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: 2018
Degree: MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Teaching unit Compulsory)
ECTS credits: 3
Teaching languages: English

Teaching staff
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 non requirements

Degree competences to which the subject contributes

Basic:
CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

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.

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: 6h 30m</th>
<th>8.67%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group: 3h 30m</td>
<td>4.67%</td>
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<td></td>
<td>Guided activities: 17h</td>
<td>22.67%</td>
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<tr>
<td></td>
<td>Self study: 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>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 3h</td>
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<tr>
<td>Laboratory classes: 1h</td>
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<tr>
<td>Self study: 4h</td>
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**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 use cases.
- Complex systems: classification and tools
- Facilities sharing and network competition. A predator-prey system approach.
- Analysis and simulation tools

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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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</thead>
<tbody>
<tr>
<td>Theory classes: 4h 30m</td>
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<tr>
<td>Laboratory classes: 1h 30m</td>
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<tr>
<td>Self study: 11h</td>
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</table>

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

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
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</table>
| • Large-scale and robustness  
• Small-world networks  
• Watts-Strogatz and Newman-Watts models  
• Phase transition  
• Scale-free networks  
• Power law distribution |

<table>
<thead>
<tr>
<th>Related activities:</th>
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</table>
| Use Case 2:  
• Analysis of an Internet Service Provider |

<table>
<thead>
<tr>
<th>Learning time: 18h</th>
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</table>
| Theory classes: 4h 30m  
Laboratory classes: 1h 30m  
Self study: 12h |

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

<table>
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<tr>
<th>Description:</th>
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| • Models of network formation  
• Price’s model  
• Uniform attachment model  
• Preferential attachment. Barabási-Albert model  
• Non-linear preferential attachment  
• Fitness model |

<table>
<thead>
<tr>
<th>Related activities:</th>
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| Use Case 3:  
• Modelling temporal evolution of network and services provider: Formation, growth and evolution. |

<table>
<thead>
<tr>
<th>Learning time: 17h</th>
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</table>
| Theory classes: 4h 30m  
Laboratory classes: 1h 30m  
Self study: 11h |
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: