School of Electrical Engineering and Telecommunications

Course Outline, Term 2, 2019

PNTH4662

Photonic Networks

Course Staff

Course Convener: Prof. Gang-Ding Peng, EE419, G.Peng@unsw.edu.au

Tutor: Prof. Gang-Ding Peng

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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

Contact Hours

The course consists of 3 hours of lectures (Week 1-4 then 2 hours from Week 5) each week, a 1-hour tutorial every fortnight and a 2-hour laboratory session each fortnight.

Context and Aims

This course will provide an in-depth overview of the fundamentals as well as modern techniques of optical fibre communication systems.

A wide range of topics will be covered in this course, including

Optical sources and detectors

Optical fibre lasers and amplifiers, Photonic components

Multiplexing techniques and systems

Analog and digital optical communication systems

Signal-to-noise ratio in optical communication systems

Nonlinear optical effects in optical fibres

Photonic Network technologies and issues, Current topics of optical fibre systems

Indicative Schedule

Week	Lecture	Tut	Lab
1	**Introduction to Fibre Optics** Refs: Lecture note; Senior: Ch.1-2, Keiser Ch.1-3, Ch.13: Ramaswami Ch.2-3		
2	**Optical Fibre Lasers and Amplifiers** Refs: Lecture note; Senior: Ch.6 & Ch.10, Keiser Ch.11, Ch.4; Ramaswami Ch.3	1	1
3	**Optical Sources and Detectors** Refs: Lecture note; Senior: Ch.6-9, Keiser Ch.4, Ch.6; Ramaswami Ch.3		1
4	**Analog & Digital Optical Communication Systems** Refs: Lecture note; Senior: Ch.11, Keiser Ch.8-9; Ramaswami Ch.2-5	2	2
5	**Midterm Exam**		2
6	**SNR in Optical Communication Systems** Refs: Lecture note; Senior: Ch.11, Keiser Ch.7; Ramaswami Ch.2-3	3	3
7	**Photonic Components** Refs: Lecture note; Senior: Ch.5-10, Keiser Ch.10, Ch.4-5; Ramaswami Ch.3		3
8	**System Considerations. Photonic Networks** Refs:Lecture note; Senior: Ch.14, Keiser Ch.12; Ramaswami Ch.6-7, Ch.9-14	4	4
9	**Multiplexing Technologies** Refs: Lecture note; Senior: Ch.11, Keiser Ch.10; Ramaswami Ch.7-8		4
10	**Nonlinear Optical Effects in Optical Fibres & Review** Refs: Lecture note; Ramaswami Ch.2	5	

Assessment

Laboratory work:	20%
Mid-term examination:	20%
Assignments:	10%
Final examination:	50%
Total	**100%**

Laboratory work: The student will be assessed by a lab demonstrator on the preparation, performance and completion of the experiments, and on the experimental reports. Students will work in groups but be assessed individually.

Assignment: There will be 3 assignments to be worked out throughout the session. *Late reports will attract a penalty of 10% per day* (including weekends).

Mid-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 exam in this course is a standard closed-book 3 hours 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.

Course Details

Credits

This is a 6 UoC course and the expected workload is 15 hours per week throughout the 10-week term.

Relationship to Other Courses

This is a 4th year / postgraduate course in the School of Electrical Engineering and Telecommunications.

Pre-requisites and Assumed Knowledge

Pre-requisite for the course: TELE3113, PHTN4661 or ELEC3115.

It is essential that the students have shown competency in fundamental courses such as mathematics, physics, electronics, signals and systems. They are strongly advised to review previous courses materials of TELE3113, PHTN4661 or ELEC3115.

Learning outcomes

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

1. *Fundamental principles & techniques of optical fibre systems*
2. *Photonic components in optical communication systems*
3. *Optical analogue and digital modulation and demodulation techniques*
4. *Noise and signal analysis of optical communication systems*
5. *Design & application of various optical communication systems*
6. *Basic aspects of optical networks*
7. *Current topics & issues in optical communication systems*

This course will contribute to the building up of a number of core UNSW graduate attributes.
This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in ***Appendix A***. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in ***Appendix B***). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix C***.

Syllabus

Optical fibres, fibre amplifiers and lasers, optical sources and detectors, photonic components, WDM; optical switching & routing, SONET; dispersion management, BER & sources of noise, power budgets; All-optical & hybrid networks, topologies; phase modulation effects & nonlinear scattering in optical links; safety, regulations & standards.

Teaching Strategies

The teaching of the course is delivered through a combination of lectures, tutorials, and laboratory work.

Lectures: The lectures provide the students with the explanation of the core materials in the course. The lectures will be delivered 2 or 3 hour per week with corresponding lecture notes.

Tutorials: The tutorials enable students to apply various methods to qualitatively and quantitatively analyse and interpret the fundamentals of optical communication systems. No solution will be provided but hints on how to solve the problems will be provided. This course is for senior and postgraduate students that the attendance of tutorial session is not compulsory. They are encouraged to attempt the tutorial questions by themselves, individually or in small groups. But it is essential that they are able to solve all the tutorial questions independently.

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 15% of the final marks.

Laboratory work: The laboratories provide the student with hands-on experience in optical communication techniques and systems. The following four experiments will be done by each student during the course of study:

1. Measurement of Laser Characteristics
2. Measurement of Avalanche Photodiode Characteristics
3. Optical Receiver Measurement
4. Measurement on Wavelength Division Multiplex System

The laboratory schedule and the student groups will be decided before the lab work starts. A lab risk assessment form (to be given later) is to be completed and signed before the start of your first experiment. The attendance of each laboratory session will be recorded by the lab demonstrator. Students are expected to carefully prepare for each of the laboratory experiments, prior to coming into the lab. Every student is required to keep an individual record of all the experiments, preferably in the form of a bound book. Lab reports must be submitted by each student. You need to attach a signed covering sheet to each of your reports. Your lab report is submitted at the time you do the next experiment or by the end of Week 13.

Note that the laboratory component contributes to 20% of the final marks. All labs are weighted equally. ***There will be no lab exemptions granted***.

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

a. The capacity for analytical and critical thinking and for creative problem-solving, which is addressed by the tutorial exercises, assignments and laboratory work.

b. The ability to engage in independent and reflective learning, which is addressed by lectures, tutorial exercises together with self-directed study.

Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the term. Ongoing assessment occurs through the lab checkpoints (see lab manual), lab exams and the mid-term exam.

Laboratory Assessment: Laboratories are primarily about learning, and the laboratory assessment is designed mainly to check your knowledge as you progress through each stage of the laboratory tasks. You are required to maintain a lab book for recording your observations. A lab book is an A4 size

notebook containing a mix of plain pages and graph sheets. You have to purchase your own lab book from any stores.

It is essential that you complete the laboratory preparation before coming to the lab. You are required to write the aim of the experiment and draw the circuit diagram if any in your lab book. This will be verified and signed by your demonstrators in the lab. You will be recording your observations/readings in your lab book first and then completing and submitting the results sheet before leaving the lab.

After completing each experiment, your work will be assessed by the laboratory demonstrator. Both the results sheet and your lab book will be assessed by the laboratory demonstrator.

Assessment marks will be awarded according to your preparation (completing set preparation exercises and correctness of these or readiness for the lab in terms of pre-reading), how much of the lab you were able to complete, your understanding of the experiments conducted during the lab, the quality of the code you write during your lab work (according to the guidelines given in lectures), and your understanding of the topic covered by the lab.

Mid-Term Exam: The mid-term examination tests your general understanding of the course material, and is designed to give you feedback on your progress through the analytical components of the course. Questions may be drawn from any material already covered in the course schedule. It may contain questions requiring some (not extensive) knowledge of laboratory material, and will definitely contain numerical and analytical questions.

Assignment: The assignment allows self-directed study leading to the solution of partly structured problems or survey report.

Final Exam: The exam in this course is a standard closed-book 2 hour written examination, comprising five compulsory questions. 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 (including laboratory), unless specifically indicated otherwise by the lecturer.

Relationship of Assessment Methods to Learning Outcomes

Assessment	**Learning outcomes**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Laboratory work & reports	✓	✓	✓	✓	✓	-	-
Mid-term exam	✓	✓	✓	✓	-	-	-
Assignment	✓	✓	✓	✓	✓	✓	✓
Final exam	✓	✓	✓	✓	✓	✓	✓

Course Resources

Reference books

1. J. Senior: ***Optical Fibre Communications: Principles and Practice***
2. G. Keiser: ***Optical Fibre Communications***,
3. R. Ramaswami, K. N. Sivarajan: ***Optical Networks: A Practical Perspective***

On-line resources

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.

Other Matters

Dates to note

Important Dates available at: https://student.unsw.edu.au/dates.

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 **15 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 can apply for special consideration when illness or other circumstances beyond your control interfere with an assessment performance. If you need to submit an application for special consideration for an exam or assessment, you must submit the application prior to the start of the exam or before the assessment is submitted, except where illness or misadventure prevent you from doing so. Be aware of the "fit to sit/submit" rule which means that if you sit an exam or submit an assignment, you are declaring yourself well enough to do so and cannot later apply for Special Consideration. For more information and how to apply, see 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 Course and Teaching Evaluation and Improvement 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:

http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

Appendices

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 digital and information literacy and lifelong learning skills through assignment work.

Appendix C: Engineers Australia (EA) Professional Engineer 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	✓
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering 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 Application of systematic engineering synthesis and design processes	✓
	PE2.4 Application of systematic approaches to the conduct and management of engineering projects	✓
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 Effective team membership and team leadership	