MONASH University

Unit Guide

ECE4043
Optical communications

Semester 2, 2017

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Unit handbook information

Synopsis

Students will study the characteristics of key components that make up optical communications systems including: lasers and advanced lightwave sources and direct modulation, optical modulators, optical fibres, optical amplifiers, filters and multiplexers, optical receivers and associated electronics. Secondly, students will use this knowledge to analyse and design optical communications systems. Examples will include local-area networks, metropolitan area networks, long-haul links and transcontinental networks.

Mode of delivery

Clayton (Day)

Workload requirements

3 hours lectures, 3 hours laboratory and practice classes and 6 hours of private study per week

Unit relationships

Prerequisites

ECE2021 (or ECE3202 or PHS2022) and ECE2041 (or ECE3402)

Prohibitions

ECE4405, ECE5043, ECE5405

Co-requisites

None

Chief Examiner(s)

Professor Manos Varvarigos

Unit Coordinator(s)

Name: Dr Bill Corcoran
Email: Bill.Corcoran@monash.edu

Campus Coordinator(s)

Name: Dr Bill Corcoran
Email: Bill.Corcoran@monash.edu
Building: 35, Room: 216
Consultation hours: 9am - 5pm. Contact for appointment.

Lecturer(s)

Name: Dr Bill Corcoran
Email: Bill.Corcoran@monash.edu
Building: 35, Room: 216
Consultation hours: Contact bill.corcoran@monash.edu to arrange meeting times.

Name: Dr Valery Rozental
Email: Valery.Rozental@monash.edu
Building: , Room:

Students will study the characteristics of key components that make up optical communications systems, including: lasers and advanced lightwave sources and direct modulation, optical modulators, optical fibres, optical amplifiers, filters and multiplexers, optical receivers and associated electronics. Secondly, students will use this knowledge to analyse and design optical communications systems. Examples will include local-area networks, metropolitan area networks, long-haul links and transcontinental networks.

By the end of the course, you should have:
Knowledge of characteristics of fibres, including dispersion and non-linearity, and of multiplexers, filters and Raman optical amplifiers. Ability to prepare a power budget for an optical communications link. Understanding of the dispersion limits and compensation techniques for optical links. Knowledge of wavelength division multiplexing in links and networks. Skills to design optical communications links for short, medium and long-haul applications, and select appropriate components during link design. Ability to simulate the interactions of components and understand performance measures. Ability to propose optical network architectures for access and metropolitan networks. Ability to specify the performance of networks from an operator's perspective. Experience in making basic measurements on optical components and systems.

Academic Overview

Engineers Australia Stage 1 competencies

The Engineers Australia Policy on Accreditation of Professional Engineering Programs requires that all programs ensure that their engineering graduates develop to a substantial degree the stage 1 competencies. Listed below are the activities in this unit that will help you to achieve these competencies.

Note: that not all stage 1 competencies are relevant to each unit.

Element of competency	Indicators of attainment	Learning outcomes
1 Knowledge and skill base		
1.1 Engages with the engineering discipline at a phenomenological level, applying sciences and engineering fundamentals to systematic investigation, interpretation, analysis and innovative solution of complex problems and broader aspects of engineering practice.	**a)** Engages with the engineering discipline at a phenomenological level, applying sciences and engineering fundamentals to systematic investigation, interpretation, analysis and innovative solution of complex problems and broader aspects of engineering practice.	1
1.2 Develops and fluently applies relevant investigation analysis, interpretation, assessment, characterisation, prediction, evaluation, modelling, decision making, measurement, evaluation, knowledge management and communication tools and techniques pertinent to the engineering discipline.	**a)** Develops and fluently applies relevant investigation analysis, interpretation, assessment, characterisation, prediction, evaluation, modelling, decision making, measurement, evaluation, knowledge management and communication tools and techniques pertinent to the engineering discipline.	1
1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline.	**a)** Proficiently applies advanced technical knowledge and skills in at least one specialist practice domain of the engineering discipline.	1
1.4 Discernment of knowledge development and research directions within the engineering discipline.	**a)** Identifies and critically appraises current developments, advanced technologies,emerging issues and interdisciplinary linkages in at least one specialist practice domain of the engineering discipline.	1
	b) Interprets and applies selected research literature to inform engineering application in at least one specialist domain of the engineering discipline.	1

1.5 Identifies and applies systematic principles of engineering design relevant to the engineering discipline.	**a)** Identifies and applies systematic principles of engineering design relevant to the engineering discipline.	1
	b) Identifies and understands the interactions between engineering systems and people in the social, cultural, environmental, commercial, legal and political contexts in which they operate, including both the positive role of engineering in sustainable development and the potentially adverse impacts of engineering activity in the engineering discipline.	1
	c) Appreciates the issues associated with international engineering practice and global operating contexts.	1
1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline.	**d)** Understands the fundamental principles of engineering project management as a basis for planning, organising and managing resources.	1
	e) Appreciates the formal structures and methodologies of systems engineering as a holistic basis for managing complexity and sustainability in engineering practice.	1
2. Engineering application ability		
2.1 Application of established engineering methods to complex engineering problem solving.	**a)** Identifies, discerns and characterises salient issues, determines and analyses causes and effects, justifies and applies appropriate simplifying assumptions, predicts performance and behaviour, synthesises solution strategies and develops substantiated conclusions.	1
	b) Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic.	1
	c) Competently addresses engineering problems involving uncertainty, ambiguity, imprecise information and wide-ranging and sometimes conflicting technical and non-technical factors.	1

	d) Investigates complex problems using research-based knowledge and research methods.	1
	e) Partitions problems, processes or systems into manageable elements for the purposes of analysis,modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the paramount consideration.	1
	f) Conceptualises alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	1
	g) Critically reviews and applies relevant standards and codes of practice underpinning the engineering discipline and nominated specialisations.	1
2.2 Fluent application of engineering techniques, tools and resources.	**a)** Proficiently identifies, selects and applies the materials, components, devices, systems, processes, resources, plant and equipment relevant to the engineering discipline.	1
	b) Constructs or selects and applies from a qualitative description of a phenomenon, process, system, component or device a mathematical, physical or computational model based on fundamental scientific principles and justifiable simplifying assumptions.	1
	c) Determines properties, performance, safe working limits, failure modes, and other inherent parameters of materials, components and systems relevant to the engineering discipline.	1
	d) Applies a wide range of engineering tools for analysis, simulation, visualisation, synthesis and design, including assessing the accuracy and limitations of such tools, and validation of their results.	1
	e) Applies formal systems engineering methods to address the planning and execution of complex, problem solving and engineering projects.	1
	f) Designs and conducts experiments, analyses and interprets result data and formulates reliable conclusions.	1

	g) Analyses sources of error in applied models and experiments; eliminates, minimises or compensates for such errors; quantifies significance of errors to any conclusions drawn.	1
2.3 Application of systematic engineering synthesis and design processes.	a) Proficiently applies technical knowledge and open ended problem solving skills as well as appropriate tools and resources to design components, elements, systems, plant, facilities and /or processes to satisfy user requirements.	1
	b) Addresses broad contextual constraints such as social, cultural, environmental, commercial, legal political and human factors, as well as health, safety and sustainability imperatives as an integral part of the design process.	1
	c) Executes and leads a whole systems design cycle approach.	1
	d) Is aware of the accountabilities of the professional engineer in relation to the 'design authority' role.	1
3. Professional and personal attributes		
3.1 Ethical conduct and professional accountability.	b) Understands the need for due-diligence in certification, compliance and risk management processes.	1
3.2 Effective oral and written communication in professional and lay domains.	a) Is proficient in listening, speaking, reading and writing English	1
	b) Prepares high quality engineering documents such as progress and project reports, reports of investigations and feasibility studies, proposals, specifications, design records, drawings, technical descriptions and presentations pertinent to the engineering discipline.	1
3.3 Creative, innovative and pro-active demeanour.	a) Applies creative approaches to identify and develop alternative concepts, solutions and procedures, appropriately challenges engineering practices from technical and non-technical viewpoints; identifies new technological opportunities.	1
	b) Seeks out new developments in the engineering discipline and specialisations and applies fundamental knowledge and systematic processes to evaluate and report potential.	1

	c) Is aware of broader fields of science, engineering, technology and commerce from which new ideas and interfaces may be drawn and readily engages with professionals from these fields to exchange ideas.	1
3.4 Professional use and management of information.	**a)** Is proficient in locating and utilising information - including accessing, systematically searching,analysing, evaluating and referencing relevant published works and data; is proficient in the use of indexes, bibliographic databases and other search facilities.	1
	b) Critically assesses the accuracy, reliability and authenticity of information.	1
3.5 Orderly management of self, and professional conduct.	**d)** Manages time and processes effectively, prioritises competing demands to achieve personal,career and organisational goals and objectives.	1
	e) Thinks critically and applies an appropriate balance of logic and intellectual criteria to analysis,judgement and decision making.	1

Teaching and learning method

The unit consists of lecture and practice/tutorial classes with a mix of computer based and practical laboratory exercises and a design project.

Lecture and tutorials or problem classes seminars:
The lectures provide an environment for learning about the fundamental concepts of optical communications, as well as an opportunity for feedback on student understanding through informal quizzes. The tutorials are an opportunity for problem-based leaning, taking the concepts from the lectures and providing concrete examples of their application.

Laboratory-based classes:
The laboratory session allow for problem-based learning with an element of enquiry-based approaches. They allow students to work on their skills in analysis. Model systems will help students identify key problem-solving approaches to the design and implementation of optical communication systems.

Simulation or virtual practice:
The design task in the latter weeks of the course provides a more open, enquiry-based learning approach, focused on a real-world problem of designing a long-haul optical fibre link in and Australian context. This task approximates the kind of project one might encounter working in optical communications.

Learning outcomes

At the successful completion of this unit you will be able to:

1. Describe the underlying physical principles of optical subsystems, and apply this understanding to predict and quantify the effect on optical fibre communication system performance.
2. Generate and analyse methods for increasing the data bandwidth of optical systems.
3. Quantify the performance of optical components within optical systems, and design systems to mitigate the effects of the performance constraints from components.
4. Simulate and predict the interactions of components, and both quantify and reflect upon their impact on performance metrics.
5. Research and appraise state-of-the-art optical technologies, and justify their incorporation into optical communications links for short-, medium- and long-haul applications.

Your feedback to us

One of the formal ways students have to provide feedback on teaching and their learning experience is through the Student Evaluation of Teaching and Units (SETU) survey. The feedback is anonymous and provides the Faculty with evidence of aspects that students are satisfied with and areas for improvement.

Previous student evaluations of this unit

In response to previous SETU results of this unit, the following changes have been made:

- Feedback was good, no specific recommendation was made. Laboratory exercises have been refined to ensure students get the most out of their time.

Student feedback has highlighted the following strength(s) in this unit:

- Feedback was good, no specific recommendation was made.

If you wish to view how previous students rated this unit, please go to:
https://unitevaluations.connect.monash.edu.au/unitevaluations/index.jsp

Unit schedule

Week	Lecture	Tutorial	Lab	Assignment /ctivity
Week 1 25 July	Introduction: Light, the global fibre network, and everything	N/A	N/A	N/A
Week 2 1 August	The transmitter (Tx): Lasers & Modulation	Tutorial problems	Lab 1: Hands-on with OTDR	N/A
Week 3 8 August	The receiver (Rx): Photodiodes and noise	Tutorial problems	Lab 2: Modulation	Submit Lab report 1
Week 4 15 August	The channel: Optical fibre and binary signalling	Tutorial problems	Lab 3: Dispersion	Submit Lab report 2
Week 5 22 August	Optical Amplifiers	Tutorial problems	Lab 4: Noise Figures & OSNR	Submit Lab report 3
Week 6 29 August	Penalties in optical links & Wavelength Division Multiplexing	Tutorial problems	Lab 5: Loss and Optical Noise Limits	Submit Lab report 4 **Distribute Design Assignment**
Week 7 5 October	Challenges in installed links & phase modulation	Tutorial problems	Design Project	Submit Lab report 5
Week 8 12 October	Coherent optical communications **& Mid Semester Revision**	Tutorial problems	Design Project	N/A
Week 9 19 October	**Mid Semester Revision,** standards and analogue links	In-tutorial test	Design Project	In-tutorial test
Semester break: 26-20 September 2016				
Week 10 3 October	**Project support** & signal processing	Tutorial problems	Design Project	N/A
Week 11 10 October	Future trends in optical communications	Tutorial problems	Design Project	N/A
Week 12 17 October	Pre-Exam Revision	Tutorial problems	Design Project	Design Report Submission
Swot Vac.: 24 - 28 October 2016				

	Examination period. LINK to Assessment Policy: http://www.policy.monash.edu/policy-bank/academic/education/assessment/assessment-in-coursework-policy.html	

Assessment requirements

Assessment summary

Continuous assessment: 40%
Examination (2 hours): 60%
Students are required to achieve at least 45% in the total continuous assessment component (assignments, tests, mid-semester exams, laboratory reports) and at least 45% in the final examination component and an overall mark of 50% to achieve a pass grade in the unit. Students failing to achieve this requirement will be given a maximum of 45% in the unit.

Assessment task	Value	Due date
Assessment Task 1: Tutorial and laboratories	10%	Progressive
Assessment Task 2: Class Test	15%	when sat (within tutorial session).
Assessment Task 3: Design Project	15%	Week 12
Final Exam	60%	To be advised

Hurdle requirements

Must attend laboratory sessions. > 45% mark required for exam.

Assessment tasks

Assessment title: Assessment Task 1: Tutorial and laboratories
Mode of delivery: On Campus
Details of task: Tutorial and laboratory sessions
Release dates (where applicable): Ongoing
Word limit (where applicable): Not applicable
Due date: Progressive
Value: 10%
Presentation requirements: *Must* attend laboratory sessions
Hurdle requirements (where applicable): *Must* attend laboratory sessions
Individual assessment in group tasks (where applicable): Yes
Criteria for marking: Attendance and laboratory report.

Additional remarks: This component is designed to help with your overall understanding of the subject matter, rather than as a major assessment component.

Assessment title: Assessment Task 2: Class Test
Mode of delivery: On Campus
Details of task: Written examination, closed book, calculator allowed. Covers previous lectures material.
Release dates (where applicable): week 2
Word limit (where applicable): Not applicable
Due date: when sat (within tutorial session).
Value: 15%
Presentation requirements: Write clearly.
Hurdle requirements (where applicable): Built-in within the continuous assessment's hurdle requirements
Individual assessment in group tasks (where applicable): Individual test.
Criteria for marking: Methodology/approach and answers.
Additional remarks: This task is aimed at helping you find out where your understanding of examinable topics and quantitative approaches may be lacking.

Assessment title: Assessment Task 3: Design Project
Mode of delivery: On campus
Details of task: Design an optical communications link using VPI software
Release dates (where applicable): Week 7
Word limit (where applicable): Not applicable
Due date: Week 12
Value: 15%
Presentation requirements: Written report, in the form of an executive summary (2-3 pages) and detailed design document (max 10 pages).
Hurdle requirements (where applicable): None.
Individual assessment in group tasks (where applicable): Yes
Criteria for marking: Written report - Clear, concise summary of system and results in written report. Sensible approach to problem. 20% on executive summary, 65% on design document, 15% on the simulation itself.
Additional remarks: This is a major assessment component for this course. You will be using advanced industrial design software, addressing a real-world problem. As experienced engineering students, you are expected to manage this project independently. Expect to use the full 6 weeks set aside for this task - make sure you plan your time well.

Examination(s)

Exam title: Final Exam
Weighting: 60%
Length: 2 hours
Type (Open/closed book): Closed book
Hurdle requirements (where applicable): Students are required to achieve at least 45% in the final examination.

Electronic devices allowed: Calculators.
Remarks (where applicable): Based (at least in part) of tutorial questions.

Calculators

A list of the Faculty of Engineering approved calculators and the process for obtaining a sticker is available online at:
http://www.eng.monash.edu.au/current-students/calculators.html

IMPORTANT: Only these listed calculators with the **authorised Monash University-Science or Monash University-Engineering STICKER** will be allowed into the examination by the invigilators.

Calculators

A faculty approved calculator is permitted (meaning only scientific calculators that are not programmable and detailed in the list below will be permitted in the examination. These calculators must be checked by the faculty and have either a Faculty of Engineering or a Faculty of Science approved sticker)

A list of the Faculty of Engineering approved calculators and the process for obtaining a sticker is available online at:

www.eng.monash.edu.au/current-students/calculators.html

IMPORTANT: Only these listed calculators with the **authorised "Monash University-Science" or "Monash University-Engineering" STICKER** will be allowed into the examination by the invigilators.

Examination material or equipment

The exam will be close book. Further clarifications will be made via Moodle before the exam.

Extensions and penalties

Due dates and extensions

The due dates for the submission of assignment and lab reports are given in the previous sections. Please make every effort to submit work by the due dates. Students are advised to NOT assume that granting of an extension is a matter of course.

If you need an extension for any of the assignments, you must submit a written request 48-hours *before* the due time and date, and attach supportive evidence such as medical certificate. **The form should preferably be forwarded as an email attachment,** sent to the unit coordinator. The email should be sent from your University email address with your name typed in lieu of signature. Note that other lecturers cannot grant extensions. Lecturer-in- charge (unit coordinator) will indicate at the time of granting the extension whether any penalty in marks will apply to the submitted work. If an extension is granted, the approval must be attached to the assignment.

Late submission

If you are late in applying for an extension or you don't have a good reason, you should still submit the work, but 10% of the total marks available for that assessment component will usually be deducted for each day late. No assignment/report will be accepted once an assignment/report has been returned to the class.

Deferred tests and examinations may be granted in cases of extenuating personal circumstances such as serious personal illness or bereavement.

Remember, you are required to keep an up-to-date copy of all submitted assignments to safeguard against the loss of work through accident or error.

Returning assignments

Students can expect assignments to be returned within two weeks of the submission date or after receipt, whichever is later.

Resubmission of assignments

Resubmission is not allowed, but late submission is allowed under extreme health or similar extreme situations on which student did not have any control.

Plagiarism and collusion

Intentional plagiarism or collusion amounts to cheating under Part 7 of the Monash University (Council) Regulations.

Plagiarism: Plagiarism means taking and using another person's ideas or manner of expressing them and passing them off as one's own. For example, by failing to give appropriate acknowledgement. The material used can be from any source (staff, students or the internet, published and unpublished works).

Collusion: Collusion means unauthorised collaboration with another person on assessable written, oral or practical work and includes paying another person to complete all or part of the work. Where there are reasonable grounds for believing that intentional plagiarism or collusion has occurred, this will be reported to the Associate Dean (Education) or delegate,

Referencing requirements

The Department of Electrical and Computer Systems Engineering uses the IEEE referencing standards. Please refer to the link below and click IEEE.

http://www.lib.monash.edu/tutorials/citing/ieee.html

To build your skills in citing and referencing, and using different referencing styles, see the online tutorial Academic Integrity: Demystifying Citing and Referencing at www.lib.monash.edu.au /tutorials/citing/

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Assignment submission

Hard Copy Submission:

Hard Copy Submission: Assignments must include a cover sheet. The coversheet is accessible via the Monash portal page located at http://my.monash.edu.au under the heading 'Learning and teaching tools.'

If no conflicting instructions are given through the course, please return assignments between 9am and 5pm to rm. 211, bld. 35, Clayton campus.

Please keep a copy of tasks completed for your records.

Online Submission: If Electronic Submission has been approved for your unit, please submit your work via the Moodle site or other; as directed by your demonstator for this unit.
Please keep a copy of tasks completed for your records.

Feedback to you

Monash aims to provide a learning environment in which students receive a range of feedback throughout their studies. In this unit the student will receive feedback on conceptual understanding through exercises in lectures, problem solving during the tutorial sessions and analytical skills during the laboratories from lecturers. You are encouraged to draw upon these sources of feedback to enhance your learning. In particular, students will receive feedback through:

- Group feedback via informal quizzes during lectures
- Group and individual feedback via problem–solving tasks in tutorials
- Individual and group mentoring in laboratory classes and the design project
- Written individual feedback through the class test

Learning resources

Prescribed textbooks

Gerd Keiser, Optical Fiber Communications, 4th ed, McGraw-Hill, 2010.

Recommended textbooks

G.P. Agrawal, Fiber Optic Communications System, Academic Press, 2002.

Monash Library Unit Reading List (if applicable to the unit):
http://readinglists.lib.monash.edu/index.html

Required resources

Students generally must be able to complete the requirements of their course without the imposition of fees that are additional to the student contribution amount or tuition fees. However, students may be charged certain incidental fees or be expected to make certain purchases to support their study. For more information about this, go to Administrative Information for Higher Education Providers: Student Support, Chapter 21, Incidental Fees at: http://www.innovation.gov.au/HigherEducation/TertiaryEducation/ResourcesAndPublications/Pages/default.aspx

VPI software is available in the laboratory for the lab tasks and the design project. The instructions for each lab will be available. Experimental equipment/ accessories are also available to offer.

Technological requirements

Students should regularly check the Moodle site for updates and announcements. Students are encouraged to bring a laptop/tablet/smart-phone/etc to class for quick quizzes, however these devices are not required to complete the course.

Other information

Policies

Monash has educational policies, procedures and guidelines, which are designed to ensure that staff and students are aware of the University's academic standards, and to provide advice on how they might uphold them. You can find Monash's Education Policies at: http://www.policy.monash.edu/policy-bank/academic/education/index.html

Graduate Attributes Policy

http://www.monash.edu/policy-bank/academic/education/course-governance-and-design/course-design-policy

Student Charter

http://www.monash.edu/students/policies/student-charter.html

Student Services

The University provides many different kinds of services to help you gain the most from your studies. Contact your tutor if you need advice and see the range of services available at: http://www.monash.edu/students

Monash University Library

The Monash University Library provides a range of services, resources and programs that enable you to save time and be more effective in your learning and research.
Go to http://www.monash.edu/library or the library tab in http://my.monash.edu.au portal for more information.

Disability Support Services

Students who have a disability, ongoing medical or mental health condition are welcome to contact Disability Support Services.

Disability Support Services also support students who are carers of a person who is aged and frail or has a disability, medical condition or mental health condition.

Disability Advisers visit all Victorian campuses on a regular basis.

- Website: monash.edu/disability
- Telephone: 03 9905 5704 to book an appointment with an Adviser;
- Email: disabilitysupportservices@monash.edu
- Drop In: Level 1, Western Annexe, 21 Chancellors Walk (Campus Centre) Clayton Campus