Moscow Aviation Institute

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FUNDAMENTALS OF SATELLITE NAVIGATION DISTANCE LEARNING COURSE

PRESENTATION CONTENTS

1. **Introduction**
2. **Course goals and objectives**
3. **Academic and methodological support of the course**
4. **Peculiarities of distance learning**
5. **Practical trainings and laboratory works**
6. **Conclusion**

1. Introduction

A full-fledged course «all-in-one»: theoretical material, tests, practical trainings , control question

Interactive mode: possibility of video addition, external source attribution, possibility of user interaction

Accessibility 24/365

Distribution of authority system

Possibility of user operation trace

Lecturer's possibility to give students marks, and comment answers

Easy-to-use navigation

Chores automation

2. The course goal

Course goal

professional development of specialists of the global navigation satellite system creation and use sphere

Target group :

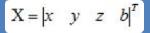**Fundamentals of satellite navigation**

The leaders of federation subjects, municipal, federal, municipal and other administrative structures;

Specialists, who started work with satellite navigation systems
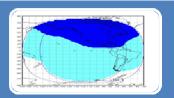
Objectives of the course

studing of GNSS creation history;
principals of GNSS construction and structure

$$X = \begin{vmatrix} x & y & z & b \end{vmatrix}^T$$
knowledge of mathematic basis and methods of navigation task solution;
study of signals, information message and link protocol used in different GNSS;

acquirement skills of work with navigation receiver with accuracy real-time ranking including differential system using;

knowledge of control methods and means of navigation sphere integrity;
knowledge of concrete systems GLONASS, GPS, GALILEO.

Students will get necessary stock of knowledge for working in such spheres as

Transport

Construction

engineering structure monitoring

Geodesy and cartography

Fundamentals of satellite navigation

Personal navigation

3. Academic and methodological support

- requirements for the trainees' level of attainment;
- requirements for discipline mastering level;
- list of lecture topics;
- discipline program;
- theoretical material – summary of lectures;
- glossary;
- illustrations (figures, tables, diagrams, schemes and etc.);
- list of self-test questions;
- list of detailed answers to self-test questions;
- list of test question to control learning;
- list of detailed answers to them;
- list of main and complementary literature;
- instructor's manual and advices for lecturer;
- methodological instructions and advices for original research;

List of lecture topics (72 hours). 1/2

Topic 1	• GNSS creation and development history (4 hours)
Topic2	• Principals of GNSS construction and structure (6 hours)
Topic 3	• Mathematic basis and methods of navigation task solution (10 hours)
Topic 4	• Study of signals, information message and link protocol used in different GNSS. (6 hours)
Topic 5	• Navigation receivers (signal processing) (10 hours)

List of lecture topics (72 hours). 2/2

Topic 6	• Differential systems (14 hours)
Topic 7	• Global navigational satellite system pathology monitoring. Continuity testing. (10 hours)
Topic 8	• Coordinate temporary supply of GNSS functioning and source of navigation temporary determination errors (6 hours)
Topic 9	• User equipment (4 hours)
Topic 10	• Work-in-progress GNSS (Galileo, Compass/Beidou, IRNSS, QZSS) (2 hours)

4. Peculiarities of distance learning

It's interactive

Possibility of user interaction

Possibility of self-testing and training for passing exams

Unique laboratory work

How does it work?

After authorization student has access :

- To the materials of the course
- To the final test for self-testing
- To the control questions for passing exams
- To the laboratory works
- To lecturer's tutorials

Theoretical material

☐ ⊟ Основы спутниковой навигации
    ⊞ ☐ ИСТОРИЯ СОЗДАНИЯ И РАЗВИТИЯ ГЛОБАЛЬНЫХ НАВИГАЦИОННЫХ СПУТНИКОВЫХ СИСТЕМ
    ⊞ ☐ ПРИНЦИПЫ ПОСТРОЕНИЯ И СТРУКТУРА ГЛОБАЛЬНЫХ НАВИГАЦИОННЫХ СПУТНИКОВЫХ СИСТЕМ
    ⊞ ☐ МЕТОДЫ РЕШЕНИЯ НАВИГАЦИОННЫХ ЗАДАЧ
    ⊞ ☐ НАВИГАЦИОННЫЕ СИГНАЛЫ И НАВИГАЦИОННЫЕ СООБЩЕНИЯ
    ⊞ ☐ ИСТОЧНИКИ ПОГРЕШНОСТЕЙ И ТОЧНОСТЬ НАВИГАЦИОННО-ВРЕМЕННЫХ ОПРЕДЕЛЕНИЙ
    ⊞ ☐ ДИФФЕРЕНЦИАЛЬНАЯ НАВИГАЦИЯ И ДИФФЕРЕНЦИАЛЬНЫЕ СИСТЕМЫ
    ⊞ ☐ МОНИТОРИНГ СОСТОЯНИЯ ГЛОБАЛЬНЫХ НАВИГАЦИОННЫХ СПУТНИКОВЫХ СИСТЕМ
    ☐ Контрольные вопросы
    ☑ Итоговый тест
  ⊞ ☐ Лабораторный практикум

- **All necessary information**
- **Division of the course into topics**
- **Simple and clear structure**
- **Multimedia content availability (both internal and external: YouTube, etc.)**

Спутник ГЛОНАСС-К, в отличие от спутника ГЛОНАСС-М, имеет третью частоту в L-диапазоне ($L3$) для повышения надежности навигационных определений, увеличенный до 10 лет срок функционирования космического аппарата, в 2 раза меньшую массу, высокое качество навигационного сигнала, сниженный до 5×10^{-11} м/с² уровень воздействия не моделируемых сил, обеспечивающие повышение точности навигационных определений в 2 раза.
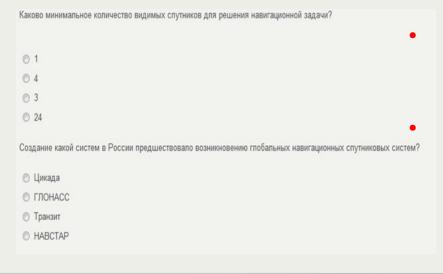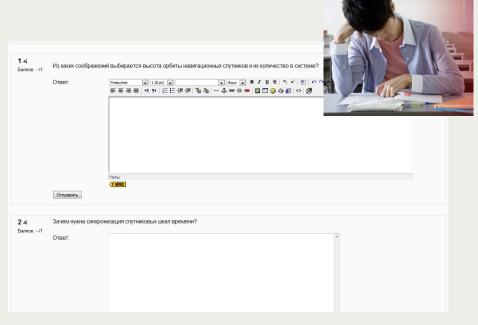
Анимация. Пуск РН Протон-М с КА "ГЛОНАСС"

При разработке ГЛОНАСС-К руководствовались тем, чтобы аппарат имел негерметичную конструктивную схему исполнения и мог выводиться различными ракетоносителями ("Союз-2", "Ангара"). Двухэтапная программа модернизации космического сегмента системы ГЛОНАСС позволит восстановить орбитальную группировку до штатного уровня, повысить качество навигационного обеспечения, снизить затраты на реализацию программы и обеспечить выполнение международных обязательств России по переходу в новый частотный

Control Questions

- **Answers to questions are given in the form of essay**

- **Possibility to change student's attempts number**

- **Lecturer can comment student's answers**

Final Test

- **Using different types of questions («Choice of several versions», «type of questions: Is the next statement right?»)**

- **Possibility to change student's attempts number**

How does it work?

Student studies materials of the topic and after it passes final test

Answer correctness checks automatically. Results display right after passing the test and ore accessible in his personal card

When student has passed the test successfully, he answers control questions

Answers are given in the form of essay

Answers correctness is estimated by the lecturer. The lecturer gives students marks

Student can get detailed commentary on his answers (for example, reference to theoretical material)

When student has passed control questions, he starts practical trainings and laboratory works

5. Practical trainings and laboratory works

List of methodological support :

Theoretical material

Student's workbook for remote access mode practical trainings which uses computerized distance learning system, including: work object, task, execution phase order, variants

List of main and complementary literature

Administrator guide for install and support of practical trainings

Source code and program manual , scripts, modules nonaffiliated into proprietary or free software, which are necessary for base academic and methodological support functioning

List of practical trainings and laboratory works

Training 1	• NSS orbital structure modeling, NSS movement modeling
Training 2	• User location identification on basis of distance measurements
Training 3	• Autonomous data integrity control in the receiver
Training 4	• Geometric extent analysis
Training 5	• GLONASS navigation
Training 6	• Differential navigation
Training 7	• Multipath propagation analysis
Training 8	• Work with GLONASS/ GPS navigational receiver

How does it work?

Student works with real equipment or its simulation, using knowledge got on previous stage of study
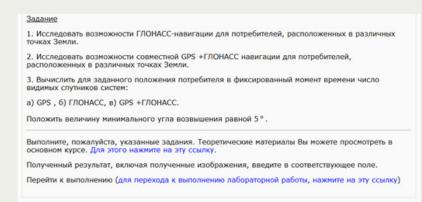
After student has finished the work, he draws up a report with graphic material
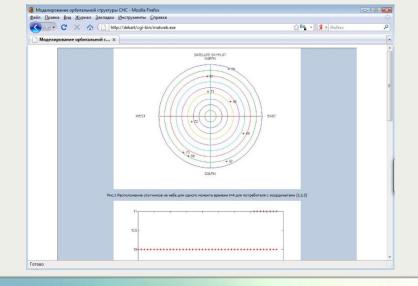
Lecturer estimates work realization and gives marks

Lecturer can comment upon work or send for reexecution

An example of practical trainings realization

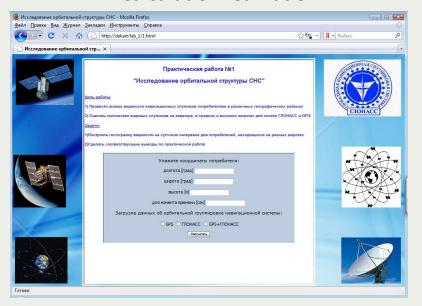## Getting task and studying theoretical material

Calculation realization

Analysis of results and report preparation

Practical trainings

Real-time mode full-fledged works

Work with real equipment

User doesn't need any subsidiary applications install

Regular interaction of students and lecturer on all stages of studying

6. C onclusion

- Academic and methodological support consisting of professional subsidiary educational programs of selected training and meeting demands of educational standards is developing.

- Necessary support of training organization implying personal student accounting, add-in professional educational programs electronic versions and academic and methodological package creation, progress inspection, financial monitoring and reports preparation is developing.

- Computerized distance learning system methodological support and software formalizing educational courses electronic version presentation is developing.

- Additional theoretical material and practical training claims which take into account distance education specificity are identified.

Thank you for your attention!