AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Introduction to synchrotron radiation and its applications

Academic year: 2017/2018 Code: JFT-2-064-s ECTS credits: 3

Faculty of: Physics and Applied Computer Science

Field of study: Technical Physics Specialty: —

Study level: Second-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 0

Course homepage: —

Responsible teacher: dr inż. Tabiś Wojciech (wtabis@agh.edu.pl)

Academic teachers: dr inż. Tabiś Wojciech (wtabis@agh.edu.pl)

Module summary

The course will provide the students with a knowledge on the generation of the synchrotron radiation, X-ray instrumentation, and its application in the condensed matter physics.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence			
M_K001	Student develops the ability to working in a team in gathering the literature, and proposing a specific experiment to be performed at a synchrotron X-ray source as well as processing of experimental data and their interpretation.	FT2A_K04, FT2A_K03, FT2A_K03	Project, Activity during classes, Involvement in teamwork, Participation in a discussion
Skills			
M_U001	Student is familiar with the X-ray diffraction, X-ray absorption and resonant X-ray scattering techniques, also under extreme conditions.	FT2A_U03, FT2A_U03, FT2A_U01, FT2A_U01	Presentation, Activity during classes

M_U002	Student is capable of selecting an appropriate experimental technique for solving a specific problem in the condensed matter physics.	FT2A_U02, FT2A_U06, FT2A_U07, FT2A_U07, FT2A_U03, FT2A_U14, FT2A_U02, FT2A_U03, FT2A_U01, FT2A_U01, FT2A_U06	Project
M_U003	Student knows the processes of generation of the x-ray radiation, its monochromatization, and properties of the X-ray radiation generated by various sources.	FT2A_U02, FT2A_U03, FT2A_U02, FT2A_U03	Activity during classes, Participation in a discussion
Knowledge			
M_W001	Student acquires knowledge of the experiments performed in extreme conditions	FT2A_W06, FT2A_W01, FT2A_W08, FT2A_W06, FT2A_W01	Activity during classes, Participation in a discussion, Presentation
M_W002	Student acquires the general knowledge of the generation and properties of the X-ray radiation from the X-ray tube, synchrotron and the X-ray free electron laser. Student becomes familiar with the X-ray instrumentation and detection of radiation.	FT2A_W06, FT2A_W05, FT2A_W05, FT2A_W06	Activity during classes, Participation in a discussion
M_W003	Student is introduced to the process of obtaining access to the synchrotron facilities for performing a proposed experiment.	FT2A_W11, FT2A_W12	Project, Activity during classes, Involvement in teamwork
M_W004	Student acquires knowledge of the experimental techniques using X-ray interaction with matter.	FT2A_W03, FT2A_W03, FT2A_W08	Activity during classes, Participation in a discussion, Presentation

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Others	E-learning
Social competence												

M_K001	Student develops the ability to working in a team in gathering the literature, and proposing a specific experiment to be performed at a synchrotron X-ray source as well as processing of experimental data and their interpretation.	-	-	-	+	-	-	-	-	-	-	-
Skills												
M_U001	Student is familiar with the X-ray diffraction, X-ray absorption and resonant X-ray scattering techniques, also under extreme conditions.	+	-	-	+	-	-	-	-	-	-	-
M_U002	Student is capable of selecting an appropriate experimental technique for solving a specific problem in the condensed matter physics.	+	-	-	+	-	-	-	-	-	-	-
M_U003	Student knows the processes of generation of the x-ray radiation, its monochromatization, and properties of the X-ray radiation generated by various sources.	+	-	-	-	-	-	-	-	-	-	-
Knowledge												
M_W001	Student acquires knowledge of the experiments performed in extreme conditions	+	-	-	+	-	-	-	-	-	-	-
M_W002	Student acquires the general knowledge of the generation and properties of the X-ray radiation from the X-ray tube, synchrotron and the X-ray free electron laser. Student becomes familiar with the X-ray instrumentation and detection of radiation.	+	-	-	-	-	-	-	-	-	-	-
M_W003	Student is introduced to the process of obtaining access to the synchrotron facilities for performing a proposed experiment.	-	-	-	+	-	-	-	-	-	-	-
M_W004	Student acquires knowledge of the experimental techniques using X-ray interaction with matter.	+	-	-	+	-	-	-	-	-	-	-

Module content

Lectures

1.Physical properties of the X-ray radiation. Generation of the X-rays; X-ray tube, synchrotron radiation. X-ray radiation by a relativistic electron. Synchrotron

instrumentation; accelerator, bending magnet, wiggler, undulator, mirror, monochromator. 3h
2.Detection of the X-rays; point detector, area detector. Acquisition systems at synchrotrons. 2h
3.X-ray absorption spectroscopy techniques in condensed matter physics. 2h
4.X-ray diffraction and resonant X-ray diffraction techniques. 2h
5.Inelastic X-ray scattering techniques and their application in the studies of the phonons and magnetic excitations. 2h
6.X-ray experiments performed in extreme condition; pulsed magnetic field, diamond anvil cell, high-temperature setups used at synchrotrons. 2h
7.X-ray free electron laser; coherence of the radiation, self-amplified stimulated-emission process. Experimental techniques based on coherent X-ray scattering. Ultrafast X-ray scattering. 2h

Project classes

1.General information. 1h
2.Presentation of the results, published in the literature, obtained by X-ray synchrotron techniques on various subjects in the condensed matter physics. 10h
3.Preparation of a proposal for an X-ray experiment based on the templates form the European synchrotron facilities. 4h

Method of calculating the final grade

The final grade will include the grade from the presentation of a selected scientific article (40%), writing a proposal for a scientific experiment at a synchrotron in a team effort (40%) and the participation in the discussion during the classes.

Prerequisites and additional requirements

Basic knowledge of physics.

Recommended literature and teaching resources

http://www.lightsources.org

Scientific publications of module course instructors related to the topic of the module

According to the WoS.

Additional information

In case of absence, student should contact the teacher to obtain the information about the material discussed during the missed classes. Within the following week, student should solve and present the problems discussed during the class.

Student workload (ECTS credits balance)

Student activity form	Student workload
Participation in lectures	15 h
Participation in project classes	15 h
Realization of independently performed tasks	15 h
Contact hours	15 h
Completion of a project	15 h
Summary student workload	75 h
Module ECTS credits	3 ECTS