Study programmes: BACHELOR STUDIES – Astronomy and Astrophysics

Course name: Mathematical Physics 1

Lecturers: Ivanka Milosević and other lecturers

Status: Optional

ECTS: 6

Attendance prerequisites: No prerequisites.

Course aims: Introducing the concepts and techniques of finite dimensional vector spaces, linear algebra and vector analysis which are extensively used in physics

Course outcome: Adoption of the notions of linear and unitary (Euclidean) spaces and linear transformations (operators). Getting in detail knowledge of the classes of linear operators used in physics (hermitean and unitary operators, projectors), their eigenvalue problem and spectral characterization in particular. Adoption of basic techniques of tensor calculus and field theory.

Course content:

1. Vector space: dimension, basis, isomorphism, scalar product;
2. Unitary and Euclidean spaces, Gram-Schmidt method of orthonormaliation, functional;
3. Linear transformations (operators): geometry of action, operators in spaces with scalar product;
4. Adjoint operators, normal operators;
5. Hermitean and statistical operators;
6. Unitary and orthogonal operators, projectors;
7. Eigenvalue problem: geometry of, eigenvector and eigenvalue;
8. Compatible operators, operator functions;
9. Tensors: definition, operations with tensors, (anti)symmetric tensors;
10. Tensor product of two vector spaces; symmetric and outer square tensor product; generalization; applications in quantum mechanics, Dirac notation;
11. Operator invariants, scalar, vector and tensor spaces;
12. Hamilton operator, grad, div, curl, directional derivative;
13. Special types of vector spaces;
14. Curvilinear coordinates;
15. Hamilton and Laplace operators in orthogonal curvilinear coordinate system, cylindrical and spherical coordinates

Literature:

1. I. Milosević, "Vector spaces and elements of vector analysis" (Faculty of Physics, Belgrade, 1997)
2. P. R. Halmos, Finite-dimensional Vector Spaces (Springer, New York, 1974)
3. S. Lipschutz, Linear Algebra, Schaum Outline Series (McGraw-Hill, NewYork 1974)
4. A. I. Kostrikin, J. I. Manin, "Linear algebra and geometry" (Nauka, Moscow, 1986)
5. M. Vujičić, Linear Algebra Thoroughly Explained (Springer, New York, 2008)

Number of hours: 7	**Lectures**: 4	**Tutorials**: 3	**Laboratory**: -	**Research**: -

Teaching and learning methods:
Lectures, Exercises (vector spaces, linear operators, eigenproblem, vector analysis).

Assessment (maximal 100 points)

Course assignments	points	Final exam	points
Lectures	10	Written exam	30
Exercises / Tutorials	20	Oral exam	20
Colloquia	-	Written-oral exam	-
Essay / Project	20		