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	10
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: 10 (Work Load/25-30)

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

Prepared by
Assoc. Prof. Dr. Sergey Borisenok

Date
16/04/2018