FUNDAMENTALS OF MOBILE COMMUNICATIONS - 2024/5

Module code: EEEM017

Module Overview

Expected prior/parallel learning: It is helpful, but not essential, to take module EEE3006 – Digital Communications, or to have equivalent learning.

Module purpose: This module equips students with fundamental knowledge and skills of mobile/personal communications systems design and forms the basis for the students to conduct further learning of advanced mobile technologies in EEEM018 – Advanced Mobile Communication Systems and EEEM061 – Advanced 5G Wireless Technologies.

Module provider

Computer Science and Electronic Eng

Module Leader

MA Yi (CS & EE)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 7

Module cap (Maximum number of students): N/A

Overall student workload

Independent Learning Hours: 90

Lecture Hours: 30

Tutorial Hours: 10

Guided Learning: 10

Captured Content: 10

Module Availability

Semester 1

Prerequisites / Co-requisites

None.

Module content

Indicative content includes the following.

Fundamental theory of communications, mobile communications, and wireless networks: modelling point-to-point communications; elements of mobile communication systems; elements of wireless networks which include fundamental problems of multiple access channel, broadcast channel, relay channel, two-way channel. and crosstalk channel. Capacity theorems and outage behaviour of fundamental channel models will be introduced. Application use-cases which relate theory to practice.

Mobile Propagation Channel & Physical Impairments: Large-scale path loss. Small-scale fading (mobility and channel time variation, wideband channel and frequency selectivity, timing, channel diversity), noise temperature. Theory and practice of handling the impact of physical channels.

Interferences and Competition: Four-terminal interference channel; Signal-to-interference noise ratio (SNR/SINR); Fundamentals of interference behaviour; Capacity theorem in competition environments.

Energy efficiency: Energy vs. Spectral Efficiency; modelling cellular system power/energy consumption; energy efficiency - spectral efficiency trade-off in cellular system

Air-Interface, Waveforms & Multiple-access: Common elements of an air interface; fundamentals of 4G waveforms and beyond; from waveform to multiple-access

Resource Allocation & Optimisation: Static vs. dynamic resource allocation; user and power allocations; elements of convex optimisation.

Densification & Heterogeneous Network: Densification process & small cells; fundamental of heterogeneous network; implementing densification (backhauling, cell association, load balancing, handover issues in heterogeneous network)

Cooperative communication: fundamental of relay based (supportive) communication (Amplify and Forward); fundamental of joint processing communication (cooperation vs. coordination); implementing cooperative communication

Assessment pattern

Assessment type	Unit of assessment	Weighting
Coursework	Group Assignment	20
Examination	2HR CLOSE-BOOK EXAM	80

Alternative Assessment

Alternative assessment (resit) as to the group assignment will be an individual assignment (individual report).

Assessment Strategy

The summative assessment for this module consists of the following.

· Group assignment: joint technical written report on selected topics in wireless communication (20%).

· 2 hrs close-book examination (80%).

Formative assessment and feedback

For the module, students will receive formative assessment/feedback in the following ways.

· During lectures, by question and answer sessions

· During tutorials/tutorial classes

· Via the marking of written reports

· Via assessed coursework

Module aims

- The aim of the module is to equip the students with the knowledge of mobile/personal communications engineering fundamentals, present the problems and possible solutions as well as familiarise them with the currently operational digital mobile communication systems in and their comparisons, as well as the international standardisation activities on future systems.
- The module also aims to provide opportunities for students to learn about the Surrey Pillars listed below.

Learning outcomes

Ref		Attributes Developed	
001	Describe the need and main purpose for the basic building blocks in modern mobile communication systems including the mobile propagation channel, relaying channel, interference behaviour, cooperative communications, MIMO, OFDM	KC	M1, M6
002	Explain the underlying principles of mobile communication systems	KC	M2, M6
003	Analyse, simulate and solve simple problems involved in link-level design	KCT	M2, M3
004	Explain the underlying concept and reasons for different design choices and report on them in written form	KCPT	M5, M16, M17

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to achieve the following aims.

- To equip students with deep understanding of the fundamental theory of mobile communications
- To facilitate students with strong capability of devising mobile communication systems and link-level resource planning.
- To develop the students' ability to work within the mobile communications industry and quickly perform a useful role in analysing, designing or managing mobile communication systems, or to enter an advanced research programme on this topic

Learning and teaching methods include the following.

- Lectures: face to face lecturing
- Seminars: face to face with technical discussions
- Tutorials: online tutorials
- Capture contents: pre-recorded videos of lecture contents
- Independent learning: this includes group assignment and other independent learning activity.

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: EEEM017

Other information

Digital Capabilities: Through this module students learn to utilise the Virtual Learning Environment @ Surrey (SurreyLearn) and other digital tools including MS-Teams Online Collaborative writing, Poll Everywhere. Students are also introduced to MATLAB SiteViewer 3D Radio Coverage Analyser, which is the state-of-the-art software platform for simulating and analysing radio propagation behaviours and radio coverage. This is unique digital capability students can develop from the University of Surrey as so far; no other universities in the world are offering this opportunity.

Employability: This module has a good combination of theory and practice. It starts from fundamental theory of mobile communications (such as Shannon theory and mobile propagation channels) and gradually moves to relatively advanced topics (such as advanced radio resource management, spectral and energy efficiencies). Through learning of those theoretical parts, students will lay a solid foundation for their future academic development such as entering PhD programme or further academic career development. Moreover, through case studies and group coursework, students will develop strong ability and skills to solve real-world problems in the wireless domain using the theory they have learned from this module. Students will also develop skills of using state-of-the-art software platform (SiteViewer) to solve practical problems that wireless industry is currently facing. All of these will equip our students very competitive capabilities of handling practical wireless problems.

Global and Cultural Capabilities: this module is delivered in an interactive and collaborative way, in a cohort that commonly represents a wealth of nationalities and backgrounds. Students are encouraged to engage with, and learn from, diverse perspectives through in-class group learning and group coursework activity.

Sustainability: one of key topics in this module is on energy efficiencies and green communications. Through seminars and tutorials, students will learn how to optimally use radio resources (spectrum and energy) in mobile networks with guaranteed Quality of Services and/or Quality of Experiences. Through coursework activities, students will learn the sustainable development of future mobile networks.

Resourcefulness and Resilience: this module provides rich learning resources which are made available and accessible through SurreyLearn. Those resources include youtube videos on state-of-the-art or bluesky wireless technology, TED talks, MIT online lectures. SurreyLearn also provided pre-recorded lectures, videos of past tutorials and seminars, past exam papers, case study materials. Moreover, students can have a taste of the world's largest 4G /5G test network at the University of Surrey, Stag Hill Campus.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
5G and Future Generation Communication Systems MSc	1	Compulsory	A weighted aggregate mark of 50% is required to pass the module
Communications Networks and Software MSc	1	Compulsory	A weighted aggregate mark of 50% is required to pass the module
Computer and Internet Engineering MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electrical and Electronic Engineering MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering MSc	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering with Computer Systems MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering with Nanotechnology MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering with Space Systems MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
RF and Microwave Engineering MSc	1	Optional	A weighted aggregate mark of 50% is required to pass the module