COURSE UNIT DESCRIPTION

Course unit title	Course unit code
Mathematics for Software Engineering II (Mathematical Analysis)	

Lecturer(s)	Padalinys
Coordinator: prof. Gediminas Stepanauskas **Other lecturers:**	Institute of Mathematics Faculty of Mathematics and Informatics Vilnius University

Cycle	Type of the course unit
1st (BA)	Compulsory

Mode of delivery	Semester or period when the course unit is delivered	Language of instruction
Face-to-face	2 semester	Lithuanian

Prerequisites
Prerequisites: Mathematics for Software Engineering I.

Number of credits allocated	Student's workload	Contact hours	Individual work
5	136	72	64

Purpose of the course unit: programme competences to be developed		
Purpose of the course unit - to provide the basic knowledge of the mathematical analysis which is necessary for software engineering studies and practice. To acquaint students with the real numbers, sets, limits of numbers' sequences, function limit and continuity, functions derivative, Taylor formula and expansions and their theory, the theory of the indefinite, definite and improper integrals. To acquire abstract thinking, an ability to understand abstract mathematical texts. To develop the ability to understand and to prove theorems and statements, interpret, paraphrase, to recognize patterns and laws, to compare them, to choose out the essential part of the whole, to classify them, to model situations and to analyze them, to formulate conclusions and base them, to choose appropriate solutions and to apply them. Students will be prepared to understand the mathematical language in other subjects studied by them.		
Learning outcomes of the course unit: students will be able to	**Teaching and learning methods**	**Assessment methods**
Be able to identify the mathematical problems, construct models using the features of the real numbers, the sets, limits of numbers' sequences and the series of numbers, the main characteristics of the functions, functions limits, function derivatives, integrals. Be able to solve problems of applying basic proof schemes of the mathematical analysis and methods of calculation (4.2).	Traditional lectures on the mathematical analysis. Practical training: solving problems that help to understand theory. Individual work: solving complimentary problems and studying the literature.	Used cumulative assessment: work in classroom's practical trainings and individual work + mid test + final exam.
Be able to think abstractly, to use the formal description techniques, to prove the correctness of propositions, to understand the nature and scope of the basic mathematical objects: the space of the real numbers and the limit of numbers' sequence, function limit, function derivative, integral. Students will be able to discuss the mathematical language (4.3).		

Course content: breakdown of the topics	Contact hours							Individual work: time and assignments	
	Lectures	Tutorials	Seminars	Practice	Laboratory work (LW)	*Tutorial during LW*	**Contact hours**	**Individual work**	**Assignments**
1. Real numbers. Rational and irrational numbers. Understanding axiomatics of the real numbers. Bounds of sets.	2	0		2			**4**	**4**	Study [2] Ch. 1, solve homework problems [3] Ch. 1, [1] Ch. I, II.3, selectively read additional literature.
2. Function. Limit and continuity. Basic functions. Composite function. Sequences. Subsequences. Monotonic sequences. Limit of the sequence. Infinite limits. Unboundednesses. Number *e*. Partial limits of the sequence, upper and lower limits. Limit of function. Continuity of function. Points of discontinuities, their classification. Arithmetic operations with continuous functions.	8	1		8			**17**	**16**	Study [2] Ch. 2, 4, solve homework problems [3] Ch. 2, 3, [1] Ch. II.1, II.2, II.4, II.5, selectively read additional literature.
3. Function derivative. Definition of the function derivative and its features. Geometric and physical interpretations of the function derivative. Differential and its geometrical interpretation. Derivatives of basic functions. Differentiation of the composite function. Mean value theorems. Higher order derivatives and differentials. Taylor's formula. Application of the Taylor formula in approximate calculation. Local extremes of the functions. Convexity of the functions. Asymptotes. Functions study using derivatives.	10	1		10			**21**	**20**	Study [2] Ch. 5, solve homework problems [1] Ch. III, selectively read additional literature.
4. Series. Number series. Their convergence. Taylor's series. Necessary series convergence condition. Harmonic series.	4	1		4			**9**	**8**	Study [2] Ch.2; solve homework problems [3] Ch. 4, 5, selectively read additional literature.
5. Integral. Indefinite integral. Integration by variable modification and integration by parts. Definite integral. Newton-Leibniz's formula. Improper integral, its integration. Common scheme of application of the definite integral.	8	1		8			**17**	**16**	Study [2] Ch. 4.9, 8.1; solve homework problems [1] Ch. VI, selectively read additional literature.
Mid test and final exam.							**4**		
Total	**32**	**4**		**32**			**72**	**64**	

Assessment strategy	Weight %	Deadline	Assessment criteria
General assessment strategy: The final mark (not exceeding 10) equals the sum of points (rounded to the nearest integer) obtained in written exam, mid test, for work in classroom's practical trainings and individual work.			

Work in classroom‘s practical trainings and individual work.	20	During all practical trainings. Final evaluations are written at the end of last practical training.	**1 point:** student actively participates in the discussions, answers questions, formulates problems and issues, provides critical remarks, successfully solves the task on the blackboard and in the exercise-book, always doing his homework. **0.5 point:** student participates in the discussions, answers questions, called to the blackboard is able to select appropriate task’s solving strategies (steps) and has sufficient knowledge to solve the tasks, doing his homework. **0 points:** student almost does not participate in the discussions and does not his homework, and called to the blackboard fails to select the appropriate task’s solving strategies (steps) and does not have the knowledge required to solve the tasks, or attended in less than 30% of the practical trainings.
Mid test (written).	35	During semester, when corresponding theoretical and practical part is finished.	The mid test is written from the first three subjects: 1. Real numbers; 2. Function. Limit and continuity; 3. Function derivative (the first part). The test consists of two parts: questions and practical (computing) tasks. <u>The questions consist</u> of **five** similar complexity opened and closed-ended **questions**, each rated **0.2 point**. These questions estimate students' ability to absorb information and understanding this information. The test’s questions ask to provide definitions, theorems and formulations of the statements, examples of applications, to explain the solving strategies (steps) of the more complex tasks (eg., proof of theorems), laws, theories, and to identify patterns of concepts, to explain sense of the conventional symbols. Each correct and complete answer to the question is measured 0.2 point, otherwise the answer is evaluated 0 points. <u>Practical (computing) tasks consist</u> of **two tasks** of different complexity, which is requested to perform the calculations. Practical (computing) tasks check students' ability to apply the acquired knowledge in computing applications. Tasks are measured **1 and 2 points**. For each of the practical tasks the evaluation criteria are as follows: **Up to 20% of the maximum assignment points:** student knows the formulas, theorems, statements, models, definitions needed to solve the task, but is not able to apply them. **Up to 60% of the maximum assignment points:** student knows the formulas, theorems, statements, models, definitions needed to solve the task. Uses them, but the solutions have principled errors which mainly affect the results of the task, the decisions are inconsistent, student mixes solution’s steps, solutions have lack of reasoning or justification, student makes calculation errors. **Up to 90% of the maximum assignment points:** student knows the formulas, theorems, statements, models, definitions needed to solve the task. Student applies them. Decisions have no principled errors which affect the results of the task, the decisions are consistent, student does not mix solution’s steps, solutions have sufficient reasoning and justification. But there are some calculation errors which do not influence results in generally. **Up to 100% of the maximum assignment points:** student knows the formulas, theorems, statements, models, definitions needed to solve the task. Student applies them. Decisions have not errors, the judgment is consistent, student does not mix

			solution's steps, reasoning and justification are exhaustive. There are not calculation errors.
Final exam (written).	45	During exam session.	The final exam is written from the three subjects: 4. Function derivative (the second part). 5. Series; 6. Integral. The final exam consists of two parts: theoretical tasks and practical (computing) tasks. <u>The theoretical part consists</u> of different complexity theoretical **two tasks**. The theoretical tasks tests students' ability to apply the acquired knowledge, the ability to divide a whole into its component parts (analysis) and tests the ability to combine individual elements into a whole, modelling, formulating hypotheses (synthesis), to state and to prove statements and theorems, to construct models and explain the concepts of the models, to investigate situations and to apply principles. Tasks are measured **1 and 2 points** as follows: **0 points:** student does not know definitions or does not understand them, incorrectly formulates the main theorems and statements, improper uses of conventional symbols (designations) or does not understand them. **Up to 25% of the maximum assignment points:** student knows definitions and understands them, knows some of the theorems and formulations of the statements, is trying to apply them, understands conventional symbols and uses them properly. **Up to 50% of the maximum assignment points:** student knows definitions and understands them, knows theorems and statements, is able to explain formulations and solving strategies (steps) of the more complex theorems in his own words. **Up to 75% of the maximum assignment points:** student has the ability to prove theorems and statements, is able to interpret, to paraphrase, to recognize patterns and laws, and to compare them, is able to identify the fundamental part of the whole and to classify them. **Up to 100% of the maximum assignment points:** student is able to prove theorems and statements, is able to interpret, to paraphrase, to recognize patterns and laws, and to compare them, to choose out the essential part of the whole, to classify them, is able to model situations and to analyze them, is able to put forward hypotheses and to justify / deny. <u>Practical (computing) tasks consist</u> of **two tasks** of similar complexity, which is requested to perform the calculations. Each task is evaluated by **1 point** according the evaluation criteria of the mid test (practical part).

Author	**Publishing year**	**Title**	**Number or volume**	**Publisher or URL**
Required reading				
[1] E. Misevičius (vadovėlis ir uždavinynas)	2007	Matematinės analizės uždavinynas	1 part	Vilniaus universiteto leidykla
[2] V. Kabaila (vadovėlis)	1983	Matematinė analizė	1 part	Mokslas, Vilnius
[3] E. Misevičius, D. Kamuntavičius, S.	1996	Matematinės analizės pratybų užduotys		Vilniaus universiteto leidykla, Vilnius

Norvidas (uždavinynas)				
Recommended reading				
G.Stepanauskas	2014; 2007; 2012; 2007	Riba; Funkcijos išvestinė ir jos taikymai; Eilutės; Neapibrėžtinis ir apibrėžtinis integralai, Paskaitų konspektai.		mif.vu.lt/~stepanauskas
V. Pekarskas	2006	Trumpas matematikos kursas		Technologija, Kaunas
K. Kubilius, L. Saulis	2000	Matematinės analizės uždavinynas	1 part	TEV, Vilnius