Course Outline

1) General

SCHOOL	SCIENCE		
DEPARTMENT	CHEMISTRY		
DEGREE	MASTER		
COURSE CODE	**18B6**	**SEMESTER**	**2**
COURSE TITLE	Photochemistry and Photocatalysis. Applications in Energy and Environmental Protection.		

INDEPENDENT TEACHING ACTIVITIES in the case that the credits are awarded to separate parts of the course e.g. Lectures, Laboratory Exercises, etc. If the credits are awarded uniformly for the entire course, enter the weekly teaching hours and total credits	**TEACHING HOURS PER WEEK**	**CREDITS**
Laboratory training	3	7
Add lines if necessary. The teaching organization and methods used are described in detail in (d).		

COURSE TYPE *general background, special background, general knowledge specialization, skill development*	SPECIAL BACKGROUND, GENERAL KNOWLEDGE SPECIALIZATION.
PREREQUISITE COURSES:	Courses from 1st semester
COURSE AND EXAM LANGUAGE:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS ?	IF NEEDED YES
COURSE WEBSITE (URL)	**https://eclass.uoa.gr/courses/CHEM270/**

(1) LEARNING OUTCOMES

LEARNING OUTCOMES

The learning outcomes, specific knowledge, skills and abilities of an appropriate level that the students will acquire after the successful completion of the course are described.

Consult Appendix A

• Description of the Level of Learning Outcomes for each course of study according to the Qualifications Framework of the European Higher Education Area

• Descriptive Indicators for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B

• Comprehensive Guide to writing Learning Outcomes

The aim of the course is to impart knowledge about a wide range of fundamental principles of photochemistry and photocatalysis and their applications in modern technology.

The expected learning outcomes are:

(i) reinforcement of knowledge and their development methodology through lectures, (ii) practice by analyzing examples of photosynthesis, photocatalysis and expected applications interactively (iii) study of modern literature with an emphasis on both photochemistry/photocatalysis and their application.

Upon successful completion of the course, the student is expected to be able to:

- Understand the fundamental laws of photochemistry
- Understand and explain the formation of excited states of complex compounds, the role of metal ions and substituents.
- Understand and explain the structure of an excited molecule and therefore the driving force of photochemical reactions.
- Choose appropriate oxidation states of metal ions as well as metal ions depending on the desired application
- Understand and explain the difference between fluorescence and phosphorescence and their consequences in a chemical reaction.
- Understand the conversion of solar energy into chemical energy.
- Design the experimental procedure for studying the kinetics of a photochemical reaction.
- Understand the mechanisms of electron transfer in a photochemical reaction.
- Understand and explain the role of photocatalysis in energy storage and transport.
- Understand and explain the role of photochemistry and photocatalysis in the synthesis of compounds with high added value.
- Design systems for photodynamic treatments.
- Design systems to protect the environment.
- Search the appropriate literature both for the analysis and for the explanation of phenomena he/she observes.

Knowledge

1. Knowledge and understanding of the effect of light with matter.
2. Knowledge and understanding of excited state structure and energy
3. Knowledge and understanding of triplet state energy transfer.
4. Knowledge and understanding of the action of radicals formed by radiation
5. Knowledge and understanding of the application of photochemistry in Energy (Energy conversion and storage, photovoltaics, Hydrogen)
6. Knowledge and understanding of the application of photochemistry in Medicine (photodynamic treatments)
7. Knowledge and understanding of the application of photochemistry in environmental protection: (photochemical purification and antipollution of water. Photodegradable Materials)

Skills

1. Skill in complex/nanoparticle design with applications in photochemistry and photocatalysis

2. Skill in the organization of appropriate synthetic methods for the regulation of photocatalyst characteristics
3. Skill in the processing of results and analysis of various techniques in order to study the mechanisms of photocatalytic/photochemical reactions.
4. Skill in the selection and organization of appropriate spectroscopic experiments to study the applications of photochemical/photocatalytic reactions.

General Skills

Taking into account the general skills that the graduate must have acquired (as stated in the Diploma Appendix and listed below) which of the following is/are the course aimed at?.

Reearch, analysis and synthesis of data and information, using the necessary technologies	*Project planning and management*
Adaptation to new situations	*Respect for diversity and multiculturalism*
Decision making	*Respect for the environment*
Independent work	*Demonstrating social, professional and ethical responsibility and sensitivity to gender issues*
Teamwork	*Exercise criticism and self-criticism*
Working in an international environment	*Promotion of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Other…….*
Generating new research ideas	

The general skills that the student should have acquired and that the course is aimed at are:

- Search, analyze and synthesize data and information, using the necessary instruments and techniques.
- Autonomous work.
- Group work.
- Work in an international environment.
- Work in an interdisciplinary environment.
- Promotion of free, creative and inductive thinking.
- Decision making.

(2) COURSE CONTENT

This course deals with:

- Fundamental laws of photochemistry. Electronic transitions of polyatomic molecules.
- Beer-Lambert law, selection rules and spectrum intensity.
- Franck-Condon principle.
- Jablonski diagram. Fluorescence - Phosphorescence.
- De-excitation processes (Vibrational relaxation, Intersystem crossing and internal conversion,
- Dissociation/Predissociation),
- Dexter and Foerster mechanisms. lifetime of excited states)
- Stern-Volmer diagram. Electron and energy transfer, short and long distance mechanisms.
- Triple state awareness.
- Chemical reactivity of excited states, acidity, potentials
- redox, character of molecular orbitals, etc.
- Photocatalysis and its basic principles.
- Modern experimental methods of studying dynamic processes of photochemical reactions
- Applications:
  - in the synthesis of materials of high added value.
  - In Energy (photosystem I and II, semiconductors, photovoltaics, photosensitization, hydrogen production.)
  - in medicine: (photodynamic therapy, antimicrobial and anticancer drugs).
  - In the protection of the environment (photochemical cleaning and anti-pollution of water. Photodegradable Materials)

(3) TEACHING AND LEARNING METHODS – EVALUATION

<table>
<tr><td>LECTURES' DELIVERY
In person, distance, etc..</td><td>• In person (lectures)
• Synchronous distance Learning (guided study)</td></tr>
<tr><td>USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGIES
Use of I.C. T. in Lectures, Laboratory Exercises, Communication with students</td><td>In Teaching:
• Presentations with multimedia content (power point, e-class)
• Collaboration/ lectures via Webex platform
In Communication with students:
• Support the learning process through the e-class electronic platform (announcements, information, messages, documents, user groups, etc.).
• Email.</td></tr>
<tr><td>TEACHING ORGANIZATION
The teaching style and methods are described in detail.
Lectures, Seminars, Laboratory Exercises, Field Exercises, Literature Study & Analysis, Tutorial, Internship (Placement), Clinical Exercises, Art Workshop, Interactive Teaching, Educational Visits, Study Preparation (Project), PaperWriting Assignments, Artistic Creation, etc. etc.

The student's study hours for each learning activity as well as unguided study hours according to ECTS principles are listed</td><td>
<table>
<tr><th>Activity</th><th>Semester workload</th></tr>
<tr><td>Lectures</td><td>65</td></tr>
<tr><td>Guided study correlated to the project</td><td>36</td></tr>
<tr><td>Unguided study</td><td>40</td></tr>
<tr><td>Study of Literature, writing and presentation of the project</td><td>99</td></tr>
<tr><td>Study preparation</td><td>20</td></tr>
<tr><td>total</td><td>250</td></tr>
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<tr><td>STUDENT EVALUATION
Description of the evaluation process

Assessment Language, Assessment Methods, Formative or Deductive, Multiple Choice Test, Short Answer Questions, Essay Development Questions, Problem Solving, Written Assignment, Report / Report, Oral Examination, Public Presentation, Laboratory Work, Clinical Patient Examination, Artistic Interpretation, Other / Others

Explicitly defined evaluation criteria are mentioned, and if and where they are accessible by students.</td><td>The evaluation of the course takes place in Greek and includes:
• written exam that includes
• multiple choice questions,
• short development of theoretical issues
• judgment
• as well as problem solving.
• Evaluation of the project (writing and oral presentation)

<u>•Course grade calculation</u>:
60% exam grade and 40% project grade

Access to their writing exam after grading</td></tr>
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(4) RECOMMENDED BIBLIOGRAPHY

- Atkins, P. W., Physical Chemistry, any edition.
- Wayne, C. E., and Wayne R. P., Photochemistry, Primer 39, 1996.
- Wayne, R. P., Principles and Applications of Photochemistry, 2nd ed., 1988.
- Gilbert, A., and Baggott, J., Essentials of Molecular Photochemistry, Blackwell, 1991. •
- Albani, J. R., Principles and Applications of Fluorescence Spectroscopy, Blackwell, 2007.
- • 6. Turro, N. J., Modern Molecular Photochemistry, University Science Books,1991.
- Suppan, P., Chemistry and Light, RSC, 1994. • 8. Lakowicz, J. R., Principles of Fluorescence Spectroscopy, 2nd ed., Springer, 1 999.

- Montalti, M., Credi, A., Prodi, L.,Gandolfi, M. T., Handbook of Photochemistry, Taylor & Francis, 2006
- Evans R.C., Douglas P., Burrows, H.D., Applied Photochemistry, Springer, 2013