DEMOCRITUS UNIVERSITY OF THRACE | DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

MSc in QUANTUM COMPUTING AND QUANTUM TECHNOLOGIES

NATIONAL CENTRE FOR SCIENTIFIC RESEARCH "DEMOKRITOS"

DEMOCRITUS UNIVERSITY OF THRACE

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

MSc in QUANTUM COMPUTING AND QUANTUM TECHNOLOGIES

Detailed course outlines.

Contents

COURSE OUTLINE

1. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QY1**	**SEMESTER**	**WINTER (1ST)**
COURSE TITLE	QUANTUM COMPUTING		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	3	9
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/1031595/

2. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand two-state quantum systems
- To understand the qubit theoretical model and its Bloch sphere representation
- To compute the states of quantum registers
- To understand the nature and use of quantum gates
- To understand the principle of quantum computation and its relation to Schrödinger equation.
- To design quantum circuits and execute quantum computations
- To use quantum simulators
- To program real quantum computers
- To understand the quantum circuit descriptions of quantum algorithms

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
Autonomous work
Working in an international environment
Critical thinking
Adaptation to new situations

3. COURSE CONTENT

1. Introduction to quantum computers and quantum computing

Two-state quantum systems

The quantum bit (qubit) and its Bloch sphere representation

Quantum registers

Quantum gates

Quantum computing and quantum circuits

Deutsch quantum algorithm

Quantum computer simulators and programming of quantum computers

Deutsch-Jozsa quantum algorithm

Berstein-Vasirani quantum algorithm

Entanglement and teleportation

The BB84 Quantum Key Distribution (QKD) protocol

Simon's quantum algorithm

4. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Microsoft Teams platform Eclass QCS and Qiskit quantum simulators

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail.
Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.

Activity	*Workload/semester*
Lectures	39
Bibliographical research and study	94
Assignments during the course	40
Final assignment and exam	52

	Total	**225**
STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving.	

5. SUGGESTED BIBLIOGRAPHY

1. R.P. Feynman, R.B. Leighton and M. Sands, "The Feynman Lectures on Physics, vol. III Quantum Mechanics", Pearson, 2012.
2. D. Mc Mahon, “Quantum Computing Explained”, Wiley-Interscience, 2008
3. V. Silva “Practical Quantum Computing for Developers”, Apress, 2018
4. E. Riefell and W. Polak, “Quantum Computing a gentle introduction”, The MIT Press, 2011
5. N. D. Mermin, “Quantum Computer Science”, Cambridge University Press, 2007
6. M. A. Nielsen and I. L. Chuang, “Quantum Computation and Quantum Information: 10th Anniversary Edition”, Cambridge University Press, 2011

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Ioannis Karafyllidis
Contact details:	Email: ykar@ee.duth.gr, Telephone: 30 25410 79548
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(1) Please write YES or NO

(2) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(3) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

6. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QY2**	**SEMESTER**	**WINTER (1ST)**
COURSE TITLE	QUANTUM DEVICES		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	3	9
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

7. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the properties and operation of semiconducting quantum devices.
- To understand the principles of operation of superconducting devices
- To understand the Josephson effect
- To design and simulate Josephson junctions, squid devices and superconducting quantum circuits
- To understand the properties and operation of molecular magnets and organic molecules
- To understand and calculate spin operators and their time evolution
- To identify proper molecular spin systems for spin-based QC

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
Autonomous work

Critical thinking
Adaptation to new situations

8. COURSE CONTENT

- Semiconducting devices:
  - quantum wells
  - 2DEG devices (HEMT)
  - quantum dots
  - Coulomb blockade
  - Single Electron Transistor (SET)
  - Tunnel FET
- Superconducting devices:
  - Introduction to the superconductivity
  - Josephson effect – Josephson junctions
  - superconducting electronic circuits
  - dc and ac squid sensors
- Molecular magnets:
  - definition (description of the compounds)
  - organic molecules
  - transition metal and rare earth ions mono-and poly-nuclear compounds
  - molecular spins (endohedral fullerenes and/or encapsulated atoms)
  - impurities in solids
- Spin based QC
  - Stern-Gerlach experiment and the quantum measurement
  - spin operators and their algebra
  - the spin Hamiltonian of two coupled spins and its time evolution
  - Breit-Rabi energy levels of atomic hydrogen

9. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Microsoft Teams platform Eclass

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail.
Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.

Activity	*Workload/semester*
Lectures	39
Bibliographical research and study	94
Assignments during the course	40
Final assignment and exam	52

	Total	**225**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving.

10. SUGGESTED BIBLIOGRAPHY

M. Premaratne and G. P. Agrawal , Theoretical Foundations of Nanoscale Quantum Devices, Cambridge University Press, 2021.

M. Razeghi, Technology of Quantum Devices, Springer, 2009.

F. Rossi, Theory of Semiconductor Quantum Devices: Microscopic Modeling and Simulation Strategies, Spinger, 2011

S. T. Ruggiero and D. A. Rudman, Superconducting Devices, Academic Press, 2013

R. Combescot, Superconductivity: An Introduction, Cambridge University Press, 2022

K. K Likharev, Dynamics of Josephson junctions and circuits, Gordon and Breach Science Publishers, 1986

D. Gatteschi, R. Sessoli, J. Villain, Molecular Nanomagnets, Oxford University Press, 2006

J. A. Weil and J. R. Bolton, Electron Paramagnetic Resonance: Elementary Theory and Practical Applications, WILEY 2007

John J. L. Morton, Brendon W. Lovett, Hybrid solid state qubits: the powerful role of electron spins, Review https://doi.org/10.48550/arXiv.1103.0418

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Panagiotis Dimitrakis (Coordinator), Michalis Pissas, Ioannis Sanakis, George Mitrikas
Contact details:	E-mail: p.dimitrakis@inn.demokritos.gr, Telephone: T: +30-210-650-3118
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(4) Please write YES or NO

(5) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(6) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

11. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QY3**	**SEMESTER**	**SPRING (2nd)**
COURSE TITLE	QUANTUM ALGORITHMS AND QUANTUM INFORMATION		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	3	9
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	QY1 – Quantum Computing
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/1031596/

12. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the expression of the Postulates of Quantum Mechanics in Quantum Computing
- To use quantum error correcting codes
- To understand and use Grover's quantum algorithm
- To understand and use the Quantum Fourier Transform
- To understand and use Shor's quantum algorithm
- To analyze physical quantum bits using the quantum un-harmonic oscillator.
- To understand and use quantum game theory and quantum games
- To understand and use quantum walks as a model of quantum computation
- To write the Hamiltonians of specific problems
- To develop novel quantum algorithms
- To use the density matrix formulation
- To understand measures of entanglement and compute entanglement.
- To understand and use von Newmann entropy
- To understand the relation of quantum information and the free energy

General Skills
Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information, *ICT Use* *Adaptation to new situations* *Decision making* *Autonomous work* *Teamwork* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Project design and management* *Equity and Inclusion* *Respect for the natural environment* *Sustainability* *Demonstration of social, professional and moral responsibility and sensitivity to gender issues* *Critical thinking* *Promoting free, creative and inductive reasoning*
Search, analysis and synthesis of data and information Autonomous work Working in an international environment Critical thinking Adaptation to new situations	

13. COURSE CONTENT

1. The Postulates of Quantum Mechanics in Quantum Computing
2. Quantum mechanics for quantum computing and quantum information
3. Quantum Error Correcting Codes
4. Grover's quantum algorithm
5. Applications and quantum circuits of Grover's quantum algorithm
6. Quantum Fourier transform
7. Quantum phase estimation
8. Shor's quantum algorithm
9. Quantum games and quantum cellular automata
10. Quantum walks
11. Quantum circuits for quantum walks and applications
12. Von Newmann entropy and measures of entanglement
13. Quantum information and free energy

14. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Microsoft Teams platform Eclass QCS and Qiskit quantum simulators
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	39
Bibliographical research and study	94
Assignments during the course	40
Final assignment and exam	52

	Total	**225**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving.

15. SUGGESTED BIBLIOGRAPHY

1. M. A. Nielsen and I. L. Chuang, “Quantum Computation and Quantum Information: 10th Anniversary Edition”, Cambridge University Press, 2011
2. I. Djordjevic, “Quantum Information Processing and Quantum Error Correction”, Academic Press, 2012.
3. L. I. Schiff, “Quantum Mechanics”, McGraw-Hill, 1988
4. J. von Newmann, “Mathematical Formulation of Quantum Mechanics”, Princeton University Press, 1983
5. R. Portugal, “Quantum walks and search algorithms”, Springer, 2013
6. G. G. LaGuardia, “Quantum error correction”, Springer, 2020
7. D. D. Stancil and G. T. Byrd, “Principles of superconducting quantum computers”, Wiley, 2022.
8. A. S. Sergienko, “Quantum communications and cryptography”, Taylor & Francis, 2006
9. G. Jaeger, “Quantum Information”, Springer, 2007

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Ioannis Karafyllidis
Contact details:	Email: ykar@ee.duth.gr, Telephone: 30 25410 79548
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(7) Please write YES or NO

(8) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(9) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

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There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

16. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QY4**	**SEMESTER**	**SPRING (2nd)**
COURSE TITLE	QUBIT DEVICES		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	3	9
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

17. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the physics and operation of quantum devices implementing qubits.
- To understand the operation of superconducting resonators
- To understand CMOS qubits
- To understand the physics and operation of quantum gates
- To design and simulate qubit devices and quantum circuits using Qiskit metal
- To design quantum processors

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
Autonomous work
Critical thinking
Adaptation to new situations

18. COURSE CONTENT

- Superconducting qubits, Flux, phase, charge and Transmon qubits
- Superconducting resonators
- CMOS qubits (QD FET - P-dopants in Si devices)
- Nitrogen vacancies in Diamond
- Atom traps
- Topological insulators
- Topological quantum bits
- Physics of quantum gates
- Quantum circuits
- Realization of quantum algorithms with molecular nanomagnets
- Spin based quantum gates

19. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Microsoft Teams platform Eclass Qiskit metal simulator
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	39
Bibliographical research and study	94
Assignments during the course	40
Final assignment and exam	52
Total	**225**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others*	The assessment language is English. Solving written assignments. Reports. Problem solving.

Please indicate all relevant information about the course assessment and how students are informed	

20. SUGGESTED BIBLIOGRAPHY

G. Chen, D. A. Church, B. G. Englert, C. Henkel, Quantum Computing Devices: Principles, Designs, and Analysis, Chapman and Hall/CRC, 2006

D. D. Stancil and G. T. Byrd, Principles of Superconducting Quantum Computers, Wiley, 2022

M. A. Nielsen and I. L. Chuang, "Quantum Computation and Quantum Information: 10th Anniversary Edition", Cambridge University Press, 2011

F. Rossi, Theory of Semiconductor Quantum Devices: Microscopic Modeling and Simulation Strategies, Spinger, 2011

M. H. Devoret, A. Wallraff, and J. M. Martinis, "Superconducting Qubits: A Short Review", http://arxiv.org/abs/cond-mat/0411174v1

Wolfgang Harneit, Quantum Computing with Endohedral Fullerenes, Review https://doi.org/10.48550/arXiv.1708.09298

Gary Wolfowicz & John J.L. Morton, Pulse Techniques for Quantum Information Processin (https://www.ucl.ac.uk/quantum-spins/sites/quantum-spins/files/paper90.pdf)

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Panagiotis Dimitrakis (Coordinator), Michalis Pissas, Ioannis Sanakis, George Mitrikas
Contact details:	E-mail: p.dimitrakis@inn.demokritos.gr, Telephone: T: +30-210-650-3118
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(10) Please write YES or NO

(11) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(12) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

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c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

21. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE1**	**SEMESTER**	**Winter**
COURSE TITLE	Optical and Quantum Communications		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	Scientific Area, Skill Development
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

22. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the nature of light
- To understand the operation of key components and modules of optical systems.
- To understand and use optical signal processing.
- To understand and use optical communications systems.
- To understand optical quantum communications

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
ICT Use
Autonomous work
Teamwork
Project Design and Management
Critical thinking

Adaptation to new situations

23. COURSE CONTENT

Essential basics: Wave nature of light, E/M waves, physical optics, optical waveguiding.
Key components and modules: Optical fiber (operation, characteristics, types), passive elements (couplers, isolators, filters, multiplexers/demultiplexers).
Active devices (sources, modulators, amplifiers, photodetectors).
Optical signal processing: Optical nonlinearities, nonlinear media, modern switching and limitations, optical switches and gates, applications to sequential and combinational circuits.
Optical interconnects, photonic integration.
Optical communications systems: Basic parts, technological evolution, performance limitations and characterization, design of real systems.
Optical communications networks: Topologies, Wavelength Division Multiplexing, optical data centers, optical access networks, passive optical networks.
Optical quantum communications: Concept, infrastructure, networks, limitations, challenges.

1. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	50
Assignments during the course	40
Final assignment and exam	34
Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report,*	The assessment language is English. • Solving written assignments. • Reports. • Problem solving.

Clinical examination of a patient, Artistic interpretation, Other/Others *Please indicate all relevant information about the course assessment and how students are informed*	

2. SUGGESTED BIBLIOGRAPHY

1. P. Lampropoulos and D. Petrosyan, Fundamentals of Quantum Optics and Quantum Information, Springer, 2007

2. M. Benslama, A. Benslama and S. Aris, Quantum Communications in New Telecommunication Systems, Willey, 2017

3. A. V. Sergienko, Quantum Communications and Cryptography, Taylor & Francis, 2006.

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Kyriakos Zoiros
Contact details:	Email: kzoiros@ee.duth.gr, Telephone: 2541079595
Supervisors: (1)	No
Evaluation methods: (2)	Assignments and Final Exam
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(13) Please write YES or NO

(14) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(15) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

24. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE2**	**SEMESTER**	**WINTER (1ST)**
COURSE TITLE	Computational Biology		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	

25. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand basic biological principles
- To understand basic bioinformatical principles
- To perform bioinformatical analysis
- To translate biological questions into bioinformatics

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

26. COURSE CONTENT

Basics for DNA, RNA, proteins

Advanced for DNA, RNA, proteins

Alignment

Data bases

Epigenetics

Gene expression

Gene expression analysis

Transcription factors

Chromatin structure and analysis

Biological networks

Evolution and phylogenetic analysis

Introduction to structural biology

Protein folding

27. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Microsoft Teams platform Eclass
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	30
Bibliographical research and study	70
Assignments during the course	50
Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving.

28. SUGGESTED BIBLIOGRAPHY

1. Bioinformatics and Functional Genomic. Eudoxus: 86054818. Academic publications.
2. Recombinant DNA. Eudoxus: 2625. Academic publications.
3. Computational Biology. Eudoxus: 320114. Hellenic Academic Books. Kallipos repository

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Petros Kolovos
Contact details:	pkolovos@mbg.duth.gr and 2551030385
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(16) Please write YES or NO

(17) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(18) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

29. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE3**	**SEMESTER**	**Winter**
COURSE TITLE	Nanoelectronics		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	Scientific Area, Skill Development
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

30. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the quantum properties of nanomaterials
- To understand the properties and operation of spintronic devices
- To understand the physics and operation of quantum dots
- To understand quantum transport and spin dependent electron transport
- To understand the concept and properties of molecular electronics
- To understand 2D nanomaterials

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
ICT Use
Autonomous work
Teamwork
Project Design and Management

Critical thinking
Adaptation to new situations

31. COURSE CONTENT

- Quantum mechanical description of nanomaterials
- Nanoelectronic and spintronic devices
- Quantum dots, nanowires, nanopillars
- Quantum transport and tunneling effects
- Magnetoresistance
- Spin-dependent electron transport
- Molecular electronics
- Graphene and 2D nanomaterials.

3. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	50
Assignments during the course	40
Final assignment and exam	34
Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. • Solving written assignments. • Reports. • Problem solving.

4. SUGGESTED BIBLIOGRAPHY

A. Ghosh, Nanoelectronics: A Molecular View, World Scientific, 2016

T. T. Heikkilä, The Physics of Nanoelectronics: Transport and Fluctuation Phenomena at Low Temperatures, OUP Oxford, 2013

E. L. Wolf, Quantum Nanoelectronics: An Introduction to Electronic Nanotechnology and Quantum Computing, Wiley-VCH, 2015

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Panagiotis Dimitrakis (Coordinator), Michalis Pissas
Contact details:	E-mail: p.dimitrakis@inn.demokritos.gr, Telephone: T: +30-210-650-3118
Supervisors: (1)	No
Evaluation methods: (2)	Assignments and Final Exam
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(19) Please write YES or NO

(20) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(21) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

32. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE4**	**SEMESTER**	**Winter**
COURSE TITLE	Quantum Solid-state Physics		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	Scientific Area, Skill Development
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

33. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the quantum mechanical description of materials
- To understand the properties and physics of quantum confinement
- To understand semiconductor nanostructures
- To understand the quantum Hall effect
- To understand the hyperfine interactions and spin orbit coupling in materials
- To understand the basics of superconductivity
- To understand the static magnetic properties of materials
- To understand the dynamic magnetic properties including Rabi oscillations
- To understand the physical meaning of the two spin relaxation times, T1, T2
- To understand the possible spin relaxation mechanisms and processes

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information, ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Production of new research ideas
Search, analysis and synthesis of data and information ICT Use Autonomous work Teamwork Project Design and Management Critical thinking Adaptation to new situations

34. COURSE CONTENT

- Semiconductor nanostructures
- Quantum confinement
- Semiconductor heterostructures
- Quantum Hall effect
- Semiconductor/dielectric tunnel junctions
- Superconductivity and physics of superconductors
- Static Magnetic properties (Hyperfine interactions, Spin orbit coupling and single ion anisotropy, Exchange coupling)
- Dynamic Magnetic properties (Real and imaginary magnetic susceptibility, Spin Relaxation times, Rabi oscillations).

5. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	50
Assignments during the course	40
Final assignment and exam	34
Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written*	The assessment language is English. • Solving written assignments. • Reports.

Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others *Please indicate all relevant information about the course assessment and how students are informed*	• Problem solving.

6. SUGGESTED BIBLIOGRAPHY

C. Kittel, Quantum Theory of Solids, Wiley, 1991

L. Kantorovich, Quantum Theory of the Solid State, Springer, 2004

P. Harrison, A. Valavanis, Quantum Wells, Wires and Dots: Theoretical and Computational Physics of Semiconductor Nanostructures, Wiley, 2016

Z. F. Ezawa, Quantum hall effects: recent theoretical and experimental developments, World Scientific, 2013

M. Tinkham, Introduction to Superconductivity, Second Edition McGraw-Hill, Inc, 1996.

D. Gatteschi, R. Sessoli, J. Villain, Molecular Nanomagnets, 2006, Oxford University Press

Sandra S. Eaton and Gareth R. Eaton, Relaxation Times of Organic Radicals and Transition Metal Ions Biological Magnetic Resonance, Volume 19: Distance Measurements in Biological Systems by EPR, edited by Berliner et al. Kluwer Academic/Plenum Publishers, New York, 2000

J. A. Weil and J. R. Bolton, Electron Paramagnetic Resonance: Elementary Theory and Practical Applications, WILEY 2007

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Panagiotis Dimitrakis (Coordinator), Michalis Pissas, Ioannis Sanakis, George Mitrikas
Contact details:	E-mail: p.dimitrakis@inn.demokritos.gr, Telephone: T: +30-210-650-3118
Supervisors: (1)	No
Evaluation methods: (2)	Assignments and Final Exam
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(22) Please write YES or NO

(23) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(24) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

35. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGINEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE5**	**SEMESTER**	**WINTER (1ST)**
COURSE TITLE	APPLIED QUANTUM MECHANICS		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses

36. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand basic features of quantum mechanics like Schrödinger's equation, operators, expectation values, probability density and probability current density, superposition principle, eigenvalues, and the uncertainty principle.
- To solve the time-independent Schrödinger equation for studying bound states in simple and complex potential wells, including problems with different effective masses and delta function potentials.
- To understand scattering in one dimension and use the time-independent Schrödinger equation for the calculation of transmission and reflection coefficients in simple and complex barriers, including problems with different effective masses and delta function potentials.
- To understand the propagation matrix method, resonant tunneling, the WKB approximation for tunneling, and the Kronig-Penney model
- To understand the algebraic method for the harmonic oscillator and use it for the quantization of different quantum systems
- To understand Landau states
- To understand how to treat an electron in a central potential and use it in applications of spherical "hard" potential and finite spherical potential, and for hydrogen-like systems.

- To understand the quantum mechanics of angular momentum, including spin and the addition of angular momenta
- To understand and use time-independent perturbation theory for non-degenerate and degenerate states and the sudden approximation
- To understand and use the variational method
- To understand and use WKB approximation for stationary states
- To understand identical particles, Pauli exclusion principle and the symmetry of the wavefunctions.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,	*Project design and management*
ICT Use	*Equity and Inclusion*
Adaptation to new situations	*Respect for the natural environment*
Decision making	*Sustainability*
Autonomous work	*Demonstration of social, professional and moral responsibility and*
Teamwork	*sensitivity to gender issues*
Working in an international environment	*Critical thinking*
Working in an interdisciplinary environment	*Promoting free, creative and inductive reasoning*
Production of new research ideas	

Search, analysis and synthesis of data and information
Autonomous work
Working in an international environment
Critical thinking
Adaptation to new situations

37. COURSE CONTENT

Basic features: Schrödinger's equation, operators, expectation values, probability density and probability current density, superposition principle, eigenvalues, uncertainty principle.

Free-particle, symmetric quantum wells, combination of infinite and finite-barrier potential wells.

Delta function potential, combination of delta function potentials and heterostructures or quantum wells, triangular potential.

Scattering in one dimension: transmission and reflection coefficients, tunneling in simple and complex barriers. The propagation matrix method.

Resonant tunneling, WKB approximation for tunneling. Periodic potential and the Kronig-Penney model.

More on operators, eigenstates and the measurement problem, Dirac notation. Harmonic oscillator: Algebraic method of the harmonic oscillator, creation and annihilation operators, and their application.

Stark effect in the harmonic oscillator, quantization of the LC circuit, quantization of lattice vibrations-phonons, free electron in a magnetic field - Landau states and connection to the semiclassical orbit.

Electron in a central potential: angular momentum, application to spherical "hard" potential and finite spherical potential, solution for hydrogen-like systems and applications in semiconductors.

Angular momentum, spin and addition of angular momenta.

Time-independent non-degenerate perturbation theory and applications.

Time-independent degenerate perturbation theory and applications, the sudden approximation and applications.

Variational method and WKB approximation for stationary states and their applications.

Identical particles, Pauli exclusion principle, the symmetry of the wavefunctions and applications.

38. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Detailed digital notes Eclass Zoom Simple computer programs for applied quantum mechanics

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail.
Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	60
Assignments during the course	30
Final assignment and exam	34
Total	**150**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

The assessment language is English.
Solving written assignments.
Reports.
Problem solving.

39. SUGGESTED BIBLIOGRAPHY

1. A. F. J. Levi, "Applied Quantum Mechanics", 2nd edition, Cambridge, 2006

2. D. K. Ferry, “Quantum Mechanics: An Introduction for Device Physicists and Electrical Engineers”, 3rd edition, CRC Press, 2021

3. D. A. B. Miller, “Quantum Mechanics for Scientists and Engineers”, Cambridge, 2008

4. C. L. Tang, “Fundamentals of Quantum Mechanics for Solid State Electronics and Optics”, Cambridge, 2005

5. D. M. Kim, “Introductory Quantum Mechanics for Applied Nanotechnology”, Wiley, 2015

6. D. G. Steel, “Introduction to Quantum Nanotechnology”, Oxford, 2021

7. V. V. Mitin, D. I. Sementsov, and N. Z. Vagidov, “Quantum Mechanics for Nanostructures”, Wiley, 2006

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Emmanuel Paspalakis
Contact details:	Email: paspalak@upatras.gr, Telephone: +30 2610 996318
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(25) Please write YES or NO

(26) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(27) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

40. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE6**	**SEMESTER**	**WINTER (1st)**
COURSE TITLE	ARTIFICIAL INTELLIGENCE AND APPLICATIONS		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/1031593/

41. LEARNING OUTCOMES

Learning Outcomes
Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To Understand what artificial intelligence is.
- To know how to solve problems through solution search techniques and their most important algorithms.
- To understand the operation of biological and artificial neural networks (ANNs) and especially multi-level feed forward ANNs.
- To know the basic concepts of fuzzy logic and fuzzy systems.
- To understand how expert systems work.
- To know how to solve problems in the above knowledge areas.
- By carrying out specialized assignments, the student implements and applies the basic knowledge of the course to selected problems using specialized educational software. At the end of the course the student will have developed the following skills:
- Ability to choose the most appropriate method of solving problems that require the use of computational intelligence techniques.
- Ability to use and program specialized software to apply artificial neural networks, genetic algorithms and fuzzy systems to problems encountered in various fields of science.

General Skills
Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information, *ICT Use* *Adaptation to new situations* *Decision making* *Autonomous work* *Teamwork* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Project design and management* *Equity and Inclusion* *Respect for the natural environment* *Sustainability* *Demonstration of social, professional and moral responsibility and sensitivity to gender issues* *Critical thinking* *Promoting free, creative and inductive reasoning*

Search, analysis and synthesis of data and information
Autonomous work
Working in an international environment
Critical thinking
Adaptation to new situations

42. COURSE CONTENT

Definitions and applications of artificial/computational intelligence.

Problem representation and solving, solution search techniques, Blind search algorithms. Heuristics and heuristic functions.

Heuristics and guided search algorithms (BestFS, A* , Hill Climbing, Simulated Annealing), Algorithms for game playing (MIN-MAX, AB pruning).

Evolutionary computations (Introduction to genetic algorithms (GA), finding solutions and optimization using GA, applications).

Basic machine learning concepts

Artificial neural networks (Basic concepts in neural computing, biological and artificial neurons, basic ANN structures and models, learning approaches, first learning algorithms (Perceptron and Hebb rules)

Training ANN with Delta rule, Multilayer networks, the back-propagation algorithm and learning factors, other types of ANN.

Introduction to expert systems and inference procedures.

Introduction to fuzzy systems (Fuzzy sets, fuzzy logic, fuzzy relations)

Fuzzy linguistic descriptions and inference (Mamdani and Sugeno types of inference), examples of a complete fuzzy system.

43. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Microsoft Teams platform Eclass Matlab and Python programming environments
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning,*	

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	60

Study visits, Study / creation, project, creation, project. Etc. *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	Assignments during the course	30
	Preparations for the oral examinations	34
	Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving. Oral examinations.

44. SUGGESTED BIBLIOGRAPHY

1. Michael Negnevitsky. Artificial Intelligence:A guide to intelligent systems, 3rd
2. edition, Addison Wesley, 2011
3. Nils J. Nilson, Artificial Intelligence, A new Synthesis, Morgan Kaufmann
4. Publishers, Inc., 1998
5. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning:
6. From Theory to Algorithms, Cambridge University Press, 2014
7. Simon Haykin, Neural Networks and Learning Machines, 3rd edition, Pearson
8. Education (Prentice Hall), 2009
9. Lefteri Tsoukalas, Robert Uhrig, Fuzzy and Neural Approaches in Engineering,
10. John Wiley & Sons, 1997

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Ioannis Boutalis
Contact details:	e-mail: ybout@ee.duth.gr, tel. +30 25410 79504
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and oral examinations.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(28) Please write YES or NO

(29) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(30) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

45. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE7**	**SEMESTER**	**Winter**
COURSE TITLE	Python Programming and Applications		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	General Knowledge, Skill Development
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/1031594/

46. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the basics of python programming
- To write simple and moderate complexity python programs
- To be able to install and use python libraries
- To use jupyter notebooks for running python programs
- To use integrated development environments of python
- To debug python programs
- To collect and analyse data using python
- To use popular quantum information processing libraries of python

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
ICT Use
Autonomous work

Teamwork
Project Design and Management
Critical thinking
Adaptation to new situations

47. COURSE CONTENT

Introduction to Python

Python Development Tools

Jupyter Notebooks, Python IDE (PyCharm)

Python Libraries for Quantum Information Processing

Python Packages

Lists, Tuples, Dictionaries, Sets

Debugging and Exception Handling

Python Virtual Environments

Python Objects and References

Python Classes

Data Acquisition

Data Analysis

Advanced Topics: Threads, Functools, Lambda Functions

7. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail.
Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	50
Assignments during the course	40
Final assignment and exam	34

	Total	**150**
STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. • Solving written assignments. • Python Programming • Reports. • Problem solving.	

8. SUGGESTED BIBLIOGRAPHY

1. Makhamisa Senekane, Hands-On Quantum Information Processing with Python, Packt Publishing, 2021

2. C.H. Swaroop, A Byte of Python, https://python.swaroopch.com/

3. Luciano Ramalho, Fluent Python: Clear, Concise, and Effective Programming, 2nd edition, O'Reilly Media, 2022.

4. Mark Lutz, Learning Python, 5th Edition Fifth Edition, Fifth edition, O'Reilly Media, 2013.

5. Al Sweigart, Automate the Boring Stuff with Python, Practical Programming for Total Beginners, 2nd edition, No Starch Press, 2019.

6. Cory Reed, Python Programming for Beginners, Independently published, 2022

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Pavlos S. Efraimidis
Contact details:	Email: pefraimi@ee.duth.gr, Telephone: 2541079756
Supervisors: (1)	No
Evaluation methods: (2)	Assignments and Final Exam
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(31) Please write YES or NO

(32) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(33) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

48. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGINEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE8**	**SEMESTER**	**WINTER (1ST)**
COURSE TITLE	QUANTUM CONTROL		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

49. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the difference between coherent and incoherent quantum dynamics
- To understand the probability amplitude approach of describing quantum dynamics
- To understand the density matrix approach for describing quantum dynamics
- To understand the time-evolution operator in quantum mechanics
- To understand resonant quantum tunneling and coherent destruction of tunneling
- To understand the spin ½ quantum dynamics and its control by magnetic fields
- To understand in detail the resonant and near-resonant driven coherent dynamics of a two-level quantum system and excitation by π-pulses
- To understand the quantum Zeno effect
- To understand weak field excitation, time-dependent perturbation theory, Fermi's golden rule, and interference control techniques, e.g., phase control techniques in quantum control
- To understand the adiabatic evolution of quantum systems
- To understand the basic quantum dynamics of three-level quantum systems under near resonant excitation
- To understand rapid adiabatic passage and stimulated Raman adiabatic passage
- To understand the concept of shortcut to adiabaticity
- To understand optimal control of quantum dynamics
- To understand basic features from current research in quantum control

General Skills *Name the desirable general skills upon successful completion of the module*	
Search, analysis and synthesis of data and information, *ICT Use* *Adaptation to new situations* *Decision making* *Autonomous work* *Teamwork* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Project design and management* *Equity and Inclusion* *Respect for the natural environment* *Sustainability* *Demonstration of social, professional and moral responsibility and sensitivity to gender issues* *Critical thinking* *Promoting free, creative and inductive reasoning*
Search, analysis and synthesis of data and information Autonomous work Working in an international environment Critical thinking Adaptation to new situations	

50. COURSE CONTENT

Introduction to quantum control

Summary of basic quantum mechanics needed for the course

Incoherent dynamics and Einstein coefficients versus the probability amplitude approach for describing quantum dynamics

Time-evolution operator and density matrix approach for describing quantum dynamics

Quantum tunneling dynamics and coherent destruction of tunneling

Control of spin dynamics by external magnetic fields

Near-resonant excitation of closed and open two-level quantum systems by electromagnetic fields – π-pulse excitation

Decay and dephasing effects in driven two-level quantum systems and the quantum Zeno effect

Weak field excitation, time-dependent perturbation theory, Fermi's golden rule, and phase control (interference control)

Adiabatic evolution for the control of quantum dynamics and rapid adiabatic passage

Dynamics of three-level quantum systems driven near resonant by electromagnetic fields and Stimulated Raman Adiabatic Passage (STIRAP)

Shortcut to adiabaticity (basic idea and examples)

Optimal control of quantum dynamics (basic idea and examples)

51. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Detailed digital notes Zoom Eclass Simple computer programs for specific examples of control of quantum dynamics

TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	***Activity***	***Workload/semester***
	Lectures	26
	Bibliographical research and study	60
	Assignments during the course	30
	Final assignment and exam	34
	Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving.

52. SUGGESTED BIBLIOGRAPHY

1. B. W. Shore, "Manipulating Quantum Structures using Laser Pulses", Cambridge, 2011
2. D. D'Alessandro, "Introduction to Quantum Control and Dynamics", 2nd edition, CRC Press, 2022
3. M. Shapiro and P. Brumer "Quantum Control of Molecular Processes", 2nd edition, Wiley, 2012
4. S. Cong, "Control of Quantum Systems: Theory and Methods", Wiley, 2014
5. S. A. Rice and M. Zhao, "Optical Control of Molecular Dynamics", Wiley, 2000
6. E. Paspalakis, I. Thanopulos, and D. Stefanatos, "Notes on Quantum Control", 2022-23 (unpublished, available online)

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Emmanuel Paspalakis
Contact details:	Email: paspalak@upatras.gr, Telephone: +30 2610 996318
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(34) Please write YES or NO

(35) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(36) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

53. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE9**	**SEMESTER**	**SPRING (2nd)**
COURSE TITLE	QUANTUM MACHINE LEARNING		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/1031590/

54. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To Understand the basic concepts of machine learning..
- To know the basic algorithms of unsupervised machine learning.
- To know the basic algorithms of supervised machine learning.
- To understand the concepts of pattern recognition, classification and classification margins.
- To know how to apply concepts and tools from quantum computing in the applications and the related algorithms for clustering, pattern classification and pattern recognition.
- By carrying out specialized assignments, the student implements and applies the basic knowledge of the course to selected problems using specialized educational software. At the end of the course the student will have developed the following skills:
- Ability to choose the most appropriate method of solving problems that require the use of quantum machine learning techniques.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,	*Project design and management*
ICT Use	*Equity and Inclusion*
Adaptation to new situations	*Respect for the natural environment*
Decision making	*Sustainabilityget*

Autonomous work *Teamwork* *Working in an international environment* *Working in an interdisciplinary environment* *Production of new research ideas*	*Demonstration of social, professional and moral responsibility and sensitivity to gender issues* *Critical thinking* *Promoting free, creative and inductive reasoning*

Search, analysis and synthesis of data and information
Autonomous work
Working in an international environment
Critical thinking
Adaptation to new situations

55. COURSE CONTENT

Introduction to preliminary machine learning concepts and mathematics - software platforms

Learning theory: Data-Driven Models, Feature Space, Classification, Regression, Supervised and Unsupervised Learning, Generalization Performance, Model Complexity.

Data types and Data preprocessing: Data types and variables, Common dataset issues, Missing data imputation, Categorical Encoding, Discretization, Variable Transformations, Handling Outliers, Scaling.

Data balancing: Oversampling methods, Undersampling methods.

Brief review on quantum mechanics and quantum computations.

Unsupervised Machine Learning techniques: Principal Component Analysis, K-Means and K-Medians Clustering, Hierarchical Clustering, Density-Based Clustering, Determining the number of clusters.

Supervised Learning: K-Nearest Neighbors, Regression Analysis (Linear regression, Nonlinear Regression. Over-fitting and Regularization).

Pattern Recognition and Neural Networks: The Perceptron, Feed-forward Networks, Deep Learning, Issues of Computational Complexity

Supervised Learning and Support Vector Machines: Optimal Margin Classifiers, Soft Margins, Nonlinearity and Kernel Functions, Least-Squares Formulation, Generalization Performance, Multiclass Problems, Issues of Computational Complexity.

Clustering and Quantum Computing: Quantum Random Access Memory, Calculating Dot Products, Quantum Principal Component Analysis,

Quantum K-Means, Quantum K-Medians, Quantum Hierarchical Clustering, Computational Complexity

Quantum Pattern Recognition: The Quantum Perceptron, Quantum Neural Networks, Computational Complexity

Quantum Classification: Nearest Neighbors, Support Vector Machines with Grover's Search, Support Vector Machines with Exponential Speedup, Computational Complexity

56. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.

USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Microsoft Teams platform Eclass Matlab and Python programming environments
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	60
Assignments during the course	30
Preparations for the oral examinations	34
Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving. Oral examinations.

57. SUGGESTED BIBLIOGRAPHY

11. Sergios Theodoridis, Machine Learning - A Bayesian and Optimization Perspective, Academic Press (Elsevier), 2015
12. M. P. Deisenroth, A. A. Faisal, C. S. Ong. Mathematics of Machine Learning, Cambridge University Press, 2020
13. Aaron Hertzmann and David Fleet, Machine Learning and Data Mining Lecture Notes, Computer Science Department, University of Toronto, 2012
14. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014
15. Peter Wittek, Quantum Machine Learning, Academic Press (Elsevier), 2014
16. Santanu Pattanayak, Quantum Machine Learning with Python, Apress, 2021.
17. Maria Schuld, Francesco Petruccione, Machine Learning with Quantum Computers, Springer, 2021.

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Ioannis Boutalis
Contact details:	e-mail: ybout@ee.duth.gr, tel. +30 25410 79504
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and oral examinations.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(37) Please write YES or NO

(38) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(39) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

58. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE10**	**SEMESTER**	**SPRING (2nd)**
COURSE TITLE	NATURAL AND UNCONVENTIONAL COMPUTING		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/1031599/

59. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the basic concepts of nature inspired computing, unconventional computing and other types of computing beyond the classic ones and mostly related with quantum computing.
- To get themselves familiarized with the concepts of future computing, the perspectives but also the advantages delivered that dictate other new types of computing when compared with the ones of today.
- To understand and know the main principles of future and emergent nanoelectronic devices that could support such types of computing, like memristive nanodevices and graphene nanoelectronic circuits.
- To familiarize themselves with material-based computing and to understand its pros and cons.
- To familiarize themselves with chemical computing and to understand its pros and cons.
- To understand the principles of neuromorphic computing, and to design corresponding models, circuits and systems.
- To know and handle with appropriate programming languages and tools, the basic computational nature and bio-inspired tools.
- To know and handle with appropriate programming languages and tools, basic computational tools for unconventional computing like Cellular Automata and Quantum Cellular Automata.

- To combine different types of future and unconventional computation tools in order to find solutions in complex engineering and generic problems.
- To practice with software and hardware tools on the implementation of such computing schemes.

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,	*Project design and management*
ICT Use	*Equity and Inclusion*
Adaptation to new situations	*Respect for the natural environment*
Decision making	*Sustainability*
Autonomous work	*Demonstration of social, professional and moral responsibility and*
Teamwork	*sensitivity to gender issues*
Working in an international environment	*Critical thinking*
Working in an interdisciplinary environment	*Promoting free, creative and inductive reasoning*
Production of new research ideas	

Search, analysis and synthesis of data and information
Autonomous work
Working in an international environment
Critical thinking
Adaptation to new situations

60. COURSE CONTENT

Introduction to future and emergent devices, circuits and systems for natural and unconventional computing.

Short presentation of memristive nanoelectronic devices for the implementation of in-memory computing.

Brief review of examples and applications of memristive circuits for unconventional computing and bio-inspired computing (spintronics computing, wave computing, quantum acceleration computing).

Bio-inspired computing Part I: Amoeba and fungi-based computing: Models, Circuits, Experiments and Programming Tools.

Bio-inspired computing Part II: Neuromorphic Computing: Neuromorphic Computing: Models, Circuits, Experiments and Programming Tools.

Bio-inspired computing Part III: Spiking Neural Networks and Oscillation Networks.

Computational tools for Unconventional Computing: Cellular Automata: Software, Hardware and Programming Tools.

Computational tools for Unconventional Computing: Quantum Cellular Automata: Software, and Programming Tools.

Chemical Computing: Models, Circuits, Experiments and Programming Tools.

In materio computing - The Graphene based computing example: Mathematical Tools, Models, Circuits, Experiments and Programming Tools.

Artificial Life Models: Software and Hardware.

Virtual Labs for the presentation of the aforementioned models (software) and circuits (hardware) for natural and unconventional computing.

61. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Digital slides Microsoft Teams platform Eclass Matlab, C++ and Python programming environments PSpice programming Environment
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	40
Virtual Labs	12
Assignments during the course	40
Preparations for the examinations	32
Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving. Oral examinations.

62. SUGGESTED BIBLIOGRAPHY

1. M. Dragoman, D. Dragoman, “Atomic-Scale Electronics Beyond CMOS”, Springer.
2. R. O. Topaloglu, H.-S. Ph. Wong “Beyond-CMOS Technologies for Next Generation Computer Design”, Springer, 2019.
3. S. Stepney, A. Adamatzky, “Inspired by Nature”, Springer, 2018.
4. W. Zhao, G. Prenat, “Spintronics-based Computing”, Springer 2015.
5. A. Adamatzky, “Collision-based Computing”, Springer 2002.
6. A. Adamatzky, “Reaction-Diffusion, Automata: Phenomenology, Localisations, Computation” Springer 2013.
7. S. Wolfram, “Cellular Automata and Complexity”, CRC Press, 1994.
8. A. Adamatzky, “Computing in Non Linear Media and Automata Collectives”, IoP, 2001.
9. L. O. Chua, G. Ch. Sirakoulis, A. Adamatzky “Handbook of Memristor Networks”, Springer, 2019.

10. I. Vourkas, G. Ch. Sirakoulis, "Memristor Based Nanoelectronic Computing Circuits and Architectures", Springer, 2016.
11. R. A. Mayers, "Unconventional Computing – A Volume in the Encyclopedia of Complexity and Systems Science", 2nd Edition, Springer, 2018.
12. F. Lombardi, "Quantum-Dot Cellular Automata Based Digital Logic Circuits: A Design Perspective", Arthech House Publishers, 2007.
13. S. Stepney, S. Rasmussen, M. Amos, "Computational Matter", Springer, 2018.

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Georgios Sirakoulis
Contact details:	e-mail: gsirak@ee.duth.gr , tel. +30 25410 79547
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and oral examinations.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(40) Please write YES or NO

(41) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(42) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

63. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE11**	**SEMESTER**	**SPRING**
COURSE TITLE	LINEAR ALGEBRA FOR QUANTUM MECHANICS		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/1031597/

64. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To compute eigenvalues and eigenvectors
- To understand vector spaces and subspaces
- To understand linear dependence and independence
- To use inner products and Inner product spaces
- To find best approximation and orthogonal projection
- To apply Gram-Smidt orthonormalization method

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
Autonomous work
Critical thinking
Adaptation to new situations

65. COURSE CONTENT

Eigenvalues and eigenvectors.
Matrix diagonalization.
Jordan canonical form.
Vector spaces and vector subspaces.
Linear dependence and linear independence.
Basis and dimension of a vector space.
Inner products and Inner product spaces.
Best approximation.
Orthogonal projection.
Gram-Smidt orthonormalization.
Linear operators and adjoint operators.
Operators in inner product spaces.
Orthonormal operators.

66. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail.
Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	44
Assignments during the course	40
Final assignment and exam	40
Total	**150**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

The assessment language is English.
Solving written assignments.
Problem solving.
Oral Exam.

67. SUGGESTED BIBLIOGRAPHY

1. K. Hoffman, R. Kunze, Linear Algebra, Prentice-Hall Inc., New Jersey.
2. R. Bellman, Introduction to Matrix Analysis, McGraw-Hill Book Company, New York.

3. R. A. Horn, C. R. Johnson, Matrix Analysis, Cambridge University Press, New York 1991.
4. L. C. Andrews, Elementary Partial Differential Equations with Boundary Value Problems, Academic Press Inc..
5. H. Sagan, Boundary Eigenalue Problems in Mathematical Physics, Dover Publications, Inc..
6. N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill Kogakusha, Ltd..

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Prof. Christos Schinas
Contact details:	Email: cschinas@ee.duth.gr, Telephone: +30 25410 79763
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(43) Please write YES or NO

(44) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(45) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

68. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE12**	**SEMESTER**	**SPRING**
COURSE TITLE	Measurement and Characterization Methods for Devices and Systems		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

69. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the basic measurement protocols and error analysis
- To understand the basic theory of measurement instrumentation
- To understand the measurement concept in quantum mechanics
- To understand the basic cryogenic measurement instrumentation
- To understand the measurement techniques and instrumentation for semiconductor, superconductor, spin-based and optical qubit devices

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
Autonomous work
Critical thinking
Adaptation to new situations

70. COURSE CONTENT

- Measurement theory and error analysis
- Theory of Quantum measurements
- Current vs voltage measurements from cryogenic to high temperatures
- Impedance measurements
- Squid measurements, dc and ac magnetic measurements
- Cryostats and Cryogenic systems
- Electron Paramagnetic Resonance (EPR) measurements

71. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	

TEACHING ORGANIZATION

The ways and methods of teaching are described in detail.
Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.

The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	44
Assignments during the course	40
Final assignment and exam	40
Total	**150**

STUDENT EVALUATION

Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others

Please indicate all relevant information about the course assessment and how students are informed

The assessment language is English.
Solving written assignments.
Problem solving.
Oral Exam.

72. SUGGESTED BIBLIOGRAPHY

- M. A. Nielsen and I. L. Chuang, “Quantum Computation and Quantum Information: 10th Anniversary Edition”, Cambridge University Press, 2011
- Joachim Stoke, Dieter Suter, Quantum Computing, WILEY-VCH GmbH, 2004
- S. Datta, “Quantum Transport”, Cambridge University Press, 2005

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Panagiotis Dimitrakis (Coordinator), Michalis Pissas, Ioannis Sanakis, George Mitrikas
Contact details:	E-mail: p.dimitrakis@inn.demokritos.gr, Telephone: T: +30-210-650-3118
Supervisors: (1)	No
Evaluation methods: (2)	Assignments and Final Exam
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(46) Please write YES or NO

(47) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(48) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

73. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE13**	**SEMESTER**	**SPRING**
COURSE TITLE	Advanced Topics in Quantum Computing and Quantum Technologies		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

74. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand the concept of anyons
- To understand knot theory
- To understand topological quantum computation
- To use Green's functions
- To understand quantum transport
- To compute the conductance of quantum structures

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information
Autonomous work
Critical thinking
Adaptation to new situations

75. COURSE CONTENT

Anyons
Topological quantum computers
Topological quantum bits and quantum gates
Braiding
Surface error correcting codes
Quantum transport
Spin valve
Landauer's formula
Green's functions
The non-equilibrium Green functions method
Nano-conductors
Conductance of nano-conductors

76. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	44
Assignments during the course	40
Final assignment and exam	40
Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Problem solving. Oral Exam.

77. SUGGESTED BIBLIOGRAPHY

78. J. K. Pachos, "Introduction to Topological Quantum Computation", Cambridge University Press, 2012.
79. T. D. Stanescu, "Introduction to Topological Quantum Matter & Quantum Computation", CRC Press, 2020
80. S. Datta, "Quantum Transport", Cambridge University Press, 2005
81. D. G. Duffy, "Green's functions with applications" CRC Press, 2015

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Prof. Ioannis Karafyllidis
Contact details:	Email: ykar@ee.duth.gr, Telephone: +30 25410 79548
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(49) Please write YES or NO

(50) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(51) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

82. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGINEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QE14**	**SEMESTER**	**SPRING (2ND)**
COURSE TITLE	QUANTUM OPTICS		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	2	6
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	None
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	https://eclass.duth.gr/courses/

83. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion of this course, the post-graduate students will be able:

- To understand two-level quantum system dynamics under interaction with a classical electromagnetic field, Rabi oscillations and semi-classical dressed states
- To understand the nonlinear optical response of a two-level quantum system and saturation effects in absorption and dispersion
- To understand nonlinear wave mixing in a two-level quantum system
- To understand coherent population trapping and electromagnetically induced transparency in a three-level quantum system
- To understand the quantization of single mode and multimode electromagnetic fields
- To understand Fock states, coherent states and squeezed states of the electromagnetic field
- To understand quantized light-matter interaction, the Jaynes-Cummings model, and the quantum dressed state picture.
- To understand vacuum Rabi oscillations and collapse and revival.
- To understand the Wigner-Weisskopf theory of spontaneous emission and quantum interference in spontaneous emission.
- To understand resonance fluorescence and the Mollow triplet
- To understand cavity quantum electrodynamics and the behavior of quantum systems in cavities
- To understand basic features from current research in quantum optics

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,	*Project design and management*
ICT Use	*Equity and Inclusion*
Adaptation to new situations	*Respect for the natural environment*
Decision making	*Sustainability*
Autonomous work	*Demonstration of social, professional and moral responsibility and*
Teamwork	*sensitivity to gender issues*
Working in an international environment	*Critical thinking*
Working in an interdisciplinary environment	*Promoting free, creative and inductive reasoning*
Production of new research ideas	

Search, analysis and synthesis of data and information
Autonomous work
Working in an international environment
Critical thinking
Adaptation to new situations

84. COURSE CONTENT

Summary of quantum mechanics issues needed for the course, including the different pictures of quantum mechanics and the quantum properties of the harmonic oscillator

Two-level quantum system dynamics under interaction with a classical electromagnetic field, Rabi oscillations, and semiclassical dressed states

Nonlinear optical response of a two-level quantum system and saturation effects in absorption and dispersion

Nonlinear wave mixing in a two-level quantum system

Coherent population trapping and electromagnetically induced transparency in a three-level quantum system

Quantization of single mode and multimode electromagnetic fields

Fock states and coherent states of the electromagnetic field and their properties

Squeezed states of the electromagnetic field and their properties

Quantized light-matter interaction, the Jaynes-Cummings model, and the quantum dressed-state picture

Interaction of the two-level quantum system with quantized electromagnetic field - quantum Rabi oscillations, vacuum Rabi oscillations, and collapse and revival

Wigner-Weisskopf theory of spontaneous emission and quantum interference effects in spontaneous emission

Resonance fluorescence and the Mollow triplet

Cavity quantum electrodynamics and the behavior of quantum systems in cavities

85. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Live distance learning.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY	Detailed digital notes Eclass

(ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	Zoom Simple computer programs for specific examples of quantum optical effects
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	

Activity	*Workload/semester*
Lectures	26
Bibliographical research and study	60
Assignments during the course	30
Final assignment and exam	34
Total	**150**

STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Solving written assignments. Reports. Problem solving.

86. SUGGESTED BIBLIOGRAPHY

1. P. Meystre and M. Sargent III, "Elements of Quantum Optics", 4th edition, Springer, 2007
2. C. C. Gerry and P. L. Knight, “Introductory Quantum Optics”, Cambridge, 2005
3. G. Grynberg, A. Aspect, and C. Fabre, “Introduction to Quantum Optics”, Cambridge, 2010
4. G. S. Agarwal, “Quantum Optics”, Cambridge, 2013
5. M. S. Zubairy and M. O. Scully, “Quantum Optics”, Cambridge, 1997
6. M. Orszag, “Quantum Optics”, 3rd edition, Springer, 2016
7. S. C. Rand, “Lectures on Light: Nonlinear and Quantum Optics Using the Density Matrix”, 2nd edition, Oxford, 2016
8. R. Loudon, “The Quantum Theory of Light”, 3rd edition, Oxford, 2000

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Emmanuel Paspalakis
Contact details:	Email: paspalak@upatras.gr, Telephone: +30 2610 996318
Supervisors: (1)	No
Evaluation methods: (2)	Students are evaluated via written assignments during the course and a written final assignment.
Implementation Instructions: (3)	The course is given via live distance learning and emergency situations will not affect lectures and student evaluation.

(52) Please write YES or NO

(53) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(54) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.

COURSE OUTLINE

87. GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
DEPARTMENT	ELECTRICAL AND COMPUTER ENGENEERING		
LEVEL OF STUDIES	POST-GRADUATE, LEVEL 7		
COURSE CODE	**QMD**	**SEMESTER**	**3rd**
COURSE TITLE	MSc. Dissertation		

TEACHING ACTIVITIES *If the ECTS Credits are distributed in distinct parts of the course e.g. lectures, labs etc. If the ECTS Credits are awarded to the whole course, then please indicate the teaching hours per week and the corresponding ECTS Credits.*	**TEACHING HOURS PER WEEK**	**ECTS CREDITS**
	-	30
Please, add lines if necessary. Teaching methods and organization of the course are described in section 4.		

COURSE TYPE *Background, General Knowledge, Scientific Area, Skill Development*	SCIENTIFIC AREA
PREREQUISITES:	Successful examination or at least four (4) courses
TEACHING & EXAMINATION LANGUAGE:	English
COURSE OFFERED TO ERASMUS STUDENTS:	No
COURSE URL:	

88. LEARNING OUTCOMES

Learning Outcomes

Please describe the learning outcomes of the course: Knowledge, skills and abilities acquired after the successful completion of the course.

After the successful completion the MSc. Dissertation, the post-graduate students will be able:

- Use quantum simulators
- Program quantum computers
- Develop novel quantum algorithms
- Understand and use quantum communication technologies
- Apply quantum computers to machine learning
- Design qubit devices and quantum circuits
- Understand and use quantum key distribution protocols

General Skills

Name the desirable general skills upon successful completion of the module

Search, analysis and synthesis of data and information,
ICT Use
Adaptation to new situations
Decision making
Autonomous work
Teamwork
Working in an international environment
Working in an interdisciplinary environment
Production of new research ideas
Project design and management
Equity and Inclusion
Respect for the natural environment
Sustainability
Demonstration of social, professional and moral responsibility and sensitivity to gender issues
Critical thinking
Promoting free, creative and inductive reasoning

Search, analysis and synthesis of data and information

Autonomous work
Critical thinking
Adaptation to new situations
Project design and management
Promoting free, creative and inductive reasoning
Promoting free, creative and inductive reasoning

89. COURSE CONTENT

The content of the MSc. Dissertation will be relevant to the MSc. Courses and will be structured by the supervisors in collaboration with the post-graduate students.

90. LEARNING & TEACHING METHODS - EVALUATION

TEACHING METHOD *Face to face, Distance learning, etc.*	Bi-weekly communication of the post-graduate students with their supervisors.
USE OF INFORMATION & COMMUNICATIONS TECHNOLOGY (ICT) *Use of ICT in Teaching, in Laboratory Education, in Communication with students*	
TEACHING ORGANIZATION *The ways and methods of teaching are described in detail.* *Lectures, Seminars, Laboratory Exercise, Field Exercise, Bibliographic research & analysis, Tutoring, Internship (Placement), Clinical Exercise, Art Workshop, Interactive learning, Study visits, Study / creation, project, creation, project. Etc.* *The supervised and unsupervised workload per activity is indicated here, so that total workload per semester complies to ECTS standards.*	
STUDENT EVALUATION *Description of the evaluation process* *Assessment Language, Assessment Methods, Formative or Concluding, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Essay / Report, Oral Exam, Presentation in audience, Laboratory Report, Clinical examination of a patient, Artistic interpretation, Other/Others* *Please indicate all relevant information about the course assessment and how students are informed*	The assessment language is English. Oral Exam. Written Assignment, Essay / Report, Presentation in audience

Activity	*Workload/semester*
Bibliographical research and state of the art	70
Study	80
Research work	500
Writing of the MSc. Dissertation	80
Preparation for the public presentation of the MSc. Dissertation	20
Total	**750**

91. SUGGESTED BIBLIOGRAPHY

The supervisors will suggest bibliography for each MSc. Dissertation

ANNEX OF THE COURSE OUTLINE

Alternative ways of examining a course in emergency situations

Teacher (full name):	Instructors
Contact details:	
Supervisors: (1)	Yes
Evaluation methods: (2)	Students are evaluated via public oral presentation of their MSc. Dissertation, which in case of emergency will be done using the Microsoft Teams or Zoom platforms.
Implementation Instructions: (3)	The supervisors and the post-graduate students will communicate bi-weekly using the Microsoft Teams or Zoom platforms.

(55) Please write YES or NO

(56) Note down the evaluation methods used by the teacher, e.g.

- *written assignment* or/and exercises
- written or oral examination with distance learning methods, provided that the integrity and reliability of the examination are ensured.

(57) In the **Implementation Instructions** section, the teacher notes down clear instructions to the students:

a) in case of **written assignment and / or exercises:** the deadline (e.g. the last week of the semester), the means of submission, the grading system, the grade percentage of the assignment in the final grade and any other necessary information.

b) in case of **oral examination with distance learning methods:** the instructions for conducting the examination (e.g. in groups of X people), the way of administration of the questions to be answered, the distance learning platforms to be used, the technical means for the implementation of the examination (microphone, camera, word processor, internet connection, communication platform), the hyperlinks for the examination, the duration of the exam, the grading system, the percentage of the oral exam in the final grade, the ways in which the inviolability and reliability of the exam are ensured and any other necessary information.

c) in case of **written examination with distance learning methods**: the way of administration of the questions to be answered, the way of submitting the answers, the duration of the exam, the grading system, the percentage of the written exam of the exam in the final grade, the ways in which the integrity and reliability of the exam are ensured and any other necessary information.

There should be an attached list with the Student Registration Numbers only of students eligible to participate in the examination.