Universidad de Alcalá

TEACHING GUIDE

Traffic Engineering

Degree in
Telematics Engineering

Universidad de Alcalá

Academic Year 2021/2022

4th Year - 1st Semester

Approved by the School Board on July 6, 2021

TEACHING GUIDE

Course Name:	**Traffic Engineering**
Code:	**380007**
Degree in:	**Telematics Engineering**
Department and area:	**Automática** **Automatic**
Type:	**Compulsory**
ECTS Credits:	**6.0**
Year and semester:	**4th Year, 1st Semester**
Teachers:	José Manuel Giménez Guzmán
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	Spanish/English friendly

1. COURSE SUMMARY

Pre-requisites:

"Traffic Engineering" is a compulsory 6 ECTS course included in the first semester – fourth year of the Engineering Degree on Telematics and an optional 6 ECTS course included in the second semester – fourth year of the Engineering Degree on Telecommunication technologies. Students who enrol in this course are recommended to have already studied the courses "Network Architectures" I and II and "Communication Networks".

Description:

"Traffic Engineering" course, together with "Signaling & Switching" course, deals with network performance issues, including switching, signaling, reliability and quality of service. Both courses complement the basic knowledge about circuit-switching networks that is provided in the "Communication Networks" course.

Traffic engineering aims at controling traffic in data networks to improve their performance and quality of service. In this course the need of providing quality of service is justified, studying traffic control techniques for its implementation. It is also an objective of the course to study the techniques used in traffic engineering to control data flows. One of the most prominent technologies to implement those techniques is Multi Protocol Label Switching (MPLS). In this course we thoroughly study this technology along with some of its applications, as, for example, virtual private networks (VPN).

Practical contents include activities related to configuration and analysis of small testbeds with routers, both in real and virtual environments.

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_TR2 - Knowledge of basic subjects and technologies that enables to learn new methods and technologies, as well as to provide versatility that allows adaptation to new situations.

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_TRU1 - Capacity of analysis and synthesis.

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_CTE2 - Ability to apply the techniques on which telematic networks, services and applications are based, such as management systems, signaling and switching, routing and routing, security (cryptographic protocols, tunneling, firewalls, collection, authentication and protection mechanisms). contents), traffic engineering (graph theory, queuing theory and teletraffic), pricing and reliability and quality of service, both in fixed, mobile, personal, local or long-haul environments, with different bandwidths, including telephony and data.

en_CTE3 - Ability to build, operate and manage telematic services using analytical planning, sizing and analysis tools.

en_CTE5 - Ability to follow the technological progress of transmission, switching and process to improve networks and telematic services.

Learning Outcomes

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

RA1. Apply algorithms and techniques that are used to achieve quality of service in data networks.

RA2. Identify quality of service architectures for IP networks.

RA3. Identify the features and foundations of the label-based switching.

RA4. Describe the MPLS applications, especially, virtual private networks.

3. CONTENTS

Contents Blocks	Total number of hours

Module 1. Quality of service in IP networks:
• Introduction.
• Algorithms and basic techniques:
  ◦ Shaping.
  ◦ Classification and marking.
  ◦ Policing.
  ◦ Active queue management.
  ◦ Scheduling.
• Integrated Services (IntServ) model.
  ◦ Resource reservation protocol (RSVP).
• Differentiated Services (DiffServ) model.
	16 hours

Module 2. Label switching:
• MPLS.
• Label distribution.
• MPLS applications:
  ◦ Layer 3 and layer 2 Virtual Private Networks (VPNs).
  ◦ Traffic engineering and control.
  ◦ Protection and restoration: traffic re routing.
	12 hours

Module 3. Laboratory assignments: • Module 1 laboratory assignments (Quality of service in IP networks). • Module 2 laboratory assignments (MPLS and traffic engineering).	26 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

Theoretical lessons (in large groups)	• Practical concept presentation and/or review. • Problem solving.
Practical lessons (in small groups)	• Practical lab sessions oriented to strengthen previously presented concepts, as well as to familiarize the student with hardware and software tools that are useful to support the study of the subject and future professional performance.
Tutoring and consutancy (individual and groups, in-room, e-mail, etc)	• Solving questions. • Support to self-learning.
Autonomous working	• Reading assignments. • Activities: exercises, search for information. • Preparation of assessment tools.

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 (Regulations for the Regulation of Teaching Learning Processes, NRPEA, 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 Regulations for the Evaluation of Apprenticeships (approved by the Governing Council on March 24, 2011 and modified in the Board of Directors). Government of May 5, 2016) 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.** The evaluation of the learning process of all students who do not apply for final evaluation or are denied it will be done, by default, according to the continuous assessment model.
- **Extraordinary Call.** The assessment procedure of the extraordinary call is similar to the one of final evaluation of 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 shows ability and initiative for solving practical problems related to algorithms and techniques that can be used to achieve quality of service.

CE2. The student is able to identify the different quality of service architectures that exist for IP networks.

CE3. The student shows that has achieved the technical knowledge about the operation and consequences of label-based switching.

CE4. The student is able to describe the different applications of MPLS, especially virtual private networks.

GRADING TOOLS

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

- **Intermediate and Final assessments (PEI and PEF)** PEI and PEF include theoretical essay and/or test questions and/or one or more exercises.
- **Laboratory assessment (PL)**: it includes questions related to the work performed in the laboratory assignments.
- **Previous tests (TP)**: it deals with the fulfillment of tests to previously check the understanding of the essential concepts of some laboratory assignments.
- **Tracking tests (PS)**: it consists of answering a questionnaire or check the correct operation after finishing laboratory assignments.

GRADING CRITERIA

- **Ordinary call, continuous assessment**: in the ordinary call-continuous assessment the relationship between the skills, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
TR2, TR3, TRU1, CTE2, CTE3, CTE5	RA1, RA2	CE1, CE2	PEI	35%
TR2, TR3, TRU1, CTE2, CTE3, CTE5	RA1-RA4	CE1-CE4	TP, PS	13%
TR2, TR3, TRU1, CTE2, CTE3, CTE5	RA1-RA4	CE1-CE4	PL	17%
TR2, TRU1, CTE2, CTE5	RA3, RA4	CE3, CE4	PEF	35%

Those students that, following the continuous assessment, do not present any of the grading tools (PEI, PEF and PL), will have the qualification of "Not presented" in the ordinary call.

- **Ordinary call, final evaluation**: in the ordinary call-final evaluation, the relationship between the

skills, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
TR2, TR3, TRU1, CTE2, CTE3, CTE5	RA1-RA4	CE1-CE4	PEF	100%

In the PEF of the "Ordinary call, final evaluation" the part related to the laboratory assignments will have a weight of 30%.

- **Extraordinary call**: the students that need the extraordinary call will be ruled by:

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
TR2, TR3, TRU1, CTE2, CTE3, CTE5	RA1-RA4	CE1-CE4	PEF	100%

In the PEF of the Extraordinary call" the part related to the laboratory assignments will have a weight of 30%.

Those students that have followed the continuous assessment in the ordinary call and have not passed the subject, can use their mark of the PL. In that case, the student will not perform the part of the exam related to the laboratory assignments, so he/she will obtain the 70% of his/her mark from the PEF of the extraordinary call and the remaining 30% from his/her mark obtained in the PL performed in the continuous assessment.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

There is not a single book that includes the whole syllabus of the subject. At the end of each lesson it will be shown the used references. Part of the books can be accessed through the UAH in the website http://proquest.safaribooksonline.com/. The most used books are:

Quality of service:

- H.J. Chao, X. Guo, “Quality of Service Control in High-Speed Networks”, John Wiley & Sons, 2002.
- K.I. Park, “QoS in Packet Networks”, MITRE Corp., 2005.
- Z. Wang, “Internet QoS: Architectures and Mechanisms for Quality of Service”, Morgan Kaufmann Publishers, 2001.
- T. Szigeti, R. Barton, C. Hattingh, K. Briley Jr. "End-to-End QoS Network Design: Quality of Service for Rich-Media & Cloud Networks" 2nd Ed, Cisco Press, 2014.

Label switching:

- H. Perros, “Connection-oriented Networks: SONET/SDH, ATM, MPLS and Optical Networks”, John Wiley & Sons, 2005.
- I. Minei, J. Lucek, “MPLS-Enabled Applications”, John Wiley & Sons, 3rd Ed, 2011.
- V. Alwayn, “Advanced MPLS Design and Implementation”, Cisco Press, 2001.

6.2. Additional Bibliography

- W. Stallings “Redes e Internet de Alta Velocidad, Rendimiento y Calidad de Servicio", 2nd Ed. Prentice Hall, 2004.
- G. Armitage "Quality of service in IP network", Macmillan Technical Publishing. 2000.
- L. De Ghein, “MPLS Fundamentals”, Cisco Press, 2007.
- E. Osborne, “Traffic engineering with MPLS”, Cisco Press, 2002.

Disclosure Note

The University of Alcalá guarantees to its students that, if due to health requirements the competent authorities do not allow the total or partial attendance of the teaching activities, the teaching plans will achieve their objectives through a teaching-learning and evaluation methodology in online format, which will return to the face-to-face mode as soon as these impediments cease.