Universidad de Alcalá

TEACHING GUIDE

Mobile Communications

Degree in
Telecommunication Technologies Engineering (GITT)
Telematics Engineering (GIT)
Telecommunication Systems Engineering (GIST)
Electronic Communications Engineering (GIEC)

Universidad de Alcalá

Academic Year 2024/2025

4th Year - 1st Semester (GITT+GIT+GIST+GIEC)

4th Year - 2nd Semester (GITT+GIT+GIST+GIEC)

Approved by the EPS School Board on June 14th, 2024

TEACHING GUIDE

Course Name:	**Mobile Communications**
Code:	**350035 (GITT+GIT+GIST+GIEC)** **390001 (GITT+GIT+GIST+GIEC)**
Degree in:	**Telecommunication Technologies Engineering (GITT)** **Telematics Engineering (GIT)** **Telecommunication Systems Engineering (GIST)** **Electronic Communications Engineering (GIEC)**
Department and area:	**Teoría de la Señal y Comunicaciones** **Signal Theory and Communications**
Type:	**Optional (Specialized) (GITT)** **Optional (Generic) (GIT+GIEC)** **Compulsory (GIST)**
ECTS Credits:	**6.0**
Year and semester:	**4th Year - 1st Semester (GITT+GIT+GIST+GIEC)** **4th Year - 2nd Semester (GITT+GIT+GIST+GIEC)**
Teachers:	Jose Antonio Portilla Figueras Donato Rodríguez Alonso
Tutoring schedule:	To be known at the beginning of the term.
Language:	Spanish/English friendly

1. COURSE SUMMARY

Mobile Communications course is a subject that deals with the integration and application of all the knowledge and capacities acquired by the student in previous courses related to radio propagation, design and dimensioning and traffic. The subject starts with the well known 2G GSM system, very appropriate for teaching purposes, continues with the 3G UMTS system, the first interference limited systems and establishes the premises for 4G systems. For all these systems, the course will focus on the Wireless Radio Access.

During this subject the student, will tackle a real world problem, that is the design and dimensioning of the BTS and Node B layout in a city from the scratch. To do this, the student will form a work team (4 students) and perform all the required task, form city information search (population, terrain, topography), access network optimization, equipment determination, aggregation network design and finally costing of the services. The project ends with a public presentation and defence of the results.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/352/2009:

en_TR3 - Aptitude to solve problems with initiative, decision making, creativity, and to communicate and to transmit knowledge, skills and workmanship, comprising the ethical and professional responsibility of the activity of the Technical Engineer of Telecommunication.

en_TR8 - Capacity of working in a multidisciplinary and multilingual team and of communicating, both in spoken and written language, knowledge, procedures, results and ideas related to telecommunications and electronics.

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the Orden CIN/352/2009:

en_CST2 - Ability to apply the techniques on which telecommunication networks, services and applications are based, both in fixed and mobile environments, personal, local or at a great distance, with different bandwidths, including telephony, broadcasting, television and data, from the point of view of transmission systems.

en_CST6 - Ability to analyze, encode, process and transmit multimedia information using analog and digital signal processing techniques.

Learning Outcomes

After succeeding in this subject the students will be able to:

RA1. To identify 2G/3G/4G reference architecture as well as the specific features of "intermediate" systems, as GPRS or HSDPA

RA2. Design and develop software tools to calculate the coverage area of a given site (BTS, NodeB or eNodeB) under propagation and capacity criteria on multiuser and multiservice environments with multimedia characteristics

RA3. Develop the strategic deployment plan of a mobile communication network on a specific area (district, town, village, city).

RA4. Calculate investment cost, with their corresponding depreciation and the cost per service unit.

3. CONTENTS

Contents Blocks	Total number of hours
Module 1. Mobile Communications Fundamentals. In this lesson general concepts and fundamentals of mobile communications are introduced. General concepts of telecommunication networks. Functional, structural, owner and time model to describe de network. Services and their parameters. Definition of traffic and Erlang. Network design and planning tasks. Noise and interference sources, receiver sensibility, link budget. Empirical propagation models. Frequency planning. Basic traffic concepts, business hour, Chapman-Kolmogorov equations. Erlang B model.	6 hours
Module 2. Second Generation (2G) Mobile Communication Systems GSM system architecture. Base Station Subsystem, Network Switching Subsystem, OAM System. Network elements, capacity constraints, costs. BTS types and features. Practical examples. TDMA air interface, logic and physical channels. Traffic models in the air interface with and without handover, with and without traffic priority. Cell range determination under capacity and propagation criteria. Network deployment estimation in a specific. Determination of cell radius, and deployment in cities, practical cases.	8 hours
Module 3. Third Generation (3G) Mobile Communication Systems. IMT 2000 framework. UMTS specific features. WCDMA air interface. Logical and physical channels. Network architecture. 3G 2G comparison. Multiservice cell range dimensioning. HSPA introduction.	8 hours
Module 4. Aggregation Network and Cost Calculation Aggregation network definition. Capacity and topology calculation. System allocation. Investment calculations, amortization, cost per minute and cost per Kbps.	4 hours
Module 5: 4G and 5G Fundamentals LTE system evolution, physical access design, cell deployment principles. 5G fundamentals and state of art	4 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	58 hours (56 hours on-site +2 exams hours)
Number of hours of student work:	92
Total hours	150

4.2. Methodological strategies, teaching materials and resources

Teaching methodology is based on a model that tries to increment the autonomy of the student, making him discover the relations among different concepts and their applications to the proposed problems. To do that, there will be theoretical explanations where the main concepts of the subject will be described. Material will based on slides on power point (or similar), white papers, articles on journal or computer experiments.

Practical work will be done solving theoretic (solved by hand) and computer based problems. Professor will try to boost up the discussion to make students participate and collaborate in order to further fix the concepts.

Lab work will be done in teams of 4 or 5 students. Each team will develop Excel based network design planning tools that are oriented to the support the development of the Final Project. This Final Project consists on the design of the cell deployment and aggregation network calculation for a specific Spanish city, considering multiservice traffic and, of course all the specific features (demographic and geographic) of the area under study.

All along the subject, all ICT resources available are going to be used. From geographic software (as Google earth), through MS Excel, Matlab and so on.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary call.

Continuous Assessment:

The assessments are:

1. Intermediate exams: The student must certified accurate theoric and practical capabilities to solve real-world cases using computer tools. There are two cases
    1. For a GSM system, determine number and type of BTS and the corresponding investment costs.
    2. Fora UMTS system, determine number and type of B Node and the corresponding investment costs.
2. Final exam. It consists on de resolution of a complete design and dimensioning problems at a countrywide level. To do that, GSM and UMTS technologies will be deployed and the aggregation network will be calculated. Finally services cost will be derived from previous results. Doing so, the students will demonstrate their global knowledge of the system.

3. Final Project: As it is explained in the previous section, students in groups of 4-5 will act as a consulting company that has to design and calculate the network deployment for a specific area. At the end of the project, the group will make a presentation of the results and send a report (calculus and description).

Assessment through final exam:

Final exam, where all concepts and techniques must be applied to a whole design problem.

Extraordinary Call

There are two possibilities

1. For students that have followed the continuous assessment in the ordinary call, assessment will be based on the Final Exam and the Final Project.
2. For students that have followed the final assessment, it will be based only in the Final Exam.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined:

CE1. Student show abilities to solve complex problems in the field of mobile communications

CE2. The student is able to solve the whole mobile network design, under capacity and coverage criteria, starting from a set of requirements that includes cost and investment factors.

CE3. Student show the abilities to write technical reports about mobile communications, as well as to present the results of the report to an audience.

CE4. The student must obtain technical knowledge about different mobile communication system, their architectures, their specific features as well as their design parameters.

CE5. The student is able to design and implement excel based software tools for the design and dimensioning of mobile communication networks

GRADING TOOLS

The work of the student is graded in terms of the assessment criteria above, through the following tools:

1. Ordinary call
    a. Continuous assessment, with two assessment exams (PEI1,PEI2).
    b. Final assessment (PEF)
    c. Final project (E)
2. Extraordinary call.
    1. Final assessment (PEF)
    2. Final assessment and Final Project

GRADING CRITERIA

Ordinary call

In the ordinary call-continuous assessment the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CST2, CST6 TR3	RA1, RA3	CE1, CE4, CE6	PEI1	10%
CST2, CST6 TR3	RA1, RA3	CE1, CE4, CE6	PEI2	15%
CST2, CST6 TR3	RA5 - RA5	CE1-CE5	PEF	40%
CST2, CST6, TR3, TR8	RA2-RA5	CE1-CE5	E	35%

There are two further conditions to pass the subject.

1. The grade of PEI1+PEI2+PEF must be over 32.5 points.
2. Due to the practical essence of the final project, and following the normative, the grade obtained in the Final Project must be over 17.5 points,

In the ordinary call-final evaluation, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CST2, CST6	RA1-RA5	CE1-CE5	PEF	100%

Extraordinary call

For those students that have attended to continuous assessment in the ordinary call.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CST2, CST6 TR3	RA1-RA5	CE1-CE5	PEF	70%
CST2, CST6, TR3, TR8	RA2-RA5	CE1-CE5	E	30%

For those students that have **not** attended to continuous assessment in the ordinary call.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CST2, CST6	RA1-RA5	CE1-CE5	PEF	100%

6. BIBLIOGRAPHY

- Comunicaciones Moìviles, Jose Maria Hernando Rabanos, Segunda Edicioìn, Editorial Centro de Estudios Ramoìn Areces, S.A.
- GSM,GPRS and EDGE perfomance, Evolution Towards 3G/UMTS. Edited by Timo Halonen, Javier Romero, Juan Melero.Wiley 2003.
- WCDMA for UMTS, RAdio Access For Third Generation Mobile Communications, Edited by Harri Holma and Antti Toskala, Wiley 2000 .

Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.