Mathematical methods in physics - opis przedmiotu

Informacje ogólne

Nazwa przedmiotu	Mathematical methods in physics
Kod przedmiotu	13.2-WF-FizP-MMP-S17
Wydział	Wydział Fizyki i Astronomii
Kierunek	Fizyka
Profil	ogólnoakademicki
Rodzaj studiów	pierwszego stopnia z tyt. licencjata
Semestr rozpoczęcia	semestr zimowy 2020/2021

Informacje o przedmiocie

Semestr	3
Liczba punktów ECTS do zdobycia	6
Typ przedmiotu	obowiązkowy
Język nauczania	angielski
Sylabus opracował	• prof. dr hab. Andrzej Maciejewski

Formy zajęć

Forma zajęć	Liczba godzin w semestrze (stacjonarne)	Liczba godzin w tygodniu (stacjonarne)	Liczba godzin w semestrze (niestacjonarne)	Liczba godzin w tygodniu (niestacjonarne)	Forma zaliczenia
Wykład	30	2	-	-	Egzamin
Ćwiczenia	30	2	-	-	Zaliczenie na ocenę

Cel przedmiotu

Acquainting the student with advanced mathematical methods necessary for understanding the contents of main study subjects.

Wymagania wstępne

Mathematical analysis I and II together with algebraic and geometric methods in physics.

Zakres tematyczny

- Elements of analytical geometry: planar and space curves, tangents and normals to planar curves, various parameterizations of of straight line, conics in Cartesian and polar coordinates, equations of plane in space, surfaces, quadrics and their classifications.

- Differential operators in curvilinear coordinates: planar and spatial Cartesian and curvilinear coordinates, curvilinear orthogonal coordinates, scalar and vector fields, differential operations on scalar and vector fields: gradient, divergence, rotation, Laplace operator in Cartesian coordinates; potential fields, divergence free fields and irrotational fields; gradient, divergence, rotation, Laplace operator in curvilinear orthogonal coordinates. Definition of tensor fields and algebraic operations on them.

- Elements of variational calculus: definition of functional and examples of them, weak and strong extrema, notion of variation of functional, necessary condition for existence of extremum of a functional, Eulera-Lagrange equations and their properties. Applications of variational calculus.

- Functions of complex variable: complex function of complex variable, limit of function, continuity of function, derivative of complex function, Cauchy-Riemanna conditions for the existence of the complex derivative, Cauchy integral formula, Taylor and Laurent series, singular points of a function, residue, calculation of integrals with the help of residue theory.

- Ordinary differential equations: first order differential equations: method of isoclines, finding solutions of various types of differential equations: separable, homogeneous, Bernoulli's and Riccati's equations, second order linear homogeneous and non-homogeneous differential equations with constant and variable coefficients, method of constant variations and method of undetermined coefficients.

- Partial differential equations of mathematical physics: vibrating string equation and d'Alembert method, membrane equation and Fouriera method of variables separation, Laplace equation.

Metody kształcenia

Conventional lecture. Computational problems illustrating the lecture material together with its physical applications.

Efekty uczenia się i metody weryfikacji osiągania efektów uczenia się

Opis efektu	Symbole efektów	Metody weryfikacji	Forma zajęć
Student knows extremum condition for functionals and applies it for various problems of mathematics and physics	• K1A_W03 • K1A_U02	• egzamin - ustny, opisowy, testowy i inne • kolokwium	• Wykład • Ćwiczenia

Opis efektu	Symbole efektów	Metody weryfikacji	Forma zajęć
Student knows various types of curvilinear coordinates, can check whether the coordinates are orthogonal, determines Lame coefficients, knows how to determine gradient, divergence, rotation and Laplace operator in given orthogonal coordinates.; applies the properties of the Kronecker delta and Levi-Civita's symbol for derivation of various vectorial identities. Student can check if vector fields are divergence free or irrotational, determines scalar and vectorial potential for given vector fields; can transform scalar functions and vectorial fields from one to another coordinates system.	• K1A_W03 • K1A_U02	• egzamin - ustny, opisowy, testowy i inne • kolokwium	• Wykład • Ćwiczenia
Student knows and understands selected problems from analytical geometry, vector analysis, variational calculus, functions of complex variable and practical aspects of ordinary and partial differential equations of selected types. Student knows elementary terminology employed in these areas of science	• K1A_W02 • K1A_K01	• egzamin - ustny, opisowy, testowy i inne • kolokwium	• Wykład • Ćwiczenia
Student knows how to check if a complex function is differentiable and calculates its derivatives, knows parametrisation of the most important curves on complex plane and calculates integrals of complex functions, applies Cauchy integral formula to determine integrals of complex functions. Student knows definition of Taylor series and expands given function into Taylor series, understands the notion of holomorphic function, knows the singular points classification. Student knows the definitions of Laurent series and residue, calculates residua using different methods, applies residues to calculate integrals	• K1A_U02	• egzamin - ustny, opisowy, testowy i inne • kolokwium	• Wykład • Ćwiczenia
Student knows and uses various parameterizations of planar and spatial curves, can write the straight line equation knowing various sets of given data, determines equations of tangents and normals to given planar curves, recognizes types of conics from their equations, rewrites conics equations from Cartesian to polar coordinates and vice versa, writes conics equations in coordinates frames with shifted origin	• K1A_W03 • K1A_U02	• egzamin - ustny, opisowy, testowy i inne • kolokwium	• Wykład • Ćwiczenia
Student can solve basic classes of first and second order ordinary differential equations. Student knows fundamental partial differential equations: string, membrane and Laplace equations and knows simplest methods of solving them	• K1A_W03 • K1A_U02 • K1A_U05	• egzamin - ustny, opisowy, testowy i inne • kolokwium	• Wykład • Ćwiczenia

Warunki zaliczenia

Lecture: Exam. The course credit is obtained by passing a final written exam composed of tasks of varying degrees of difficulty.

Class: Written test. A student is required to obtain at least the lowest passing grade from the test organized during class.

To be admitted to the exam a student must receive a credit for the class.

Final grade: weighted average of grades from exam (60%) and class (40%).

Literatura podstawowa

[1] R. Leitner, *Zarys matematyki wyższej*, część I, II i III, WNT, Warszawa 1998.

[2] D. McQuarrie, *Matematyka dla przyrodników i inżynierów,* T. 1, 2 i 3, PWN, Warszawa 2006.

[3] T. Jurlewicz, Z. Skoczylas, *Algebra i geometria analityczna*, Oficyna Wydawnicza GiS, Wrocław 2011.

[4] E. Karaśkiewicz, *Zarys teorii wektorów i tensorów*, PWN, Warszawa 1974.

[5] I. M. Gelfand, S. W. Fomin, *Rachunek wariacyjny*, PWN, Warszawa 1970.

[6] J. Długosz, *Funkcje zespolone*, Oficyna Wydawnicza GiS, Wrocław 2005.

[7] M. Gewert, Z. Skoczylas, *Równania różniczkowe zwyczajne*, Oficyna Wydawnicza GiS, Wrocław 2006.

[8] G. I. Zaporożec, *Metody rozwiązywania zadań z analizy matematycznej*, WNT, Warszawa 1976.

Literatura uzupełniająca

[1] F. W. Byron, R. W. Fuller, *Metody matematyczne w fizyce klasycznej i kwantowej*, t. 1-2, PWN, Warszawa 1974,

eng. F. W. Byron, R. W. Fuller, Mathematics of Classical and Quantum Physics, vol I and II *Dover Publications, Inc., New York,* 1992

[2] J. Bird, *Higher engineering mathematics*, Elsevier, Amsterdam 2006.

[3] A. Dubrovin, S. P. Novikov, A.T. Fomenko *Modern Geometry. Methods and Applications,* Part 1, Springer-Verlag, 1984.

Uwagi

Zmodyfikowane przez dr hab. Piotr Lubiński, prof. UZ (ostatnia modyfikacja: 03-06-2020 17:10)