SYLABUS PRZEDMIOTU W SZKOLE DOKTORSKIEJ

Tytuł	**Mathematics**
Tytuł w jęz. ang.	Mathematics

Status przedmiotu	**obowiązkowy** dla:
	do wyboru dla:

Autor/autorzy sylabusa:	Zespół : 1.	koordynator:
		członek zespołu:
		członek zespołu:

Sygnatura przedmiotu:

Część A

1. **Syntetyczna charakterystyka przedmiotu** *(główne hasła – około 400 znaków)*:

The course offers a more advanced introduction to these topics in mathematics that see frequent applications in economic theory. The main body of the course comprises linear algebra, mathematical analysis 1 and mathematical analysis 2 including measure theory and integrals with respect to measures. These main building blocks are complemented with selected topics from topology, complex analysis, functional analysis, and set-valued mappings.

Słowa kluczowe *(3 – 6 słów)*:
linear algebra, mathematical analysis, economic theory

Część B

Przedmiotowe efekty uczenia się		**Powiązanie z efektami uczenia się dla SzD**
Wiedza *(liczba efektów od 2 do 5)*		

Umiejętności *(liczba efektów od 2 do 5)*		
Kompetencje społeczne *(liczba efektów od 1 do 3)*		

Część C
Semestralny plan zajęć:
1. Algebra. Groups. Definition. Examples: permutations, linear mappings. Orbits, fixed points and stabilizers. Basic properties. Fields. Definition. Examples: real and complex numbers. 2. Complex analysis I. Field of complex numbers (complex number, conjugate, opposite and inverse complex numbers. Basic operations on complex numbers. Module and argument of a complex number. Polar coordinates and geometric interpretation. Complex functions of real variable. Curves, Jordan curves and contours. Complex functions of a complex variable: Power and roots of complex numbers. Exponential and trigonometric functions. Logs and power. Polynomials. 3. Linear algebra I. Linear spaces. Linear subspace. Linear combination and linear independence. Basis and dimension of a linear space. 4. Matrices I. Matrices and matrix algebra. Rank, inverse matrix, elementary operations, determinant. Tensors. 5. Linear algebra II. Linear mappings. Matrix of a linear mapping. Rank and kernel of a linear mapping. Non-singular linear mappings. Isomorphic linear spaces. Invariant subspaces. 6. Functional analysis I. Normed spaces. Banach spaces. Cauchy sequences and complete spaces. Linear operators and functionals in normed spaces. Linear operators and bounded linear operators. Holder inequality. Continuous and bounded linear operators. Norm of a linear operator. Normed spaces of linear operators. 7. Spectrum of a linear mapping. Eigenvalues. Eigenvalues and a norm of a linear operator. Spectrum and resolvent of a linear operator. Power series. 8. Matrices II. Eigenvalues, characteristic polynomial. Invariant spaces. Decomposition into a simple sum of subspaces. Jordan decomposition. 9. Functional analysis II. Inner product. Unitary space. Hilbert space. Orthogonal elements and separable spaces. Fourier series and Riesz-Fisher theorem. Gramm-Schmidt orthonormalization.

10. Topology. Topological space. Metric space. Metrizable topology. Continuous mappings. Connectedness. Hausdorff spaces. Compactness.
11. Mathematical analysis I. Sequences and their properties. Series and their properties. Power series. Selected additional topics. Functions, limits, continuous functions and their properties. homeomorphisms. Derivatives. Mean value theorem. Taylor theorem. Riemann integrals. Stieltjes integrals. Selected properties of Riemann-Stieltjes integrals. Dirac's delta. Calculating integrals.
12. Complex analysis II. Derivatives of complex functions of real variable. Derivatives of complex functions. Integrals of complex functions of real variable. Integrals over contours.
13. Mathematical analysis II. First order calculus of functions. Selected properties. First order conditions for optimality. Mean value theorem. First order calculus of mappings. Inverse mappings. Diffeomorphisms. Smooth manifolds. Tangent space to a manifold. Implicit functions. First order conditions for optimality over manifolds. Higher order calculus of functions and mappings.
14. Measure theory I. Sigma-algebra. Measurable space. Measurable mappings. Simple functions. Measures. Outer measure and Caratheodory theorem. Outer Lebesgue measure and Lebesgue measure.
15. Integrals with respect to measure. Integrals of non-negative functions and their properties. Integrals of functions and their properties. Limit theorems.
16. Measure theory II. Finite product of measurable spaces. Countable products of measurable spaces. General products of measurable spaces and Kolomogorov theorem.
17. Lebesgue integral. Integral of functions of single variable. Mean value theorem. Fubini theorem. Substitutions.
18. Measure theory II. Working with measures. Types of measures: absolutely continuous and singular measures.
19. Set-valued mappings. Set-valued mappings. Lower and upper continuous mappings. Maximum theorem. Selections, Michael theorem, Kuratowski-Ryll-Nardzewski theorem.

Literatura podstawowa *(jeśli wybrane fragmenty publikacji zwartych, to wskazane podanie rozdziałów, ew. stron)***:**

1. J. Kłopotowski, Algebra liniowa, Szkoła Główna Handlowa w Warszawie, 2001
2. W. Rudin, Podstawy analizy matematycznej, Państwowe Wydawnictwo Naukowe, 1982
3. A. Birkholc, Analiza matematyczna. Funkcje wielu zmiennych. Wydawnictwo Naukowe PWN, 2018
4. J. Chądzyński, Wstęp do analizy zespolonej, Wydawnictwo Naukowe PWN, 1999

Literatura uzupełniająca *(jeśli wybrane fragmenty publikacji zwartych, to wskazane podanie rozdziałów, ew. stron)***:**

1. P. Bilinsgley, Probability and Measure, John Wiley & Sons, 1995

Część D

Forma zajęć:	**Wymiar zajęć w godz.:**
Ogółem godzin *w tym:*	60
wykład	60

Elementy oceny końcowej (ogółem 100%), *w tym*:	
egzamin pisemny	100%
Liczba punktów ECTS	7

Część E
Metody dydaktyczne (nauczania) stosowane przez prowadzącego
M.1. wykład tradycyjny M.2. wykład z wykorzystaniem technik multimedialnych

Część F
Metody weryfikacji (sprawdziany) osiągnięcia przedmiotowych efektów kształcenia
W.1. egzamin pisemny (*pytania otwarte, zadania*) W.2. egzamin ustny