Syllabus Semester 3 University of Szeged

ERASMUS MUNDUS JOINT MASTER DEGREE LASCALA

CONTENT

Year 2 – Semester 3
University of Szeged, Hungary

COURSE SYLLABUS LASCALA master

Course Title: Weekly practice work at the ELI facility
Course Semester: 3rd
Country: Hungary
Number of ECTS: 10

Aims:
To provide hands-on experience for students az the ELI ALPS large scale facility

Content (including lab trainings, projects, industry visits, etc.):
Optical coating technologies
Vacuum technologies
Nanofabriaction tools
Command control schemes for large scale facilities
Radiation safety protocols at a high intensity laser institute
Radiobiological studies
Experiments with a high average power laser
Applications of attosecond pulses
THz spectroscopy
Condensed matter physics experiment

Prerequisites:

Recommended Books:

Teaching Staff:
Árpád Mohácsi PhD, Judit Budai PhD, Lajos Fülöp PhD, Tamara Kecskés PhD, Tünde Tőkés PhD, Ádám Börzsönyi PhD, Balázs Major PhD, József Fülöp PhD, László Óvári PhD

Grading System in % (homework, oral presentation, lab training, mid-term exam, final exam, etc.)
100 % lab training

Hours: (Lecture / Tutorial / Practical courses)
10 laboratory practice (4 hours each)

COURSE SYLLABUS LASCALA master

Course Title: Selected topics in femto- and attosecond pulse phenomena
Course Semester: 3rd
Country: Hungary
Number of ECTS: 4

Aims:

To deepen the understanding of the students via advanced numerical modelling in the field of ultrashort light pulses

Content (including lab trainings, projects, industry visits, etc.):

1. Introduction to short light pulses. Spectral and temporal description. Chirp and GDD of ultrashort pulses.
2. Gaussian beam propagation (monochromatic beams, ultrashort pulses); truncated Gaussian beams.
3. Modelling the high-order harmonic generation process: a) classical model, b) Lewenstein model, c) saddlepoint approximation
4. Harmonic- and attochirp in HHG.
5. A short introduction to nonlinear optics. Phasematching in 2nd harmonic generation.
6. Macroscopic aspects of HHG (phasematching, absorption).
7. Compression of ultrashort pulses

Prerequisites:

Recommended Books:

Diels-Rudolph: Ultrashort laser pulse phenomena
Chang: Fundamentals of attosecond optics

Teaching Staff:

Katalin Varjú PhD, Balázs Major PhD

Grading System in % (homework, oral presentation, lab training, mid-term exam, final exam, etc.)

100 % advanced homework

Hours: (Lecture / Tutorial / Practical courses)

6 lectures (1,5 hours) + 6 tutorial (1,5 hours)

COURSE SYLLABUS LASCALA master

Course Title: Femtosecond optics with Python
Course Semester: 3rd
Country: Hungary
Number of ECTS: 3

Aims:

To provide students with an understanding how the Python programming language with its modules can be used for modelling

- temporal distortions of ultrashort laser pulses caused by propagation through dispersive optical elements,
- temporal pulse stretching and compression.

Content (including lab trainings, projects, industry visits, etc.):

Fundamentals of Python programming, Scientific computing with NumPy and SciPy, Plotting with Matplotlib, Temporal shape of transform limited laser pulses, Effects of the phase derivatives on the temporal shape of the pulses, Propagation of ultrashort laser pulses through dispersive optical elements, Simulation of pulse stretching and compression.

Prerequisites:

Recommended Books:

[1] P. Wentworth, J. Elkner, A. B. Downey and Ch. Meyers: How to Think Like a Computer Scientist, Learning with Python 3 (2012)
http://openbookproject.net/thinkcs/python/english3e/

[2] H. Fangohr: Introduction to Python for Computational Science and Engineering (University of Southampton, 2016)
https://fangohr.github.io/teaching/python/book.html

[3] J-C. Diels, W. Rudolph: Ultrashort Laser Pulse Phenomena (Academic Press, 2006)

Teaching Staff:

Attila P. Kovács

Grading System in % (homework, oral presentation, lab training, mid-term exam, final exam, etc.)

40 % homework, 20% mid-term exam, 40% final exam

Hours: (Lecture / Tutorial / Practical courses)

1 hr/week lecture, 1 hr/week practical

COURSE SYLLABUS LASCALA master

Course Title: Fundamentals of femtosecond and nonlinear optics
Course Semester: 3rd
Country: Hungary
Number of ECTS: 3

Aims:
This module will provide a general overview about how the temporal-spatial shape, intensity and spectrum of ultrashort laser pulses change when they go through linear and nonlinear media.

Content (including lab trainings, projects, industry visits, etc.):
Propagation of ultrashort laser pulses in dispersive media, Dispersion properties of optical elements, Amplification of ultrashort laser pulses, Focusing of ultrashort laser pulses, Basics of nonlinear optics, Frequency conversion of laser pulses, Material and angular dispersion measurements of optical elements, Amplitude and phase reconstruction of ultrashort laser pulses

Prerequisites:

Recommended Books:
[1] J-C. Diels, W. Rudolph: Ultrashort Laser Pulse Phenomena (Academic Press, 2006)

Teaching Staff:
Attila P. Kovács, Z. Horváth, K. Osvay

Grading System in % (homework, oral presentation, lab training, mid-term exam, final exam, etc.)
50% mid-term exam, 50% final exam

Hours: (Lecture / Tutorial / Practical courses)
2 hr/week lecture

Course Title: Theory and detection of gravitational waves by laser interferometric instruments
Course Semester: 3rd
Country: Hungary
Number of ECTS: 5

Aims:
This module will provide a general overview about the formation of gravitational waves and their detection.

Content (including lab trainings, projects, industry visits, etc.):
Gravitational waves on flat background. Helicity and polarisations. Electromagnetic analogy. Gravitational waves in strong gravity regimes: the geometrical optics approximation. Sources of gravitational waves. Spinning compact binary dynamics. Indirect detection by Hulse-Taylor pulsar. Earth-based laser-interferometric gravitational wave detectors: LIGO, Virgo, Kagra. Space-born instruments: LISA Pathfinder, LISA. Prospective detection from pulsar timing and from B-mode polarisation of the Cosmic Microwave Background.

Prerequisites:

Recommended Books:
[1] M. Maggiore, Gravitational Waves: Volume 1: Theory and Experiments, Oxford University Press, 2007

[2] H. Grote, Gravitational Waves, A History of Discovery, Taylor & Francis, 2019

[3] C. M. Will, N. Yunes, Is Einstein still right?, Oxford University Press, 2020

Teaching Staff:
L. Á. Gergely

Grading System in % (homework, oral presentation, lab training, mid-term exam, final exam, etc.)
100% final exam

Hours: (Lecture / Tutorial / Practical courses)
2 hr/week lecture

COURSE SYLLABUS LASCALA master

Course Title: Scalar diffraction theory and its applications
Course Semester: 3rd
Country: Hungary
Number of ECTS: 5

Aims:

This module will provide a general overview about the foundation of scalar diffraction theory and some important applications.

Content (including lab trainings, projects, industry visits, etc.):

The Huygens-Fresnel principle, Scalar diffraction integrals, Fresnel and Fraunhofer diffraction. Example of Fraunhofer diffraction patterns, Examples of Fresnel diffraction, Fresnel diffraction at a circular aperture. Evaluation of the integrals with the Lommel functions, Fresnel diffraction at a circular aperture, structure of the diffraction patterns. Imaging properties of thin lenses, Fourier transform properties of thin lenses. The diffraction theory of aberrations, aberration function. Tolerance conditions for primary aberrations. Diffraction patterns of primary aberrations. Focusing of femtosecond pulses.

Prerequisites:

Electrodynamics, Linear algebra, Mathematical analysis

Recommended Books:

[1] M. Born and E. Wolf, Principles of Optics, Pergamon Press, 1989

[2] M. V. Klein and T. E. Furtak, Optics, John Wiley & Sons, 1986

[3] E. Hecht, Optics, Addison Wesley Publishing Company, 1997

[4] J. W. Goodman, Introduction to Fourier Optics, McGraw-Hill Book Company, 1968

Teaching Staff:

Z. Horváth

Grading System in % (homework, oral presentation, lab training, mid-term exam, final exam, etc.)

50% mid-term exam, 50% final exam

Hours: (Lecture / Tutorial / Practical courses)

2 hr/week lecture

CONTACTS

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