Universidad
de Alcalá

TEACHING GUIDE

Contents distribution networks

**Master in
Telecommunication Engineering**

Universidad de Alcalá

Academic Year 2023/2024

1st Year - 2nd Semester

TEACHING GUIDE

Course Name:	**Contents distribution networks**
Code:	**201808**
Master in:	**Telecommunication Engineering**
Department and area:	**Automática** **Ingeniería Telemática**
Type:	**Compulsory**
ECTS Credits:	**4.5**
Year and semester:	**1st Year, 2nd Semester**
Teachers:	Por definir
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	Spanish / English-Friendly

1. COURSE SUMMARY

Prerequisites:

To have prior knowledge in network switching.

Description:

The course studies different mechanisms existing today for the content distribution in communications networks: Content Distribution Networks (CDNs), IP multicast and Peer to-Peer networks (P2P).

Content Distribution Networks (CDNs) allow the deployment of services based on IP communications in a scalable and efficient way as well as mechanisms to achieve high availability in the provided services. Thus, the most common architectures not only involve the servers providing the services, but also other elements such as load balancers, caches, DNS servers, etc.

The IP multicast technology is widely used by Internet Service Providers (ISPs) to achieve efficient distribution of multimedia content over IP networks since it allows the use of point-multipoint data flows efficiently. The course delves into its operation and behaviour, advantages and disadvantages.

Finally, the most relevant aspects of Peer-to-Peer networks are studied in relation to the technologies most commonly used nowadays. Therefore, the operation of structured Peer to-Peer networks such as Chord or Kademlia and services such as BitTorrent are studied in depth, which require making use of concepts such as storage, search and recovery in Peer-to-Peer networks.

All previous described solutions can be used independently or combined, and, currently, they are the most commonly used for content distribution in web-type services, multimedia "streaming" distribution based on IPTV, and in massive on-line games.

The course complements the skills for service design and data networks performance optimisation. The different content distribution mechanisms are studied from descriptive, architectural and algorithmic points of view, making emphasis in typical use cases to study and compare the different aforementioned technologies.

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/355/2009:

en_CGT1 - Skill of analysis and synthesis.

en_CGT2 - Skill of organization and planning.

en_CGT3 - Skill to analyze and search for information from diverse sources

en_CGT4 - Skill to make decisions.

en_CGT5 - Skill to adapt to new situations.

en_CB6 - To have and understand knowledges that provide a basis or opportunity to be original in the development and/or application of ideas, often in a research context

en_CB7 - That students know how to apply the acquired knowledge and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area

of study.

en_CB10 - That students have the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.

en_CT1 - Troubleshooting skill

en_CT3 - Skill to work in a team

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/355/2009:

en_CTecTel4 - Ability to design and dimension transport, broadcast and distribution networks of multimedia signals.

en_CTecTel6 - Ability to model, design, implement, manage, operate and maintain networks, services and contents.

en_EURACE - Link to the correlation table between the Learning Outcomes, according to the ENAEE (European Network for Accreditation of Engineering Education) standards, and the Master's subjects where the corresponding skills are acquired.

Learning Outcomes

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

RA1. To know and use the different existing mechanisms for content distribution.

RA2. To know and use the different mechanisms based on caches, load balancers and DNS to improve content distribution in data networks.

RA3. To know and use the basic principles of multicast routing in IP networks.

RA4. To know and use the different mechanisms provided by the Peer-to-Peer networks.

RA5. To apply the knowledge from previous aforementioned technologies to select and/or design a content distribution service.

3. CONTENTS

Contents Blocks	Total number of hours
Module 1. Introduction: motivations, definitions and use cases.	2 hours
Module 2. Content Delivery Networks: VRRP, load balancers, caches, DNS, high availability architectures and use cases.	12 hours
Module 3. Multicast: multicast addressing, IGMP, multicast routing and its applications.	12 hours
Module 4. Peer-to-Peer networks: Peer-to-Peer networks taxonomy, structured Peer-to-Peer networks, Chord, Kademlia and BitTorrent.	12 hours
Module 5. Transversal skills: project presentations of the course.	6 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	45 hours
Number of hours of student work:	68 hours (including study, activities, forms, reports, course project)
Total hours	113 hours

4.2. Methodological strategies, teaching materials and resources

"Flipped learning" and class activities	By using "flipped learning", the lecturer in class will solve any doubts related to the personal work tasks requested previously. Besides, complementary activities will be done to consolidate the most relevant contents as well as assess the acquired knowledge from the students.
Cooperative team works	Along the course, different practical laboratories are requested as well as a course project in which the students not only need to demonstrate their technical knowledge, but also their team work capacity and cooperative skills.
Personal training	The students must prepare individually the "flipped learning" classes and make use of the required time to finish the requested individual/group activities.

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 proposed evaluation process is inspired by continuous evaluation, although, respecting the regulations of the University of Alcalá, the student may take the final evaluation. To qualify for the final evaluation, students of the Master's Degree will have to request it in writing to the director of the Master's Degree in the first two weeks of teaching the subject, explaining the reasons that prevent them from following the continuous evaluation system. The evaluation of the learning process of all students who do not submit an application in this regard or see it denied will be carried out, by default, according to the continuous evaluation model described below. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call

Continuous Assessment:

The course has a practical orientation to acquire te required knowledge and skills related to content distribution; hence, the assessment tools are as follows:

1. **Class activities (AC).** During the classes, different activities, problem and exercises would be done to later assess the acquired skills from the students.
2. **Laboratory deliverables (EL).** Performance of laboratory practices and delivery of the corresponding deliverables in which the student must demonstrate the acquired knowledge and technical skills.
3. **Project of the course (PA).** A final project of the course to not only demonstrate the acquired knowledge and technical skills, but also their team organisation, team work and autonomous capabilities.

The students must submit the deliverables according the laboratory practices as well as the final project of the course following the established schedule.

Assessment through final exam:

In the case of evaluation by means of a final exam, the evaluation elements to be used will be a**Final Assessment (PEF).**

Extraordinary Call

The procedure will be the same as that described for the assessment by means of a final exam in the ordinary call.

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. The student demonstrates skills related to theory, comprehension and use of the concepts and basic mechanisms related to content distribution in data communication networks.

CE2. The student demonstrates skills related to theory, comprehension and use of the concepts and basic mechanisms related to CDNs.

CE3. The student demonstrates skills related to theory, comprehension and use of the concepts and basic mechanisms related to multicast routing in IP networks.

CE4. The student demonstrates skills related to theory, comprehension and use of the concepts and basic mechanisms related to Peer-to-Peer networks.

CE5. The student demonstrates skills to apply the acquired knowledge from the studied technologies in the course in order to select/design/deploy a basic content distribution service.

GRADING TOOLS

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

1. Ordinary call based on continuous assessment:
    a. **Class activities (AC).** Results from the different activities performed during the course.
    b. **Laboratory deliverables (EL).** Deliverables reporting the results from the laboratories

programmed during the course.

  c. **Project of the course (PA).** Presentation and deliverable reporting the results from the project of the course.

  d. **Final assessment (PEF).** Assessment considering all the knowledge and skills that must be acquired to surpass the course.

2. Extraordinary call based on final assessment (PEF).

Both passive and active plagiarism in any requested activity, deliverable or project will be penalised according the public normative from the University of Alcalá.

GRADING CRITERIA

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

Skills	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB7, CT1, CTecTel4	RA1-RA4	CE1-CE4	AC	30%
CB7, CGT1, CT3, CTecTel4	RA1-RA4	CE1-CE4	EL	30%
CB6, CB10, CGT2-CGT5, CT3, CTecTel4, CTecTel6	RA5	CE5	PA	40%

According to the continuous assessment evaluation, the student must acquire an appropriate level in the acquisition of the necessary skills and learning outcomes. To guarantee this acquisition, the student must pass the PA with a score over its 50% value since the PA is essential in the ordinary call-continuous assessment.

The "Non-presented" mark will be given if the student in ordinary call based on continuous assessment does not present any deliverable.

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

Skills	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6, CB7, CB10, CGT1-CGT5, CT1, CT3, CTecTel04, CTecTel06	RA1-RA5	CE1-CE5	PEF	100%

Extraordinary call

The same procedure used in **ordinary call-final evaluation**.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Chandra Kopparapu. "Load Balancing Servers, Firewalls, and Caches". Editorial Wiley, 2002.
- Iván Vidal, Ignacio Soto, Albert Banchs, Jaime Garcia-Reinoso, Iván Lozano, Gonzalo Camarillo. "Multimedia Networking Technologies, Protocols and Architectures. Editorial Artech House 2019.
- R. Steinmetz and K. Wehrle, Peer-to-Peer Systems and Applications (Lecture Notes in Computer Science). Secaucus, NJ, USA: Springer-Verlag New York, Inc., 2005.

6.2. Additional Bibliography

- Markus Hofmann. "Content Networking: Architecture, Protocols, and Practice". Editorial Morgan Kaufmann, 2005.Beau Williamson. "Developing IP Multicast Networks Vol.I". Editorial Cisco Press, 1999.
- Eng Keong Lua, Jon Crowcroft, Marcelo Pias, Ravi Sharma and Steven Lim, "A Survey and Comparison of Peer-to-Peer Overlay Network Schemes", IEEE Communications Survey and tutorial, March 2004.
- Bram Cohen, "Incentives Build Robustness in BitTorrent", Technical Report.

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.