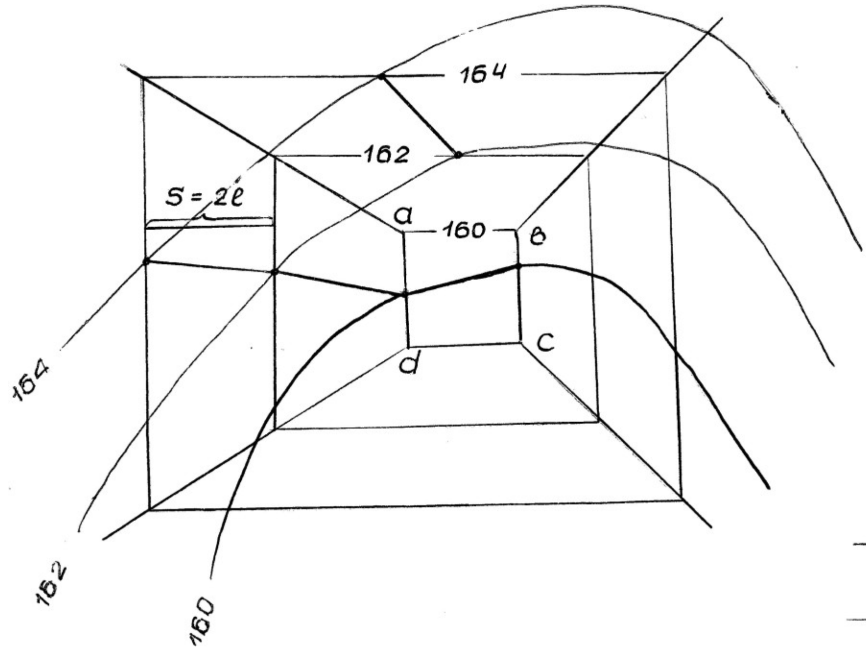
Verifiable Learning Outcomes:

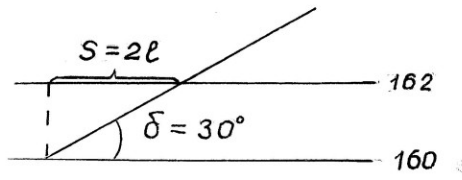
Samples of problem solving

Task 4

ABCD is the area of the quarry bottom with a mark of 160 m. Slope inclination angles:

$\delta AB = \delta BC = \delta CB = \delta = 45^o$; $\delta DA = 30^o$ M 1:200. Draw the lines of intersection of the slopes and their exit to the surface.


164
162
S = 2ℓ
a
160
в
c
d
164
162
160


S = 2ℓ
162
δ = 30°
160

Task for practical work No. 6 and No. 7 Variant 1

Task1
The straight line AB and AC are given: A (X,Y,180), B (X,Y,150), C (X,Y,160), M 1:1000.
Determine the angle between AB and AC.

Task 2
Construct the horizontals of the cylindrical surface given by the guide AB CO and the elements of occurrence, forming $\alpha_o = 180^o$, $\delta_o = 45^o$.
Coordinates of points A (X;Y,300), B (X,Y,310), C (X,Y,320), O (X,Y,300). Section of horizontals h= 10 м . M 1:1000. At the point E (X,Y,310) - surface restore the perpendicular to the surface.

Task 3
Hypsometric plan of the reservoir and the AB excavation is given. Determine coordinates of the points where the excavation meets the formation M 1: 200.

Task 4
Along two parallel layers there are mines AB and CD: A (X,U,20), B (X,U,30), C (X,U,25), D (X,U,35). M 1: 1000.
Find the shortest distance between the workings to carry out the ventilation stack.

Task 5
The following planes P_1 are set: A (X;Y;120), $\alpha p1=50^o$, $\delta_{p1} = 45^o$
P_2: B (X;Y;140), $\alpha p2 = 110^o$, $\delta_{p2} = 60^o$ M 1:1000
Determine the angle between P_1 and P_2.

Option 2

Task 1
The conical surface of the AVSO guide is specified:
A (X,U,150), B (X,U,140), C (X,U,150), O (X,U,150), and vertex E (X,U,180).
Through the point K (X,Y,140) of the surface draw a planeQ tangent to the surface and a normal to the plane Q. Determine the elements of occurrence of the perpendicular M 1: 1000.

Task 2
The following planes P_1 are set: A (X;Y;100), $\alpha p1=320^o$, $\delta_{p1} = 45^o$
P_2: B (X;Y;120), $\alpha p2 = 190^o$, $\delta_{p2} = 45^o$ M 1:1000
Determine the angle between P_1 and P_2.

Task 3
ABCD is the site of the quarry bottom with 100 m mark. Slope inclination angles: AB = 60°, BC = 53°, CD = 40°, AD = 45°.
Draw the lines of intersection of slopes and their exit to the surface. Section of slope horizontals h= 3 m, M 1: 200.

Task 4
The plane P: A (X;U;70), $\alpha r=290^o$, $\delta r= 30^o$ and excavation BC B (X;U;140), C (X,U,130) M 1:1000 are set.
Determine the angle between the plane P and the excavation BC

Task 5
The cylindrical surface of the ABC guide is set: A (X;Y;70), B(X;Y;60), C (X.Y,70) M 1:1000. The angle of propagation of the formations $\alpha o= 90^o$, the angle of inclination of the formations $\delta o= 45^o$. Through the point

To (X,Y,60) of the surface, draw a plane Q tangent to the surface and a perpendicular to the plane Q. Determine the elements of the perpendicular.

Practical work No. 8

Topic: Construction of a hypsometric plan of a reservoir.
Purpose: To learn how to construct a hypsometric plan of the soil or roof of a formation.

1 On the plan the position of exploration line 1-1 is plotted, on which the vertical wellheads are shown through the distance taken from Table 1, taking into account the scale.
2 From the first exploration line, the distance between the exploration lines, taking into account the scale, is plotted as exploration line 2-2. On line 2-2, vertical wellheads are shown at the same distance as on line 1-1.
3 Near the wells sign their numbers, wellhead, roof and deposit soil marks (see Appendix A) or wellhead, roof and formation thickness marks. The marks are taken from Table 1.
4 For each exploration line, a vertical section is drawn to the scale of the plan. On the section, the horizon lines are drawn to scale, starting at the lowest elevation. Measure the distances between wells and transfer them to the lower horizon line. The ground surface is constructed from the wellhead marks by raising the points to their horizon. By marks of soil and roof of a layer, raising them on their horizon, build soil and roof of a layer. If soil marks are not given, then build the roof of the formation and downwards, taking into account the scale, lay off the vertical thickness of the formation, and get the soil of the formation.
5 Select the height of the cross-section through which the horizon lines are drawn, dissecting the soil (roof) of the formation. The points of intersection of the horizon lines with the soil (roof) of the formation are projected to the lower horizon with the obtained marks and transferred to the plan, to the given exploration line (measure the distances from the wells to the points with marks).
6 Similar constructions are made along all exploration lines and through points with the same marks the horizontals of the soil (roof) of the formation are drawn.
7 Draw up the plan by symbols (see Annex A).Option 1 Table 1- Data on

exploration lines

Exploration lines	Well numbers	Markings, m			Distances, m		Scale
		estuaries	roofs	soils	between exploration lines	between you and me	
1-1	1	279.0	260.0	245.3	40	30	1:1000
	2	279.4	255.0	234.7			
	3	278.3	257.0	240.4			
2-2	4	271.0	260.4	245.0	40	30	Height cross-sections
	5	268.3	254.6	240.0			
	6	267.5	256.5	239.0			
Construct bed soil horizontals							

Option 2

Table 1- Data on exploration lines

Exploration lines	Well numbers	Markings, m		Vertical reservoir thickness, m	Distances, m		Scale
		estuaries	roofs		between exploration lines	between you and me	
1-1	1	250.0	238.0	3.5	20	15	1:500
	2	249.6	230.2	6.4			
	3	247.3	236.4	4.7			
2-2	4	249.3	236.0	3.0	20	15	Select the height of the section
	5	249.3	232.0	5.4			
	6	247.5	234.0	4.0			
Plot the horizontals of the reservoir roof							

Task for practical work No. 8 Variant 1

Table 1- Data on exploration lines

Exploration lines	Well numbers	Markings, m		Vertical reservoir thickness, m	Distances, m		Scale
		estuaries	soils		between exploration lines	between you and me	
1-1	1 2 3 4 5	303.3 302.0 301.1 300.0 299.3	241.0 252.2 261.5 272.8 284.2	1.8 3.2 6.8 4.0 1.5	40	30	1:1000
2-2	6 7 8 9 10	303.9 303.0 302.1 301.5 300.5	245.4 254.7 265.6 275.0 287.4	2.8 9.8 14.2 10.5 3.7	40	30	Select the height of the section
Construct bed soil horizontals							

Option 2 Table 1-

Data on exploration lines

Exploration lines	Well numbers	Markings, m		Vertical reservoir thickness, m	Distances, m		Scale
		estuaries	soils		between exploration lines	between you and me	
1-1	11 12 13 14 15	305.9 305.1 304.3 303.4 302.0	275.9 275.1 274.3 273.4 272.0	6.3 16.1 11.5 15.4 5.7	40	30	1:1000
2-2	16 17 18 19 20	307.2 306.3 305.2 303.8 302.5	277.2 276.3 275.2 273.8 272.5	4.2 10.5 15.5 12.6 5.5	40	30	Select the height of the section
Construct bed soil horizontals							

Practical work No. 9

Topic: Construction of vertical cross-sections across the strike and along the strike of the deposit.
Objective: to learn how to construct sections.
Equipment: drawing tools, calculators, A3 drawing paper, ink. Number of hours - 6 hours

Operating Procedure:

1 Copy part of the mining plan (plans attached) in M 1:1000. Draw a line of section 1-1 along the axis of the quadrangle, across the strike of the formation (see samples).

2 On line 1-1 on the plan mark the points of intersection with surface horizontals 4,5,9, with the sides of drifts 1-2, 5-7, with the roof 3,8, soil 1,5 strata, points 103, 102.5 of the theodolite course. Transfer these points to the horizon line 100 on the section.

3 On the section at a scale (4cm) draw the lines of horizons 100,140.

The points lying on the surface horizontals 4,5,9 according to the surface markings are scaled up to their height, connect the ground surface. Set back the sediment load downwards, draw a line of contact with the sediment.
4 At points 1,5, lying on the strata soil (drifts run along the strata soil), from the horizon line lay off the strata dip angles 45°, 50° and draw the strata soil.
5 At points 3,8 the roof of the strata is drawn parallel to the soil.
6 The points of theodolite course with marks 103.0; 102.5, lying in the roof (soil) of the quershlag, are raised in scale to their horizon and draw the roof (soil) of the quershlag. The height (h) of the overburden is laid down (up) and the soil of the overburden is obtained.
7 Through the points lying on the sides of drifts 1-2; 6-7 show the sections of drifts in formations.
8 To build a section along the strike of the Gorely formation, along the axis of its drift, line 2-2 is drawn on the plan.
9 Mark the points of intersection with the Earth surface horizontals 12, 13. with the sides of the quershlag 10, 11 and points of theodolite course 99.4; 100.0, transfer to the section on the horizon line 100.
10 From points 12 and 13, plot the Earth's surface to scale, calculate the sediment load, and draw the sediment contact line.
11 On section 1-1 through the middle of the drift of the Gorely formation draw a vertical line to the intersection with the roof and soil of the formation, the obtained points are projected horizontally to section 2-2, and the roof and soil of the formation are obtained.
12 The points of theodolite course 99.4; 100.0 are raised by marks to their horizon, connected, and the drift roof is obtained.
The height of the drift is put downwards and the drift soil is obtained.
13 The points lying on the plan on the sides of the capstone show the cross-section of the capstone in Section 2-2.

Practical work No. 10

Topic: Construction of a hypsometric plan of a fold.
Objective: to learn how to construct horizontals of the stratum soil and exit of the stratum soil and roof under the sediment, to determine the type of fold, elements of its occurrence.

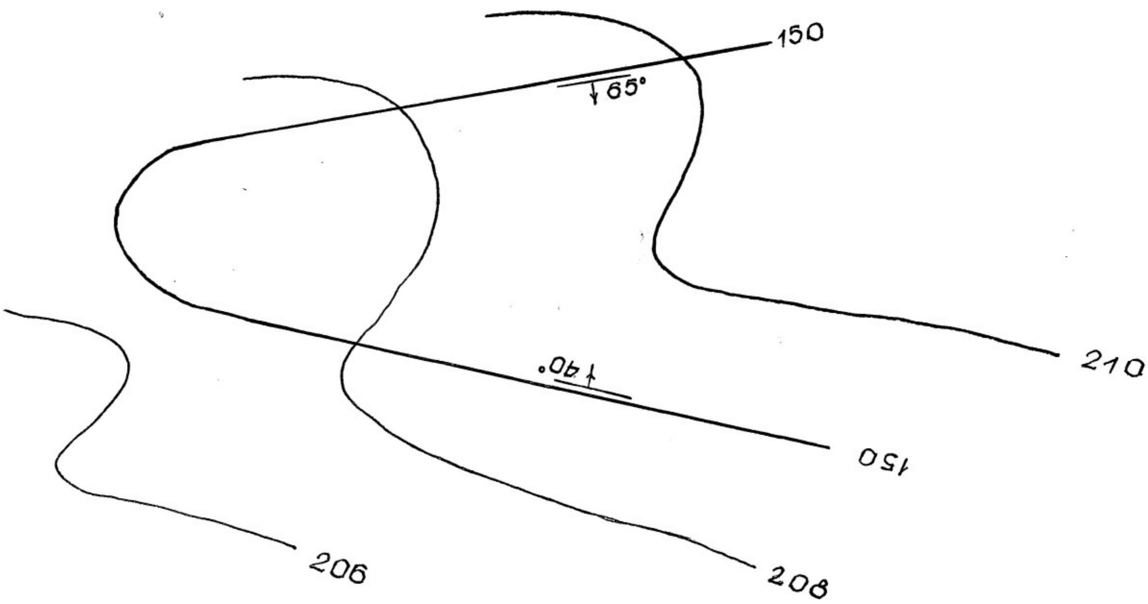
Number of hours - 6 h

Operating Procedure:
1 Draw the soil horizontals of the folded form of the stratum and the ground surface horizontals according to the initial data. Draw the ground surface horizontals on the whole sheet through the given section height.
2 Reduce the surface elevations by the sediment load (h_n). Record the resulting marks in brackets.
3 Construct vertical sections at the wing dip angles, and with the resulting embedment S= 10 ℓ, grade the wing dip lines to obtain horizontals with marks under the sediments. Construct the lock of the fold.
4 Find the point of intersection of the same-named horizontals under the sediment and the horizontals of the fold wings. This is the exit of the soil of the wings of the fold under the sediment.
5 On vertical sections with regard to the scale perpendicular to the stratum soil, plot the normal thickness of the stratum and parallel to the stratum soil build the stratum roof.
6 Measure the horizontal thickness of the formation on the transect, transfer it to the plan and plot it perpendicularly to the wing dip from the outlet of the wing soil of the sediment fold. At the points obtained, parallel to the outlet of the wing soil, draw the outlet of the roof of the sedimentary fold wings. See Figure 1.
7 Determine the elements of the crease
occurrence: Elements of the hinge
occurrence: α_o, δ_o
Fold angle: γ
Elements of axial plane occurrence: α', δ'

Record the results of the fold elements in the table, see Appendix B.
8 Determine the type of fold by the elements of fold occurrence and enter it in the table.

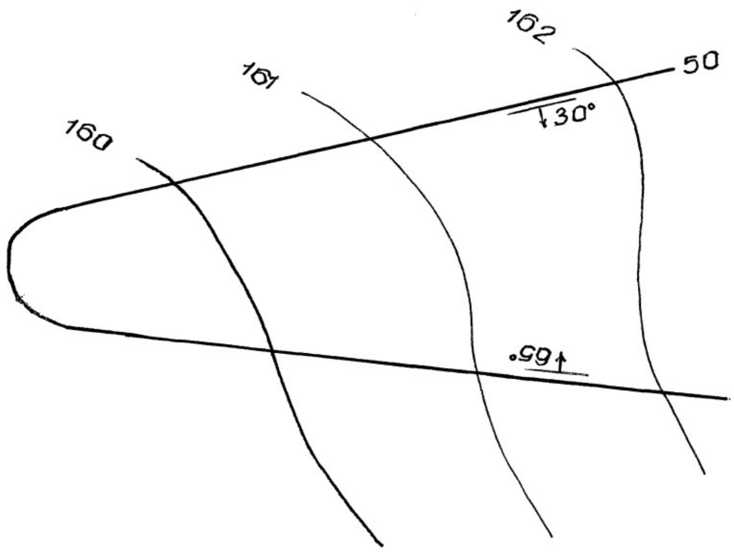
Task for practical work No. 10 Variant 1

The horizontal of the fold wings soil, angles of wings incidence are set. M 1: 1000. Sediment thickness - h_n = 5 m. Normal bed thickness - m = 4 m
Plot the horizontals of the wings of the fold with a section height of h = 10 m and the exit of the wings under the sediment load. Determine the elements of the fold occurrence and the type of fold.



Option 2

The horizontal of the fold wings soil, angles of wings incidence are set. M 1: 2000. Sediment thickness - h_n = 28 m. Normal bed thickness - m = 4 m
Plot the horizontals of the wings of the fold with a section height of h = 10 m and the exit of the wings under the sediment load. Determine the elements of the fold occurrence and the type of fold.



4.4 List of topics of laboratory works

Laboratory work is not provided in the course.

4.5 Types of independent work of students

Independent work of students is a set of independent activities of students aimed at in-depth study of educational material and development of skills to use knowledge in practical work.

Independent work takes place during the whole time of studying the discipline: at lectures - making an outline; at laboratory classes - doing work and making an outline, as well as when doing a term paper.

Independent work is divided into in-class and out-of-class work.

Independent classroom work of students is carried out during class hours under the methodological guidance of the teacher.

Extracurricular independent work of students includes reading special literature on the discipline, completing calculations and term papers, preparation for control classroom classes. Students are provided with special and methodological literature through the library of the institute and the department for the independent performance of graphical calculations and term papers.

The control of students' independent work is carried out during the reception of graphical works.

Table 4.3 - Types of Independent Work of Students (IWS)

Subject number (sections) disciplines	**Type of independent work of students**	**Labour hours, hours**
1	2	3
Introduction (1)	Execution of coursework	3
Щ)	Execution of calculation and graphic works on the subject of practical work Execution of coursework	4 3
2(1)	Execution of calculation and graphic works on the subject of practical work Execution of coursework	2 3
3(1)	Execution of calculation and graphic works on the subject of practical work Execution of coursework	2 3
4(2)	Study of theoretical material within the framework of the topic, Execution of graphical calculations on the topic laboratory work Execution of coursework	2 2 3
5(2)	Study of theoretical material within the framework of the topic, Execution of graphical calculations on the topic laboratory work Execution of coursework	2 2 3
6(2)	Study of theoretical material within the framework of the topic, Execution of graphical calculations on the topic laboratory work Execution of coursework	2 2 3
7(2)	Study of theoretical material within the framework of the topic, Execution of calculation and graphic works on the subject of practical work Execution of coursework	2 2 3
8(2)	Study of theoretical material within the framework of the topic, Execution of calculation and graphical works on the topic laboratory work Execution of coursework	2 2 3
9(2)	Study of theoretical material within the framework of the topic, Execution of calculation and graphical works on the topic laboratory work Execution of coursework	2 2 3
	Bottom line: in **h** / in **ZU**	**62/1.72**

4.6 List of coursework topics

Coursework is carried out in order to consolidate and generalise theoretical knowledge in the discipline "Mining Geometry" and to acquire practical skills in the field of geometrization of mineral deposits. The list of coursework topics is presented in Table 4.4.

Table 4.4 - List of coursework topics

№№ np	Coursework topics
1	Gypsum deposit. Geometrization of occurrence conditions and calculation of selenite reserves
2	Gypsum deposit. Geometrization of occurrence conditions and calculation of calcite reserves
3	Gypsum deposit. Geometricisation of overburden conditions and calculation of overburden volumes
4	Gypsum deposit. Geometrization of occurrence conditions and estimation of ornamental gypsum reserves
5	Gypsum deposit. Assessment of deposit karstification and study of statistical characteristics of gypsum reserves estimation parameters
6	Sand and gravel mixture deposit (SGS) Geometrization of occurrence conditions and calculation of balance and commercial reserves.
7	CBC deposit. Geometrization of occurrence conditions and calculation of GGS reserves
8	Brick clay deposit. Geometrization of occurrence conditions and calculation of remaining clay reserves at the deposit
9	Geometrization and estimation of clay deposit reserves
10	Geometrization of a folded coal deposit
11	Geometrization of a large-capacity field
12	Geometrization of a coal deposit of the type
13	Geometrization of a folded coal deposit of the type
14	Investigation of statistical patterns of geological indicators. One-dimensional models
15	Investigation of statistical patterns of geological indicators. Two-dimensional models
16	Investigation of statistical patterns of geological indicators. Multivariate models
17	Sand deposit Geometrization of occurrence conditions and estimation of sand reserves
18	Sand deposit Geometrization of occurrence conditions and estimation of sand reserves
19	CBC deposit Geometrization of occurrence conditions and reserves estimation
20	GGS deposit . Geometrization of occurrence conditions and estimation of GGS reserves
21	Geometrization of a coal deposit area complicated by discontinuities
22	Stone deposit in an oil field. Geometrization of occurrence conditions and calculation of stone reserves.
23	A deposit of construction soils. Geometrization of occurrence conditions and calculation of reserves of construction soils:

5. Educational technologies used for the formation of competences

Lecture classes in the discipline are based on an active learning method, in which students are not passive listeners, but active learners.

participants class, responding in response to questions instructor. The instructor's questions are aimed to activation processes assimilation of the material. The teacher in advance outlines list questions, The teacher outlines in advance a list of questions to stimulate associative thinking and make connections with previously learnt material. Laboratory classes are based on the interactive method of teaching, in which students interact not only with the teacher, but also with each other.

6. Management and control of competence development

6.1 Current control of mastering the given disciplinary parts of competences

Current control mastering disciplinary parts The current control of mastering disciplinary parts of competences is conducted in the following forms:

- schedule of attendance at lecture classes;
- practical work;
- defence of practical work.

6.2 Routine and intermediate control of mastering the given disciplinary parts of competences

Routine control mastering disciplinary parts competences is conducted at the end of the discipline sections in the following forms:

- control of computational and graphic works (sections 1-9);
- control fulfilment of assignmentson coursework according to the schedule .

6.3 Final control of mastering the given disciplinary parts of competences

1) Score

No credit is given

2) Examination in semester 7

- Admission to the examination is carried out only in the case of correct completion of all calculations and graphical works, and successful defence of the course work

- The grade for the coursework is assigned according to the results of compliance with the schedule of its implementation, correctness of its implementation, compliance with the mining and graphic documentation and successful defence.

- The examination on the discipline is conducted orally on tickets. The ticket contains two theoretical questions.

- The examination grade is given without taking into account the results of the end-of-term assessment and the grade for the course work.

Assessment fund, including standard assignments, control works, tests and evaluation methods, evaluation criteria, list of control tasks, assessment criteria, and a list of tests

The points and table of planning of learning outcomes, control tasks for the credit, allowing to assess the results of mastering this discipline, are included in the UMKD as a separate document.

6.4 Types of current, end-of-term and final control of mastering elements and parts of competences

Table 6.1 - Types of control of mastering elements and parts of competences

Controlled learning outcomes disciplines (HEAs)	Type of control			
	TT	PR	CR	Examination
He does:				
methods of building models of mineral deposits;	+		+	+
Skills:				
justify and use existing methods of geometrization and forecasting of field indicators location in space;			+	+
geometrization of mineral deposits of various types;			+	+
manage the movement of reserves, keep records of mineral losses and dilution in mining;			+	+
Owned by:				
methods of working with spatial geometric data; methods of studying and analysing mining and geological conditions of mineral deposits for their effective industrial development;		+	+	+
methods of drawing mining geometric drawings;		+	+	+
methods of quantitative assessment of variability of deposit parameters and complexity of their geological structure;		+	+	+
mining and geometric methods of solving problems of mining and geological exploration, subsoil protection and rational subsoil use.		+	+	+

TT - current testing (control of knowledge on the topic);
DP - practical (calculation and graphic) work with the preparation of a report (assessment of mastery).
Coursework (control of knowledge, skills, competences).

7. Schedule of the educational process in the discipline

7.1 The schedule of the educational process in the discipline "Mining Geometry". 7 semester.

Type of work	Distribution of hours by school week																		Total h
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Lectures	2	2	2	2	2	2	2	2	2										**18**
Practical exercises	2	2	2	2	2	2	2	2		2		2		2		2		2	**26**
Self-study theoretical material			**1**	**1**	2	2	2	2	2										**12**
Execution of RGR on PR topics		**1**	**1**	**1**	**1**	2	2	2		2		2		2		2		2	**20**
Fulfilment coursework		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2			**30**
CEB						**1**											**1**		**2**
Module:	**Ml**																		
Counter-testing						+											+		
Discipline control																			**Examen**

№	List of references
1	2
1	Bukrinsky V.A. Geometry of subsoil. - M.: Izd-vo MGGU, 2002. - 549 c.
2	Geometry of subsoil (mining geometry): textbook for universities / V. M. Kalinchenko [et al.]; Ed. by V. M. Kalinchenko , I. N. N. Kalinchenko. M. Kalinchenko , I. N. Ushakova .- Novocherkassk : NOC, 2000 .- 526 p. : ill. : ill. - Bibliography: p. 521 .

3	Zarayskiy V.N., Streltsov V.I. Rational use and protection of subsoil at mining enterprises. - M.: Nedra, 1987. - 293 c.
4	Geometrisation of mineral deposits / Edited by V.A.Bukrinsky and Y.V.Korobchenko. - M.: Nedra, 1977.376 p.
5	Kudryashov P.P., Kuzmin V.I. Geometrization and accounting of reserves of solid mineral deposits. - M.: Nedra, 1981.-276 p.
6	Lomonosov G.G. Mining-engineering graphics. - M.: Nedra, 1976, -264 p.
7	Borisenko Z.G. Methodology of geometrization of reservoirs and oil and gas deposits. - Moscow: Nedra, 1980. - 206 c.
8	Bukrinsky V.A. Geometry of Subsoil: Textbook. - Moscow: Nedra, 1985. - 526 c.
9	Ushakov I.N. Mining geometry: Textbook. -M.: Nedra, 1979. - 478c.
10	Surveying and subsoil use : scientific, technical and industrial journal / Geomar-SV .
11	Surveyor's Bulletin : scientific, technical and industrial journal / Committee of the Russian Federation on Metallurgy; Ministry of Fuel and Energy of the Russian Federation. Department of Coal Industry; Metrotonnellgeodesia; State Institute for the Design of non-ferrous metallurgy enterprises; Geomar .- Moscow : Geomar
12	GOST 2.850-75 - GOST 2.857-75 Mining graphic documentation
13	Collection of Guiding Documents "Subsoil Protection and Geological and Surveying Control", Moscow: ZAO STC PB.
14	Collection of guiding materials on subsoil protection during development of MPI. - M.: Nedra, 1987.-591 p.
15	Instruction on surveyor's accounting of mining operations volumes for mining operations of minerals by open pit mining / Approved by the post. Gosgortechnadzor
16	Rules of subsoil protection / Approved by the post of Gosgortechnadzor. Gosgortechnadzor

7.2 Computer-based training and monitoring programmes

For design practical works it is recommended use **AutoCAD, Microsoft Office Word, Excel.**

8. Technical teaching aids

During lectures and laboratory work, demonstration drawings (about 50 sheets on the computer) are used to characterise the geological structure of various types of mineral deposits (plans, sections, visual projections) and methods of solving various mining and geometric problems.