PHYS3160

Optical Physics

Session 2, Special circumstance, North Ryde 2020

Department of Physics and Astronomy

Contents

Notice

As part of Phase 3 of our return to campus plan, most units will now run tutorials, seminars and ot her small group learning activities on campus for the second half-year, while keeping an online ver sion available for those students unable to return or those who choose to continue their studies onli ne.

To check the availability of face-to-face and onlin e activities for your unit, please go to timetable vi ewer. To check detailed information on unit asses sments visit your unit's iLearn space or consult yo ur unit convenor.

General Information

Unit convenor and teaching staff
Convenor/Lecturer
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Credit points
10

Prerequisites
PHYS301 or PHYS3010

Corequisites

Co-badged status
Phys799 MRes Shell Unit

Unit description
Optics touches on many branches of physics and technology in the world today. The theme of this unit is physical optics, understanding how interference and diffraction determine how light propagates and interacts with optical systems. Interference underpins practical devices such as the Fabry-Perot interferometer, and multilayer dielectric filters; diffraction is critical for analysing beam propagation and image formation. The mode theory of light propagation in free space and optical waveguides is developed and applied to lasers, nonlinear frequency conversion, and fibre optics. Key optical methods are studied in the regular laboratory program together with advanced data analysis techniques and report writing providing a strong foundation for future research project work.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

ULO1: Analyse and interpret recent examples of applied optics research.

ULO2: Apply theoretical concepts underpinning central topics in optics to common scenarios in experimental optics.

ULO3: Communicate effectively on topics in contemporary optics to an audience.

ULO4: Demonstrate a sophisticated level of experimental skill including understanding advanced experimental methods, carrying out measurements with appropriate analysis and the preparation of detailed reports.

General Assessment Information

This unit has hurdle requirements, specifying a minimum standard that must be attained. To pass this unit you must obtain a mark of at least 50% in the unit overall, as well as a 40% hurdle requirement in the final examination, lab reports and lab logbook.

Assignments

Due: **various** Weighting: **15%**

There will be 6 assignments with equal weight, three from each part of the course. Assignments will be issued on Wednesday of Wks 1, 3, 5, 7, 9, 11, and will be due 12 days (Mon 5pm) later.

We encourage students to use feedback from Assignment 1 and/or within tutorials to discuss any issues relating to continuation beyond the Census Date.

Extension Requests

Given the importance placed on assignments as a key aid to learning, we aim to return your

assignments, marked and with feedback within 1-2 weeks of their due date. This will allow us to provide you feedback in time to aid your ongoing learning through the course. Extensions will only be considered if requested with valid reasons prior to the due date. Work submitted after the due date without an approved extension will accrue a penalty of 10% per additional day for the first week. Work submitted more than one week late will be marked at the lecturer's discretion.

Laboratory Reports

Due: **various** Weighting: **20% This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)**

Students must complete 4 experiments and submit two full reports and associated drafts together with their log book and calculations for the other two experiments. Submission of the 2 reports, and a logbook with a record of 4 experiments completed, and the associated calculations and analysis for the two experiments not the subject of a formal report, is mandatory.

Reports

- You should refer to the document "Recommendations for Laboratory Report Writing" when preparing reports.
- A draft report or report can only be submitted once a satisfactory sign off on your laboratory book record of the experiment has been obtained.
- Draft reports are optional but they represent an important opportunity to improve your report writing by gaining feedback during the writing stage. They will not be formally assessed. They will be returned to you annotated with suggestions for improvement which you should act on in your final report submitted for assessment.
- Any report submitted after a draft phase must submit the original draft with the report.
- Draft reports will be returned no later than one week after submission. Reports for assessment will be returned no later than two weeks after submission.
- Photocopies of all relevant pages for the experiment from your log-book should be submitted with your draft and/or report.
- Submissions should be to Dr Gina Dunford in the third year laboratory by the due date.

Submission Dates

1. Draft first report – 1pm Wed, Week 5
2. First report – 1pm Wed, Week 7
3. Draft second report – 1pm Wed, Week 10
4. Second report – 1pm Wed, Week 12

Assessment of full reports will be graded according to its conformity to the report Recommendations (see above). The marking scheme will have separate components for Abstract/Conclusions, Introduction, Experiment Description (Methods), Results, Analysis and

Discussion, and Overall Presentation.

Satisfactory completion of the laboratory assessment is a hurdle task. You must achieve at least 40% in each of the two assessed tasks to pass the unit. If you fail to reach this mark, you must arrange to retake that assessment item, after discussion with the marker.

Laboratory Logbook

Due: **Mon 5pm Wk 13** Weighting: **10% This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)**

Logbooks with the record of experimental data are to be kept and submitted by the above due date. The marking criteria are readability, layout, completeness and clarity.

Your submitted laboratory logbook is to include the write-up of all four experiments with graphs, analysis and calculations. The logbook should not have the formal background and polished presentation of a formal report. It should contain all recorded data and your analysis of measurements, as well as your conclusions. It should provide sufficient information for a reader to assess the validity of your experimental procedure and conclusions.

Presentation

Due: **Week 10** Weighting: **5% This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)**

In Week 10, students will provide a short presentation based on one of their laboratory experiments. This will be held in the usual laboratory times-slot. Presentations should aim to:

1. Describe the physics principles that underpin the experiment;
2. What findings were achieved;
3. How these principles have been applied or adapted in recent research.

Students may work alone or in pairs and will have seven minutes per student for the presentation. Assessment will be based on the clarity and effectiveness of presentation, your explanation of the essential physics in your chosen area, and your discussion of why this area is significant.

You may use aids such as PowerPoint or overhead transparencies but this is not required. Some of the most effective presentations use nothing more than the whiteboard. We are more interested in seeing how you can be creative and effective in your communication, than the degree to which you have mastered fancy software tricks. The presentation will be assessed according to the three areas of Scientific Accuracy, Content and Depth, and Style (with equal weighting). Further details on requirements and the assessment will be provided during the semester.

Final Exam

Due: **End of Unit** Weighting: **50% This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)**

The examination consists of thirteen questions worth 4 marks each and six questions worth 8

marks each. All questions are to be answered. The exam questions will test knowledge across the material provided in the lectures and assignments only.

The final examination is a hurdle requirement. You must obtain a mark of at least 40% in the final exam to be eligible to pass the unit. If your mark in the final examination is between 30% and 39% inclusive, you will be given a second and final chance to attain the required level of performance. The mark awarded for the second exam towards your final unit mark will be capped at 40%.

If you receive special consideration for the final exam, a supplementary exam will be scheduled after results are released. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to submitting an application. Approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination. Second chance exams for hurdle assessments will also be scheduled in this period.

Assessment Tasks

Name	Weighting	Hurdle	Due
Lab reports	30%	Yes	Various
Final exam	50%	Yes	End of Unit
Presentation	5%	Yes	Week 10
Problem sets	15%	No	Various

Lab reports

Assessment Type [1]: Lab report
Indicative Time on Task [2]: 20 hours
Due: **Various**
Weighting: **30%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Reports on your laboratory experiments.

On successful completion you will be able to:

- Analyse and interpret recent examples of applied optics research.
- Apply theoretical concepts underpinning central topics in optics to common scenarios in

experimental optics.
- Demonstrate a sophisticated level of experimental skill including understanding advanced experimental methods, carrying out measurements with appropriate analysis and the preparation of detailed reports.

Final exam

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **End of Unit**
Weighting: **50%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

A written examination in the University Examination period.

On successful completion you will be able to:
- Analyse and interpret recent examples of applied optics research.
- Apply theoretical concepts underpinning central topics in optics to common scenarios in experimental optics.

Presentation

Assessment Type [1]: Presentation
Indicative Time on Task [2]: 10 hours
Due: **Week 10**
Weighting: **5%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

A researched oral presentation.

On successful completion you will be able to:
- Communicate effectively on topics in contemporary optics to an audience.

Problem sets

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 24 hours

Due: **Various**
Weighting: **15%**

Six written assignments on problem solving and exploring concepts in optics.

On successful completion you will be able to:

- Analyse and interpret recent examples of applied optics research.
- Apply theoretical concepts underpinning central topics in optics to common scenarios in experimental optics.

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[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

Lecture notes are posted on iLearn.

Textbook

Introduction to Optics (3rd Edition) by FL Pedrotti and LS Pedrotti (Prentice-Hall, 2007)

Recommended Reading

- Optics by E Hecht (Addison-Wesley)
- Optical Physics (3rd Edition) by SG Lipson and H Lipson and DS Tannhauser (Cambridge University Press)
- The Fabry-Perot Interferometer by JM Vaughan (Adam Hilger)
- Interferometry by WH Steel (Cambridge University Press)
- Optical Holography by P Hariharan (Cambridge University Press)
- Optical Waves in Crystals by A Yariv and P Yeh (Wiley)

Teaching Strategy

This unit is taught through lectures and tutorials and through undertaking laboratory experiments. Lectures aim to provide an interactive and effective learning experience. Questions during and outside lectures are strongly encouraged in this unit – please do not be afraid to ask as it is likely

that your classmates will also want to know the answer. You are strongly encouraged to read the relevant sections of the iLearn notes and/or textbook before lectures and to discuss the content with classmates and lecturers.

This unit includes a compulsory experimental component. The experiments are stand-alone investigations and may include topics not covered by the lecture content of this course – They are an important part of the learning for this unit and the skills learned are essential for a well-rounded physics graduate.

You should aim to spend 3 hours per week working on the assignments. You may wish to discuss your assignment problems with other students and the lecturers, but you are required to hand in your own work (see the note on plagiarism below). Assignments are provided as one of the key learning activities for this unit, they are not there just for assessment. It is by applying knowledge learned from lectures and textbooks to solve problems that you are best able to test and develop your skills and understanding of the material.

Unit Schedule

Part I: EM propagation through complex media

- Electromagnetic waves in media
- Fresnel reflection coefficients
- Multi-layer optical coatings
- Gaussian beams
- Descriptions of polarisation states and control
- Anisotropic media
- Non-linear optics

Part II: Coherent optics and interference

- Interference
- Fabry-Perot interferometer
- Fourier theory
- Diffraction theory
- Fourier optics
- Fraunhofer (far-field) diffraction
- Fresnel (near-field) diffraction
- Near field optics
- Spatial coherence
- Temporal coherence
- Holography

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

W.H."Beattie" Steel PRIZE

As a result of a generous donation to the University, the W H “Beattie” Steel Prize for Optical Physics may be awarded to the strongest student in the unit. We expect the value of the prize to be in the vicinity of $400.

Beattie Steel gained the highest French doctorate for his work on Fourier Transform methods at L’Institut d’Optique in Paris. He was President of the International Commission of Optics, author of “Interferometry” and a winner of the Mees Medal, given by the Optical Society of America. He

led Optics research at CSIRO, Lindfield for 30 years and he continued this as an Honorary Professor at Macquarie University.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to help you improve your marks and take control of your study.

- Getting help with your assignment
- Workshops
- StudyWise
- Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Laboratory

Required work

You must attend the scheduled laboratory session each week from Week 1 to Week 12. Access to the laboratory at other times will not normally be possible due to staffing constraints. You are urged to finish one experiment at a time, aiming to take no more than three laboratory sessions.

Students must complete 4 experiments and submit two full reports and associated drafts

together with their laboratory logbook and calculations for the other two experiments. Submission of the 2 reports, and a logbook with a record of 4 experiments completed, and the associated calculations and analysis for the two experiments not the subject of a formal report, is mandatory. **The logbook in the laboratory class must be updated at each attendance**. Students writing experimental results onto loose sheets of paper will have these confiscated in the laboratory. Data etc. collected in electronic formats must be reproduced in hardcopy in the logbook. This original record is the logbook that must be submitted for assessment.

We expect to mark and return laboratory reports submitted on time, within two weeks at most.

Available Experiments

- Correlation Interferometer
- Diffraction and Image Formation
- Fabry-Perot Interferometer
- Photon Counting
- Polarised Light and Berry Phase
- Photon Counting
- Tunable diode laser
- Optical Tweezers
- Heterodyning/Laser doppler velocimetry

Safety

A condition of entry to the laboratory is a thorough knowledge of the safety requirements in the laboratory, given in the document entitled "Health and Safety Guidelines in the 300 Level Physics Laboratory". Students will be issued with the document in week 2 and will complete a short written quiz to demonstrate their understanding of safety requirements observed during all laboratory sessions. The safety aspects of the laboratory can also be found on posters in the laboratory.

General notes

- The laboratory sessions start in the **first** week of the semester.
- You must sign in and out using the Attendance Book (your name, date and experiment, legibly).
- Students should make a booking for three laboratory afternoons for each experiment they undertake. A booking gives priority provided the students arrive punctually at the start of the laboratory session.
- Logbooks with the record of experimental data are to be kept. These will be assessed with criteria for readability, layout, completeness and clarity. A student must gain a satisfactory sign-off in their experimental log-book before any draft or report submission can be made.