COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USWN-M-O-II-S-19/20Z**					
Unit: **Moduł 4 [moduł]**					
Course title: **Harmonic analysis (PODSTAWOWE)**					Course code: **WN17AIIJ2802_35S**
Name of field of study: **matematyka**					
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic**		Specialty:		
Course / module status **elective**	Language of instruction: **semestr: 3 - english language (100%)**				

Year	Semester	Form of instruction	No. of hours	w tym e-learning	Type of credit	ECTS
2	3	konwersatorium	30	0	pg	6
		lecture	30	0	e	
Total			**60**			**6**

Course / module coordinator	**dr JAROSŁAW WOŹNIAK**
Course instructor	
Course / module objectives	**The lectures give students basic notions and basic theorems of harmonic analysis together with various corresponding examples. The exercises by the conservatorium help the students in the practic application of these notions to solving different mathematical problems by means of applications of harmonic analysis and in perfecting the proof techniques.**
Prerequisites	**The knowledge of elements of differential and integral calculus, of functional analysis and of ordinary and partial differential equations.**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	1	EP1	**The student knows basic theorems from the fields of harmonic analysis.**	**K_W05**
	2	EP2	**The student gets the deep knowledge of the basic fields of mathematics.**	**K_W01**
skills	1	EP3	**The student uses the language and methods of functional analysis for solving problems from mathematical analysis and its applications, specially properties of classical Banach spaces and Hilbert spaces.**	**K_U06**
	2	EP4	**The student knows how to apply the algebraic methods (specially methods based on linear algebra) in solving problems from different fields of mathematics and practic problems.**	**K_U07**
	3	EP5	**The student gets the proving skill for theorems of functional analysis and also the skill for overthrowing hypothesis by means of the construction and the choice of counterexamples.**	**K_U01 K_U06**
social competences	1	EP6	**The student knows how to formulate precisely questions for deepening his understanding of this theme or for searching the missing elements of the understanding.**	**K_K01 K_K02**

CONTENT	Semester	No. of hours	w tym e-learning
Subject title: **Harmonic analysis**			

Format of instruction: **lecture**			
1. **Fourier series.**	3	9	
2. **Fourier transform, inverse Fourier transform, Plancherel theorem.**	3	12	
3. **Applications of harmonic analysis to solving differential equations.**	3	9	
Format of instruction: **konwersatorium**			
1. **Fourier series.**	3	9	
2. **Fourier transform, inverse Fourier transform, Plancherel theorem.**	3	12	
3. **Applications of harmonic analysis to solving differential equations.**	3	9	

Modes of delivery	**Lecture, explanation, discussion**	
Assessment methods		No. of learning outcome from the syllabus
	EGZAMIN USTNY	**EP1,EP2,EP3,EP4,EP5,EP6**
	SPRAWDZIAN	**EP1,EP2,EP3,EP4,EP5**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP6**
Grading criteria	**The workshops are graded based on written in-class test with open problems and on observation of activity throughout the semester and on grades from selected written home assignements. The lecture is graded based on oral exam.**	
	Grade calculation principles	
	The final grade for the course is an average of grades for both parts of the course.	

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	3	Harmonic analysis		Arytmetyczna	
	3	Harmonic analysis [konwersatorium]	zaliczenie z oceną		
	3	Harmonic analysis [wykład]	egzamin		

Basic reading	J. Musielak (1989): Introduction to Functional Analysis, PWN, Warszawa
	W. Rudin (2001): Functional Analysis, PWN, Warszawa
Supplementary reading	A.N. Kolmogorov, S.V. Fomin (1999): Elements of the Theory of Functions and Functional Analysis, Dover Publications
	K. Yosida (1995): Functional Analysis, Springer

STUDENT WORKLOAD

	No. of hours	W tym e-learning
Contact hours	**60**	
Participation in test / exam	**6**	
Preparation for contact hours	**35**	
Private reading and studying	**22**	
Participation in tutorials	**12**	
Preparation of project / essay / etc.	**0**	
Preparation for test / exam	**15**	
TOTAL workload	**150**	
ECTS credits	**6**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USWN-M-O-II-S-19/20Z**		
Unit: **Moduł 3 [moduł]**		
Course title: **Entire and meromorphic functions (PODSTAWOWE)**		Course code: **WN17AIIJ2799_37S**
Name of field of study: **matematyka**		
Mode and cycle of study: **second degree, full - time**	Profile of study: **general academic**	Specialty:
Course / module status **elective**	Language of instruction: **semestr: 2 - english language (100%)**	

Year	Semester	Form of instruction	No. of hours	w tym e-learning	Type of credit	ECTS
1	2	konwersatorium	30	0	pg	6
		lecture	30	0	e	
Total			**60**			**6**

Course / module coordinator	**dr EWA CIECHANOWICZ**
Course instructor	
Course / module objectives	**Broadening and reinforcing knowledge and skills concerning the analysis of functions of a single complex variable. Presentation of basic notions of the theory of growth and value distribution of entire and meromorphic functions of a single variable.**
Prerequisites	**Knowledge of basics of complex analysis with respect to functions of a single variable.**

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	1	EP1	**A student has extended knowledge in the field of complex analysis.**	**K_W01 K_W03 K_W05**
	2	EP2	**A student knows the main conjectures and theorems of complex analysis**	**K_W01 K_W03 K_W05**
	3	EP3	**A student has deeper knowledge with respect to entire and meromorphic functions.**	**K_W03**
	4	EP4	**A student is able to understand formulation of the issues in the theory of entire and meromorphic functions which are a matter of current research.**	**K_W04**
	5	EP5	**A student knows the interrelations between complex analysis and other areas of research.**	**K_W05**
skills	1	EP6	**A student is able to prove theorems and disprove false conjectures in the field of complex analysis**	**K_U01 K_U02**
	2	EP7	**A student is well-versed in the methods of complex analysis.**	**K_U02**
	3	EP8	**A student is able to conduct proofs applying methods from other areas of mathematics.**	**K_U02**
social competences	1	EP9	**A student knows limitations of his/her knowledge and understands the need for further education.**	**K_K01**
	2	EP10	**A student is able to formulate questions leading to deepening of knowledge .**	**K_K01**
	3	EP11	**A student is able to formulate opinions about selected issues of complex analysis.**	**K_K02**

CONTENT	Semester	No. of hours	w tym e-learning
Subject title: **Entire and meromorphic functions**			
Format of instruction: **lecture**			
1. **Meromorphic functions. Poisson-Jensen formula.**	2	2	
2. **The first fundamental theorem of Nevanlinna.**	2	2	
3. **Charateristic of a meromorphic function. Properties of characteristic function. Characteristics of an entire function**	2	2	
4. **Order of a meromorphic function. Categories of growth.**	2	2	
5. **The theorem of Hadamard-Nevanlinna on representation of a meromorphic function of finite order according to its zeros and poles. Examples.**	2	4	
6. **Weierstrass product for a meromorphic function of a fixed order.**	2	4	
7. **The lemma on the logarithmic derivative**	2	2	
8. **The second fundamental theorem of Nevanlinna. Defect of a meromorphic function. The theorem on defects and Picard?s theorem.**	2	4	
9. **Deviation of a meromorphic function. Petrenko?s theory.**	2	4	
10. **Asymptotic values of entire and meromorphic fuctions. Denjoy-Carleman-Ahlfors theorem.**	2	2	
11. **Strong asymptotic values of meromorphic functions.**	2	2	
Format of instruction: **konwersatorium**			
1. **Meromorphic functions. Poisson-Jensen formula.**	2	2	
2. **The first fundamental theorem of Nevanlinna.**	2	2	
3. **Charateristic of a meromorphic function. Properties of characteristic function. Characteristics of an entire function**	2	2	
4. **Order of a meromorphic function. Categories of growth.**	2	2	
5. **The theorem of Hadamard-Nevanlinna on representation of a meromorphic function of finite order according to its zeros and poles. Examples.**	2	4	
6. **Weierstrass product for a meromorphic function of a fixed order.**	2	4	
7. **The lemma on the logarithmic derivative**	2	2	
8. **The second fundamental theorem of Nevanlinna. Defect of a meromorphic function. The theorem on defects and Picard?s theorem.**	2	4	
9. **Deviation of a meromorphic function. Petrenko?s theory.**	2	4	
10. **Asymptotic values of entire and meromorphic fuctions. Denjoy-Carleman-Ahlfors theorem.**	2	2	
11. **Strong asymptotic values of meromorphic functions.**	2	2	

Modes of delivery	**Lecture, explanation, discussion**	
Assessment methods		No. of learning outcome from the syllabus
	EGZAMIN PISEMNY	**EP1,EP2,EP3,EP4,EP5,EP6,EP7,EP8**
	SPRAWDZIAN	**EP1,EP2,EP3,EP4,EP5,EP6,EP7,EP8**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP10,EP11,EP9**
Grading criteria	**To pass the workshop part of the course a student needs to pass the in-class tests.** **To pass the lecture part of the course a student needs to pass a written exam.** **To obtain the course credit a student needs to get positive grades from both parts.**	
	Grade calculation principles	
	The final grade for the course is an average of grades for both parts of the course.	

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	2	Entire and meromorphic functions		Arytmetyczna	
	2	Entire and meromorphic functions [wykład]	egzamin		
	2	Entire and meromorphic functions [konwersatorium]	zaliczenie z ocena		

Basic reading	Conway, J. (1978): Functions of one complex variable, Springer
	Hayman, W.K. (1964): Meromorphic functions, Clarendon Press
	Leja, F. (1979): Funkcje zespolone, PWN
Supplementary reading	Petrenko, V.P. (1978): Growth of meromorphic functions, Vysha Shkola

STUDENT WORKLOAD

	No. of hours	
		W tym e-learning
Contact hours	**60**	
Participation in test / exam	**6**	
Preparation for contact hours	**30**	
Private reading and studying	**14**	
Participation in tutorials	**20**	
Preparation of project / essay / etc.	**0**	
Preparation for test / exam	**20**	
TOTAL workload	**150**	
ECTS credits	**6**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USWN-M-O-II-S-19/20Z**						
Unit: **Moduł 1 [moduł]**						
Course title: **Elements of Algebraic Topology (PODSTAWOWE)**					Course code: **WN17AIIJ2796_32S**	
Name of field of study: **matematyka**						
Mode and cycle of study: **second degree, full - time**		Profile of study: **general academic**		Specialty:		
Course / module status **elective**		Language of instruction: **semestr: 1 - english language (100%)**				
Year	**Semester**	**Form of instruction**	**No. of hours**		**Type of credit**	**ECTS**
				w tym e-learning		
1	1	konwersatorium	30	0	pg	6
		lecture	30	0	e	
Total			**60**			**6**
Course / module coordinator	**dr hab. inż. PIOTR KRASOŃ**					
Course instructor						
Course / module objectives	**An objective of this lecture is to acquaint a student with the basics in algebraic topology. Workshops should give more profound understanding of new notions , gaining flexibility and easiness in dealing with them as well as mastering of technics of proofs on exemplary simple problems**					
Prerequisites	**basic high-school knowledge, theory of sets, and basic point set topology**					

LEARNING OUTCOMES

Category	**No.**	**Code**	**Description**	Ref. to programme benchmarks
knowledge	1	EP1	**Student has knowledge of fundamentals of algebraic topology**	**K_W01 K_W03 K_W06**
	2	EP2	**understands well a role and significance of mathematical reasoning**	**K_W02**
	3	EP3	**has profound knowledge in the chosen branch of theoretical and applied mathematics**	**K_W03**
skills	1	EP4	**student has an ability of constructing mathematical reasoning, proving theorems as well as disproving conjectures through construction and choice of counterexamples**	**K_U01**
	2	EP5	**has an ability of checking formal correctness of reasonings in building formal proofs**	**K_U01**
	3	EP6	**has abilities of recognising topological structures in mathematical objects appearing in e.g. geometry or analysis;**	**K_U05**
social competences	1	EP7	**student knows limitations of his knowledge and understands the need for further studies**	**K_K01**
	2	EP8	**can precisely formulate questions useful for deeper understanding of the topic or finding lacking elements of reasoning**	**K_K01**

CONTENT	Semester	No. of hours	
			w tym e-learning

Subject title: **Elements of Algebraic Topology**			
Format of instruction: **lecture**			
1. **Homotopy, fundamental group**	1	4	
2. **Covering spaces, lifting of mappings**	1	4	
3. **Cofibrations, fibrations, CW- complexes**	1	3	
4. **Higher homotopy groups**	1	6	
5. **Homologies: symplicial, cellular, singular**	1	3	
6. **Cohomologies**	1	5	
7. **Applications : Brouwer fixed point theorem, Borsuk-Ulam theorem**	1	5	
Format of instruction: **konwersatorium**			
1. **Homotopy, fundamental group**	1	4	
2. **Covering spaces, lifting of mappings**	1	4	
3. **Cofibrations, fibrations, CW- complexes**	1	3	
4. **Higher homotopy groups**	1	6	
5. **Homologies: symplicial, cellular, singular**	1	3	
6. **Cohomologies**	1	5	
7. **Applications : Brouwer fixed point theorem, Borsuk-Ulam theorem**	1	5	

Modes of delivery	**Informal lecture, conversatorial lecture, explanations, disccussion**	
Assessment methods		No. of learning outcome from the syllabus
	EGZAMIN USTNY	**EP1,EP2,EP3,EP4,EP5**
	KOLOKWIUM	**EP1,EP2,EP3,EP4,EP5,EP6**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP7,EP8**
Grading criteria	**The lecture is graded based on oral exam. The workshops are graded based on written in-class tests and on observation of activity throughout the semester.**	
	Grade calculation principles	
	The final grade is the weighted arithmetic average from grades from all formats of instruction.	

Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	1	Elements of Algebraic Topology		Arytmetyczna	
	1	Elements of Algebraic Topology [wykład]	egzamin		
	1	Elements of Algebraic Topology [konwersatorium]	zaliczenie z oceną		

Basic reading	M.J. Greenberg : Lectures in algebraic topology
Supplementary reading	E.Spanier : Algebraic Topology
	J.Munkres : Topology

STUDENT WORKLOAD

	No. of hours	
		W tym e-learning
Contact hours	**60**	
Participation in test / exam	**6**	

Preparation for contact hours	**24**	
Private reading and studying	**40**	
Participation in tutorials	**10**	
Preparation of project / essay / etc.	**0**	
Preparation for test / exam	**10**	
TOTAL workload	**150**	
ECTS credits	**6**	

COURSE SYLLABUS AND SPECIFICATION

Curriculum title: **USWN-M-O-II-S-19/20Z**						
Unit: **Moduł 2 [moduł]**						
Course title: **General measure theory (PODSTAWOWE)**					Course code: **WN17AIIJ2797_33S**	
Name of field of study: **matematyka**						
Mode and cycle of study: **second degree, full - time**		Profile of study: **general academic**		Specialty:		
Course / module status **elective**		Language of instruction: **semestr: 1 - english language (100%)**				
Year	**Semester**	**Form of instruction**	**No. of hours**		**Type of credit**	**ECTS**
				w tym e-learning		
1	1	konwersatorium	30	0	pg	6
		lecture	30	0	e	
Total			**60**			**6**
Course / module coordinator	**dr hab. FRANCISZEK PRUS-WIŚNIOWSKI**					
Course instructor						
Course / module objectives	**The main purpose is to acquaint students with general measure theory and general integral theory. The workshops aim at gaining good grasp of basic concepts and methods of proving as well as providing more detailed information on some topics.**					
Prerequisites	**The Lebesgue measure and integral on real line. Elements of topology and of metric spaces.**					

LEARNING OUTCOMES

Category	No.	Code	Description	Ref. to programme benchmarks
knowledge	1	EP1	**manifests an in-depth knowledge of the basic branches of mathematics**	**K_W01**
	2	EP2	**understands well the role and importance of the construction of mathematical reasoning**	**K_W02**
	3	EP3	**knows the most important theorems and hypotheses of main branches of mathematics**	**K_W01**
	4	EP4	**has an in-depth knowledge of the selected field of mathematics: knows most classical definitions and theorems and their proofs**	**K_W03**
	5	EP5	**knows connections of the issues of a selected field with other fields of theoretical and applied mathematics**	**K_W03 K_W04**

skills	1	EP6	is able to construct mathematical reasoning: proving theorems and refuting hypotheses by construction and selection of counter-examples	K_U01 K_U02 K_U13
	2	EP7	has the ability to express mathematical contents in speech and writing, in mathematical texts of different nature	K_U11 K_U13
	3	EP8	has the ability to validate inferences in constructing formal proofs	K_U01 K_U13
	4	EP9	knows the construction of Lebesgue?s measure and integral; can use the concept of the measure theory in typical theoretical and practical issues	K_U04 K_U13
	5	EP10	has the ability to recognise topological structures in mathematical objects. e.g. in geometry or mathematical analysis; can use the basic topological properties of sets, functions and transformations	K_U05 K_U13
	6	EP11	can examine in the selected field the proofs in which, if necessary, uses also the tools of other branches of mathematics	K_U01 K_U13
	7	EP14	can work in a team; understands the necessity of working systematically on all projects which are long-term in nature	K_U13 K_U15
social competences	1	EP12	is aware of the limitations of his / her own knowledge and understands the need of further education	K_K01 K_K04
	2	EP13	is ready to precisely formulate the questions which are aimed at increasing his / her own understanding of a given topic or finding the missing elements of reasoning	K_K01 K_K02

CONTENT	Semester	No. of hours	w tym e-learning
Subject title: **General measure theory**			
Format of instruction: **lecture**			
1. **General measure spaces (measures, signed measures, Hahn and Jordan decompositions, construction of outer measures, theorems of extension to measures)**	1	12	
2. **Integration with respect to general measures (meaurable functions, integral of nonnegative function, integral of arbitrary function, Lebesgue-Stieltjes integral, the Vitali-Hahn-Saks theorem)**	1	12	
3. **Some more important measures (the Lebesgue measure in euclidean spaces, change of variable in the Lebesgue integral, the Lebesgue-Stieltjes integral, Borel measures)**	1	6	
Format of instruction: **konwersatorium**			
1. **General measure spaces**	1	12	
2. **Integration with respect to general measures**	1	12	
3. **Some more important measures**	1	6	

Modes of delivery	**Lecture, explanations, discussion, written description of some solutions**	
Assessment methods		No. of learning outcome from the syllabus
	EGZAMIN USTNY	**EP1,EP10,EP11,EP2,EP3,EP4,EP5,EP6,EP7,EP8,EP9**
	SPRAWDZIAN	**EP1,EP10,EP3,EP4,EP6,EP7,EP8,EP9**
	ZAJĘCIA PRAKTYCZNE (WERYFIKACJA POPRZEZ OBSERWACJĘ)	**EP1,EP10,EP11,EP12,EP13,EP14,EP2,EP3,EP4,EP5,EP6,EP7,EP8,EP9**

Grading criteria	**The workshops are graded based on written in-class test with open problems and on observation of activity throughout the semester and on grades from selected written home assignements.** **The lecture is graded based on oral exam.**				
	Grade calculation principles				
	The final grade is the weighted arithmetic average from grades from all formats of instruction.				
Final grade calculation method	Sem.	Course	Type of credit	Grade calc. method	Weight for the average
	1	General measure theory		Arytmetyczna	
	1	General measure theory [konwersatorium]	zaliczenie z oceną		
	1	General measure theory [wykład]	egzamin		
Basic reading	Royden H.L., Fitzpatrick P. (1998): Real Analysis, Macmillan Publishing Company				
Supplementary reading	Yeh J. (2008): Real Analysis, World Scientific				

STUDENT WORKLOAD

	No. of hours	
		W tym e-learning
Contact hours	**60**	
Participation in test / exam	**10**	
Preparation for contact hours	**30**	
Private reading and studying	**20**	
Participation in tutorials	**10**	
Preparation of project / essay / etc.	**0**	
Preparation for test / exam	**20**	
TOTAL workload	**150**	
ECTS credits	**6**	