PHTN4661
Optical Circuits and Fibres

Course Outline – Semester 1, 2017

Australia's Global University | Faculty of Engineering | School of Electrical Engineering and Telecommunications

Course Staff

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Consultations: The preferred consultation time for this course is after lectures and during the tutorial. Please feel free for any additional consultation at the start or end of lectures, tutorials or laboratory sessions.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms – in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

Course Summary

Credits: The course is a 6 UoC course。 The expected workload is 10 hours per week throughout the 13 week session.

Contact hours: The course consists of 2 hours of lectures, a 1-hour tutorial each fortnight and a 2-hour laboratory session each fortnight.

Course Aims & Contents

This course will provide an in-depth overview of the fundamentals as well as modern techniques of optical fibres, optical waveguides and photonic devices.

The course aims to understand, and become familiar with, fundamental principles, theoretical methods and experimental techniques of optical fibres and related technologies, and enable the student to carry out basic optical fibre and waveguide related analysis, design and measurement. The primary aim of this course is to provide students with a solid foundation in optical fibre and waveguide technologies.

This course will cover the following

- Overview of optical fibres and optical waveguides
- Single mode and multimode fibres and waveguides
- Modal field analysis & properties
- Optical transmission: attenuation, dispersion and bandwidth
- Polarization & birefringence
- Photonic components
- Photonic circuitry and system design
- Manufacture of optical fibres and waveguides
- Optical measurement and experiment

Relation to Other Courses

The course is a professional elective offered to undergraduate and postgraduate students at UNSW. The course gives the foundations for fibre optics –optical fibres, fibre components and systems, fibre based photonic networks.

Pre-requisites: This course is essentially self-contained. There are no pre-requisites for this course.

Assumed knowledge: It is essential that the students are familiar with the fundamentals of electromagnetic theory, engineering mathematic methods and communication system theory. It is further assumed that the students have satisfactorily completed undergraduate courses in electrical engineering or physics. If you feel you don't have the appropriate background, then these books should help.

B.P. Lathi, Modern Digital & Analog Communication Systems

D.K. Cheng, Field & Wave Electromagnetics

Following courses: This course is followed by the post-graduate course PHTN4662 or ELEC9355.

Learning Outcomes

You are expected to attend all lectures, tutorials, labs, and mid-semester exams in order to maximise learning. You must prepare well for your laboratory classes and your lab work will be assessed. In addition to the lecture notes/video, you should read relevant sections of the recommended text. Reading additional texts will further enhance your learning experience. Group learning is also encouraged. UNSW assumes that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

At the conclusion of this course, the students will have solid knowledge of:

O1. How to use the main theoretical methods for modelling and analysing optical waveguides and fibres;

O2. The fundamental properties and relations of multi-mode and single-mode optical fibres;

O3. The main technical issues and considerations when using optical fibres in communication systems and networks;

O4. The main experimental methods and measurement techniques of optical fibres; and

O5. General aspects of optical circuit and fibre design, manufacture and application.

This course will contribute to the building up of a number of core UNSW graduate attributes.

Course Context & Schedule

Week	Lecture	Tut	Lab
1	Course Overview. Introduction to Lab Work		
2	Waveguide Model & Analysis I – *Ray Method*	1	1
3	Waveguide Model & Analysis II – *Wave Method*	1	1
4	Optical Waveguide Materials. Attenuation & Related Issues	2	2
5	Mode Coupling	2	2
6	Optical Waveguide & Fibre Fabrication	3	3
7	Midterm Exam	3	3
8	*Public Holiday*		
9	Waveguide Model & Analysis III – *Approximation Method*	4	4
10	Waveguide & Fibre Measurement	4	4
11	Birefringence & Polarisation. Optical Circuits & Related Issues	5	5
12	Optical components. Current topics. Course review	5	5

Laboratory program

The laboratory schedule is deliberately designed to provide practical, hands-on exposure to the concepts conveyed in lectures soon after they are covered in class. You are required to attend laboratory from Week 2 to Week 12. Laboratory attendance WILL be kept, and you MUST attend at least 80% of labs.

Expt 1: Measurement of fibre's attenuation --- the cut back method

Expt 2: optical time domain reflectometry (OTDR) and fusion splicing

Expt 3: Measurement of second mode (LP_{11} mode) cutoff

Expt 4: Measurement of the far-field pattern of a single-mode fibre

Expt 5: Spectral characterization of optical fibre components

Note on Laboratory:

1. The lab notes will be distributed by the lecturer or the lab demonstrator.
2. Lab allocations will be finalised in Week 2.
3. All the lab sessions will be fixed. Should you need to change your lab time, please contact your lecturer or lab demonstrator.
4. The assessable labs start in week 3 and end in week 11, and must be attended every second week.

Laboratory Exemption

There is no laboratory exemption for this course. Regardless of whether equivalent labs have been completed in previous courses, all students enrolled in this course must take the labs.

Teaching Strategies

The course consists of the following elements: lectures, laboratory experiments, tutorials, assignments, consultations and assessments. Effective learning can be achieved when you are actively engaged in the learning process and communicating and discussing freely with the course lecturer, tutor, lab demonstrator and fellow students.

Lectures: The lectures provide the students with a focus on the key concepts, principles and methods in the course. There will be a few notes handed out that cover some class materials but these will not be sufficient. Students should attend all the lectures and take notes during class.

Laboratory work: The laboratory work provides the student with hands-on experience and exposure to various optical fibres, optical components and circuitry, and optical measurement systems. The laboratory sessions are short. Students must come well prepared for the laboratory sessions.

Tutorials: The tutorials provide the student with problems and questions directly linked to quantitative and qualitative understanding of optical fibre materials, physical properties, modelling, analysis, design and application of optical fibres. The tutorials take the student through most of course topics and aim to make the students familiar with technical considerations, issues and methods in solving problems and questions in optical fibres. Please note: Only some of problems will be discussed in tutorial sessions. The students are strongly encouraged to complete all the tutorial questions by themselves or in small groups. If help in any particular problem is needed, students are welcome to inform the lecturer / tutor.

Assignments: The assignments enable students to apply various methods to qualitatively and quantitatively analyse and interpret the fundamentals of optical communication systems. The assignments will be marked and returned as feedback to students for assessing their progress in understanding and learning course materials. Note that the assignments are compulsory and contribute to the final marks.

Consultations: Students are strongly encouraged to consult the course lecturer during and after lecture or tutorial time regarding any questions, problems or difficulties. Students may seek consultation with the course lecturer at other times by appointment. If necessary, regular consultation times could be arranged.

UNSW graduate attributes: This course delivery is designed to address a number of core UNSW graduate attributes:

- The capacity for analytical and critical thinking and for creative problem-solving, which is addressed by the tutorial exercises, assignments and laboratory work.
- The ability to engage in independent and reflective learning, which is addressed by lectures, tutorial exercises together with self-directed study.

Assessment

Laboratory work: The student will be assessed by a lab demonstrator on the preparation, performance, reports of the experiments as well as lab OHS compliance. Students will work in groups but be assessed individually.

> **N.B.:** *Engineering labs are potentially dangerous places; rooms 347 & 348 are no exceptions.* ***Students' behaviour must conform at all times to the rules applying to the School's laboratories.*** *Also, when conducting your experiments you will need to be aware of any specific hazards (eg sharp materials) associated with them. Students are responsible for their own conduct and share responsibility for the safety of all people in the laboratories.*

Midterm examination: The middle-term exam will be closed-book 1.5 hour written examination. University approved calculators are allowed. The examination tests general understanding of the course materials covered up to the middle-term.

Assignment: There will be 2 assignments to be worked out throughout the session. *Late reports will attract a penalty of 10% per day* (including weekends).

Final examination: The final exam will be a standard closed-book 3 hour written examination. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course, unless specifically indicated otherwise by the lecture staff. Assessment is a graded mark according the correct fraction of the answers to the exam questions.

Summary of assessment

Laboratory work:	20%
Midterm Exam:	20%
Assignments:	10%
Final examination:	50%
Total:	**100%**

Relationship of Assessment Methods to Learning Outcomes

Assessment	**Learning outcomes**				
	O1	O2	O3	O4	O5
Laboratory work & reports	✓	✓	✓	✓	✓
Mid-term exam	✓	✓	✓	-	✓
Assignment	✓	✓	✓	-	✓
Final exam	✓	✓	✓	✓	✓

Course Resources

We do not prescribe a textbook. We recommend you have either of these as a main reference book:

J. Senior: ***Optical Fibre Communications: Principles and Practice***

G. Keiser: ***Optical Fibre Communications***

Students are encouraged to purchase one of these books as is provides the most coverage of the topics in this course and also its following course: PHTN4662 or ELEC9355. There are also quite a few copies of them in the UNSW library.

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and occasionally quizzes. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Mailing list

Announcements concerning course information will be given in the lectures and/or on Moodle and/or via email (which will be sent to your student email address).

Other Matters

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://student.unsw.edu.au/guide), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **ten to twelve hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face classes and *independent, self-directed study*. In periods where you need to need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be **lodged online through myUNSW within 3 working days of the assessment**, not to course or school staff. For more detail, consult https://student.unsw.edu.au/special-consideration.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the myExperience process. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

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 and UNSW policies:

https://student.unsw.edu.au/guide

https://www.engineering.unsw.edu.au/electrical-engineering/resources

Appendix A: Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;
- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved by the laboratory experiments and interactive checkpoint assessments and lab exams during the labs.
- Developing capable independent and collaborative enquiry, through a series of tutorial questions spanning the duration of the course.
- Developing digital and information literacy and lifelong learning skills through assignment work.

Appendix C: Engineers Australia (EA) Professional Engineer (PE) Competency Standard

	Program Intended Learning Outcomes		
PE1: Knowledge and Skill Base	PE1.1	Comprehensive, theory-based understanding of underpinning fundamentals	✓
	PE1.2	Conceptual understanding of underpinning maths, analysis, statistics, computing	✓
	PE1.3	In-depth understanding of specialist bodies of knowledge	✓
	PE1.4	Discernment of knowledge development and research directions	
	PE1.5	Knowledge of engineering design practice	✓
PE2: Engineering Application Ability	PE2.1	Application of established engineering methods to complex problem solving	✓
	PE2.2	Fluent application of engineering techniques, tools and resources	✓
	PE2.3		
	PE2.4		
PE3: Professional and Personal Attributes	PE3.1	Ethical conduct and professional accountability	
	PE3.2	Effective oral and written communication (professional and lay domains)	✓
	PE3.3	Creative, innovative and pro-active demeanour	✓
	PE3.4	Professional use and management of information	✓
	PE3.5	Orderly management of self, and professional conduct	
	PE3.6	PE3.6 Effective team membership and team leadership	✓