School of Physics

Course Outline 2020

PHYS3114

Electrodynamics

School of Physics

Faculty of Science

T3, 2020

1. Staff

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor	Oleg Tretiakov	o.tretiakov@unsw.edu.au	Consultation times: by arrangement via email	(02) 9385 6103
Lecturer	Peter Reece	p.reece@unsw.edu.au	Consultation times: by arrangement via email	(02) 9385 4998
Teaching Support Officer	Zofia Krawczyk-Bernotas	z.krawczyk-bernotas@unsw.edu.au	School of Physics office G06, Old Main Building	(02) 9385 5969
Laboratory Manager	Tamara Reztsova	t.reztsova@unsw.edu.au		(02) 9385 4577

2. Course information

Prerequisites: (PHYS2114 or PHYS2210) and PHYS2113

Teaching times and locations: online

2.1 Course summary

Classical electrodynamics is important from both the fundamental and applied viewpoints. This course aims to provide students with an introduction to the principles and behaviours of dynamical electric and magnetic systems, and a theoretical foundation in classical field theory. The course will begin with the application of electromagnetic theory to study optical phenomena, before moving on to more formal topics. It will finish with an introduction to relativistic electrodynamics and its covariant formulation, paving the way for a quantum field theory of electrodynamics (QED). Topics to be covered include: Scalar diffraction theory. Image formation and Fourier Optics, Coherence. Electromagnetic fields in dispersive media. Scattering. Maxwell's equations potential formulation. Gauge transformation. Poynting's theorem, conservation laws. Green's function solution of static problems. Inhomogeneous wave equation and Green's function solution. Dipole radiation. Emission of radiation from accelerating and decelerating charges. Relativistic electrodynamics. Covariant formulation.

Graduate Attributes Developed in this Course:

- Research, inquiry and analytical thinking abilities
- Capability and motivation for intellectual development
- Ethical, social and professional understanding
- Communication in a scientific/technical context
- Collaborative and management skills

- Information literacy

2.3 Course learning outcomes (CLO)

By the end of this course, you will be able to:

• Apply electromagnetic theory to problems in optical physics.
• Use Maxwell's equations in classical and covariand form to analyse static and simple time-dependent systems of charge and current distributions.
• Apply Maxwell's equations and advanced mathematical techniques (Green's functions) to describe the behaviour of electromagnetic waves for a number of important geometric arrangements.
• Demonstrate the practical implications of electromagnetic theory in experiments.

2.4 Relationship between course and program learning outcomes and assessments

The course learning outcomes are assessed in the 4 assessment tasks. These assessments are largely of a critical-thinking nature designed to determine students' ability to deploy acquired knowledge to new situations, which is a key graduate attribute for successful university graduates.

3. Strategies and approaches to learning

3.1 Learning and teaching activities

Assumed Knowledge
Prerequisites: (PHYS2114 or PHYS2210) and PHYS2113

Timetable

Lectures: 1 x 2hr, 2 x 1hr per week (Week 1-5, 7-10)
Tutorials: 1hr per week (Weeks 1-5, 7-10)
Laboratory: 2x 4hr labs

Lecture Timetable

Day Time Location
Monday (w1-3, 5, 7-11) 09:00-11:00 Online
Thursday (w1-5, 7-10) 15:00-16:00 Online
Friday (w1-5, 7-10) 10:00-11:00 Online

Lecture Information
This course is taught by two lecturers teaching 18 hours each.

Tutorial:
Thursday (w1-5, 7-10) 16:00-17:00 Physics Theatre
Friday (w1-5, 7-10) 17:00-18:00 Physics Theatre

Laboratory
Wednesday 9:00-13:00 Online
Wednesday 14:00-18:00 Online
Thursday 09:00-13:00 Online

3.2 Expectations of students

We believe that effective learning is best supported by a climate of enquiry, in which students are actively engaged in the learning process. To ensure effective learning, students should participate in class. Effective learning is achieved when students attend all classes, have prepared effectively for classes by reading through previous lecture notes, in the case of lectures, and, in the case of tutorials or laboratories, have made a serious attempt at doing the problems or pre-work themselves prior to the class. Furthermore, lectures should be viewed by the student as an opportunity to learn, rather than just copy down lecture notes. Effective learning is achieved when students have a genuine interest in the subject and make a serious effort to master the basic material.

Academic misconduct will not be tolerated in any form in this course. Substantiated instances of cheating, plagiarism or copying answers may result in a failure grade or significant deduction of marks. Please https://student.unsw.edu.au/plagiarism if you are in any way unsure of what constitutes plagiarism. Assignments in this class are to be done independently.

4. Course schedule and structure

Detailed Syllabus

Topic 1: Review of Optics and Scalar Diffraction: Fraunhofer Diffraction, Huygens-Fresnel theory; Introduction to 1D Fourier Transforms and the Convolution Theorem. Far-field diffraction problems involving slits and gratings.

Topic 2: Introduction to Geometric Optics; Phase response of a lens; 2D Fourier Transforms, Hankel Transforms; Abbe’s Theory of Image Formation; Imaging systems and limits of resolution. Spatial Filtering, Image Processing and Enhancement as applied to Fourier theory and Abbe’s theory.

Topic 3: Introduction to Coherence covers basic concepts in optical coherence. Classical Coherence Theory and the van Cittert-Zernike Theorem. Coherence from extended sources.

Topic 4: Public holiday; Wave propagation in vacuum and in simple media; Wave packet in a dispersive medium; Causality and analyticity of $\chi(\omega)$, dispersion relations; Midsession exam.

Topic 5: Review of Maxwell equations, Poynting's theorem, Conservation of energy and momentum, Conservation of angular momentum. Scattering of electromagnetic waves, Scattering matrix and Stokes parameters, Optical theorem, Mie Scattering, Thomson scattering, Rayleigh scattering. Review of Special Relativity, Lorentz transformation, Review of 4-formalism.

Topic 6: Green's function solution to static problems, Inhomogeneous wave equations, Green's function solution, Retarded waves, potentials and fields.

Topic 7: Fields of a time-dependent electric dipole: exact solution; Radiation, detachment, Larmor's formula, Dipole antenna, Cartesian multipole radiation (electric and magnetic dipole), Fields from moving charges.

Topic 8: Liénard-Wiechert potentials, Synchrotron radiation, Radiation reaction, Cherenkov radiation, Bremsstrahlung, Thomas precession, Topic 9: Covariant formulation of electrodynamics: Lorentz force, field tensor; Covariant Maxwell's equations, gauge transformations, Covariant conservation laws, Lagrangian description for a closed system of non-relativistic point particles.

Topic 10: Action principle, Euler-Lagrange equation, Covariant formulation, invariance and conservation laws, Noether's theorem.

5. Assessment

5.1 Assessment tasks

Assessment
Course assessment comprises assignments, in-session test, laboratory and final examination.

Assessment task	Length	Weight	Mark	Due date *(normally midnight on due date)*
Mid-term Test	50 mins	15%		Friday 9th October (Week 4)
Assignment		15%		Friday 20th November (Week 10)
Laboratory		10%		See note below
Final Exam	2 hours	60%		See exam schedule (TBA)

Laboratory Information

2 labs for a total of 8 hours of lab in the term (2 x 4 hours) + laboratory report(s), marked in lab in the week following the experiment. The laboratory component of the course will be held in the Physics Laboratory, Room 142, Old Main Building. For details about lab days, times and class codes, see http://timetable.unsw.edu.au/2019/PHYS3114.html or contact Laboratory Staff or Student Advisor.

Further information

UNSW grading system: student.unsw.edu.au/grades

UNSW assessment policy: student.unsw.edu.au/assessment5.2

Assessment criteria and standards

Please see Moodle for a marking rubric for each assessment task.

5.3 Submission of assessment tasks

Assignment Submissions
Unless otherwise specified, assignments should be submitted online by 5pm on the due date.

A downloadable assignment cover sheet is available from
https://www.physics.unsw.edu.au/current-students/cover-sheet

Marks will be deducted for late assignments, at a rate of 5% of the maximum possible mark for the assignment per day. A weekend will count as two days. An assignment submitted after the solutions have been posted will automatically receive 0%.

5.4. Feedback on assessment

Please see Moodle for details on how feedback will be provided for each assessment task

6. Academic integrity, referencing and plagiarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.

Further information about referencing styles can be located at student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits**:** honesty, trust, fairness, respect, responsibility and courage.[1] At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and **plagiarism** can be located at:

- The *Current Students* site student.unsw.edu.au/plagiarism*,* and
- The *ELISE* training site subjectguides.library.unsw.edu.au/elise

The *Conduct and Integrity Unit* provides further resources to assist you to understand your conduct obligations as a student: student.unsw.edu.au/conduct.

7. Readings and resources

Prescribed Text:
A. Zangwill, *Modern Electrodynamics*

Recommended:
D. J .Griffiths, *Introduction to Electrodynamics*
J. D. Jackson, *Classical Electrodynamics*
W. Greiner, *Classical Electrodynamics*
E. Hecht, *Optics*
J. Goodman, *Fourier Optics*

Other Resources
Lecture notes will be posted on Moodle

[1] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.

8. Administrative matters

Communications

Students should check their UNSW email account regularly as all official university communication will be sent to that address. Students should use their university email account when writing to UNSW staff and should always include their name and student number.

Health and Safety

The School of Physics is actively committed to the health, safety and welfare of its staff and students. Information on relevant UNSW Occupational Health and Safety policies and expectations is available at: www.ohs.unsw.edu.au and https://www.physics.unsw.edu.au/about/safety

Recommended Internet Sites

The School of Physics website is www.physics.unsw.edu.au. Under the "Current Students" link students will find information about degrees, courses, and assessment.

The University website my.unsw.edu.au provides links to the UNSW Handbook, Timetables, Calendars and other student information.

Student Complaint Procedures

UNSW has procedures for dealing with complaints. These aim to solve grievances as quickly and as close to the source as possible. Information is available here: student.unsw.edu.au/complaints. Staff who can assist include:

School Contacts:

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9. Additional support for students

- The *Current Students* Gateway: student.unsw.edu.au
- Academic Skills and Support: student.unsw.edu.au/skills
- Student Wellbeing, Health and Safety: student.unsw.edu.au/wellbeing
- Disability Support Services: student.unsw.edu.au/disability
- UNSW IT Service Centre: www.it.unsw.edu.au/students