CYA Syllabus

PHYS 377|ARCH 377 Unveiling the Past: Particle Physics in Heritage Science

Fall 2024

Course Instructor: Dr. George Polymeris

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Class Times (days, hours):

(Office) Hours Available:

Course Description

Social science is a group of academic disciplines that examine human behavior. It incorporates all branches of academic study that deal with human behavior, both present and past. The study of such aspects in the past includes topics such as archaeology, geoarchaeolgy, cultural heritage, and conservation of art objects. Archaeometry is a compound word (from the ancient Greek words *archaeos*- meaning ancient, and, *-metron*, denoting unit or measurement) that etymologically defines the interdisciplinary application of scientific techniques to the study of all aforementioned aspects of human behavior in the past. Such techniques are primarily based on fundamental principles and phenomena of physics. Nevertheless, the early 20th century is of particular significance, as it is associated with the development of nuclear and solid-state physics. The course describes the numerus applications of elementary particles, accelerators, and radiation physics in general to the study of heritage objects and historic/prehistoric events, such as age assessment, characterization, environmental reconstruction, and palaeo-archaeo-thermometry. As Greece bridges not only three continents, but also a variety of cultures and civilizations, it holds significant importance in reconstructions of early European prehistory. The proximity of the region to Africa and West Asia, whether by sea or land, makes it a Palaeolithic "land of promise." Therefore, special emphasis will be placed on applications within the Eastern part of the Mediterranean Sea.

Learning Objectives

This course will primarily teach students to:

- Identify which techniques can be used for geo-archaeological studies, depending on the questions that scientists deal with.
- Explain how radiation could be applied to Cultural Heritage and Environmental Reconstruction.
- Suggest integrated approaches based on the individual features of the various geo-archaeological projects.
- Evaluate the significance of studying Cultural Heritage and Environmental Reconstruction in our everyday lives.
- Recognize which techniques utilize radioactivity for peaceful applications.

Course Requirements

After the end of each session, the corresponding course material will be distributed to students in either PowerPoint or PDF file formats. This material is more than sufficient for students to excel in both midterm and final exams. There is no required/mandatory bibliography.

- Class contribution – Class contribution includes physical and mental presence in the classroom, punctual attendance, preparation, active participation in class discussions, and occasional posts on the Moodle forum. Class contribution is one of the most important factors in determining your grade for the semester. Students are expected to arrive prepared, engage in discussions, ask questions, and express their opinions during class. If feeling extremely uncomfortable speaking in front of a large group, thoughts or reflections may be submitted in writing via email. However, if neither participation in class nor submission of thoughts via email occurs, contribution grade will be low.

- Assignment – Presentation – Group projects based on literature will be conducted, and results will be disseminated through presentations. Topics and instructions will be provided in advance. Each presentation should consist of 10-15 slides and last no longer than 10 minutes.

- Mid-term Exam – After the conclusion of each session or a series of related sessions, indicative homework quizzes will be distributed to the students, who are expected to review the solutions and discuss their answers with the instructor. Questions from these quizzes (or similar) will be used for both midterm and final exams. Quizzes and exams will be administered in multiple-choice format.

- Final Exam – Oral, in groups.

Details about assignments and exams will be provided in advance. No late assignments or make-up exams will be accepted unless discussed with me in advance. If unable to attend class, please inform me beforehand by sending an email.

Evaluation and Grading

Your grade for this course will be based on the following distribution:

Percentages

Class contribution – 15%

Assignment – Presentation – 30%

Mid-term exam – 25%

Final exam – 30%

Regulations and Accommodations

Attendance Policy

CYA regards attendance in class and on-site (in Athens or during field study trips) as essential, so attendance at all scheduled meetings is required. All absences are recorded and have consequences that may affect your grade. Illness or other such compelling reasons which result in absences should be reported immediately at the Report Medical Issue form (https:/forms.gle/DpYx6iATVgZpkJpj8).

Academic Accommodations

Students are required to submit an official letter from the office at their school that handles academic accommodations (generally the Office of Disability Services), or to have that office send a letter. Students who have submitted such a letter to CYA should also talk to their professors individually to discuss how these accommodations will work in each specific course.

Site Visits and Accessibility

This course will be conducted at the premises of the National Center for Scientific Research "Demokritos".

Policy on Original Work

Plagiarism is literary theft. As such, it is a serious offense, which will not be tolerated, whether at students' home institution or at CYA. Plagiarism on an examination or in a paper will result in an F grade for the course. Students must cite the author of any and all ideas that are not common knowledge or their own. If in doubt, it is safest to cite the source. Submissions should be original and reflect the students' own ideas and thoughts. If students are unsure about what counts as original work, they are advised to consult with

their professor and refer to the Student Handbook.

Use of Laptops

In-class use of laptops and other devices is permitted, though not obligatory. Note-taking is not required. After the end of each session, the corresponding course material will be provided to students in either PowerPoint or PDF file formats. Privileges for laptops or other devices will be revoked if they are not used for class-related activities. The use of a laptop is compulsory for specific sessions, such as session 8 (Radiocarbon dating in laboratory), session 14 (Luminescence Theory 3) and sessions 17 and 21 (Statistical analysis of dating results 1 & 2).

Upgrade to 400-level Course

Courses can be upgraded to a 400-level. This typically requires an additional 25% of work on the part of the student. The option to upgrade becomes available during the second week of classes. If you are interested in this option, please talk to your professor.

Class Schedule

Class Day	Day/Date/Place (if applicable)	Topic / Readings / Assignments Due
	Sept 5 – 7	**Field Study: Delphi and Ancient Olympia**
1	Mon Sept 9	**Ionizing Radiation, X-rays and radioactive decay; basic mathematical and physical background – *Theory***
2	Wed Sept 11	**The concepts of time, age, age span and period/epoch/eons in various scientific fields – *Theory***
3	Mon Sept 16	**Indirect dating techniques in geology, archaeology and cosmology – *Theory***
	Sept 18 – 21	**Field Study: Crete**
4	Mon Sept 23	**Introduction to direct dating techniques. Radiometric Dating techniques and basic features – *Theory***
5	Wed Sept 25	**Human Evolution and the need for direct dating techniques – *Theory***
6	Mon Sept 30	**Dendrochronology and lichenometry – *Theory***
7	Wed Oct 2	**Radiocarbon dating technique 1** Basic principles, measurements, Rezervoir of C14 and age calculation – ***Theory***
8	Mon Oct 7	**Radiocarbon dating in laboratory – *Lab***
9	Wed Oct 9	**Radiocarbon dating technique 2** Applications of the technique in the Mediterranean, contribution of the technique to archaeology – ***Theory***
10	Mon Oct 14	**Stimulated luminescence dating technique 1** Basic principles, measurements, the concept of environmental radiation, age calculation – ***Theory***

11	Wed Oct 16	**Stimulated luminescence dating technique 2** Dosimetry of ionizing radiation, application of dosimetry to age assessment and other applications to health and Cultural Heritage – ***Theory***
12	**Mon Oct 21**	**Midterm Week**
13	**Wed Oct 23**	**Midterm Week**
	Oct 25 – Nov 3	**Fall Break**
14	Mon Nov 4	**Stimulated luminescence dating technique 3** Applications of archaeology, geology and geography – ***Theory***
15	Wed Nov 6	**Uranium-Thorium Dating technique; concept, theory and applications within Greece and Mediterranean – *Theory***
16	Mon Nov 11	**Potassium-Argon Dating technique; concept, theory and applications – *Theory***
	Nov 12 – 15	**Field Study: Peloponnese**
17	Mon Nov 18	**Statistical analysis of dating results 1; Bayesian Statistics, Simulation; Artificial Intelligence in dating; Associated software – *Lab***
18	Wed Nov 20	**X-rays and their applications – *Theory***
19	Mon Nov 25	**Accelerator physics and their applications to Cultural Heritage and Environmental Studies – *Theory***
20	Wed Nov 27	**Visit to the accelerator lab of NCSR "Demokritos"**
	Nov 28 – Dec 1	**Thanksgiving Break**
21	Mon Dec 2	**Statistical analysis of dating results 2; Bayesian Statistics, Simulation; Artificial Intelligence in dating; Associated software – *Lab***
22	Wed Dec 4	**Palaeothermometry, thermochronometry and applications – *Theory***
23	Mon Dec 9	**Thermal and optical characterization techniques – *Theory***
24	Wed Dec 11	**Cultural Heritage and Environmental fingerprint – *Theory***
	Mon Dec 16	**Final Exam Week**
	Wed Dec 18	**Final Exam Week**

N.B.: The course schedule, in terms of subjects and readings, may be subject to change to benefit student learning and to keep up to date with current research.

Schedule at a glance

Day #	Date	Session	Venue
	Sep 5-7	**Field Study**	**Delphi and Ancient Olympia**

Day #	Date	Session	Venue
1	Sep 9	Elementary features of ionizing radiation	NCSR "Demokritos"
2	Sep 11	The concept of time and age	NCSR "Demokritos"
3	Sep 16	Indirect dating techniques	NCSR "Demokritos"
	Sep 18 – 21	**Field Study**	**Crete**
4	Sep 23	Radiometric dating techniques	NCSR "Demokritos"
5	Sep 25	Human evolution and need for dating	NCSR "Demokritos"
6	Sep 30	Dendrochronology and lichenometry	NCSR "Demokritos"
7	Oct 2	Radiocarbon Theory 1	NCSR "Demokritos"
8	Oct 7	Radiocarbon Laboratory	NCSR "Demokritos"
9	Oct 9	Radiocarbon Theory 2	NCSR "Demokritos"
10	Oct 14	Luminescence Theory 1	NCSR "Demokritos"
11	Oct 16	Luminescence Theory 2	NCSR "Demokritos"
12	**Oct 21**	**Midterm Week**	NCSR "Demokritos"
13	**Oct 23**	**Midterm Week**	NCSR "Demokritos"
	Oct 25 – Nov 3	**Fall Break**	
14	Nov 4	Luminescence Theory 3	NCSR "Demokritos"
15	Nov 6	Uranium-Thorium; concept, theory and applications	NCSR "Demokritos"
16	Nov 11	Potassium-Argon; concept, theory and applications	NCSR "Demokritos"
	Nov 12 - 15	**Field Study**	**Peloponnese**
17	Nov 18	Computational analysis in age determination	NCSR "Demokritos"
18	Nov 20	X-rays and their applications	NCSR "Demokritos"
19	Nov 25	Accelerator physics in Cultural Heritage	NCSR "Demokritos"
20	Nov 27	Visit to the accelerator lab	
	Nov 28 – Dec 1	**Thanksgiving Break**	
21	Dec 2	Obsidian in Cultural Heritage	NCSR "Demokritos"
22	Dec 4	Palaeothermometry & thermochronometry	NCSR "Demokritos"
23	Dec 9	Thermal and optical characterization of materials	NCSR "Demokritos"
24	Dec 11	Cultural Heritage and Environmental fingerprint	NCSR "Demokritos"
	Dec 16	**Final Exam Week**	
	Dec 18	**Final Exam Week**	

Course Bibliography

Required

Lecture materials (PowerPoint slides or PDFs).

Recommended

[1] Aitken, Martin J. Science-based Dating in Archaeology. Addison Wesley Longman Limited, 1997.

[2] Walker, Mike. Quaternary Dating Methods. John Wiley & Sons, 2013.