syllabus

1. Information regarding the programme

1.1 Higher education institution	**Babeş Bolyai University**
1.2 Faculty	**Faculty of Mathematics and Computer Science**
1.3 Department	**Department of Computer Science**
1.4 Field of study	**Mathematics**
1.5 Study cycle	
1.6 Study programme / Qualification	**Quantum Computing and Communication (în limba engleză)**

2. Information regarding the discipline

2.1 Name of the discipline	Introduction to the Mathematics of Quantum Computing						
2.2 Course coordinator	Asist. Dr. Tudor Micu						
2.3 Seminar coordinator	Asist. Dr. Tudor Micu						
2.4. Year of study	**1**	2.5 Semester	**1**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**DF**
2.8 Code of the discipline				PQE0001			

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	4	Of which: 3.2 course	2	3.3 seminar/laboratory	2
3.4 Total hours in the curriculum	40	Of which: 3.5 course	20	3.6 seminar/laboratory	20
Time allotment:	hours				
Learning using manual, course support, bibliography, course notes	10				
Additional documentation (in libraries, on electronic platforms, field documentation)	10				
Preparation for seminars/labs, homework, papers, portfolios and essays	10				

Tutorship	5
Evaluations	2
Other activities:	-
3.7 Total individual study hours	35
3.8 Total hours per semester	75
3.9 Number of ECTS credits	3

4. Prerequisites (if necessary)

4.1. Curriculum	• - High school mathematics
4.2. Competencies	• - ability to perform symbolic calculations • - ability to operate with abstract concepts • - ability to perform logical deductions • - ability to solve math problems based on acquired notions

5. Conditions (if necessary)

5.1. For the course	blackboard, projector
5.2. for the seminar /lab activities	blackboard, projector

6. Specific competencies acquired

Professional competencies	• □ C1.1 Identifying the notions, describing the theories and using the specific language. • □ C2.3 Applying the adequate analytical theoretical methods to a given problem.
Transversal competencies	• □ CT1. Applying some rules of precise and efficient work, showing a responsible attitude regarding the scientific domain and teaching training for an optimal and creative development of the personal potential in specific situations, respecting the deontological norms.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Acquire (and/or revise) some of the main mathematical notions required in the process of studying quantum computing.
7.2 Specific objective of the discipline	• Ensure that the candidates can successfully follow the subsequent courses within the postgraduate program on Quantum Computing.

8. Content

8.1 Course	Teaching methods	Remarks
Lecture 1: Introductory Notions	Explanation, dialogue, examples, proofs	
Lecture 2: Complex Numbers	Explanation, dialogue, examples, proofs	
Lecture 3: Elements of Arithmetic	Explanation, dialogue, examples, proofs	
Lecture 4: Matrices and Vectors	Explanation, dialogue, examples, proofs	
Lecture 5: Groups	Explanation, dialogue, examples, proofs	
Lecture 6: Linear Algebra I	Explanation, dialogue, examples, proofs	
Lecture 7: Linear Algebra II	Explanation, dialogue, examples, proofs	
Lecture 8: Hilbert Spaces	Explanation, dialogue, examples, proofs	
Evaluation		

Bibliography

[1] Kaye, P., Laflamme, R., Mosca, M.: *An Introduction to Quantum Computing*, Oxford University Press, 2007.
[2] Lang, S.: *Algebra*, Springer-Verlag, New-York, 2002.
[3] Nielsen, M.A., Chuang, I.L.: *Quantum Computation and Quantum Information*, Cambridge University Press, 2010.

[4] Scherer, W.: *Mathematics of Quantum Computing – An Introduction*, Springer Nature, 2019.
[5] Yanofsky, N.S., Mannucci, M.A.: *Quantum Computing for Computer Scientists*, Cambridge University Press, 2008.
[6] Zygelman, B.: *A First Introduction to Quantum Computing and Information*, Springer Nature, 2018.

8.2 Seminar / laboratory	Teaching methods	Remarks
Seminar 1: Introductory Notions (Sets, Logarithms, Number Systems) – exercises	Explanation, dialogue, examples, proofs	
Seminar 2: Complex Numbers (algebraic form, polar form, modulus, argument) – exercises	Explanation, dialogue, examples, proofs	
Seminar 3: Arithmetic (divisibility, prime numbers, Fermat's little theorem– exercises	Explanation, dialogue, examples, proofs	
Seminar 4: Matrices and Vectors (addition, multiplication, determinants, tensor product) – exercises	Explanation, dialogue, examples, proofs	
Seminar 5: Groups (finite groups, order, Lagrange's theorem) – exercises	Explanation, dialogue, examples, proofs	
Seminar 6: Linear Algebra I (vector spaces, bases, linear maps) – exercises	Explanation, dialogue, examples, proofs	
Seminar 7: Linear Algebra II (matrices associated to linear maps, base change)– exercises	Explanation, dialogue, examples, proofs	
Seminar 8: Hilbert Spaces - exercises	Explanation, dialogue, examples, proofs	

Bibliography

[1] Crivei, S., Basic Abstract Algebra, Casa Cărții de Știință, Cluj-Napoca, 2002, 2003;
[2] Purdea, I., Pop, I., Algebra, GIL, Zalău, 2003;
[3] Rotman, J., Advanced Modern Algebra, Prentice Hall, New Jersey, 2002.
[4] Hardy, D., Richman, C., Walker, C. Applied Algebra, CRC Press, 2009.
[5] Nicholson, K.C., Linear Algebra with Applications, https://lyryx.com/wpcontent/uploads/2018/01/Nicholson-OpenLAWA-2018A.pdf

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Written exam		100%
10.5 Seminar/lab activities			
10.6 Minimum performance standards			
• ¬ to acquire minimum 5 (out of 10) points to pass the exam			

Date

07.09.2022

Signature of course coordinator

Asist. Dr. Tudor Micu

Date of approval

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Signature of the head of department

Prof. Dr. Laura Dioșan