Course guide
300258 - NETENG - Network Engineering

Last modified: 11/05/2026

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 744 - ENTEL - Department of Network Engineering.

Degree: MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Compulsory subject).

Academic year: 2026 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Check https://mitra.upc.es/SIA/infoweb.unitatDocent?w_idioma=ENG&w_codi_ud_p=300258

Others: Check https://mitra.upc.es/SIA/infoweb.unitatDocent?w_idioma=ENG&w_codi_ud_p=300258

PRIOR SKILLS

Be graduated in engineering or sciences having completed the corresponding credits. Basic knowledge of mathematics.

REQUIREMENTS

There are no requirements

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
04 MTM. (ENG) Analizar, modelar y diseñar redes de comunicaciones de gran escala.
06 MTM. (ENG) Modelar, diseñar, implementar y evaluar sistemas competitivos, cooperativos y dinámicos.

Generical:
06 RES. (ENG) Resolver problemas y mejorar procesos en cualquier ámbito social a partir de la aplicación de las TIC, integrando conocimientos de diversos ámbitos y aplicando ingeniería de alto nivel tecnológico.
03 DIS. (ENG) Diseñar aplicaciones de alto valor añadido basadas en las Tecnologías de la Información y las Comunicaciones (TIC), aplicadas a cualquier ámbito de la sociedad.

Transversal:
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
06 URI. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Basic:
CB7. Students will be able to apply the acquired knowledge and their ability to solve problems in new or little explored environments in broader (or multidisciplinary) contexts related to their study area.

TEACHING METHODOLOGY

The lectures consist essentially of lectures by the professor (encouraging the active participation of students), but also ask students to work certain parts of the course on their own (self-learning) from materials provided by teacher (slides, documents on use cases / products, book chapters, etc.).
The concepts of theory is reinforced by doing exercises, which will in many cases the solution, thus providing a self-assessment of learning achieved in each unit and activity.
Practical sessions and the project based on use cases is done in pairs using simulation and planning software tools

LEARNING OBJECTIVES OF THE SUBJECT

Objectives:

Analyze, model and design large-scale networks, services and systems governed by dynamic, deterministic or random processes.

STUDY LOAD

Type	Hours	Percentage
Hours large group	6,5	8.67
Self study	48,0	64.00
Guided activities	17,0	22.67
Hours small group	3,5	4.67

Total learning time: 75 h

CONTENTS

Unit 1. Lecture 1, 2 Title: Introduction to large-scale dynamic systems (1 week)

Description:
• Introduction to large-scale dynamic systems.
• Taxonomy, classification
• Complex systems. Dynamical systems. Models
• Graph theory and networks. Taxonomy, classification.

Related activities:
• Definition of the course project composed of three uses cases.
• Complex systems: classification and tools
• Facilities sharing and network competition. A predator-prey system approach.
• Analysis and simulation tools

Full-or-part-time: 8h
Theory classes: 3h
Laboratory classes: 1h
Self study : 4h

Unit 2. Lecture 3, 4, 5 Title: Complex systems (1 week)

Description:
• Complex systems introduction
• Dynamical systems. Definitions and classification
• Logistic function
• Predator-Prey system
• Chaotic systems
• The logistic Map
• Dynamical systems with time delays. Hutchinson's time-delay model

Related activities:
Use Case 1:
- Facilities sharing and network competition. A predator-prey system approach

Full-or-part-time: 17h
Theory classes: 4h 30m
Laboratory classes: 1h 30m
Self study : 11h

Unit 3. Lecture 6, 7, 8 Title: Network models (1.5 weeks)

Description:
• Large-scale and robustness
• Random networks. Erdös-Rényi model. Percolation.
• Small-world networks
• Watts-Strogatz and Newman-Watts models
• Phase transition
• Scale-free networks
• Power law distribution

Related activities:
Use Case 2:
• Analysis of an Internet Service Provider

Full-or-part-time: 18h
Theory classes: 4h 30m
Laboratory classes: 1h 30m
Self study : 12h

Unit 4. Lecture 9, 10, 11 Title: Growing networks models (1.5 weeks)

Description:
• Models of network formation
• Price's model
• Uniform attachment model
• Preferential attachment. Barabási-Albert model
• Non-linear preferential attachment
• Fitness model

Related activities:
Use Case 3:
• Modelling temporal evolution of network and services provider:
Formation, growth and evolution.

Full-or-part-time: 17h
Theory classes: 4h 30m
Laboratory classes: 1h 30m
Self study : 11h

Unit 5. Lecture 12 Title: Competitive and cooperative systems (1 week)

Description:
• Game Theory. Inverse Game Theory
• Static (finite and continuous) games
• Finite Games. Decisions. Utility maximization
• Dominant strategies. Cooperative outcomes: Prisoner's dilemma.
• Nash equilibrium: pure and mixed strategies
• Dynamic games. Cournot competition

Related activities:
Use Case 3 (cont.):
• Profit maximization. Internet service provider

Full-or-part-time: 12h
Theory classes: 1h 30m
Laboratory classes: 0h 30m
Self study : 10h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

Check https://mitra.upc.es/SIA/infoweb.unitatDocent?w_idioma=ENG&w_codi_ud_p=300258

BIBLIOGRAPHY

Basic:
- Newman, M. E. J. Networks : an introduction. Oxford ; New York: Oxford University Press, 2010. ISBN 9780199206650.
- Sayama, Hiroki. Introduction to the modeling and analysis of complex systems. Geneseo, New York: Open SUNY Textbooks, Milne Library, State University of New York, 2015. ISBN 9781942341086.
- Barron, E. N. Game theory : an introduction. 2nd ed. Hoboken, N.J.: John Wiley & Sons, cop. 2008. ISBN 9781118216934.
- Barabási, Albert-László. Network Science Book [on line]. [Consultation: 03/10/2018]. Available on: networksciencebook.com.
- Marinescu, Dan C. Complex systems and clouds : a self-organization and self-management perspective. First edition. Amsterdam: Elsevier, [2008]. ISBN 9780128040416.

Complementary:
- Srikant, R. Communication Networks : an optimization, control, and stochastic networks perspective. Cambridge University Press, 2014. ISBN 9781107036055.
- Chiang, Mung. Networked life : 20 questions and answers [Recurs electrònic] [on line]. Cambridge ; New York: Cambridge University Press, 2012 [Consultation: 26/07/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1025055. ISBN 9781139570145.