

PHTN4661

Optical Circuits and Fibres



COURSE INTRODUCTION – SESSION 1, 2009

COURSE STAFF

Course convener: A/Prof. F. Ladouceur f.ladouceur@unsw.edu.au
Lab tutors: Mr Mark Hiscocks m.hiscocks@student.unsw.edu.au
Dr Iain Skinner i.skinner@unsw.edu.au

Consultations: Students are encouraged to use the open consultation hours; students may seek consultation with the course convener at other times by appointment.

COURSE DETAILS

Credits: The course is a 6 UoC course; expected workload is 10–12 hours per week throughout the 12 week session.

Contact hours: The course consist of 2 hours of lectures per week, and 2 hours of laboratory sessions or tutorial per week:

Lectures: Wednesday, 9am–11am, room Quad 1049
Lab sessions: Wednesday, 2pm–4m, room EE214

Tutorials and laboratories will alternate on a weakly basis. Laboratory classes start during week 2.

COURSE DETAILS

CONTEXT AND AIMS

Optical circuits are miniaturised and integrated optical paths and devices onto a single planar substrate. They are commonly used in traditional optical telecommunications but are now finding new application fields in sensing, MEMs, astronomy and data transfer (chip-to-chip, board-to-board).

Aims: The course aims to make student familiar with standard *silica-on-silicon* planar waveguide technology and its interface with standard telecom optical fibres. In that process, the student will be introduced to the modelling and design of optical circuits.

RELATION WITH OTHER COURSES

For those with a special interest, this course builds on the fundamental formalism associated with waveguides studied in Stage 3, by exploring how they can be used to build functional optical circuits.

Prerequisite: Stage 3 electromagnetic course

Assumed knowledge: It is assumed that the students possess a good understanding of electromagnetism (e.g. Maxwell's equations), and have a good computer literacy, in particular familiarity with C++ programming and *MathLab* or *Mathematica*.

Following courses: This course is a pre/co-requisite for post-graduate courses.

LEARNING OUTCOMES

After successfully completing this course, students will be expected to:

1. Understand the typical applications of optical circuits;
2. Understand the coupling mechanisms with optical fibres;
3. Model using various techniques the basic building blocks of integrated circuits;
4. Design simple optical circuits (paths, phase shifters, interferometers, etc)
5. Understand the limitations placed on optical circuits imposed by fabrication, losses and integration;

The course delivery methods and course content address a number of core UNSW graduate attributes; these include:

1. The capacity for analytical and critical thinking and for creative problem-solving, which is addressed by the laboratories and tutorial exercises;
2. The ability to engage in independent and reflective learning, which is addressed by the laboratories;
3. The skills of effective communication, which are addressed by the laboratory reports.

Please refer to <http://www.ltu.unsw.edu.au/content/userDocs/GradAttrEng.pdf> for more information about graduate attributes.

TEACHING STRATEGY

The course consists of the following elements: lectures, virtual lab work and a measurement project:

Lectures: During the lectures, integrated optics and related design issues are discussed and the appropriate theoretical framework is introduced. The lectures provide the students with a focus on the core material in the course and stresses the important conceptual advances. Numerous examples of optical integrated circuits are discussed in order to convey a qualitative understanding of their operations. Students are expected to attend the lectures and prepare themselves for them.

Virtual lab work: The laboratory work will be based on an in-house software library (Light Numerical Recipes). The student will be asked to use this library, in the form of C++ programs, to study various aspects of light propagation in optical circuits.

Measurement project: You will be asked to measure the important properties of an unknown reel of optical fibre assigned to you and report on what you have learnt. This project will be conducted in teams of 2 to 3 and will be spread over the semester. Access to laboratory will be determined early on.

ASSESSMENT

There are four components of the assessment in this course:

Lab work: 5 laboratory sessions for 25% overall weight
 Project: 15% overall weight
 Quiz: 10% overall weight
 Final exam: 50% overall weight

COURSE SCHEDULE

WEEK	TASKS/CONTENT
1	<i>Course introduction</i> – Course administration, overview of waveguiding, properties of silica, guidance, silica-on-silicon.
2	<i>Waveguide modes</i> – waveguide parameters, wave equation, slab waveguide, modal properties. Laboratory 1: Modes of rectangular waveguides
3	<i>Optical fibers</i> – Weak guidance approximation, fibre characteristics, bound modes, dispersion, attenuation, fabrication.
4	<i>Approximate modal methods</i> – Gaussian approximation, Effective Index Method. Laboratory 2: Waveguide design: coupling
5	<i>Loss mechanisms</i> – Scattering, bend loss, splice loss, substrate leakage.
6	<i>Mode coupling and beating: Part I</i> – Perturbation theory, mode beating, mode coupling, couplers. Laboratory 3: Phase shifter
7	<i>Mode coupling and beating: Part II</i> – Perturbation theory, mode beating, mode coupling, couplers.

WEEK	TASKS/CONTENT
8	<i>Propagation</i> – Spatial transient, bound, leaky and radiation modes, beam propagation. Laboratory 4: Mode coupling
9	<i>Passive integrated optical circuits</i> – silica-on-silicon, examples: multiplexers, arrayed waveguides, gratings, opto-mechanical switch.
10	<i>Circuit design</i> – Waveguide geometry, optical path design, masks. Laboratory 5: Beam Propagation Method
11	<i>Cutting edge: diamond waveguides</i>
12	<i>Overall review</i>

RESOURCES FOR STUDENTS

TEXT BOOKS

There will not be a single prescribed text, but possible suitable references to add to a growing personal professional library:

- F. Ladouceur and J.D. Love, *Silica Based Buried Channel Waveguides and Devices*, Kluwer.
- R. März, *Integrated Optics*, Artech House, Boston.
- A.W. Snyder and J.D. Love, *Optical Waveguide Theory*, Kluwer.

ON-LINE RESOURCES

The course will make continuous usage of WebCT/Vista for course and laboratory material distribution: <http://vista.elearning.unsw.edu.au>

OTHER MATTERS

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other peoples work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a serious offence by the University and severe penalties may apply. For more information about plagiarism, please refer to <http://www.lc.unsw.edu.au/plagiarism>

Continual Course Improvement

Students are advised that the course is under constant revision in order to improve the learning outcomes of its students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School policies, see <http://scoff.ee.unsw.edu.au/>.