AGU Graduate School of Engineering and Science ……………………………………… Program

COURSE RECORD

Code	**ECE 590**
Name	**Quantum Informatics**
Hour per week	3 (3 + 0)
Credit	3
ECTS	7,5
Level/Year	Graduate
Semester	Spring
Type	Elective
Location	
Prerequisites	None
Special Conditions	No
Coordinator(s)	Assoc. Prof. Dr. Sergey Borisenok
Webpage	
Content	Interdisciplinary introduction to basic concepts of quantum informatics and quantum computation processes covers: • Classical information (Boolean) processes. Quantum logic processes. • Quantum logical gates and their matrix description. • Qubits. Basic quantum gates. Qutrits. • Quantum mechanical approach to logic. • Pure and entangled states. Qubits as quantum systems. • Control of qubit state. • Von Neumann entropy. • Quantum decoherence. • EPR paradox and Bell's states. Quantum teleportation. • Different physical models of quantum computation.
Objectives	The purpose of this course is: 1. to deepen the student understanding of the basic principles of quantum information processes; 2. to deepen the student understanding of the basic principles of quantum computations and algorithms; 3. to develop the student understanding of the engineering background for modern qubit-based devices; 4. to improve the student informatics skills for engineering applications; 5. to improve the student skills for their independent studies of original scientific literature.
Learning Outcomes	LO1. Learn the basic principles of interdisciplinary approach to modern engineering science; LO2. Learn the basic of modern approach to quantum computations; LO3. Learn the basic areas of application for quantum informatics algorithms; LO4. Learn the methods of quantum engineering in the developing of modern and forthcoming computational technologies; LO5. Learn the social impact of modern quantum engineering science; LO6. Learn the contribution of quantum informatics to the solution of global challenge problems.
Requirements	Basic knowledge of calculus and general physics.
Reading List	TEXTBOOK: 1. Jaeger, G. 2007. Quantum Information, Springer, New York, ISBN 0-387-35725-4. 2. Nielsen, M.A. and Chuang, I.L. 2000. Quantum Computation and Quantum Information. Cambridge University Press, ISBN 0-521-63235-8. RECOMMENDED BOOKS: 3. Miller, D. 2008. Quantum Mechanics for Scientists and Engineers, Cambridge. ISBN: 9780521897839. 4. Scientific articles.

Ethical Rules and Course Policy	Cooperation vs. Cheating • Grading will be based on individual performance. Students are expected to be aware of the difference between cooperation and cheating (if you cannot distinguish the difference, please ask for advice). Plagiarism • Definition: the practice of taking someone else's work or ideas and passing them off as one's own. • Proper citing is suggested to avoid plagiarism. Latecomers • You are allowed to join the class maximum 10 minutes after the class starts.

LEARNING ACTIVITIES

Activities	**Number**	**Weight (%)**
Lecture	14	10%
Group Works	8	20%
Presentations	2	20%
Web Search	5	10%
Exams	2	40%
	Total	100%

ASSESSMENT

Evaluation Criteria	**Weight** (%)
Quizzes	15%
Weekly Assignments and Homework	15%
Presentations	20%
Attendance/Participation	10%
Midterm Exam	20%
Final Exam	20%
Total	100%

For a detailed description of grading policy and scale, please refer to the website https://goo.gl/HbPM2y section 28.

COURSE LOAD

Activity	**Duration** (hour)	**Quantity**	**Work Load** (hour)
Lectures	1	14	14
In class activities	1	14	14
Group work	1	8	8
Pre-Work for Presentation	16	2	32
Presentation	6	2	12
Homework	8	2	16
Research (Web, Library)	4	16	64
Required Readings	5	16	80
Pre-Work for Midterm	32	1	32
Midterm Exam	3	1	3
Pre-work for Final	32	1	32
Final Exam	3	1	3
		General Sum	**310**

ECTS: 7,5 (Work Load/25-30)

CONTRIBUTION TO PROGRAMME OUTCOMES*

	PO1	PO2	PO3	PO4	PO5	PO6
LO1	5	5	2	5	4	5
LO2	5	5	3	5	5	4
LO3	5	4	4	4	5	4
LO4	4	5	3	4	5	4
LO5	3	3	3	5	5	5
LO6	2	3	2	5	4	5

* Contribution Level: 0: None, 1: Very Low, 2: Low, 3: Medium, 4: High, 5: Very High

WEEKLY SCHEDULE

W	Topic	Outcomes
1	Classical information (Boolean) processes. Quantum logic processes. Activity: Lecture, Web search	LO1, LO2
2	Quantum logic gates and their matrix description. Activity: Lecture, Web search	LO1, LO2
3	Qubits (quantum bits). Basic quantum gates. Activity: Lecture, group work	LO1, LO2
4	Quantum mechanical approach to logic. Activity: Lecture, group work	LO1, LO2, LO3
5	Pure and entangled states. Qubits as quantum systems. Activity: Lecture, group work	LO2, LO3
6	Qubit control. Activity: Lecture Free Week Activity, Web search, group work	LO2, LO3, LO5
7	Von Neumann entropy. Activity: Lecture, group work	LO2, LO3, LO5
8	Summary for Qubits and Quantum Gates. Midterm Exam. Activity: Presentations, midterm exam	LO1 – LO6
9	Quantum decoherence. Activity: Lecture, Web search	LO2, LO3
10	EPR paradox and Bell's states. Quantum teleportation. Activity: Lecture, group work	LO1, LO4
11	Qutrits and their applications. Activity: Lecture, Web search	LO4, LO5, LO6
12	Optics based quantum computations. Activity: Lecture, group work	LO1, LO2, LO4
13	NMR based quantum computations. Activity: Lecture, group work	LO1, LO2, LO4
14	Solid state based quantum computations. Activity: Lecture, group work	LO1, LO2, LO4
15	Ion trapping based quantum computations. Conclusions. Activity: Lecture, presentations	LO1, LO4, LO5, LO6
16	Final Exam. Activity: Final exam	LO1 – LO6

Prepared by
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Date
16/04/2018