300258 - NETENG - Network Engineering

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 744 - ENTEL - Department of Network Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Teaching unit Compulsory)
ECTS credits: 3
Teaching languages: English

Coordinator: Sallent Ribes, Sebastian

Opening hours
Timetable: Monday between noon and 2 PM.

Prior skills
Be graduated in engineering or sciences having completed the corresponding credits

Requirements
There are no requirements

Degree competences to which the subject contributes

Basic:
04 MTM. (ENG) Analizar, modelar y diseñar redes de comunicaciones de gran escala.

Specific:
06 MTM. (ENG) Modelar, diseñar, implementar y evaluar sistemas competitivos, cooperativos y dinámicos.

General:
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.
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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

<table>
<thead>
<tr>
<th>Total learning time: 75h</th>
<th>Hours large group:</th>
<th>6h 30m</th>
<th>8.67%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
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<td>Hours small group:</td>
<td>3h 30m</td>
<td>4.67%</td>
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<td>Guided activities:</td>
<td>17h</td>
<td>22.67%</td>
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<td></td>
<td>Self study:</td>
<td>48h</td>
<td>64.00%</td>
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### Content

<table>
<thead>
<tr>
<th>Unit 1. Lecture 1, 2 Title: Introduction to large-scale dynamic systems (1 week)</th>
<th>Learning time: 8h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>• Introduction to large-scale dynamic systems.</td>
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<tr>
<td>• Taxonomy, classification</td>
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<tr>
<td>• Complex systems. Dynamical systems. Models</td>
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<tr>
<td>• Graph theory and networks. Taxonomy, classification.</td>
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<td><strong>Related activities:</strong></td>
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<td>• Definition of the course project composed of three uses cases.</td>
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<td>• Complex systems: classification and tools</td>
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<td>• Facilities sharing and network competition. A predator-prey system approach.</td>
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<td>• Analysis and simulation tools</td>
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<tr>
<th>Unit 2. Lecture 3, 4, 5 Title: Complex systems (1 week)</th>
<th>Learning time: 17h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
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<tr>
<td>• Complex systems introduction</td>
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<tr>
<td>• Dynamical systems. Definitions and classification</td>
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<td>• Logistic function</td>
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<td>• Predator-Prey system</td>
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<td>• Chaotic systems</td>
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<td>• The logistic Map</td>
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<td>• Dynamical systems with time delays. Hutchinson’s time-delay model</td>
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<tr>
<td><strong>Related activities:</strong></td>
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<tr>
<td>Use Case 1:</td>
<td></td>
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<tr>
<td>- Facilities sharing and network competition. A predator-prey system approach</td>
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</tbody>
</table>
## Unit 3. Lecture 6, 7, 8 Title: Network models (1.5 weeks)

**Learning time:** 18h  
Theory classes: 4h 30m  
Laboratory classes: 1h 30m  
Self study: 12h

**Description:**  
- Large-scale and robustness  
- 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

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

**Learning time:** 17h  
Theory classes: 4h 30m  
Laboratory classes: 1h 30m  
Self study: 11h

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

Learning time: 12h
- Theory classes: 1h 30m
- Laboratory classes: 0h 30m
- Self study: 10h

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

Qualification system

- Class participation: 10%
- Uses cases and final presentation project: 40%
- Midterm exam: 20%
- Quizzes: 10%
- Final exam: 20%

Bibliography

Basic:

Complementary: