PHYS7906

Advanced Photonics

Session 2, In person-scheduled-weekday, North Ryde 2025

School of Mathematical and Physical Sciences

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General Information

Unit convenor and teaching staff
Rich Mildren
rich.mildren@mq.edu.au

Judith Dawes
judith.dawes@mq.edu.au

Credit points
10

Prerequisites
Admission to GradDipResFSE or GradCertResFSE

Corequisites

Co-badged status

Unit description
The photonics revolution, sparked by the invention of the laser and low-loss optical fibres, has profoundly impacted society. Alongside silicon electronics, it is the core technology enabling the Internet, yet its role is invisible to most users. This unit offers a theoretical survey of key physics and technologies in modern photonics and optical science. Topics may be adjusted to fit the cohort's interests but typically cover ray and wave treatments of light, propagation in single and multi-mode optical fibres, waveguide dispersion, nonlinear optics, optical materials, devices like lasers and detectors, laser processing, nano-photonics, microscopy, and molecular spectroscopy. While emphasising the rigorous theory (mainly based on Maxwell's electromagnetism, with elements of quantum physics), we focus on the technology drivers and real-world implications. The unit includes a substantial experimental component to develop photonics lab skills and familiarity with optical devices used in research.

Learning in this unit enhances student understanding of global challenges identified by the United Nations Sustainable Development Goals (UNSDGs) Industry, Innovation and Infrastructure

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: demonstrate a comprehensive knowledge of optical materials and their use in linear optics.
ULO2: discuss a range of research principles and methods in photonics.
ULO3: describe the principles and methods for advanced photonics topics such as laser structuring of materials and applications.
ULO4: explain the origin of optical nonlinearities and be able to manipulate and interpret the mathematical descriptions of nonlinear phenomena.
ULO5: apply advanced optical techniques and concepts in a photonics laboratory environment, including planning and execution of experiments, performing appropriate quantitative analysis and reflection to provide a sophisticated scientific response to one or more physics questions, and the preparation of written or other reports to communicate these results.

Assessment Tasks

Name	Weighting	Hurdle	Due	Groupwork/Individual	Short Extension	AI Approach
Lab report	25%	No	week 9		No	
Assignment	25%	No	Week 12		No	
Final exam	50%	No	Final examination period		No	

Lab report

Assessment Type [1]: Lab report
Indicative Time on Task [2]: 12 hours
Due: **week 9**
Weighting: **25%**
Groupwork/Individual:
Short extension [3]: No
AI Approach:

Report of the planning, execution and analysis of a laboratory-based photonics investigation.

On successful completion you will be able to:

- demonstrate a comprehensive knowledge of optical materials and their use in linear optics.

- discuss a range of research principles and methods in photonics.
- describe the principles and methods for advanced photonics topics such as laser structuring of materials and applications.
- explain the origin of optical nonlinearities and be able to manipulate and interpret the mathematical descriptions of nonlinear phenomena.
- apply advanced optical techniques and concepts in a photonics laboratory environment, including planning and execution of experiments, performing appropriate quantitative analysis and reflection to provide a sophisticated scientific response to one or more physics questions, and the preparation of written or other reports to communicate these results.

Assignment

Assessment Type [1]: Problem set
Indicative Time on Task [2]: 24 hours
Due: **Week 12**
Weighting: **25%**
Groupwork/Individual:
Short extension [3]: No
AI Approach:

Problem based assignment.

On successful completion you will be able to:

- demonstrate a comprehensive knowledge of optical materials and their use in linear optics.
- discuss a range of research principles and methods in photonics.
- describe the principles and methods for advanced photonics topics such as laser structuring of materials and applications.
- explain the origin of optical nonlinearities and be able to manipulate and interpret the mathematical descriptions of nonlinear phenomena.

Final exam

Assessment Type [1]: Examination
Indicative Time on Task [2]: 20 hours
Due: **Final examination period**
Weighting: **50%**
Groupwork/Individual:

Short extension [3]: No
AI Approach:

Exam in the University Examination period, covering the entire content of the unit.

On successful completion you will be able to:

- demonstrate a comprehensive knowledge of optical materials and their use in linear optics.
- discuss a range of research principles and methods in photonics.
- describe the principles and methods for advanced photonics topics such as laser structuring of materials and applications.
- explain the origin of optical nonlinearities and be able to manipulate and interpret the mathematical descriptions of nonlinear phenomena.

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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
- Academic Success 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.

[3] An automatic short extension is available for some assessments. Apply through the Service Connect Portal.

Delivery and Resources

We will take a survey approach, selecting topics from the following list: Properties of light ◦ Atomic transitions ◦ Laser theory and rate equations ◦ Optical resonators ◦ Q-switching and mode-locking ◦ Theory of ray optics and Gaussian beams ◦ Maxwell's equations and the wave equation ◦ Optical waveguides and propagation ◦ Anisotropic media ◦ Introduction to nonlinear optics ◦ Optical communications ◦ Molecular spectroscopy ◦ Laser spectroscopy ◦ Frequency combs **Delivery** With a small class, we will adopt a mix of discussion-style workshops and lab sessions, and home reading.

Tutorial problems will be assigned regularly and discussed in class. Solutions to additional assigned problems will be due in week 12.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policie

s.mq.edu.au). 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
- Assessment Procedure
- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

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

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.edu.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/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 connect.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

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

Academic Success

Academic Success provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the 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

Macquarie University offers a range of Student Support Services including:

- IT Support
- Accessibility and disability support with study
- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues
- Student Advocacy provides independent advice on MQ policies, procedures, and processes

Student Enquiries

Got a question? Ask us via the Service Connect Portal, or contact Service Connect.

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.

Changes from Previous Offering

Assessments were adjusted from 2024 to streamline delivery, with 3 assessments required.

Unit information based on version 2025.04 of the Handbook