



МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ
РОССИЙСКОЙ ФЕДЕРАЦИИ
федеральное государственное бюджетное образовательное учреждение
высшего образования
МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ
ГЕОДЕЗИИ И КАРТОГРАФИИ
(МИИГАиК)

Геодезический факультет
Кафедра лингвистики



**ДОКУМЕНТ ПОДПИСАН
ЭЛЕКТРОННОЙ ПОДПИСЬЮ**

Сертификат: 5387FD2AF5B17FED816FDE9A1D4973B1
Владелец: Степанченко Алексей Леонидович
Действителен: с 21.07.2025 по 14.10.2026

«УТВЕРЖДАЮ»

Проректор
А. Л. Степанченко
16 февраля 2024 г.

**ФОНД ОЦЕНОЧНЫХ СРЕДСТВ ПО ДИСЦИПЛИНЕ (МОДУЛЮ)
ОБЩЕНАУЧНЫЙ
«Б1.О.01.02 ЛИНГВИСТИЧЕСКАЯ ПОДГОТОВКА В ПРОФЕССИОНАЛЬНОЙ
ДЕЯТЕЛЬНОСТИ»**

Уровень высшего образования: магистратура

Направление подготовки: 21.04.03 Геодезия и дистанционное зондирование

Направленность(профиль) подготовки: Геодезия

Квалификация (степень) выпускника: магистр

Форма обучения: очная

Год набора (приема на обучение): 2024

Срок получения образования: 2 года

Объем:
в зачетных единицах: 4 з.е.
в академических часах: 144 ак.ч.

Москва, 2024

Разработчики:

Заведующий кафедрой Лингвистики, доцент Герасимов И. П.

Старший преподаватель кафедры Лингвистики Ацута Е. В.

Старший преподаватель кафедры Лингвистики Трофименко С. А.

Фонд оценочных средств по дисциплине (модулю) составлен в соответствии с требованиями ФГОС ВО по направлению подготовки 21.04.03 Геодезия и дистанционное зондирование, утвержденного приказом Минобрнауки от 11.08.2020 № 938

Согласование и утверждение

№	Подразделение	Ответственное лицо	ФИО	Виза	Дата, протокол (при наличии)
1	Геодезический факультет	Председатель ученого совета факультета	Половнев О. В.	Рассмотрено	11.12.2023, № 7/23

1. Планируемые результаты обучения, соотнесенные с планируемыми результатами освоения образовательной программы

УК-4 Способен применять современные коммуникативные технологии, в том числе на иностранном(ых) языке(ах), для академического и профессионального взаимодействия

УК-4.1 Устанавливает и развивает профессиональные контакты в соответствии с потребностями совместной деятельности, включая обмен информацией и выработку единой стратегии взаимодействия

Знать:

УК-4.1/Зн1 Лексический минимум в объеме 2000 учебных лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников

Уметь:

УК-4.1/Ум1 Выполнять переводы технических текстов с иностранного языка

Владеть:

УК-4.1/Нв1 Навыками чтения, аудирования, разговорной речи, письмо в профессиональной области.

УК-4.2 Составляет, переводит и редактирует различные академические тексты (рефераты, эссе, обзоры, статьи и т.д.), в том числе на иностранном языке

Знать:

УК-4.2/Зн1 Основные способы работы на языковом и речевым материалом

Уметь:

УК-4.2/Ум1 Выполнять перевод технических текстов с иностранного языка

Владеть:

УК-4.2/Нв1 Приемами самостоятельной работы с языковым материалом с использованием справочной и учебной литературы

УК-4.3 Представляет результаты академической и профессиональной деятельности на различных публичных мероприятиях, включая международные, выбирая наиболее подходящий формат

Знать:

УК-4.3/Зн1 нормы произношения, лексику иностранного языка общеупотребительного, терминологического и профессионального содержания; типовые способы построения высказываний в устной и письменной речи

Уметь:

УК-4.3/Ум1 осуществляет коммуникацию с зарубежными партнерами; переводит научно-техническую литературу, связанную с профессиональной деятельностью

Владеть:

УК-4.3/Нв1 стратегиями проведения сопоставительного анализа факторов культуры различных стран

УК-4.4 Аргументированно и конструктивно отстаивает свои позиции и идеи в академических и профессиональных дискуссиях на государственном языке РФ и иностранном языке

Знать:

УК-4.4/Зн1 лексический минимум в объеме 2000 лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников

Уметь:

УК-4.4/Ум1 осуществлять коммуникацию с зарубежными партнерами; переводить научно-техническую литературу по вопросам, связанным с профессиональной деятельностью

Владеть:

УК-4.4/Нв1 компенсаторными умениями, помогающими преодолеть "сбои" в коммуникации, вызванные объективными и субъективными, социокультурными причинами

2. Показатели и критерии оценивания компетенций

Планируемые результаты освоения программы	Уровень овладения	Критерии оценивания (перечень сформированных ИДК/ЗУВ по уровням освоения)
УК-4 Способен применять современные коммуникативные технологии, в том числе на иностранном(ых) языке(ах), для академического и профессионального взаимодействия	Повышенный	ИДК УК-4.1 Устанавливает и развивает профессиональные контакты в соответствии с потребностями совместной деятельности, включая обмен информацией и выработку единой стратегии взаимодействия Знать: УК-4.1/Зн1 Лексический минимум в объеме 2000 учебных лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников Уметь: УК-4.1/Ум1 Выполнять переводы технических текстов с иностранного языка Владеть: УК-4.1/Нв1 Навыками чтения, аудирования, разговорной речи, письмо в профессиональной области. ИДК УК-4.2 Составляет, переводит и редактирует различные академические тексты (рефераты, эссе, обзоры, статьи и т.д.), в том числе на иностранном языке Знать: УК-4.2/Зн1 Основные способы работы на языковом и речевом материалом Уметь: УК-4.2/Ум1 Выполнять перевод технических текстов с иностранного языка Владеть: УК-4.2/Нв1 Приемами самостоятельной работы с языковым материалом с использованием справочной и учебной литературы

ИДК УК-4.3 Представляет результаты академической и профессиональной деятельности на различных публичных мероприятиях, включая международные, выбирая наиболее подходящий формат

Знать:

УК-4.3/Зн1 нормы произношения, лексику иностранного языка общеупотребительного, терминологического и профессионального содержания; типовые способы построения высказываний в устной и письменной речи

Уметь:

УК-4.3/Ум1 осуществляет коммуникацию с зарубежными партнерами; переводит научно-техническую литературу, связанную с профессиональной деятельностью

Владеть:

УК-4.3/Нв1 стратегиями проведения сопоставительного анализа факторов культуры различных стран

ИДК УК-4.4 Аргументированно и конструктивно отстаивает свои позиции и идеи в академических и профессиональных дискуссиях на государственном языке РФ и иностранном языке

Знать:

УК-4.4/Зн1 лексический минимум в объеме 2000 лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников

Уметь:

УК-4.4/Ум1 осуществлять коммуникацию с зарубежными партнерами; переводить научно-техническую литературу по вопросам, связанным с профессиональной деятельностью

Владеть:

УК-4.4/Нв1 компенсаторными умениями, помогающими преодолеть "сбои" в коммуникации, вызванные объективными и субъективными, социокультурными причинами

Базовый	ИДК УК-4.1 Устанавливает и развивает профессиональные контакты в соответствии с потребностями совместной деятельности, включая обмен информацией и выработку единой стратегии взаимодействия Знать: УК-4.1/Зн1 Лексический минимум в объеме 2000 учебных лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников Уметь: УК-4.1/Ум1 Выполнять переводы технических текстов с иностранного языка ИДК УК-4.2 Составляет, переводит и редактирует различные академические тексты (рефераты, эссе, обзоры, статьи и т.д.), в том числе на иностранном языке Знать: УК-4.2/Зн1 Основные способы работы на языковом и речевым материалом Уметь: УК-4.2/Ум1 Выполнять перевод технических текстов с иностранного языка ИДК УК-4.3 Представляет результаты академической и профессиональной деятельности на различных публичных мероприятиях, включая международные, выбирая наиболее подходящий формат Знать: УК-4.3/Зн1 нормы произношения, лексику иностранного языка общеупотребительного, терминологического и профессионального содержания; типовые способы построения высказываний в устной и письменной речи Уметь: УК-4.3/Ум1 осуществляет коммуникацию с зарубежными партнерами; переводит научно-техническую литературу, связанную с профессиональной деятельностью
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	ИДК УК-4.4 Аргументированно и конструктивно отстаивает свои позиции и идеи в академических и профессиональных дискуссиях на государственном языке РФ и иностранном языке Знать: УК-4.4/Зн1 лексический минимум в объеме 2000 лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников Уметь: УК-4.4/Ум1 осуществлять коммуникацию с зарубежными партнерами; переводить научно-техническую литературу по вопросам, связанным с профессиональной деятельностью
Пороговый	ИДК УК-4.1 Устанавливает и развивает профессиональные контакты в соответствии с потребностями совместной деятельности, включая обмен информацией и выработку единой стратегии взаимодействия Знать: УК-4.1/Зн1 Лексический минимум в объеме 2000 учебных лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников ИДК УК-4.2 Составляет, переводит и редактирует различные академические тексты (рефераты, эссе, обзоры, статьи и т.д.), в том числе на иностранном языке Знать: УК-4.2/Зн1 Основные способы работы на языковом и речевом материалом ИДК УК-4.3 Представляет результаты академической и профессиональной деятельности на различных публичных мероприятиях, включая международные, выбирая наиболее подходящий формат Знать: УК-4.3/Зн1 нормы произношения, лексику иностранного языка общеупотребительного, терминологического и профессионального содержания; типовые способы построения высказываний в устной и письменной речи

		ИДК УК-4.4 Аргументированно и конструктивно отстаивает свои позиции и идеи в академических и профессиональных дискуссиях на государственном языке РФ и иностранном языке Знать: УК-4.4/Зн1 лексический минимум в объеме 2000 лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников
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3. Шкала оценивания

Оценка	Критерии оценивания (перечень сформированных ИДК/ЗУВ)
Зачтено	УК-4.1 Устанавливает и развивает профессиональные контакты в соответствии с потребностями совместной деятельности, включая обмен информацией и выработку единой стратегии взаимодействия УК-4.1/Зн1 Лексический минимум в объеме 2000 учебных лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников УК-4.2 Составляет, переводит и редактирует различные академические тексты (рефераты, эссе, обзоры, статьи и т.д.), в том числе на иностранном языке УК-4.2/Зн1 Основные способы работы на языковом и речевым материалом УК-4.3 Представляет результаты академической и профессиональной деятельности на различных публичных мероприятиях, включая международные, выбирая наиболее подходящий формат УК-4.3/Зн1 нормы произношения, лексику иностранного языка общеупотребительного, терминологического и профессионального содержания; типовые способы построения высказываний в устной и письменной речи УК-4.4 Аргументированно и конструктивно отстаивает свои позиции и идеи в академических и профессиональных дискуссиях на государственном языке РФ и иностранном языке УК-4.4/Зн1 лексический минимум в объеме 2000 лексических единиц общего и терминологического характера, необходимого для возможности получения информации профессионального содержания из зарубежных источников
Не зачтено	Результаты обучения не сформированы на достаточном уровне

4. Контрольные мероприятия по дисциплине

Вид контроля	Форма контроля/Оценочное средство
Текущий контроль	Контрольная работа
Промежуточная аттестация	Зачет

№	Наименование раздела	Контролируем	Вид контроля/ используемые оценочные материалы
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п/п	Наименование раздела	ые ИДК	Текущий	Промежут. аттестация
1	Научно-ориентированная иноязычная коммуникация с учетом отраслевой специализации	УК-4.1 УК-4.2		Зачет
2	Профессионально ориентированный перевод в научной сфере с учетом отраслевой специализации	УК-4.1 УК-4.4	Контрольная работа	Зачет
3	Информационно-коммуникационные технологии в иноязычной научно- исследовательской деятельности специалиста	УК-4.1 УК-4.2 УК-4.3 УК-4.4		Зачет

5. Порядок проведения промежуточной аттестации

Порядок проведения промежуточной аттестации регламентируется локальными нормативными актами Университета:

- Положением о формах, периодичности, порядке текущего контроля успеваемости и промежуточной аттестации обучающихся по основным образовательным программам высшего образования – программам бакалавриата, программам специалитета, программам магистратуры в федеральном государственном бюджетном образовательном учреждении высшего образования «Московский государственный университет геодезии и картографии», п.6 «Организация и проведение промежуточной аттестации».
- Положением о порядке осуществления образовательного процесса, проведения текущего контроля успеваемости и промежуточной аттестации обучающихся с применением электронного обучения и дистанционных образовательных технологий в федеральном государственном бюджетном образовательном учреждении высшего образования «Московский государственный университет геодезии и картографии», п.8 «Проведение промежуточной аттестации с применением ЭО и ДОТ».

Промежуточная аттестация: Зачет, 1 семестр.

6. Оценочные материалы текущего контроля

Раздел 2. Профессионально ориентированный перевод в научной сфере с учетом отраслевой специализации

Контролируемые ИДК: УК-4.1 УК-4.4

Тема 2.1. Основы теории перевода узкоспециальных текстов.

Форма контроля/оценочное средство: Контрольная работа

Вопросы/Задания:

1. Translate the text

TRIANGULATION

A system of triangles usually affords superior horizontal control. All of the angles and at least one side (the base) of the triangulation system are measured. Though several arrangements can be used, one of the best is the quadrangle or a chain of quadrangles. Each quadrangle, with its four sides and two diagonals, provides eight angles that are measured. To be geometrically consistent, the angles must satisfy three so-called angle equations and one side equation. That is to say the three angles of each triangle, which add to 180°, must be of such sizes that computation through any set of adjacent triangles with the quadrangles will give the same values for any side. Ideally, the quadrangles should be parallelograms. If the system is connected with previously determined stations, the new system

must fit the established measurements.

When the survey encompasses an area large enough for the Earth's curvature to be a factor, an imaginary mathematical representation of the Earth must be employed as a reference surface. A level surface at mean sea level is considered to represent the Earth's size and shape, and this is called the geoid. Because of gravity anomalies, the geoid is irregular; however, it is very nearly the surface generated by an ellipse rotating on its minor axis – i.e. an ellipsoid slightly flattened at the ends, or oblate. Such a figure is called a spheroid. Several have been computed by various authorities; the one usually used as a reference surface by English-speaking nations is (Alexander Ross) Clarke's Spheroid of 1866. This oblate spheroid has a polar diameter about 27 miles (43 kilometres) less than its diameter at the Equator.

Because the directions of gravity converge toward the geoid, a length of the Earth's surface measured above the geoid must be reduced to its sea-level equivalent – i.e. to that of the geoid. These lengths are assumed to be the distances, measured on the spheroid, between the extended lines of gravity down to the spheroid from the ends of the measured lengths on the actual surface of the Earth. The positions of the survey stations on the Earth's surface are given in spherical coordinates.

Bench marks, or marked points on the Earth's surface, connected by precise leveling constitute the vertical controls of surveying. The elevations of bench marks are given in terms of their heights above a selected level surface called a datum. In large-level surveys the usual datum is the geoid. The elevation taken as zero for the reference datum is the height of mean sea level determined by a series of observations at various points along the seashore taken continuously for a period of 19 years or more. Because mean sea level is not quite the same as the geoid, probably because of ocean currents, in adjusting the level grid for the United States and Canada all heights determined for mean sea level have been held at zero elevation.

7. Оценочные материалы промежуточной аттестации

1 семестр, Зачет

Контролируемые ИДК: УК-4.1 УК-4.2 УК-4.3 УК-4.4

Вопросы/Задания:

1. Translate the text. (1800 printed characters; time – 45 min.)

GEODETIC AND PLANE SURVEYS

Two general classifications of surveys are geodetic and plane. They differ principally in the assumptions on which the computations are based, although field measurements for geodetic surveys are usually performed to a higher order of accuracy than those for plane surveys.

In geodetic surveying, the curved surface of the Earth is considered by performing the computations on an ellipsoid (curved surface approximating the size and shape of the Earth). It is now becoming common to do geodetic computations in a three-dimensional, Earth-centered, Earth-fixed (ECEF) Cartesian coordinate system. The calculations involve solving equations derived from solid geometry and calculus. Geodetic methods are employed to determine relative positions of widely spaced monuments and to compute lengths and directions of the long lines between them. These monuments serve as the basis for referencing other subordinate surveys of lesser extents.

In early geodetic surveys, painstaking efforts were employed to accurately observe angles and distances. The angles were measured using precise ground-based theodolites, and the distances were measured using special tapes made from metal having a low coefficient of thermal expansion. From these basic measurements, the relative positions of the monuments were computed. Later, electronic instruments were used for observing the angles and distances. // Although these latter types of instruments are still sometimes used on geodetic surveys, satellite positioning has now almost completely replaced other instruments for these types of surveys. Satellite positioning can provide the needed positions with much greater accuracy, speed, and economy. GNSS receivers enable ground stations to be located precisely by observing distances to satellites operating in known positions along their orbits.

2. Translate the text. (1800 printed characters; time – 45 min.)

Satellite positioning can provide the needed positions with much greater accuracy, speed, and economy. GNSS receivers enable ground stations to be located precisely by observing distances to satellites operating in known positions along their orbits. GNSS surveys are being used in all forms of surveying including geodetic, hydrographic, construction, and boundary surveying. The principles of operation of the global positioning system are given further, field and office procedures used in static GNSS surveys are discussed still further, and the methods used in kinematic GNSS surveys are discussed even further.

In plane surveying, except for leveling, the reference base for fieldwork and computations is assumed to be a flat horizontal surface. The direction of a plumb line (and thus gravity) is considered parallel throughout the survey region, and all observed angles are presumed to be plane angles. For areas of limited size, the surface of our vast ellipsoid is actually nearly flat. On a line 5 mi long, the ellipsoid arc and chord lengths differ by only about 0.02 ft. A plane surface tangent to the ellipsoid departs only about 0.7 ft at 1 mi from the point of tangency. In a triangle having an area of 75 square miles, the difference between the sum of the three ellipsoidal angles and three plane angles is only about 1 sec. Therefore, it is evident that except in surveys covering extensive areas, the Earth's surface can be approximated as a plane, thus simplifying computations and techniques. // In general, algebra, plane and analytical geometry, and plane trigonometry are used in plane-surveying calculations. Even for very large areas, map projections allow plane-surveying computations to be used.

3. Translate the text. (1800 printed characters; time – 45 min.)

Survey work of all kinds tends to be expensive and the precise comparative cost of air and ground methods can usually only be determined with regard to particular cases. Air survey methods benefit from economies of scale where a large number of boundaries or points of detail have to be recorded. The capital and running costs of aeroplanes and the equipment used in aerial surveys are high, and the personnel required are highly skilled and relatively well paid in comparison with some field surveyors. The number of days in the year on which flying can be done is normally quite small but then in many countries the number of days on which field survey work can be carried out is restricted for climatic reasons though not so much as for flying.

There may be difficulty in getting approval for air survey from the military authorities who in many countries have traditionally opposed public access to aerial photographs for supposed security reasons. Given the ready availability and quality of modern satellite imagery, this restriction makes little sense. Would-be terrorists can easily obtain from elsewhere the sort of information that opponents of public access to aerial photography seek to hide. Opposition to the use of aerial photography has increased the cost of many surveys and reduced their effectiveness with consequent but unmeasured costs that have significant impact on the national economy.//

Broadly speaking, aerial photographs have been used in cadastral mapping in five different ways. In the simplest case, contact scale or enlarged photographs may be used as a base on which to outline the parcels. In some countries it is sufficient to produce a plan which acts as a signpost to the parcels, the boundaries of which can be determined by inspection on the ground. In such cases there is no need to record the accurate dimensions of any land parcel so long as its boundaries are clearly visible on the photographs. Thus in Kenya, photographs enlarged to 1: 2,500 scale have been used to form the base from which the boundaries of the parcels could be traced. Such an approach is expedient where large numbers of parcels need to be recorded over a short period of time. Where time and money allow, the areas can be resurveyed to higher accuracy at a later date.

More accurate mapping may be achieved by using rectified photographs that remove any distortions occurring when the photography is not done with the camera pointing exactly vertically downwards. The Land Titling Programme in Thailand made extensive use of enlarged rectified photographs, with supplementary information provided by ground survey. Cadastral photomaps at scales of 1:4,000 and

larger were produced. A similar technique was used in Botswana where the photo-maps were suitably annotated to identify particular parcels. Given a vast area of savannah country with no nearby ground survey control, it is possible to identify patterns in the vegetation and to trace on to the photographs the outlines of areas of land allocated for purposes such as veterinary stations, air strips and police posts. The dimensions of the plots can then be added from measurements made by taping on the ground. A disadvantage in using rectifiers is the relatively high cost of this equipment.

4. Translate the text. (1800 printed characters; time – 45 min.)

Except for control surveys, most other types described are usually performed using plane-surveying procedures, but geodetic methods may be employed on the others if a survey covers an extensive area or requires extreme accuracy.

Ground, aerial, and satellite surveys are broad classifications sometimes used. Ground surveys utilize measurements made with ground-based equipment such as automatic levels and total station instruments. Aerial surveys are accomplished using either photogrammetry or remote sensing. Photogrammetry uses cameras that are carried usually in airplanes to obtain images, whereas remote sensing employs cameras and other types of sensors that can be transported in either aircraft or satellites. Procedures for analyzing and reducing the image data are described further. Aerial methods have been used in all the specialized types of surveys listed, except for optical tooling, and in this area terrestrial (ground-based) photographs are often used. Satellite surveys include the determination of ground locations from measurements made to satellites using GNSS receivers, or the use of satellite images for mapping and monitoring large regions of the Earth.

Computerization speeds up the processes of field and photogrammetric survey, the storage, retrieval and analysis of data, and the preparation and production of cadastral maps and plans.

5. Translate the text. (1800 printed characters; time – 45 min.)

TRIANGULATION

A system of triangles usually affords superior horizontal control. All of the angles and at least one side (the base) of the triangulation system are measured. Though several arrangements can be used, one of the best is the quadrangle or a chain of quadrangles. Each quadrangle, with its four sides and two diagonals, provides eight angles that are measured. To be geometrically consistent, the angles must satisfy three so-called angle equations and one side equation. That is to say the three angles of each triangle, which add to 180° , must be of such sizes that computation through any set of adjacent triangles with the quadrangles will give the same values for any side. Ideally, the quadrangles should be parallelograms. If the system is connected with previously determined stations, the new system must fit the established measurements.

When the survey encompasses an area large enough for the Earth's curvature to be a factor, an imaginary mathematical representation of the Earth must be employed as a reference surface. A level surface at mean sea level is considered to represent the Earth's size and shape, and this is called the geoid. Because of gravity anomalies, the geoid is irregular; however, it is very nearly the surface generated by an ellipse rotating on its minor axis – i.e. an ellipsoid slightly flattened at the ends, or oblate. Such a figure is called a spheroid. //Several have been computed by various authorities; the one usually used as a reference surface by English-speaking nations is (Alexander Ross) Clarke's Spheroid of 1866. This oblate spheroid has a polar diameter about 27 miles (43 kilometres) less than its diameter at the Equator.

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have been held at zero elevation.

6. Translate the text. (1800 printed characters; time – 45 min.)

TOOLS AND PRODUCTS OF MODERN GEODESY

Today, the toolbox of geodesy comprises a number of space-geodetic and terrestrial techniques, which together allow for detailed observations of the «three pillars of geodesy» (Geokinematics, Earth Rotation, the Gravity Field) on a wide range of spatial and temporal scales. With a mix of terrestrial, airborne, and spaceborne techniques, geodesy today determines and monitors changes in Earth's shape, gravitational field and rotation with unprecedented accuracy, resolution (temporal as well as spatial), and long-term stability. At the same time, geodetic observation technologies are in constant development with new technologies extending the observation capabilities almost continuously in terms of accuracy, spatial and temporal coverage and resolution, parameters observed, latency and quality. Together, these observations provide the basis to determine and monitor the ITRF and ICRF as the metrological basis for all Earth observations. Equally important, the observations themselves are directly related to mass transport and dynamics in the Earth system. Thus, the geodetic measurements form the basis for Earth system observations in the true meaning of these words. Beutler et al. suggested a development towards an interdisciplinary service in support of Earth sciences for the IGS. With the establishment of GGOS, IAG has extended this concept of an observing system and service for Earth system sciences to the whole of geodesy.//

It is obvious that there is an intimate relationship between the three pillars of geodesy and the reference systems and frames. For geokinematics and Earth rotation, the relationship works both ways: the reference systems are required for positioning purposes (terrestrial and celestial) and for studying Earth rotation, and monitoring through the space geodetic techniques is necessary to realize the two frames and the time-dependent transformation between them.

7. Translate the text. (1800 printed characters; time – 45 min.)

A Brief History of Surveying, Geodesy, and Geomatics

Surveying dates back to ancient civilizations, where early land measurement was essential for agriculture, construction, and taxation. The Egyptians (around 3000 BCE) used simple geometry to reestablish property boundaries after Nile floods, while the Greeks and Romans advanced surveying for road and aqueduct construction.

During the Renaissance, geodesy—the science of Earth's shape and size—gained prominence. Eratosthenes (240 BCE) calculated Earth's circumference, while 17th-century astronomers like Snellius and Picard improved triangulation methods. The invention of the theodolite (16th century) and later the telescope-enhanced instruments revolutionized precision.

The 18th–19th centuries saw national surveying projects, such as the Great Trigonometric Survey of India and the French meridian arc measurements, refining the geodetic model. The industrial era introduced mechanical calculators and standardized units (meter, 1791).

The 20th century brought seismic shifts: aerial photography (WWI), electronic distance measurement (1940s), and satellite geodesy. The launch of Sputnik (1957) enabled Doppler positioning, leading to GPS (1973). Computers digitized mapping, birthing geomatics—the integration of surveying, GIS, and remote sensing.

Today, GNSS, LiDAR, and AI-driven analytics dominate, enabling real-time, centimeter-accurate positioning. From ropes and chains to space-based tech, surveying remains foundational in shaping our understanding of space and place.

8. Translate the text. (1800 printed characters; time – 45 min.)

A geodetic network is a network of triangles which are measured exactly by techniques of terrestrial

surveying or by satellite geodesy. In "classical geodesy" (up to the sixties) this is done by triangulation, based on measurements of angles and of some sparse distances; the precise orientation to geographic North is done by methods of geodetic astronomy. The mainly used instruments are theodolites and tachometers to be equipped by infrared range finders, data bases, communication systems and partly by satellite links. Beginning with ca 1960, the electronic distance measurement (EDM) was introduced, when the first prototypes became small enough to work in the field. EDM increased the network accuracies up to 1:1 million (1 cm per 10 km; today at least 10 times better), and also the economy of surveying. At the same time the geodetic use of satellites begun, e.g. the bright satellites of Echo I and II and Pageos. By means of these space probes, global networks were determined, which later proved the theory of plate tectonics.

An important improvement was the introduction of radio and electronic satellites like Geos A and B (1965-70), of the Transit system¹⁵ (Doppler effect) 1967-1990 — which was the predecessor of the GPS - and of laser techniques like Lageos (USA) or Starlette (France).

Despite of the space techniques, small networks for cadastre and technical projects are mainly measured terrestrially, but in many cases closed together to national and global networks by satellite geodesy. //

In the meantime, several hundred geodetic satellites are orbiting, supplemented by a huge number of remote sensing satellites - and last but not least by the navigation systems of GPS and GLONASS, which will be followed by the European Galileo satellites in 2008. Nowadays the spacebased geodetic networks¹⁷ are more flexible and economic than terrestrial ones; the further existence of fixed point¹⁸ networks is already discussed, but will survive at least for administrative and legal demands on local and regional scales. Whereas the worldwide networks cannot be defined to be fixed, because Geodynamics is changing the position of all continents by amounts of 2 cm up to 20 cm per year. Therefore, modern global networks like ETRF or ITRF (International Terrestrial Reference Frame) show not only coordinates of their "fixed points", but also their annual velocities.

9. Translate the text. (1800 printed characters; time – 45 min.)

Geoid and reference ellipsoid

1. Geoid and reference ellipsoid. The geoid is essentially the shape of the earth abstracted from its topographic features. It is an idealized equilibrium surface of sea water, the mean sea level surface in the absence of currents, air pressure variations etc. and continued under the continental masses. The geoid, unlike the ellipsoid, is too complicated to serve as the computational surface on which to solve geometrical problems like point positioning .

2. A reference ellipsoid, customarily chosen to be the same size (volume) as the geoid, is described by its semi-major axis (equatorial radius) a and flattening f . The quantity $f = (a - b) / a$, where b is the semi-minor axis (polar radius) is a purely geometrical one. The mechanical ellipticity of the earth (dynamical flattening) is determined by observation and differs from the geometrical because the earth is not of uniform density.

3. Co-ordinate systems in space. The locations of points in three-dimensional space are most conveniently described by three Cartesian or rectangular coordinates, X, Y and Z . Since the advent of satellite positioning, such coordinate systems are said to be typically geocentric: the Z axis is aligned with the Earth's (conventional or instantaneous) rotation axis, while the X axis lies within the Greenwich observatory's meridian plane.

4. Before the satellite geodesy era, the coordinate systems associated with geodetic datums attempted to be geocentric, but their origins differed from the geocentre by hundreds of metres, due to regional deviations in the direction of the plumbline (vertical). //These regional geodetic datums, such as ED50 (European Datum 1950¹²) or NAD83 (North American Datum 1983¹³) have ellipsoids associated with them that are regional 'best fits' to the geoids within their areas of validity, minimizing the deflections¹⁴ of the vertical over these areas.

10. Translate the text. (1800 printed characters; time – 45 min.)

1. In late October and early November 2009, DRDC (Минобороны Канады) collected airborne hyperspectral imagery near Suffield, Alberta (50°13'N, 110°10'W) using an Itres SASI-600 SWIR pushbroom imaging system.(съёмочная система непрерывного сканирования Itres SASI-600 SWIR (коротковолновый ИК-сенсор).
2. The sensor was flown at various altitudes ranging from 330m to 1700m above ground level in order to acquire imagery at across-track ground sampling distance (GSD) of 0.4m, 1.0m, and 2.0m, while along track GSD remained constant at 1.0m. Imagery was collected between 13h00 and 15h00 local time, which resulted in sun elevation between 17 and 25 degrees.
3. Furthermore, thin altostratus clouds and an overcast of altocumulus clouds on the first (29 Oct) and second day (03 Nov) of collect respectively degraded the illumination conditions considerably. Compared to typical reflective hyperspectral field trials usually conducted under clear skies and high solar elevation, this data collection was conducted under significantly adverse environmental conditions not often considered in the hyperspectral literature.
4. One objective of this field trial was the evaluation of the constrained energy minimization (CEM) algorithm sub-pixel abundance estimation accuracy. For this purpose, we designed targets of known abundances made of thin strips of painted metal (маринованный металл). The design allowed changes to the abundance level by varying the distance between the strips of metals while their overall size (5m x 5m) ensured that they filled completely at least one pixel in the imagery. We used two different types of paint to vary the contrast between the target and background, one beige and one green.

11. Translate the text. (1800 printed characters; time – 45 min.)

1. The HYMEX project addressed applications divided in 3 categories: 1. Target detection and identification: This includes targets such as military vehicles, camouflages and various man-made materials. 2. Land mapping applications: This includes the characterization of soil and vegetation. 3. Marine mapping applications: This includes beach characterization and near-shore bathymetry, as well as water color mapping (отображение глубин гипсометрией) .
2. As mentioned in the introduction, DRDC (Минобороны Канады) developed expertise and advanced exploitation techniques for target detection over the years but had limited expertise for terrain analysis and water mapping. To identify available techniques for the last 2 categories, HYMEX conducted a survey of about 60 different groups from industry, academia and other government departments forming the Canadian remote sensing community.
3. The HYMEX project conducted several field trials at different locations across Canada to acquire remotely sensed hyperspectral imagery and ground truth for testing the various algorithms. Each location had specific characteristics likely to affect the performance of the algorithms. Marine trials were conducted in two different locations (East and West coast). Land trials were conducted in an Acadian forest, a boreal forest, an aspen dominant forest and in prairie grassland.
4. One trial was conducted in winter under snow conditions. While some space-based hyperspectral imagery was acquired, the project main data type came from airborne hyperspectral sensors.

12. Translate the text. (1800 printed characters; time – 45 min.)

1. At over 40 years, the Landsat series of satellites provides the longest temporal record of space-based land surface observations and the successful February 2013 launch of the Landsat 8 satellite is continuing this legacy.
2. The Landsat 8 payload includes the Operational Land Imager (OLI) that has a new 1375 μm band designed to monitor cirrus clouds and the Thermal Infrared Sensor (TIRS) that together provide improved cloud detection capabilities. In addition, the radiometric resolution and the dynamic range of the OLI is improved compared to previous Landsat sensors, reducing band saturation over highly reflective objects, such as snow or cloud. Landsat 8 data are nominally processed into 185 km $\times$ 180 km scenes and, unlike for previous Landsat sensors, are provided with a spatially explicit 30 m

quality assessment band that includes a cloud and cirrus cloud mask.

3. Landsat data are less appropriate for quantification of cloud properties and amount compared to near daily global coverage and certain active cloud remote sensing systems although Landsat data have been valuable for cloud morphology analyses. However, quantification of the incidence of cloudiness for Landsat terrestrial monitoring applications, especially in persistently cloudy regions, is important because optically thick clouds preclude optical and thermal wavelength remote sensing of the surface.

4. The Landsat sensors are in polar orbiting sun synchronous orbits with a 16 day repeat cycle and considerable global spatial and temporal variability in cloudiness at the time of Landsat overpass.

13. Translate the text. (1800 printed characters; time – 45 min.)

1. Time is a multifaceted concept, with deeply personal and subjective meanings as well as formally constructed but still arbitrary meanings, and ontologies for time in GIScience can be as complex as they are for space in geography. At its simplest, however, and in the practice of GIScience research, it is still useful to think about space–time research challenges in three basic temporal domains: (1) past time—documenting and interpreting historical events, places, and processes; (2) future time—modeling, simulating, or projecting future spatial scenarios; and (3) real time—understanding and interacting with events, people, places, and spatial processes as they are emerging and mutually evolving in a dynamic and mobile world.

2. Although interrelated, of course, each of these simple categories has its own special set of challenges in gathering, understanding, and representing space–time integrated data. Historical time and geographic data, especially from the more distant past, are highly constrained by preexisting and frequently indefinite or inconsistent time and space categories of bygone eras.

3. Historical geographic information systems (GIS) cannot ignore and must struggle to work within and reconcile the profusion of its received categories of time and space. Future time GIScience work is less restricted, in the sense that its temporal and spatial constructs are not necessarily constrained by past categories or practices and can more freely be structured as the researcher or modeler wishes; its delineations of space or time need not be confined to those of a world or a time that is occurring or already has occurred.

14. Translate the text. (1800 printed characters; time – 45 min.)

1. Over the past 30 years, a global warming of 0.2 °C per decade has been detected. The significant increase in temperature in the Arctic and Antarctic regions is contributing to global sea level rise, which greatly influences the living environment and socioeconomic settings of human beings living near the current mean sea level. According to Mitrovica et al., the melting of the Greenland ice complex is equivalent to 0.6 mm year⁻¹ of sea level rise over the last century. More recently, Shepherd et al. reported that the total contribution of the polar ice sheets to sea level rise has been 0.59 ± 0.20 mm year⁻¹ on average since 1992 using satellite altimetry, interferometry, and gravimetry datasets, with the current rate being about 1 mm year⁻¹.

2. As a consequence, it is important to measure the surface velocity, mass and surface elevation of the Arctic and Antarctic ice sheets in order to model and simulate how they will respond to a warming climate, and to predict their contribution to sea level rise.

3. The Center for Remote Sensing of Ice Sheets (Центр дистанционного зондирования ледяных щитов (CRISIS)), with the mission of developing new technologies and computer models to measure and predict the response of sea level change to the mass balance of ice sheets in the Arctic and Antarctic, collects much-needed data relevant to ice sheets and the rapid changes they are undergoing. Large amounts of geospatial data have been collected or generated from remote sensors for the advanced monitoring and investigation of the polar environment at CRISIS.

15. Translate the text. (1800 printed characters; time – 45 min.)

1. Mapping and spatial data collection are two activities that have radically changed from primarily professional domains to increased involvement of the public. This shift in activity patterns has

occurred as a result of significant technological advances during the last decade. This includes the ability to create content online more easily through Web 2.0, the proliferation of mobile devices that can record the location of features, and open access to satellite imagery and online maps.

2. The literature describes this phenomenon using a multitude of terms, which have emerged from different disciplines; some are focused on the spatial nature of the data such as volunteered geographic information (VGI) and neogeography, while others have much broader applicability, e.g., crowdsourcing, citizen science and user-generated content, to name but a few.

3. Despite their differences, these terms are often used interchangeably to capture the same basic idea of citizen involvement in carrying out various activities relating to geographic information science. These activities can be driven by the needs of a second party such as a commercial company needing to outsource micro-tasks or by researchers who need large data sets collected that would otherwise not be possible using their own resources.

4. Citizens may be motivated to contribute for a diverse set of reasons. The participants involved might, for instance, feel compelled to contribute by a collective cause such as contributing to an open map of the world through OpenStreetMap. Another motivation is simply the desire to share information more widely, by, for example, placing georeferenced photographs online via a site like Panoramio or georeferenced commentary captured via Twitter. Whatever the motivation for collecting and sharing the data, these systems have become important sources of geographical data and are now being used by others for applications that may be unforeseen by the contributors, such as scientific research.

16. Translate the text. (1800 printed characters; time – 45 min.)

1. There are many applications of global population density datasets, with particular relevance for urban and regional research, international development and natural hazard risk. This paper describes the creation of an interactive map of the population data to allow researchers and the general public to quickly and intuitively view spatial patterns and statistics from the dataset.

2. The interactive map is viewable at the site <http://luminocity3d.org/WorldPopDen>. The aim of the map is to be relevant for a range of users who are interested in a variety of study areas and scales of analysis. This scale flexibility is a strength of interactive mapping. The cartographic solution implemented here was firstly to use the multiple data scales available in the population data for different zoom levels in the interactive map. Secondly, a carefully designed data classification and colour scheme was developed to differentiate the main rural, suburban, urban and super-urban density patterns in the dataset. And lastly, interactive statistics are provided at both national and city level scales displaying numerical comparisons in population and density, including change over time statistics using the temporal Glasgow University (GU) data.

3. The aim of the global population density map is to clearly display density patterns across a range of spatial scales, specifically from continental perspectives to more detailed national and city-region scales. This range of scales is intended to take advantage of the high-resolution data available in GU, expanding the variety of users and applications that the map is relevant to.

4. Two GU raster data products are included in the map: the 1 km cell resolution 2015 population data and the more detailed 250 m cell resolution 2015 population data. The different data resolutions are used at different viewing scales to improve data legibility. The 1 km data is used for continental and national scale maps, as shown in Figure 1 for the examples of Europe and East Asia. The 250 m data is used for regional scale maps.

17. Translate the text. (1800 printed characters; time – 45 min.)

The Definition and Significance of Boundaries in Surveying

Boundary definition stands as one of the most crucial responsibilities in the field of surveying, serving as the foundation for property rights and land management. This complex process involves much more than simply measuring distances - it requires a careful blend of legal interpretation, historical research, and precise measurement techniques to establish clear and indisputable property lines.

At its core, boundary determination begins with a thorough examination of legal documents. Surveyors meticulously analyze deeds, historical surveys, and land records to understand the original intent behind property divisions. This paper trail often reveals fascinating insights into how communities have evolved over time, with some boundary disputes tracing back centuries. The surveyor's role as an interpreter of these documents makes them an essential bridge between the legal system and physical land use.

Modern technology has revolutionized boundary surveys while maintaining their traditional importance. While surveyors still use fundamental tools like theodolites and measuring tapes, they now integrate advanced solutions such as GPS and GNSS receivers that provide centimeter-level accuracy. These technological advancements work in tandem with traditional methods - a surveyor might use satellite positioning to verify the location of an old stone marker mentioned in a 19th-century deed.

The physical marking of boundaries remains a tangible and critical part of the process. Surveyors install durable monuments at key points, choosing materials designed to withstand environmental changes. These markers range from simple iron rods to elaborate engraved stones, each serving as a permanent reference for future surveys. The placement of each marker carries significant legal weight, making precision absolutely essential.

Boundary surveys frequently encounter challenges that test a surveyor's expertise. Discrepancies between historical records and current land use often emerge, requiring careful reconciliation. Natural processes like erosion or tree growth can obscure original markers, while human activities sometimes lead to accidental or intentional encroachments. In these situations, surveyors must combine technical skills with diplomatic acumen to resolve conflicts.

The importance of accurate boundary definition extends far beyond individual properties. Well-defined boundaries form the backbone of functional communities, enabling proper land development, rational urban planning, and fair taxation systems. They provide the framework for infrastructure projects, environmental protection efforts, and disaster management planning. In essence, the work of boundary surveyors helps maintain the fundamental order of our physical and legal landscapes.

As populations grow and land becomes increasingly valuable, the role of boundary surveyors will only grow in importance. Their unique combination of technical precision, historical knowledge, and legal understanding makes them indispensable in creating and maintaining the invisible lines that shape our world. The next time you see a surveyor at work, remember they're not just measuring land - they're preserving a system of ownership and use that forms the foundation of modern society.

18. Translate the text. (1800 printed characters; time – 45 min.)

Technical Limitations in Boundary Surveying: Navigating the Gaps Between Theory and Practice

Boundary surveying, while increasingly supported by advanced technologies, still faces inherent technical limitations that challenge even the most experienced professionals. These constraints affect measurement accuracy, data interpretation, and the reconciliation of modern surveys with historical records, often creating complex situations in the field.

1. Accuracy Limitations of Measurement Tools

Modern surveying instruments, though precise, are not infallible. GNSS receivers—while capable of centimeter-level accuracy under ideal conditions—face signal interference in urban canyons, under heavy tree canopies, or near power lines. Total stations and electronic distance measurement (EDM) devices are similarly affected by atmospheric conditions like humidity and temperature fluctuations, requiring constant calibration. These physical constraints mean that even with high-end equipment, measurements always carry a margin of error that surveyors must account for in their final determinations.

2. Challenges with Historical Data Integration

Many boundary surveys require correlating contemporary measurements with historical records that

used different technologies and standards. Older surveys might reference chains, rods, or varas—units no longer in common use—with conversion factors that introduce rounding errors. Some 19th-century surveys relied on magnetic bearings rather than true north, creating discrepancies when overlaying them on modern coordinate systems. Surveyors often struggle to match the precision of current tools with the inherent imprecision of legacy data, leading to interpretation challenges.

3. Limitations in Marker Detection

Even with ground-penetrating radar (GPR) and metal detectors, locating original boundary monuments can be problematic. Iron pins may have corroded, stone markers might have been moved or buried under decades of soil accumulation, and wooden stakes often rot away entirely. In some cases, natural features like trees or rocks referenced in old deeds have disappeared without trace. These gaps force surveyors to rely on indirect evidence and professional judgment, introducing subjectivity into what should be an objective process.

As boundary surveying continues to evolve with new technologies like AI-assisted analysis and improved sensor networks, these technical limitations will gradually diminish—but likely never disappear entirely. The profession's strength lies in its practitioners' ability to navigate these constraints while maintaining the integrity of property boundaries that form the foundation of land ownership systems worldwide.

19. Translate the text. (1800 printed characters; time – 45 min.)

Technical Limitations in Boundary Surveying: Navigating the Gaps Between Theory and Practice

Boundary surveying, while increasingly supported by advanced technologies, still faces inherent technical limitations that challenge even the most experienced professionals. These constraints affect measurement accuracy, data interpretation, and the reconciliation of modern surveys with historical records, often creating complex situations in the field.

1. Software and Data Processing Constraints

While CAD and GIS software have revolutionized surveying, they present their own limitations. Coordinate rounding in digital systems can create small but meaningful discrepancies when working with large datasets. Different software platforms may interpret survey data slightly differently, especially when handling complex boundary curves or irregular parcels. Additionally, the transition from paper-based plats to digital formats sometimes introduces errors during scanning or georeferencing of historical documents.

2. Line-of-Sight and Terrain Challenges

Traditional surveying methods still rely on line-of-sight measurements, which can be obstructed by terrain features like hills, buildings, or dense vegetation. In rugged or inaccessible areas, surveyors may need to compromise on optimal measurement points, potentially affecting accuracy. Even drone-based LiDAR surveys face limitations in heavily wooded areas where laser pulses cannot penetrate to ground level.

3. Temporal Factors in Measurements

Boundary surveys conducted at different times may yield varying results due to seasonal changes. Frozen ground in winter affects tripod stability, while summer foliage blocks GNSS signals. More fundamentally, tectonic plate movement (up to several centimeters per year in active regions) means that coordinates are technically always in flux, though this is rarely accounted for in local surveys.

Mitigating Technical Limitations

Surveyors address these challenges through redundancy (multiple measurement methods), rigorous error analysis, and clear documentation of uncertainties. They combine technologies—using GNSS where possible and supplementing with total stations or tape measurements where necessary. Most importantly, they recognize that technology provides tools rather than absolute answers, maintaining a healthy skepticism about any single data source.

20. Translate the text. (1800 printed characters; time – 45 min.)

BIM-Enabled Surveys: Transforming Construction Documentation

Building Information Modeling (BIM) has revolutionized the construction industry by enabling more accurate, efficient, and collaborative project management. One of its significant applications is in the realm of surveys, where BIM-enabled surveys enhance the precision and usability of site data.

Traditional surveying methods often involve manual measurements and paper-based documentation, which can be time-consuming and prone to errors. In contrast, BIM-enabled surveys utilize advanced technologies like laser scanning and drone imaging to capture highly detailed 3D data of existing structures and sites. This data is then integrated directly into BIM software, creating comprehensive digital models.

The advantages of BIM-enabled surveys are numerous. They allow for rapid data collection that reduces on-site time and minimizes disruptions. The detailed models facilitate better clash detection, enabling teams to identify potential conflicts early in the design process. Additionally, BIM models serve as valuable as-built references for renovation or maintenance projects, ensuring accuracy and reducing rework.

Furthermore, BIM-enabled surveys support collaborative workflows by providing stakeholders with shared, up-to-date digital models. This openness enhances communication, coordination, and decision-making throughout the project lifecycle.

In summary, BIM-enabled surveys represent a significant step forward in construction documentation, offering increased accuracy, efficiency, and collaboration. As technology advances, their role in delivering smarter, more sustainable projects will only grow, shaping the future of construction practices.

21. Look through the text. Give its brief contents (preparation time - 15 min.).

SPECIALIZED TYPES OF SURVEYS

Many types of surveys are so specialized that a person proficient in a particular discipline may have little contact with the other areas. Persons seeking careers in surveying and mapping, however, should be knowledgeable in every phase, since all are closely related in modern practice. Some important classifications are described briefly here.

Topographic surveys determine locations of natural and artificial features and elevations used in map making.

Land, boundary, and cadastral surveys establish property lines and property corner markers. The term cadastral is now generally applied to surveys of the public lands systems. There are three major categories: original surveys to establish new section corners in unsurveyed areas that still exist in Alaska and several western states; retracement surveys to recover previously established boundary lines; and subdivision surveys to establish monuments and delineate new parcels of ownership. Condominium surveys, which provide a legal record of ownership, are a type of boundary survey.

Ground, aerial, and satellite surveys are broad classifications sometimes used. Ground surveys utilize measurements made with ground-based equipment such as automatic levels and total station instruments. Aerial surveys are accomplished using either photogrammetry or remote sensing. Photogrammetry uses cameras that are carried usually in airplanes to obtain images, whereas remote sensing employs cameras and other types of sensors that can be transported in either aircraft or satellites. Procedures for analyzing and reducing the image data are described further. Aerial methods have been used in all the specialized types of surveys listed, except for optical tooling, and in this area terrestrial (ground-based) photographs are often used. Satellite surveys include the determination of ground locations from measurements made to satellites using GNSS receivers, or the use of satellite images for mapping and monitoring large regions of the Earth.

22. Look through the text. Give its brief contents (preparation time - 15 min.).

HEIGHT DETERMINATION

Heights of surface features above sea level are determined in four main ways: by spirit leveling, by measuring vertical angles and distances, by measuring differences in atmospheric pressure, and, since the late 20th century, by using three-dimensional satellite or inertial systems. Of these the first is the most accurate; the second is next in accuracy but faster; the third is least accurate but can be

fastest if heights are to be measured at well-separated points. The last two techniques require sophisticated equipment that is still very expensive.

In spirit leveling the surveyor has for centuries used a surveying level, which consists of a horizontal telescope fitted with cross hairs, rotating around a vertical axis on a tripod, with a very sensitive spirit level fixed to it; the instrument is adjusted until the bubble is exactly centred. The reading on a graduated vertical staff is observed through the telescope. If such staffs are placed on successive ground points, and the telescope is truly level, the difference between the readings at the cross hairs will equal that between the heights of the points. By moving the level and the staffs alternately along a path or road and repeating this procedure, differences in height can be accurately measured over long horizontal distances.

In the most precise work, over a distance of 100 kilometres the error may be kept to less than a centimeter. To achieve this accuracy great care has to be taken. The instrument must have a high-magnification telescope and a very sensitive bubble, and the graduated scale on the staff must be made of a strip of invar (an alloy with a very small coefficient of thermal expansion). Moreover, the staffs must be placed on pegs or special heavy steel plates, and the distance between them and the level must always be the same to cancel the effects of aerial refraction of the light.

In less precise work a single wooden staff can be used; for detailed leveling of a small area, the staff is moved from one point to another without moving the level so that heights can be measured with a radius of about 100 metres. The distances of these points from the instrument can be measured by tape or more commonly, by recording not only the reading at the central cross hair in the field of view of the telescope but also those at the stadia hairs, that is by tachymetry. The bearing of each point is observed by compass or on the horizontal circle of the level so that it can be plotted or drawn on the map.

23. Look through the text. Give its brief contents (preparation time - 15 min.).

There are many purposes for which large-scale air photographs are required, other than for the making of maps. Such cases are erosion surveys, forest inventory surveys, land-use surveys and many others. It may often prove economical to use aerial photography that meets the needs of the cadastral survey and to make maps on this basis, even though the cost of such photography would not be justified solely for the purposes of cadastral mapping.

The general conclusions drawn from the above observations may be stated as follows:

1. Where air surveys are part of the ordinary survey practice of a country, they may also prove suitable for large cadastral jobs, provided that the amount of supplementary ground work required is not so large as to make it more economical to use ground staff alone. In such cases it may be economical to use photography of sufficiently large scale to meet the needs of cadastral surveying even though this exceeds the requirements of other mapping projects. To carry out a dual or multiple purpose survey through one set of photographs may make economic sense. Often however the needs of different applications of the photography are incompatible and multiple sets of photography may be required.

2. Where a new cadastral survey of a large area is required to be carried out quickly, air survey is often the best practical method, unless a great deal of supplementary ground work proves necessary.

3. Unless reasonably full-time employment can be found for the staff and equipment of a national mapping agency's air survey department, it will usually be better to contract the work out to a commercial agency.

4. Cadastral surveys of small areas, extensions to existing surveys, and revision work will usually best be done by the ground staff of the national cadastral survey organization, according to a continuous programme.

24. Look through the text. Give its brief contents (preparation time - 15 min.).

Here, we review the impact of computers on the surveying and mapping of land parcels, and on the recording and dissemination of land-related information. The main advantage of computerization is the speed with which data may be handled.

Computers can, inter alia, be used to:

- a. speed up the collection and processing of cadastral survey data;
- b. make significant reductions in the cost and space required for storing and retrieving land records;
- c. prevent unnecessary duplication of records;

- d. simplify the preparation of “back-up” copies of registers in case of disaster;
- e. accelerate the processing of data for the first registration of title;
- f. reduce the time and cost involved in transferring property rights and in processing mortgages;
- g. facilitate the monitoring and analysis of market and rental values of land and property;
- h. provide better estimates of the value of land for taxation or compulsory acquisition;
- i. improve efficiency and effectiveness in collecting land and property taxes;

The list of possible applications of information technology (IT) is almost endless. It is often as valid to ask whether a country can afford to be without a good computerized land information system as it is to ask whether it can afford to install one.

Computerization speeds up the processes of field and photogrammetric survey, the storage, retrieval and analysis of data, and the preparation and production of cadastral maps and plans. Automatic data recording has two advantages - it reduces the human mistakes that occur in writing down and subsequently transcribing field survey observations, and it facilitates the transfer of data for subsequent computation and adjustment. In spite of the increased cost of modern surveying equipment, productivity can be significantly increased through the use of computers. This then makes it possible to reduce the unit costs of survey.

25. Look through the text. Give its brief contents (preparation time - 15 min.).

When planning a 3D surveying and modeling project, beside all the technical parameters that should be kept in mind (e.g. location, accessibility, geometric detail, budget), a very crucial thing to know is the final user of the 3D data and the final project's goal, in order to clarify what is actually needed.

Nowadays there is a large number of geomatics data acquisition tools for mapping purposes and for visual Cultural Heritage digital recording. These include satellite imagery, digital aerial cameras, radar platforms, airborne and terrestrial laser scanners, UAVs, panoramic linear sensors, SRL or consumer-grade terrestrial digital cameras and GNSS/INS systems for precise positioning. Beside data acquisition systems, today new software has been developed and many automated data processing procedures are available. For what concerned new functionality for 3D data management, there are new advances in Geographic Information Systems (GIS) and 3D repositories (e.g. BIM) while in the visualization field the rendering and animation software are now more affordable with lower costs and higher results. The continuous development of new sensors, data capture methodologies and multi-resolution 3D representations are contributing significantly to the documentation, conservation, and presentation of heritage information and to the growth of research in the Cultural Heritage field. The generation of reality-based 3D models of heritage sites and objects is nowadays performed using methodologies based on passive sensors and image data, active sensors and range data, classical surveying (e.g. total stations or GNSS), 2D maps, or an integration of the aforementioned techniques.

26. Look through the text. Give its brief contents (preparation time - 15 min.).

HYDROGRAPHY

Surveying of underwater features, or hydrographic surveying, formerly required techniques very different from ground surveying, for two reasons: the surveyor ordinarily was moving instead of stationary, and the surface being mapped could not be seen. The first problem, making it difficult to establish a framework except near land or in shoal areas, was dealt with by dead reckoning between points established by astronomical fixes. In effect a traverse would be run with the ship's bearing measured by compass and distances obtained either by measuring speed and time or by a modern log that directly records distances. These have to be checked frequently, because however accurate the log or airspeed indicator and compass, the track of a ship or aircraft is not the same as its course. Crosscurrents or winds continually drive the craft off course, and those along the course affect the speed and the distance run over the ground beneath.

The only way a hydrographer could chart the seabed before underwater echo sounding and television became available was to cast overboard at intervals a sounding line with a lead weight at the end and measure the length of the line paid out when the weight hit the bottom. The line was marked in fathoms, that is, units of one one-thousandth of a nautical mile, or approximately six feet (1, 8 metres).

Sounding by lead is obviously very slow, especially in deep waters, and the introduction of echo sounding in the early 20th century marked a great improvement. It was made possible by the

invention of electronic devices for the measurement of short intervals of time. Echo sounding depends on timing the lapse between the transmission of a short loud noise or pulse and its return from the target – in this case the bottom of the sea or lake. Sound travels about 5,000 feet (1,500 metres) per second in water, so that an accuracy of a few milliseconds in measurements of the time intervals gives depths within a few feet.

27. Look through the text. Give its brief contents (preparation time - 15 min.).

VLBI observes radio signals emitted by quasars. These fixed points constitute the ICRF, and variations in the orientation of the Earth are measured with respect to the ICRF. This technique is sensitive to processes that change the relative position of the radio telescopes with respect to the source, such as a change in the orientation of the Earth in space or a change in the position of the telescopes due to, for example, tidal displacements or tectonic motions. If just two telescopes are observing the same source, then only two components of the Earth's rotation can be determined. A rotation of the Earth about an axis parallel to the baseline connecting the two radio telescopes does not change the relative position of the telescopes with respect to the source, and hence this component of the Earth's orientation is not determinable from VLBI observations taken on that single baseline. Multibaseline VLBI observations with satisfactory geometry can determine all of the components of the Earth's rotation including their time rates-of-change. In fact, the motion of the axis of rotation of the Earth in space (precession and nutation) and the rotation angle around the axis of rotation are uniquely monitored by VLBI through its direct connection to the ICRF.

GNSS: GNSS signals observed by a network of ground stations can be used to determine the orientation of the network of receivers as a whole. In practice, in order to achieve higher accuracy, more sophisticated analysis techniques are employed to determine the EOPs and other quantities such as orbital parameters of the satellites, positions of the stations, and atmospheric parameters such as the zenith path delay. Only polar motion and its time rate-of-change can be independently determined from GNSS measurements. UT1 cannot be separated from the orbital elements of the satellites and hence cannot be determined from GNSS data. The time rate-of-change of UT1, which is related to the length of the day, can be determined from GNSS measurements. But because of the corrupting influence of orbit error, VLBI measurements are usually used to constrain the GNSS-derived Length of Day (LOD) estimates.

28. Look through the text. Give its brief contents (preparation time - 15 min.).

KINDS OF HORIZONTAL ANGLES

The kinds of horizontal angles most commonly observed in surveying are (1) interior angles, (2) angles to the right, and (3) deflection angles. Because they differ considerably, the kind used must be clearly indicated in field notes. Interior angles are observed on the inside of a closed polygon. Normally the angle at each apex within the polygon is measured. Then, a check can be made on their values because the sum of all interior angles in any polygon must equal $(n - 2) 180^\circ$ where n – is the number of angles. Polygons are commonly used for boundary surveys and many other types of work. Surveyors (geomatics engineers) normally refer to them as closed traverses.

Exterior angles, located outside a closed polygon, are supplements (пополнение угла до 360 град.) of interior angles. The advantage to be gained by observing them is their use as another check, since the sum of the interior and exterior angles at any station must total 360° .

Angles to the right are measured clockwise from the rear to the forward station. Note: As a survey progresses, stations are commonly identified by consecutive alphabetical letters, or by increasing numbers. Most data collectors require that angles to the right be observed in the field.

29. Look through the text. Give its brief contents (preparation time - 15 min.).

DIRECTION OF A LINE

The direction of a line is defined by the horizontal angle between the line and an arbitrarily chosen reference line called a meridian. Different meridians are used for specifying directions including (a) geodetic (also often called true), (b) astronomic, (c) magnetic, (d) grid, (e) record, and (f) assumed.

The geodetic meridian is the north-south reference line that passes through a mean position of the Earth's geographic poles. The positions of the poles defined as their mean locations between the period of 1900.0 and 1905.0 (see Section 19.3).

Wobbling (прецессия) of the Earth's rotational axis causes the position of the Earth's geographic poles to vary with time. At any point, the astronomic meridian is the north-south reference line that

passes through the instantaneous position of the Earth's geographic poles. Astronomic meridians derive their name from the field operation to obtain them, which consists in making observations on the celestial objects. Geodetic and astronomic meridians are very nearly the same, and the former can be computed from the latter by making small corrections.

A magnetic meridian is defined by a freely suspended magnetic needle that is only influenced by the Earth's magnetic field.

Surveys based on a state or other plane coordinate system employ a grid meridian for reference. Grid north is the direction of geodetic north for a selected central meridian and held parallel to it over the entire area covered by a plane coordinate system.

30. Look through the text. Give its brief contents (preparation time - 15 min.).

AZIMUTHS

Azimuths are horizontal angles observed clockwise from any reference meridian. In plane surveying, azimuths are generally observed from north, but astronomers and the military have used south as the reference direction. The National Geodetic Survey (NGS) also used south as its reference for azimuths for NAD27, but north has been adopted for NAD83.

BEARINGS

Bearings are another system for designating directions of lines. The bearing of a line is defined as the acute horizontal angle between a reference meridian and the line. The angle is observed from either the north or south toward the east or west, to give a reading smaller than 90°. The letter N or S preceding the angle, and E or W following it shows the proper quadrant. Thus, a properly expressed bearing includes quadrant letters and an angular value. An example is N80°E.

31. Look through the text. Give its brief contents (preparation time - 15 min.).

Like other GNSS systems, GLONASS relies on a constellation of satellites transmitting synchronized signals. A receiver calculates its position by measuring the time delay of signals from at least four satellites. Key features include:

- Satellites: 24 operational satellites in Medium Earth Orbit (MEO) at ~19, 100 km altitude.
- Orbital Planes: Three orbital planes (8 satellites each) inclined at 64.8°.
- Accuracy: ~2–8 meters (civilian), with military signals being more precise.

Satellite navigation devices supporting both GPS and GLONASS have more satellites available, meaning positions can be fixed more quickly and accurately, especially in built-up areas where buildings may obscure the view to some satellites. GLONASS supplementation of GPS systems also improves positioning in high latitudes (north or south).

Development of GLONASS began in the Soviet Union in 1976. Beginning on 12 October 1982, numerous rocket launches added satellites to the system until the completion of the constellation in 1995. In 2001, after a decline in capacity during the late 1990s, the restoration of the system was made a government priority, and funding increased substantially. GLONASS is the most expensive program of the Roscosmos, consuming a third of its budget in 2010.

By 2010, GLONASS had achieved full coverage of Russia's territory. Russia continues to upgrade GLONASS with:

- GLONASS-K2 (2020s): Next-gen satellites with improved CDMA signals.
- GLONASS-KM (2030s): Planned advanced satellites for enhanced precision.
- Integration with Other Systems: Some receivers combine GPS + GLONASS + Galileo + BeiDou for maximum accuracy.

GLONASS ensures Russia's independence in global navigation while contributing to worldwide GNSS services. Despite challenges, it remains a key player in satellite positioning technology, complementing other systems for better reliability and coverage.

32. Look through the text. Give its brief contents (preparation time - 15 min.).

A geographic information system (GIS) consists of integrated computer hardware and software that store, manage, analyze, edit, output, and visualize geographic data. Much of this often happens within a spatial database, however, this is not essential to meet the definition of a GIS. In a broader sense, one may consider such a system also to include human users and support staff, procedures and workflows, the body of knowledge of relevant concepts and methods, and institutional organizations. The uncounted plural, geographic information systems, also abbreviated GIS, is the most common term for the industry and profession concerned with these systems. It is roughly synonymous with

geoinformatics. The academic discipline that studies these systems and their underlying geographic principles, may also be abbreviated as GIS, but the unambiguous GIScience is more common. GIScience is often considered a subdiscipline of geography within the branch of technical geography. Geographic information systems are utilized in multiple technologies, processes, techniques and methods. They are attached to various operations and numerous applications, that relate to: engineering, planning, management, transport/logistics, insurance, telecommunications, and business. For this reason, GIS and location intelligence applications are at the foundation of location-enabled services, which rely on geographic analysis and visualization.

33. Look through the text. Give its brief contents (preparation time - 15 min.).

In the era of GPS, GNSS, LiDAR, and drone mapping, the question arises: “Do modern surveyors still need to learn classical techniques like triangulation, trilateration, and plane table surveying?”

The Continued Relevance of Classical Surveying Methods in the Digital Age

With the widespread adoption of GPS, GNSS, LiDAR, and drone mapping technologies, some may question whether traditional surveying techniques like triangulation, trilateration, and plane table surveying still hold value. The reality is that these classical methods remain an essential part of a surveyor's skill set, complementing modern technology rather than being replaced by it.

1. Building a Strong Theoretical Foundation

Modern surveying technologies are built upon the same geometric and mathematical principles used in classical methods. Understanding triangulation (angle-based measurements) and trilateration (distance-based calculations) helps surveyors grasp how satellite positioning works. Without this knowledge, interpreting GNSS data or troubleshooting errors becomes significantly more difficult.

2. Ensuring Reliability When Technology Fails

While GNSS provides fast and efficient measurements, it is not infallible. Signal obstructions in urban environments, dense forests, or underground sites can render satellite-based positioning unreliable. Additionally, electronic equipment may malfunction due to battery failure, software glitches, or harsh weather conditions. In such scenarios, classical surveying techniques serve as a dependable backup, ensuring continuity in fieldwork.

3. Validating and Retracing Historical Surveys

Many existing land records, property boundaries, and topographic maps were originally surveyed using traditional methods. When resurveying or verifying these records, familiarity with plane table surveys, theodolite measurements, and chain surveying is crucial. Ignoring classical techniques can lead to misinterpretations of old data, resulting in legal disputes or costly errors.

Conclusion: The Best Surveyors Blend Old and New

While modern technology has revolutionized surveying, classical methods remain indispensable. A skilled surveyor must be proficient in both traditional techniques and cutting-edge tools—ensuring accuracy, adaptability, and problem-solving ability in any situation.

34. Look through the text. Give its brief contents (preparation time - 15 min.).

At over 40 years, the Landsat series of satellites provides the longest temporal record of space-based land surface observations and the successful February 2013 launch of the Landsat 8 satellite is continuing this legacy.

2. The Landsat 8 payload includes the Operational Land Imager (OLI) that has a new 1375 μm band designed to monitor cirrus clouds and the Thermal Infrared Sensor (TIRS) that together provide improved cloud detection capabilities. In addition, the radiometric resolution and the dynamic range of the OLI is improved compared to previous Landsat sensors, reducing band saturation over highly reflective objects, such as snow or cloud. Landsat 8 data are nominally processed into 185 km $\times$ 180 km scenes and, unlike for previous Landsat sensors, are provided with a spatially explicit 30 m quality assessment band that includes a cloud and cirrus cloud mask.

3. Landsat data are less appropriate for quantification of cloud properties and amount compared to near daily global coverage and certain active cloud remote sensing systems although Landsat data have been valuable for cloud morphology analyses. However, quantification of the incidence of cloudiness for Landsat terrestrial monitoring applications, especially in persistently cloudy regions, is important because optically thick clouds preclude optical and thermal wavelength remote sensing of the surface.

4. The Landsat sensors are in polar orbiting sun synchronous orbits with a 16 day repeat cycle and

considerable global spatial and temporal variability in cloudiness at the time of Landsat overpass.

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Mining Surveys: An Overview

Mining surveys (маркшейдерская съемка) are essential processes in the exploration, development, and management of mineral resources. They involve the systematic measurement and mapping of underground and surface features to accurately locate mineral deposits, plan mining operations, and ensure safety and efficiency.

Purpose of Mining Surveys

1. Exploration and Prospecting: Identifying potential mineral deposits by mapping geological features and conducting geophysical and geochemical surveys.
2. Mine Planning and Design: Creating detailed maps of the mine site, including ore bodies, rock formations, and existing infrastructure to optimize extraction processes.
3. Mine Development: Assisting in the layout of tunnels, shafts, and other underground structures with precise measurements.
4. Monitoring and Safety: Tracking ground movement, deformation, and subsidence to prevent accidents and ensure the safety of workers.
5. Resource Estimation: Calculating the volume and grade of mineral deposits to determine their economic viability.

Types of Mining Surveys

- Surface Surveys: These include topographical surveys, geological mapping, and drilling surveys

conducted on the surface to understand the terrain and locate mineral deposits.

- Underground Surveys: Focused on mapping underground tunnels, shafts, and ore bodies, often using advanced instruments like total stations, laser scanners, and GPS.
- Monitoring Surveys: Regular surveys to observe ground movement, deformation, or subsidence, especially in open-pit and underground mines.

38. Look through the text. Give its brief contents (preparation time - 15 min.).

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Techniques and Instruments

- Total Station: A versatile instrument combining electronic distance measurement and angular measurement for precise mapping.
- GPS (Global Positioning System): Used for accurate positioning on the surface and sometimes underground with specialized equipment.
- Laser Scanning and 3D Modeling: Provide detailed 3D representations of underground and surface features.
- Photogrammetry: Uses aerial photographs to create detailed maps and models of large areas.

Importance of Accurate Mining Surveys

Accurate surveys are vital for minimizing operational costs, maximizing resource recovery, ensuring safety, and complying with legal and environmental regulations. They form the backbone of effective mine management by providing reliable data for decision-making.

Mining surveys play a crucial role in the mining industry, enabling efficient exploration, planning, and operational safety. Advancements in technology continue to enhance the precision and scope of these surveys, contributing to more sustainable and productive mining practices.

39. Look through the text. Give its brief contents (preparation time - 15 min.).

Modern Surveying Equipment: Revolutionizing Precision and Efficiency

Surveying has undergone a technological revolution in recent decades, with advanced equipment transforming how professionals measure, map, and analyze land. Modern tools offer unprecedented accuracy, speed, and versatility, enabling surveyors to tackle complex projects with greater confidence and efficiency.

1. Global Navigation Satellite Systems (GNSS)

GNSS receivers, including GPS, GLONASS, Galileo, and BeiDou systems, have become indispensable for boundary surveys, construction layout, and geodetic control. Modern multi-frequency receivers achieve centimeter-level accuracy in real-time (RTK) or through post-processing. These systems allow surveyors to establish precise coordinates without needing line-of-sight to traditional control points, revolutionizing large-area surveys and remote location work.

2. Robotic Total Stations

Today's robotic total stations combine electronic distance measurement (EDM), angle sensors, and automated tracking capabilities. A single operator can control the instrument remotely via a data collector or tablet, significantly improving productivity. Advanced models feature automatic target recognition, 360-degree prisms, and integrated cameras for visual documentation. These systems excel in construction surveys, monitoring applications, and detailed topographic mapping.

3. 3D Laser Scanning (LiDAR)

Terrestrial and mobile LiDAR systems capture millions of precise 3D measurements per second, creating highly detailed point clouds of structures, terrain, and infrastructure. This technology proves invaluable for as-built documentation, heritage preservation, and complex industrial surveys where traditional methods would be impractical. Airborne LiDAR mounted on drones or aircraft efficiently maps large areas, penetrating vegetation to reveal ground surfaces.

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Terrestrial and mobile LiDAR systems capture millions of precise 3D measurements per second, creating highly detailed point clouds of structures, terrain, and infrastructure. This technology proves invaluable for as-built documentation, heritage preservation, and complex industrial surveys where traditional methods would be impractical. Airborne LiDAR mounted on drones or aircraft efficiently maps large areas, penetrating vegetation to reveal ground surfaces.

Unmanned Aerial Vehicles (UAVs/Drones)

Equipped with high-resolution cameras, multispectral sensors, or LiDAR payloads, surveying drones provide rapid aerial data collection for topographic mapping, volumetrics, and progress monitoring. Photogrammetric processing creates orthomosaics and digital surface models with centimeter accuracy. Drones particularly shine in hazardous or inaccessible areas, reducing safety risks while cutting survey time dramatically.

Ground Penetrating Radar (GPR)

GPR systems help surveyors locate underground utilities, rebar in concrete, and buried survey markers non-destructively. By emitting high-frequency radio waves and analyzing reflections, these tools reveal subsurface features invisible to the naked eye, preventing costly excavation errors and improving the reliability of boundary retracement.

Mobile Mapping Systems

Vehicle-mounted systems integrate GNSS, inertial measurement units (IMUs), LiDAR, and cameras to capture georeferenced data at highway speeds. These solutions revolutionized road surveys, utility mapping, and corridor documentation, providing comprehensive datasets with minimal traffic disruption.

41. Answer the question

In what way has the launching of artificial satellites changed the profession of a surveyor?

42. Answer the question

What two types of surveys are you familiar with?

43. Answer the question

What is GIS?

44. Answer the question

What modern surveying equipment are you familiar with?

45. Answer the question

What modern surveying methods do you know?

46. Answer the question

What definition can be given of geodesy?

47. Answer the question

What event became the advent of space geodesy?

48. Answer the question

Has computerization played any role in surveying?

49. Answer the question

What do they measure in geodesy?

50. Answer the question

Why is it important to have correct maps?

51. Answer the question

What classical surveying methods are you familiar with?

52. Answer the question

What is the total station used for?

53. Answer the question

What GNSS systems are you familiar with?

54. Answer the question

What event has changed the procedures of surveying?

55. Answer the question

What event has changed the procedures of surveying?

56. Answer the question

What event has changed the procedures of surveying?

57. Answer the question

What three terms are you familiar with meaning “surveying”?

58. Answer the question

What kinds of surveys are you familiar with?

59. Answer the question

What are the principles the GPS is based on?

60. Answer the question

What role has computerization played in surveying?