**Mathematics MA**

# Programme structure

Competence are to be taken:

Module 1: Methods of teaching in mathematics

[Method](http://catalog.american.edu/preview_course.php?catoid=3&coid=8279&TB_iframe=true)s of Teaching Higher Education Mathematics

*Track 1: Differential equations and mathematical physics*

Dynamical systems theory

Qualitative theory of differential equations

Boundary-value problems for ordinary differential equations

Boundary-value problems for partial differential equations

Inverse problems of mathematical physics

Additional chapters on differential equations and mathematical physics

Singularly perturbed integro-differential equations

Navier–Stokes equations

*Track 2: Control theory*

Constructive theory of boundary value optimal control problems

Inverse problems for stochastic differential equations

Methods for solving boundary value problems

Generalized Functions and its Applications

Stability theory for dynamical systems

Theory of phase systems

Boundary value optimal control problems

Differential games

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| Module Description | | | | | | | | | | | | | |
| Module Level | Name of module | Number of credits (ECTS) | | | | Semester in which the module taught | | | Form of study | | | Language | |
|  |  |  | | | |  | | |  | | |  | |
| Name of courses | Language | Person Responsible | | | | Prerequisites | | | | | | | |
|  |  | | | | |  | | | | | | | |
| Course 1 Generalized functions and its applications | | | | | | | | | | | | | |
| Reading List (Список литератур) – необходимо предоставить список за 2000-2016 гг. | | | | | | | | | | | | | |
| **Main (основной список)** | | | | **Recommended (Дополнительный список)** | | | | | | | | | |
| 1. Vladimirov V.S. Methods of the theory of generalized functions. – Taylor & Francis, 2002.  2. Serovajsky S. Sequential models of mathematical physics. – Almaty, Print-S, 2004 (in Russian).  3. Grubb G. Distributions and Operators, Springer. 2009. | | | | 1. Tihonov A.N., Samarsky A.A. Mathematical physics equations. – M., Nauka, 2008 (in Russian).  2. Abraham R., Marsden J. Foundations of mechanics: a mathematical exposition of classical mechanics with an introduction to the qualitative theory of dynamical systems. – Providence: AMS Chelsea Pub, 2008.  3. Kusse B. Mathematical Physics: Applied Mathematics for Scientists and Engineers – Germany: Wiley-VCH, 2006.  4. Stakgold I. Boundary value problems of mathematical physics (2 vol.), Philadelphia: Society for Industrial and Applied Mathematics, 2000. | | | | | | | | | |
| Content  1-15 lessons | | | | Learning Assessment and Examination (Оценка результатов обучения и форма экзамена) | | | | | | | | | |
| 1. Introduction into mathematical physics equations. 2. Approximation and convergence of the numerical method for the heat equation. 3. Generalized functions. Generalized derivatives. Sobolev spaces Minimization of functionals. Stationary condition. Gradient method. 4. Generalized solution of the mathematical physics problems. Relations between classical and generalized solution. 5. Physical sense of the generalized solution of the stationary heat equation. Generalized model. 6. Approximation of the generalized model for the stationary heat equation. 7. Convergence of the sequences and Cauchy principle. 8. Picard method and contracting mapping theorem. 9. Completeness of the spaces. Examples of incomplete spaces. 10. Cantor’s definition of the set of real numbers. 11. Applications of the completion theorem. 12. Sequential generalized functions theory. 13. Sequentialextension of extremum problems. 14. Sequential models of mathematical physics problems. I 15. Sequential models of mathematical physics problems. II | | | | 1. The students receive the task for the homework each week. Its results are taken into account.  2. During the seminar sessions, students solve problems that are taken into account in the certification process.  3. During the lectures the students answer to the questions that are taken into account in the certification process.  4. In the middle of the semester a midterm is conducted.  5. At the end of the semester a written exam is conducted. | | | | | | | | | |
| Learning outcomes (результаты обучения) – (**Результаты** **обучения** должны быть **ясно** и кратко **описаны**) | | | | | | | | | | | | | |
| Knowledge and Understanding (subject specific) Знание и понимание (предметно- специфические) | Cognitive/Intellectual skills (generic) (Когнитивные / Интеллектуальные навыки (общие)) | | Key/transferable skills (generic) Основные / профессиональные навыки (общие) | | | | | Practical skills (subject specific) (Практические навыки (предметно-специфические)) | | | | | |
| ***Knowledge base***: methods of analysis of the generalized functions  ***Ethical issues (принятые нормы поведения)***:  standard  ***Disciplinary methodologies:***  standard | ***Analysis***: analysis of the generalized functions  ***Synthesis:*** the place of the generalized functions theory in mathematics  ***Evaluation:*** evaluation of the knowledge  ***Application:*** applications of the generalized functions theory for the problems of physics | | ***Group working***: joint analysis of the generalized functions  ***Learning resources***: using the information of the lectures, seminars and independent work  ***Self evaluation***: self-control of knowledge for the generalized functions theory  ***Management of information:*** using the texts of lectures, recommended list of textbooks and information of Internet  ***Communications***: relation between the generalized functions theory and other directions of mathematics and physics  ***Problem-solving***: applications of generalized functions theory in physics | | | | | ***Application of skills***: the generalized functions theory has many applications in physics.  ***Autonomy in skill use***: After this course, the students can use the generalized functions theory for solving physical problems.  ***Technical expertise***: After this course, the students can be experts in the generalized functions theory | | | | | |
| Teaching Methods and Learning Process | | | | | | | | | | | | | |
| ***Lectures will*** | ***Seminars will*** | | ***Tutorials*** | | | | | ***Students will be directed to read*** | | | | | |
| **ECTS Student Work Load** (1ECTS = 30 часов. Соответственно если по описанному предмету 4 ECTS, общее количество часов должно быть 120 ч (4ECTS\*30 часов = 120 ч) | | | | | | | | | | | | |
| **Activities** | | | | | **Number** | | **Unit** | | | **Hour** | **Total**  **(Work Load)** | |
| Course Contact Hour (Academic Calendar: 15 weeks) | | | | | 15 | | Week | | | 4 | 60 | |
| Preliminary Preparation | | | | | 15 | | Week | | | 1 | 15 | |
| Assignment (s) | | | | | 5 | | Number | | | 1 | 5 | |
| Presentation/Seminars | | | | | 5 | | Number | | | 2 | 5 | |
| Quiz | | | | | 5 | | Number | | | 3 | 15 | |
| Mid-Term Exam (s) | | | | | 1 | | Number | | | 3 | 3 | |
| Project (s) | | | | | 5 | | Number | | | 2 | 10 | |
| Field Studies (Technical Visits) | | | | | 0 | | Number | | | 0 | 0 | |
| Practice (Laboratory, Virtual Court, Studio Studies etc.) | | | | |  | | Week/Number | | |  |  | |
| Final Exam/ | | | | | 1 | | Number | | | 7 | 7 | |
| Final Project/ Dissertation and Preparation, the final work | | | | |  | |  | | | 0 | 0 | |
| Other (Placement/Internship etc.) | | | | | - | | Number | | | 0 | 0 | |
| **Total Work Load** | | | | | | | | | | | **120** | |
| **Total Work Load/ 30 hours** | | | | | | | | | | |  | |
| **ECTS Credits** | | | | | | | | | | | **4** | |

# Track 3 : Mathematical analysis and function theory

## Module 1: Mathematical and Complex analysis

## Course 1 Multidimensional Complex Analysis

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| Master Degree  Module Description | | | | | |
| Module title | Module Level | Credit Points (ECTS) | | Semester in which the module taught | Relation to Curriculum (Foundational/ Major Core /Major Elective) |
| **Mathematical and Complex analysis** | Elective Professional | 10 | | 2 | Individual educational trajectory modules |
| Courses | Language | Prerequisites | | Person Responsible | Lecturer |
| 1 [Multidimensional](http://catalog.american.edu/preview_course.php?catoid=3&coid=8280&TB_iframe=true) Complex Analysis | Kazakh/Russian/English | Theory of complex variable functions | | Abduahitova G.E. | Abduahitova G.E. |
| 2 [Number-theoretic](http://catalog.american.edu/preview_course.php?catoid=3&coid=8356&TB_iframe=true) methods in approximate analysis and their applications | Kazakh/Russian/English | Mathematical analysis, functional analysis | | Sherniyazov K.Y. | Sherniyazov K.Y. |
| Course 1 Multidimensional Complex Analysis | | | | | |
| Reading List | Content  1-15 lessons | | Learning outcomes | Teaching Methods and Learning Process | Learning Assessment and Examination |
| 1. Required  1. B.V. Shabat.  Introduction to complex analysis: Functions of several variables, 1975.  2. Malgrange B. Lectures on the theory of functions of several complex variables, 1984  3. B.A. Fuks; A.A Brown; J.M. Danskin; Introduction to the theory of analytic functions of several complex variables, 1963  4. R.C. Gunning, Hugo Rossi. Analytic Functions of Several Complex Variables, 2009  2. Recommended  1. Holomorphic Operator Functions of One Variable and Applications: Methods from Complex Analysis in Several Variables (Operator Theory: Advances and Applications) Israel Gohberg, Jurgen Leiterer | 1. Complex Euclidean space. The space Cn. 2. The simplest domains. 3. Holomorphic functions. The concept of holomorphy. 4. Pluriharmonic functions. 5. Simplest properties of holomorphic functions. 6. The fundamental theorem of Hartogs. 7. Power series in Multidimensional Complex Analysis 8. Other series. 9. Holomorphic mappings. Properties of holomorphic mappings. 10. Biholomorphic mappings. 11. Fatou’s example. 12. The concept of a manifolds. 13. Complexification of Minkowski space 14. Stokes’s formula in multidimensional complex analysis 15. The Cauchy-Poincare theorem. | | Knowledge and Understanding (subject specific) | ***Lectures will make*** a selection from the orientation readings and material for classroom discussion based on their own judgment. It is recommended that students used those texts not selected for classroom discussion as background readings which will help them contextualize the texts which will be subject of discussion (lecture-discussions, lectures with case studies, lecture-study, fluent brainstorming, lecture with the use of feedback techniques, lecture-consultation).  ***Seminars will*** be used to proving theorems, and exploring examples. From this material, you will also create a course portfolio, consisting of exercises, theorems, and proofs we’ve done in class. Sometimes, if we don’t finish things in class, you’ll have to finish them at home. This portfolio will help to fill out missing pieces of the textbook. It will be graded at the end of the course.  ***Tutorials*** The textbook for this course is B.V. Shabat.  Introduction to complex analysis: Functions of several variables. This book is very readable, has been well liked by students in the past, and contains lots of good exercises and examples.  ***The module is offered by blended learning.*** | Individual and group activities, such as in-semester assessments, will be used to provide you with on-going feedback. An end-of-semester examination, will complement this aspect of the work.  In-semester assessments may take the form of homework assignments, supervised class tests. The assessments will reinforce the material covered in lectures and in your personal study. Your capacity to solve problems and to think critically and analytically will also be addressed through problems presented in lectures and facilitated seminars.  The final examination will test your comprehension of the subject material and your ability to apply this understanding to real world problems. |
| ***Knowledge base****:* As a result of studying of discipline graduate students should *gain knowledge in*the theory of complex-valued functions of several variables, pluriharmonic functions, simplest properties of holomorphic functions, power series and other series, holomorphic mappings, Fatou’s example.  ***Ethical issues****:* the ability to identify, reflect upon, evaluate, integrate, and apply different types of information and knowledge to form independent judgments.    ***Disciplinary methodologies:***  be able to work independently and participate in multidisciplinary teams. |
| Cognitive/Intellectual skills (generic) |
| ***Analysis****:* identify and compare the properties of complex-valued functions of several variables.  ***Synthesis:*** should be able to demonstrate an understanding of complex-valued functions of several variables to other branches of mathematics and to related fields.  ***Evaluation:*** will gain an understanding of studying theory of holomorphic functions of several variables, the fundamental theorem of Hartogs, basic theorems of differentiation; series expansions, holomorphic mappings, properties of holomorphic mappings, biholomorphic mappings.  ***Application:*** demonstrate a working knowledge of holomorphic functions of several variables |
| Key/transferable skills (generic) |
| ***Group working:*** working in a group can be beneficial for everyone involved, provided that you do not abuse the privilege. Make sure that everyone in your group is making a contribution.  ***Learning resources:***graduatestudents will be expected to expand on the subject matter provided as lecture notes in class. This will take the form of accessing various external and internal resources, such as the library and the Internet.  ***Self evaluation:*** knowledge and skills learned in the subject also forms a basis of many professional careers.  ***Management of information:***  can manage information, apply the knowledge and skills obtained to study further concepts.  ***Autonomy:*** demonstrate knowledge of core mathematical concepts. (definitions and theorems in multidimensional complex analysis, definitions and theorems in holomorphic mappings, definitions and theorems in multidimensional complex analysis)  ***Communications:*** the ability to communicate and interact effectively with different audiences, developing their ability to collaborate intellectually and creatively in diverse contexts, and to appreciate ambiguity and nuance, while emphasizing the importance of clarity and precision in communication and reasoning.  ***Problem-solving:*** execute advanced mathematical procedures and build upon these standard procedures. |
| Practical skills (subject specific) |
|  |  | | ***Application of skills:*** apply theories to analyze the structure of multidimensional complex analysis.  ***Autonomy in skill use:*** Independently apply the principles of holomorphic functions in multidimensional complex analysis to develop and analyze conjectures and proofs. (understanding of multidimensional complex analysis, development of definitions, development and proof of conjectures).  ***Technical expertise:*** ability to manage information and documentation |  |  |

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| **ECTS Student Work Load** | | | | | | |
| **Activities** | | **Number** | **Unit** | | **Hour** | **Total**  **(Work Load)** |
| Course Contact Hour (Academic Calendar: 15 weeks) | | 15 | Week | | 2 | 30 |
| Preliminary Preparation | | 15 | Week | | 1 | 15 |
| Assignment (s) (Problem solving) | | 15 | Number | | 3 | 45 |
| Presentation/Seminars | | 15 | Number | | 2 | 30 |
| Quiz | |  | Number | |  |  |
| Mid-Term Exam (s) | | 1 | Number | | 4 | 4 |
| Project (s) | | 1 | Number | | 4 | 4 |
| Field Studies (Technical Visits) | |  | Number | |  |  |
| Practice (Laboratory, Virtual Court, Studio Studies etc.) | | 15 | Week/Number | | 1 | 15 |
| Final Exam/ | | 1 | Number | | 7 | 7 |
| Final Project/ Dissertation and Preparation | |  |  | |  |  |
| Other (Placement/Internship etc.) | |  | Number | |  |  |
| **Total Work Load** | | | | | | **150** |
| **Total Work Load/ 30 hours** | | | | | |  |
| **ECTS Credits** | | | | | | **5** |
| 1 ECTS CREDIT equivalence: 30 study hours. | | | | | | |
| Types of activities | Percentage | | | Time spent on | | |
| Classroom hours: | 30% | | | 45 hours | | |
| Tutorials: | 6% | | | 10 hours | | |
| Work in Groups / Practical Work: | 17% | | | 25 hours | | |
| Self-study (at home / library ): | 40 % | | | 60 hours | | |
| Assessment (Test, Written exams, etc): | 7% | | | 10 hours | | |
| Total | 100% | | | 150 hours | | |