PHTN322

Optical and Photonic Devices and Systems 2

S2 Day 2014

Physics and Astronomy

Contents

General Information

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Credit points 3
Prerequisites (OPTO221(P) or PHTN221(P)) and (OPTO300(P) or OPTO321(P) or PHTN321(P))
Corequisites
Co-badged status
Unit description Optical systems range from nanotechnology-based devices to compact integrated optical components built up with waveguides, to larger systems for biophotonics, optical data storage, metrology, microscopy, machine vision and imaging. In this unit, the design and operation of such systems is reviewed, including engineering aspects such as fabrication; signal-to-noise ratio; opto-mechanical design and packaging; thermal management; and control software. The laboratory component of the unit includes a team project incorporating system design and assembly.

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:

An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.

The ability to evaluate specifications of source devices, components and systems from a broad range of commercial optoelectronic technologies.

An understanding of key design issues in optoelectronic systems, including safety, mechanical constraints, packaging and the requirements of different applications.

An understanding of the principles of operation of a range of optoelectronic devices and instruments, and familiarity with the use of same in the laboratory.

The ability to write clear, concise and relevant technical reports incorporating and analysing data from measurements, as well as concepts and information from a range of sources including books, articles, product literature or web sites.

An understanding of the requirements of oral presentation on technical topics, and experience in both presenting and assessing such talks by peers.

Assessment Tasks

Name	Weighting	Due
Assignment	15%	Week 3, 6, 9, 12
Examination	50%	University exam period
Laboratory	20%	Weeks 2-7 and 9-11
Technology Profile and Seminar	15%	22nd October

Assignment

Due: **Week 3, 6, 9, 12**
Weighting: **15%**

Four, approximately, fortnightly assignments will be set and a record of achievement maintained. This will count for 15% of the assessment.

Given the importance we place on assignments, as a key aid to learning, we expect assignments to be submitted on time. In turn, we undertake to return your assignments (provided they were submitted on time), marked and with feedback within two 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.

On successful completion you will be able to:

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
- The ability to write clear, concise and relevant technical reports incorporating and analysing data from measurements, as well as concepts and information from a range of sources including books, articles, product literature or web sites.
- An understanding of the requirements of oral presentation on technical topics, and experience in both presenting and assessing such talks by peers.

Examination

Due: **University exam period**
Weighting: **50%**

The examination will be in two parts, A and B, and will be of three hours duration. Part A questions will refer to the first half of the unit, predominantly about optical imaging systems, biophotonics and machine vision. Part B questions will refer to the second half of the unit, predominantly about optical communications, photonics technology and optical metrology.

On successful completion you will be able to:

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.

Laboratory

Due: **Weeks 2-7 and 9-11**
Weighting: **20%**

Students will complete two 2-day as well as five 1-day laboratory experiments.

The first two experiments will be done over two weeks (weeks 2 and 3 and weeks 4 and 5, respectively) and a laboratory report will need to be submitted after completion of each of those two experiments (2 reports in total).

Another five (smaller-scale) experiments will be done in weeks 6, 7, 9, 10 and 11. Those are individual experiments that all can be completed in a single day. A seperate report will have to be submitted for each individual experiment (5 reports in total).

All laboratory reports (7 in total) will make up 20% of the total assessment.

On successful completion you will be able to:

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
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- An understanding of key design issues in optoelectronic systems, including safety, mechanical constraints, packaging and the requirements of different applications.
- An understanding of the principles of operation of a range of optoelectronic devices and instruments, and familiarity with the use of same in the laboratory.
- The ability to write clear, concise and relevant technical reports incorporating and analysing data from measurements, as well as concepts and information from a range of sources including books, articles, product literature or web sites.
- An understanding of the requirements of oral presentation on technical topics, and experience in both presenting and assessing such talks by peers.

Technology Profile and Seminar

Due: **22nd October**
Weighting: **15%**

A technology profile on a photonics device or system is due on Wednesday 22nd October. Each member of the class will present a 20 minute talk either as part of a team presentation or as an individual presentation from their technology profile during scheduled laboratory or lecture time. The technology profile and seminar make up 15% of the assessment.

The technology profile should be about 3000 words in length with appropriate use of figures and diagrams. You have the option to complete the technology profile, as a team task with proportional scaling of the length. This would enable a profile covering a small technology area in detail, a related series of technologies, or a broader technology to be covered, in addition to gaining teamwork skills.

Most workplaces are structured around teams of people rather than individuals. The profile will be preceded by handing in a brief and a list/file of reference material to be used for the profile by Wednesday 10th September.

We will provide all students in the class with an example of the profile. We hope that these profiles will be useful for you in your future careers, and you may wish to show your profile to potential employers to indicate your abilities.

You should begin by determining your brief and reference sources to be used in producing the technology profile. For example, imagine that you are a technology consultant, asked to summarise the current state of a particular optoelectronic technology (system or device) for a company that is considering using the technology. Your brief would be to understand how the system or device works, to analyse the advantages and limitations of the technology either generally, and/or for the specific purpose envisaged, and possibly to compare and contrast the technology with the one currently being employed. Selection of reference resources is critical to completing a high quality technology profile.

You must submit your brief and list of/file of references to be used, and the members of your team if applicable, to Alex Fuerbach for approval, on or before Wednesday 10th September.

The profile should, first, state the brief, and provide an executive summary of no more than 250 words of your conclusions with respect to your brief, and the body of the text should explain the physical phenomena underlying the technology that you select, and discuss typical designs, specifications, parameters or operating conditions. You should aim to provide an up-to-date survey of the topic, and must cite your sources (books, journal articles, patents, web sites and product literature) for the profile fully. Depending on your topic, you may discuss commercial or fabrication issues associated with the technology. You should aim for a clear, readable style in your profile text. Profiles written by teams should not be simply an assembly of individual efforts, but should have a coherent overall structure. You should only choose the teamwork option if you can timetable meeting as a team to plan and coordinate the production of a single, larger-scale technology profile.

Seminar

Each member of the class will present a 20 minute talk, either as part of a team presentation or as an individual presentation from their technology profile during scheduled laboratory or lecture time. Additional notes will be given on seminar presentation later in the semester.

Your audience will be both academics and peers, and each member of the audience will provide written comments on the talks. You should aim for clear, persuasive and logical presentation of the concepts and ideas. Enthusiasm and careful preparation are important for good presentations, and we expect you should practise your talk in advance to improve your timing and fluency. Teams should ensure that each member presents a coherent section of the whole.

Criteria for Assessment

The profiles will be assessed on:

1. (i) adequately addressing the brief (40%)
2. (ii) clarity of written descriptions and readability (20%)

(iii) appropriate use of figures and diagrams (20%)
(iv) use of a range of reference material chosen using careful judgement (20%).
Each criterion will be judged as unsatisfactory, satisfactory, good, very good or excellent. The final mark will be calculated using weighted numerical equivalents to these descriptors. The profiles for teams will be assessed to give equal marks for each team member.

The seminars will be assessed on:

1. (i) clarity of presentation (overall for teams) (20%)
2. (ii) information content (60%)

(iii) style of presentation (20%).

The detailed descriptors and process for conversion to a mark will be followed.
The technology profile and seminar will account for 15% of your final assessment in PHTN322.

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- The ability to write clear, concise and relevant technical reports incorporating and analysing data from measurements, as well as concepts and information from a range of sources including books, articles, product literature or web sites.
- An understanding of the requirements of oral presentation on technical topics, and experience in both presenting and assessing such talks by peers.

Delivery and Resources

Teaching Strategy:

This unit is taught through lectures and tutorials and through undertaking laboratory experiments.

We strongly encourage students to attend lectures because they provide a much more interactive and effective learning experience than studying a text book. 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 should aim to read the relevant sections of the recommended reading before and after lectures and discuss the content with classmates and lecturers.

This unit includes a compulsory experimental component. This is 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.

Laboratory Requirements

The laboratory operates on Thursdays 2-5 pm.

You must record your experimental data and deliberations in a laboratory exercise book which will be checked during and at the end of semester. A laboratory report prepared in loose-leaf form is to be handed in after the mid-semester break. Late reports may be penalised. Separate guidelines for report writing in the Photonics laboratory are available.

Unit Schedule

Lecturers: A/Prof Andrei Zvyagin (AZ), Dr Alex Fuerbach (AF) , A/Prof Jin Dayong (JD)

Week 1: Optical Imaging: Classification, light sources, detectors, lenses (AZ)

Week 2: Optical Microscopy: Classification, fundamentals, design parameters, aberrations (AZ)

Week 3: Imaging systems: Fluorescent, confocal microscopy, flow cytometry (JD)

Week 4: Biophotonics: Light interaction with tissue, scattering/absorption, biosensing (AZ)

Week 5: Machine vision: Key instrumentation, basic requirements, applications, examples (AZ)

Week 6: Image processing: Image enhancement, filtering: processing, shape recognition (AZ)

Week 7: Gaussian Beams, ABCD Matrix formalism (AF)

Week 8-9: Light-matter interaction, Laser fabrication, Laser machining (AF)

Week 10-11: Photonics technology: Optical communications: Optical networks, all-optical processing (AF)

Week 12: Optical data storage: Laser writing, erasing, encoding, storage capacity, 5D-data storage (AF)

Week 13: Unit review (AZ, AF, JD)

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

In addition, a number of other policies can be found in the Learning and Teaching Category of 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/support/student_conduct/

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 improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

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

IT Help

For help with University computer systems and technology, visit http://informatics.mq.edu.au/help/.

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

Graduate Capabilities

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
- The ability to evaluate specifications of source devices, components and systems from a broad range of commercial optoelectronic technologies.
- An understanding of key design issues in optoelectronic systems, including safety, mechanical constraints, packaging and the requirements of different applications.
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- An understanding of the requirements of oral presentation on technical topics, and experience in both presenting and assessing such talks by peers.

Assessment tasks

- Assignment
- Examination
- Laboratory
- Technology Profile and Seminar

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
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Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

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- Examination
- Laboratory
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Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
- The ability to evaluate specifications of source devices, components and systems from a broad range of commercial optoelectronic technologies.
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- Laboratory
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Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
- The ability to evaluate specifications of source devices, components and systems from a broad range of commercial optoelectronic technologies.
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Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
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Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
- The ability to write clear, concise and relevant technical reports incorporating and analysing data from measurements, as well as concepts and information from a range of sources including books, articles, product literature or web sites.
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Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcomes

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
- The ability to write clear, concise and relevant technical reports incorporating and analysing data from measurements, as well as concepts and information from a range of sources including books, articles, product literature or web sites.
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Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcomes

- An advanced level understanding of photonics systems, including their underlying optics principles, application scope and technological implementation.
- The ability to write clear, concise and relevant technical reports incorporating and analysing data from measurements, as well as concepts and information from a range of sources including books, articles, product literature or web sites.
- An understanding of the requirements of oral presentation on technical topics, and experience in both presenting and assessing such talks by peers.

Assessment tasks

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Changes since First Published

Date	Description
07/08/2014	The laboratory content of the unit has been specified in greater detail. Laboratory dates as well as details of the laboratory assessment haven been added.