ELEC9350

Optical fibres

COURSE INFORMATION

Session 1, 2008

Course Staff

Course lecturer: A/Prof G.D. Peng
Room EE309, Tel: 9385 4014, Email: G.Peng@unsw.edu.au

Laboratory demonstrator: Asrul Amzi
Room EE217, Tel: 9385 5534, Email: @unsw.edu.au

Course Context and Aims

The course aims to make the student familiar with fundamental principles, theoretical methods and experimental technologies of optical fibres, and enable the student to carry out basic optical fibre related analysis, design and measurement.

This course will cover topics including

- Advantages & limitations of optical fibres
- Single mode and multimode fibres
- Optical fibre modal analysis & properties
- Optical fibres: Attenuation, dispersion and bandwidth
- Polarization & Birefringence in fibres
- Fibre-based components
- Optical fibre system design considerations
- Manufacture of optical fibres and cables
- Optical fibre measurement and experiment

Consultations

Students are encouraged to consult after lecture time; Students may seek consultation with the course lecturer at other times by appointment. If necessary, regular consultation times could be arranged.

Credits: The expected workload is 10–15 hours per week throughout the 12 week session.

Course Details

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

Lecture: 6:00pm-9:00pm Week 1 and Week 12  EE418
6:00pm-7:30pm Week 2 and Week 11  EE418
Tutorial: 7:30pm-9:00pm Week 2 and Week 11  EE418
Laboratory: 7:30pm-9:00pm Week 2 and Week 11  EE347

Course Schedule

Week 1  11/3
Introduction and Review
Snell's law, Fresnel reflection, TEM waves, Waveguides & modes,
Advantages & limitations, Basic structure

Week 2  18/3
Fibre measurement I
Fibre loss, OTDR, Index profile, Cut-off wavelength,

Week 3&4  1/4, 8/4
Analysis model and method I
Ray analysis- Acceptance angle, Numerical aperture
Impulse response
Step index multimode fibres, Graded-index multimode fibres
Modal analysis-
Weak guidance, Boundary conditions, Eigenvalue equation, modal cut-off, modal fields.
Guided and cladding modes, Fibres types

Week 5  15/4
Attenuation and related issues
Attenuation and absorption mechanisms
Bending and microbending losses in fibres. Tapered Fibres

Week 6  22/4
Analysis model and method II
Equivalent step index, Spot-sizes

Week 7  29/4
Dispersion and bandwidth
Material dispersion, Modal dispersion, Waveguide dispersion, Bandwidth and pulse
broadening
Dispersion in step-index multimode fibre. Dispersion in graded-index multimode fibres

Week 8  6/5
Anisotropy, Birefringence / Polarisation
Fibre materials & fabrication, silica and silicate glasses, dopants, polymers
Fibre cable designs, protection and aging

Week 9  13/5
Fibre measurement II

Week 10  20/5
System design issues and considerations
Launching, jointing and connecting fibres
Launching efficiencies and jointing losses, connectors
Power budget, Bandwidth budget, System design issues
Week 11  27/5  
*Fibre-based components* Manufacture of optical fibres and cables  
Couplers, Fibre Bragg gratings, EDFA, sensing elements

Week 12  3/6  
*Fibre & cable manufacture*  
Current research topics  
Course review

Relation to other courses
The course is a professional elective offered to postgraduate students at the University of New South Wales. The course gives the foundations for fibre optics.

Pre-requisites: There is 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 ELEC9355.

Learning outcomes
At the conclusion of this course, the students should have a good understanding of
1. the fundamental properties of multi-mode and single-mode optical fibres;
2. the main technical issues and considerations when using optical fibre in communication systems & devices;
3. measurement and testing methods and techniques of optical fibres; and
4. the design & manufacture of fibres.

Teaching strategies
The course consists of the following elements: lectures, laboratory experiments, tutorials and consultations.

Lectures
The lectures provide the students with a focus on the key concepts, principles and methods in the course. Students are expected to attend the lectures.

Laboratory work
The laboratory work provides the student with hands-on experience and exposure to various optical fibres, optical components and optical measurement systems. The laboratory sessions are short. Students are 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. 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.

Assessment
Your final mark is determined by three parts:

- Laboratory Work 25%
- Middle Term Exam 20%
- Final Examination 55%

Laboratory work assessment: Your laboratory mark is determined from the 3 reports you submit (5% each) and from an assessment of your bench work by the demonstrator (10%). The latter will depend on how proficiently and professionally you conduct all FIVE experiments.

There are five compulsory experiments to be completed in this course. They are not difficult with proper preparation & careful procedure. Experiments are done in pairs and you work in the same pair all session. The laboratory schedule and the pairings will be finalised in Week 1. Then the laboratory pairings and rotation schedule will be on the noticeboard outside EE347. Experiments begin in week 2.

As a professional engineer, your experiment must be recorded in an appropriate laboratory notebook. You must submit an individual written report for each of the SECOND, THIRD and FOURTH experiments that you do. These should be given to the lab demonstrator at the beginning of the next lab class you attend (ie third, fourth & fifth).

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.

More details about the lab programme will be handed out.

Middle term 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.

Final examination: The final exam will be 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. Assessment is a graded mark according the correct fraction of the answers to the exam questions.
Resources for Students
Textbooks
We do not prescribe a textbook. We recommend you have either of these as a main reference book:

J. Senior (1992), *Optical Fibre Communications*, 2nd ed, Prentice-Hall

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

Course materials
Course related materials and notes will be handed out in class during the session.

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 lecturer or via the Course and Teaching Evaluation and Improvement Process.

Administrative Matters
You need to be informed on the School's and University's policies about students' responsibilities, academic & other misconduct, special consideration, conduct of examinations, and the submission & assessment of assignments as well as students’s equity and diversity, occupational heath and safety, enrolment and rights. Such policies can be found at www.ee.unsw.edu.au and www.student.unsw.edu.au/atoz, respectively.

Any student who, by reason of disability, needs modification of his/her teaching or learning environment is encouraged to contact us or the University's Equity Officer (Disability) on 9385 4734.

Notices about this course will be available on the board outside rooms EE347.