Federal State Autonomous Educational Institution of Higher Education "Moscow Institute of Physics and Technology (National Research University)"

APPROVED
Vice Rector for Academic Affairs

A.A. Voronov

Work program of the course (training module)

course:	Analytic Geometry/Аналитическая геометрия
major:	Biotechnology
specialization:	Biomedical Engineering/Биомедицинская инженерия
	Phystech School of Biological and Medical Physics
	Chair of Higher Mathematics
term:	1
qualification:	Bachelor

Semester, form of interim assessment: 2 (spring) - Exam

Academic hours: 60 AH in total, including:
lectures: 30 AH.
seminars: 30 AH.
laboratory practical: 0 AH.

Independent work: 90 AH.

Exam preparation: 30 AH.

In total: 180 AH, credits in total: 4

Number of course papers, tasks: 3

Authors of the program:

D.V. Beklemishev, doctor of pedagogical sciences, full professor, professor
A.N. Burmistrov, candidate of physics and mathematical sciences, associate professor, associate professor
P.A. Kozhevnikov, candidate of physics and mathematical sciences, associate professor, associate professor
O.K. Podlipskiy, candidate of physics and mathematical sciences, associate professor, associate professor
I.A. Chubarov, candidate of physics and mathematical sciences, associate professor, associate professor
O.G. Podlipskaya, candidate of physics and mathematical sciences, assistant

The program was discussed at the Chair of Higher Mathematics 21.05.2020

Annotation

The discipline belongs to the basic part of the educational program. Topics such as a Straight line and a plane in space, second-order Lines and surfaces, plane Transformations, an n-th order Determinant, and Matrices are considered. Course objectives - the acquisition by students of theoretical knowledge and practical skills in the field of vector algebra, matrix algebra, prepare students for the study of related mathematical subjects, acquiring skills in the application of analytical methods in physics and other natural Sciences.

1. Study objective

Purpose of the course

to provide students with foundations of analytic geometry that will help them to study advanced mathematical disciplines – differential equations, complex analysis, mathematical physics, functional analysis, analytical mechanics, theoretical physics, methods of optimal control, etc.

Tasks of the course

- to provide students with theoretical knowledge and practical skills in geometry;
- to motivate students towards treatment of related mathematical disciplines;
- to equip students with skills to apply techniques of analytic geometry in physics and other natural sciences.

2. List of the planned results of the course (training module), correlated with the planned results of the mastering the educational program

Mastering the discipline is aimed at the formation of the following competencies:

Code and the name of the competence	Competency indicators
UC-1 Search and identify, critically assess, and synthesize information, apply a systematic approach to problem-solving	UC-1.1 Analyze problems, highlight the stages of their solution, plan the actions required to solve them
	UC-1.2 Find, critically assess, and select information required for the task in hand
	UC-1.3 Consider various options for solving a problem, assess the advantages and disadvantages of each option
	UC-1.4 Make competent judgments and estimates supported by logic and reasoning
UC-6 Use time-management skills, apply principles of self-development and lifelong learning	UC-6.2 Plan independent activities in professional problem-solving; critically analyze the work performed; find creative ways to use relevant experience for self-development

3. List of the planned results of the course (training module)

As a result of studying the course the student should:

know:

- definition of vectors and vector operations (dot, vector, and triple product), their properties;
- equations of straight lines, planes, conics, and second-order surfaces;
- properties of curves and second-order surfaces;
- properties of affine and orthogonal transformations of plane.

be able to:

- to apply vector algebra to solve geometric and physical problems;
- to solve geometric problems by the coordinate method, use linear transformations to solve geometric problems;
- to perform matrix operations, to invert matrices, to compute determinants.

master:

- general concepts and definitions related to vectors: linear independence, basis, plane and space orientation;
- orthogonal and affine classification of lines and second-order surfaces.

4. Content of the course (training module), structured by topics (sections), indicating the number of allocated academic hours and types of training sessions

4.1. The sections of the course (training module) and the complexity of the types of training sessions

№	Topic (section) of the course	Types of training sessions, including independent work			
		Lectures	Seminars	Laboratory practical	Independent work
1	Straight line and plane in space	8	8		16
2	Lines and surfaces of the second order	8	8		24
3	Convert the plane	6	6		18
4	n-th order determinant	4	4		16
5	Matrixes	4	4		16
AH in total		30	30		90
Exam preparation		30 AH.			
Total complexity		180 AH., credits in total 4			

4.2. Content of the course (training module), structured by topics (sections)

Semester: 2 (Spring)

1. Straight line and plane in space

A line in space. Vector and coordinate equations of a line in space. A plane in space. Types of equations of a plane in space. Positional and metric problems of lines and planes in space. Transition from one form of line or plane equation in space to another. Bundle of lines. Bundle of planes and sheaf of planes. Linear inequalities.

2. Lines and surfaces of the second order

Coordinate equations of lines in plane and surfaces in space. Algebraic lines and surfaces. Invariance of order of algebraic curves in plane under linear changes of variables. Coordinate equations of curves in space. Invariance of order of algebraic curves and surfaces in space under linear changes of variables. Coordinate equations of some geometrical objects in plane and bodies in space.

Conics in plane and their orthogonal classification. Reduction of a conic equation to a standard form. Center lines. Conjugate diameters. Asymptotic direction. Invariants.

Ellipse, hyperbola, and parabola. Their properties. Tangents to an ellipse, a hyperbola, and a parabola. Equations of an ellipse, a hyperbola, and a parabola in the polar coordinate system.

Ellipsoids, hyperboloids, and paraboloids. Their basic properties. Rectilinear generators. Cylinders and cones. Surfaces of revolution. Classification and standard equations of second-order algebraic surfaces.

3. Convert the plane

Mappings and transformations of the plane. Composition of mappings. Inverse mapping. One-to-one mapping. Linear transformations of the plane and their properties. The coordinate representation of linear transformations of the plane.

Affine transformations and their geometric properties. The main directions of an affine transformation. Geometric meaning of the modulus and the sign of the determinant of an affine transformation matrix. Affine classification of conics in plane.

4. n-th order determinant

Definition and basic properties of determinants. Minors and cofactors. Cofactor expansion of a determinant along a row or a column. Determinant of matrix product.

5. Matrixes

Multiplication and inversion of matrices. Orthogonal matrices. Elementary row operations on matrices. Representation of row operations as multiplication by specific matrices.

5. Description of the material and technical facilities that are necessary for the implementation of the educational process of the course (training module)

A classroom equipped with multimedia projector, screen, and microphone.

6. List of the main and additional literature, that is necessary for the course (training module) mastering

Main literature

Мантуров, О. В.
Курс высшей математики [Текст] : Линейная алгебра. Аналитическая геометрия. Дифференциальные исчисление функций одной переменной : учебник для втузов / О. В. Мантуров, Н. М. Матвеев .— М. : Высшая школа, 1986 .— 480 с. : ил. - Библиогр.: с. 475. - Предм. указ.: с. 476-480. - 70 000 экз. - ISBN 5-06-000758-6

Additional literature

Лившиц, К. И.
Курс линейной алгебры и аналитической геометрии [Электронный ресурс] : учеб. пособие / К. И. Лившиц .— СПб. : Лань, 2017 .— (Учебники для вузов. Специальная литература) . Электрон. версия печ. публикации .

7. List of web resources that are necessary for the course (training module) mastering

http://www.math.mipt.ru
http://lib.mipt.ru
http://joshua.smcvt.edu/linearalgebra
https://arxiv.org/pdf/1111.6521.pdf

8. List of information technologies used for implementation of the educational process, including a list of software and information reference systems (if necessary)

The lectures use multimedia technologies, including presentations.

9. Guidelines for students to master the course

Given in the annually developed homework.

SUPPLEMENT

Assessment funds for course (training module)

major:	Biotechnology
specialization:	Biomedical Engineering/Биомедицинская инженерия
	Phystech School of Biological and Medical Physics
	Chair of Higher Mathematics
term:	1
qualification:	Bachelor

Semester, form of interim assessment: 2 (spring) - Exam

Authors:

D.V. Beklemishev, doctor of pedagogical sciences, full professor, professor

A.N. Burmistrov, candidate of physics and mathematical sciences, associate professor, associate professor

P.A. Kozhevnikov, candidate of physics and mathematical sciences, associate professor, associate professor

O.K. Podlipskiy, candidate of physics and mathematical sciences, associate professor, associate professor

I.A. Chubarov, candidate of physics and mathematical sciences, associate professor, associate professor

O.G. Podlipskaya, candidate of physics and mathematical sciences, assistant

1. Competencies formed during the process of studying the course

Code and the name of the competence	Competency indicators
UC-1 Search and identify, critically assess, and synthesize information, apply a systematic approach to problem-solving	UC-1.1 Analyze problems, highlight the stages of their solution, plan the actions required to solve them
	UC-1.2 Find, critically assess, and select information required for the task in hand
	UC-1.3 Consider various options for solving a problem, assess the advantages and disadvantages of each option
	UC-1.4 Make competent judgments and estimates supported by logic and reasoning
UC-6 Use time-management skills, apply principles of self-development and lifelong learning	UC-6.2 Plan independent activities in professional problem-solving; critically analyze the work performed; find creative ways to use relevant experience for self-development

2. Competency assessment indicators

As a result of studying the course the student should:

know:

- definition of vectors and vector operations (dot, vector, and triple product), their properties;
- equations of straight lines, planes, conics, and second-order surfaces;
- properties of curves and second-order surfaces;
- properties of affine and orthogonal transformations of plane.

be able to:

- to apply vector algebra to solve geometric and physical problems;
- to solve geometric problems by the coordinate method, use linear transformations to solve geometric problems;
- to perform matrix operations, to invert matrices, to compute determinants.

master:

- general concepts and definitions related to vectors: linear independence, basis, plane and space orientation;
- orthogonal and affine classification of lines and second-order surfaces.

3. List of typical control tasks used to evaluate knowledge and skills

Current control is carried out on the basis of a point-rating system (BRS) for evaluating knowledge in the discipline being studied. The BRS takes into account the students ' performance of a set of homework assignments and tests in accordance with the curriculum. Data on attendance and current academic performance are entered by teachers in special journals and recorded in the BRS.

Current control on the basis of homework is carried out during the academic semester in the terms set by the Educational Department, in accordance with the curriculum.

To pass the task, the student must provide a solution to the homework problem in writing, answer the questions of the teacher and write a test paper on the task, which checks the knowledge of concepts and statements on the topics of the task and the ability to solve problems.

You can't use other people's help, computers, or mobile phones during the test.

* A BRS is attached to the subject being studied.

4. Evaluation criteria

Certification in the discipline "Analytic Geometry/Аналитическая геометрия" is carried out in the form of an exam. The examination is conducted in accordance with the previously performed by the students in the control tasks.

Control tasks:

1. Write down the equation of the line [r,ā]=b in vector-parametric form.
2. Specify a normal vector of a straight line on a plane that has an angular coefficient K in a rectangular coordinate system.
3. Is the curve given by the equation 2x2–4xy+5y2+8x–2y=0 Central? Find the coordinates of its center. Determine the type of curve.
4. Let A and B be two square matrices of the same size. Should be the same as the rank of the matrices AB and BA?
5. Write down the General solution of the equation x1+x2+X3+x4 =0 as the sum of the particular solution and an arbitrary linear combination of the fundamental system of solutions.
6. Regardless of whether a linear space with the usual operations of addition and multiplication on the number:
a) set of functions integrated by Riemann on the interval [a, b];
b) a set of functions defined on [a, b] and such that f(a)=0.

Examples of examination tickets:

Ticket 1
1) Write down the equation of the line [r,ā]=b in vector-parametric form.
2) Specify any normal vector of a straight line on the plane having in a rectangular coordinate system an angular coefficient K.

Ticket 2
1) Write down the General solution of the equation x1+x2+X3+x4 =0 as the sum of the particular solution and an arbitrary linear combination of the fundamental system of solutions.
2) whether Forms a linear space with the usual operations of addition and multiplication by a number:
a) set of functions integrated by Riemann on the interval [a, b];
b) a set of functions defined on [a, b] and such that f(a)=0.

Grade "excellent (10)" is given to a student who has exhibited extensive and deep knowledge of the course and ability to apply skills when solving specific tasks;

Grade "excellent (9)" is given to a student who has exhibited extensive and deep knowledge of the course and ability to apply skills when solving specific tasks, but he has made minor errors that were independently found and corrected;

Grade "excellent (8)" is given to a student who has exhibited extensive and deep knowledge of the course and ability to apply skills when solving specific tasks, but he has made minor errors that were independently corrected after the instructions of an examiner;

Grade "good (7)" is given to a student who has a good command of the course and is able to apply skills when solving specific tasks, but has made minor mistakes when answering questions or solving problems;

Grade "good (6)" is given to a student who has a good command of the course and is able to apply skills when solving specific tasks, but has made rare mistakes when answering questions or solving problems;

Grade "good (5)" is given to a student who has a good command of the course and is able to apply skills when solving specific tasks, but has made mistakes when answering questions or solving problems;

Grade "satisfactory (4)" is given to a student who has exhibited fragmented knowledge, has made inaccurate formulation of the basic concepts, but understands the subject well, is able to apply the knowledge in standard situations and possesses skills necessary for the future study;

Grade "satisfactory (3)" is given to a student who has exhibited fragmented knowledge, has made inaccurate formulation of the basic concepts, has inconsistencies in understanding the course, but is able to apply the knowledge in standard situations and possesses skills necessary for the future study;

Grade "unsatisfactory (2)" is given to a student who does not possess knowledge of the essential concept of the course, has made gross mistakes in formulations of basic concepts and cannot use the knowledge in solving typical tasks;

Grade "unsatisfactory (1)" is given to a student who has exhibited total lack of knowledge of the course.

5. Methodological materials defining the procedures for the assessment of knowledge, skills, abilities and/or experience

During the oral exam, a student is given one (astronomical) hour to prepare the answer to the question. The schedule of discussion between an examiner and a student is limited by two hours.
During the exam, students can use the discipline program.

«СОГЛАСОВАНО»

Проректора по учебной работе и довузовской подготовке

_____ А.А. Воронов

«____» _____ 2020

Балльно-рейтинговая система оценки знаний студентов

Дисциплина: **Analytic Geometry/Аналитическая геометрия**
1 курс, 2 семестр, экзамен

Кафедра: **высшей математики**

№	Вид занятий	Сумма баллов
1.	Посещение лекций	0–3
2.	Проверка теоретических знаний	0–3
3.	Контрольная работы, проводимые в классе	0–18
4.	Домашняя работа	0–6
5.	Итоговый контроль Экзамен (устный ответ)	0–70
	ИТОГО	**0–100**

*Если при учете этого вида работы итоговая сумма за работу в семестре превосходит 30 баллов, то считать ее равной 30 баллам.

Сумма баллов за устный ответ начисляется по формуле $N * 7$, где $N \geq 3$ — предварительная оценка за устный ответ по десятибалльной шкале. Если $N = 1, 2$, то итоговая оценка совпадает с N.

Соответствие оценок итоговой академической успеваемости балльно-рейтинговой системы.

Баллы БРС	Оценки	
93–100	10	отлично
86–92	9	
79–85	8	
72–78	7	хорошо
65–71	6	
58–64	5	
51–57	4	удовлетворительно
44–50	3	
30–43	2	неудовлетворительно
0–29	1	

Регламент принятия домашних заданий и проведения экзамена определяется «Положением о текущем контроле успеваемости и промежуточной аттестации студентов на кафедре высшей математики».

Зав.кафедрой _____ Г. Е. Иванов