Course guide
270016 - XC - Computer Networks

Last modified: 30/01/2024

Unit in charge: Barcelona School of Informatics
Teaching unit: 701 - DAC - Department of Computer Architecture.

Degree: BACHELOR'S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, English

LECTURER

Coordinating lecturer: LLORENÇ CERDÀ ALABERN

Others:

Primer quadrimestre:
LLORENÇ CERDÀ ALABERN - 13, 14, 43
JORDI DOMINGO PASCUAL - 41, 42, 43
FELIX FREITAG - 11
LEANDRO NAVARRO MOLDES - 11, 12, 13, 14, 41, 42
JORDI PAILLISSÉ VILANOVA - 12

Segon quadrimestre:
ROGER BAIG VIÑAS - 41, 42, 43
LLORENÇ CERDÀ ALABERN - 11, 12, 13, 23
JORDI DOMINGO PASCUAL - 31, 32, 33
PAU FERRER CID - 21, 51
FELIX FREITAG - 43
JORGE GARCÍA VIDAL - 21, 22, 23
LEANDRO NAVARRO MOLDES - 31, 51, 52, 53
JORDI PAILLISSÉ VILANOVA - 22, 33, 41
FATIMA YOLANDA RODRIGUEZ GALAN - 12, 42
AXEL TOMAS WASSINGTON - 13, 32

PRIOR SKILLS

Students are expected to have acquired a level of technical English that enables them to follow documentation, manuals and standards, as well as a basic understanding of computer structure: main computer components, input/output devices, bus, direct memory access, interrupts. They are also expected to be familiar with operating systems and have a user-level knowledge of UNIX, OS organisation, drivers, processes, communication between processes and data structures.

REQUIREMENTS

- Pre-Corequisite SO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CT2.3. To design, develop, select and evaluate computer applications, systems and services and, at the same time, ensure its reliability, security and quality in function of ethical principles and the current legislation and normative.
CT2.4. To demonstrate knowledge and capacity to apply the needed tools for storage, processing and access to the information system, even if they are web-based systems.
CT3.6. To demonstrate knowledge about the ethical dimension of the company: in general, the social and corporative responsibility and, concretely, the civil and professional responsibilities of the informatics engineer.
CT6.1. To demonstrate knowledge and capacity to manage and maintain computer systems, services and applications.
CT6.2. To demonstrate knowledge, comprehension and capacity to evaluate the structure and architecture of computers, and the basic components that compound them.
CT6.4. To demonstrate knowledge and capacity to apply the characteristics, functionalities and structure of the Distributed Systems and Computer and Internet Networks guaranteeing its use and management, as well as the design and implementation of application based on them.
CT7.1. To demonstrate knowledge about metrics of quality and be able to use them.
CT7.2. To evaluate hardware/software systems in function of a determined criteria of quality.
CT7.3. To determine the factors that affect negatively the security and reliability of a hardware/software system, and minimize its effects.
CT8.1. To identify current and emerging technologies and evaluate if they are applicable, to satisfy the users needs.
CT8.4. To elaborate the list of technical conditions for a computers installation fulfilling all the current standards and normative.

Generical:
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

TEACHING METHODOLOGY

The subject is composed of theory and laboratory classes. Concepts will be explained in the theory classes, and related exercises will be completed. Students will be assigned problems to be completed in class.

Laboratory work represents an important part of the course. Students should obtain, at the beginning of course, a laboratory notebook providing a brief explanation of the theory and guidelines for each practical. The face-to-face laboratory sessions will be scheduled once the corresponding concepts have been covered in theory classes. Students will prepare for these sessions by reviewing the relevant theoretical concepts. Each face-to-face session will conclude with a mini-test.

LEARNING OBJECTIVES OF THE SUBJECT

1.Identify the main functions associated with physical level protocols, links, networks, transport and networked applications and identify the level to which a protocol belongs.
2.Identify applications using a client-server paradigm and distinguish between temporary and well-known ports.
3.Predict protocol functioning and interpret the content of messages that use web, FTP, e-mail and DNS applications.
4.Interpret electronically represented documents (HTML and XML).
5.Interpret IP header fields, IP datagram fragmentation and messages generated by the ARP and ICMP protocols.
6.Interpret and deduce routing table content, predict RIP routing protocol behaviour and messages, design IP network address allocation, distinguish between public and private addresses and use NAT.
7.Design the basic configuration of a firewall (NAT, access lists and tunnels).
8.Differentiate between the services and functions for TCP and UDP and interpret header content for TCP segments and UDP datagrams.
9.Create time diagrams to model protocol behaviour in ARQ and particularly in TCP.
10.Predict TCP flow and congestion control behaviour, specifically the functioning of pop-up windows, segment transmission mechanisms, congestion windows and slow-start and congestion-avoidance algorithms.
11.Estimate the effective traffic rate for a TCP connection in different conditions (lags, link transmission speeds, segment losses, etc.).
12.Represent time diagrams representing MAC protocols for the local area networks studied.
13.Determine the active flow control mechanisms used for a local area network, traffic distribution according to station and device topology (hubs, switches and routers), distinguish between collision and broadcast domains, configure VLANs/trunks and determine the network topology for the configured VLAN.
14.Identify bottlenecks in a local area network and calculate the effective flow rate for different traffic conditions.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	10.00
Hours large group	30,0	20.00
Guided activities	6,0	4.00
Self study	84,0	56.00
Hours medium group	15,0	10.00

Total learning time: 150 h

CONTENTS

Introduction

Description:
Introduction to the Internet, packet networks, standardisation bodies and the ISO OSI reference model.

IP Networks

Description:
Knowing the format of an IP datagram. IP addressing, numbering, Pubic and Private IP addresses, subnetting. IP supporting protocols (ICMP, ARP, DHCP, DNS). IP routing, routing table and concepts of IGP and EGP routing algorithms. NAT and security in IP networks: Concept of firewall and virtual private networks.

TCP protocol

Description:
The transport layer and its most important functions. Automatic error retrieval protocols such as ARQ. TCP/IP network transport layers, UDP and TCP protocols and particularly TCP flow control and congestion control mechanisms. Application interfaces and the transport layer (sockets).

Local Area Networks

Description:
Transmission media and structured wiring. Principles of access protocols for a shared environment on a local area network, Ethernet protocol, switches, VLANs and trunking. Basic wireless networks and protocol 802.11 (WiFi).

Network applications

Description:
The client-server paradigm for TCP/IP network applications. Applications (web, e-mail, DNS) and the protocols they use (HTTP, SMTP). Main formats for representing application documents (HTML, XML).

ACTIVITIES

Topic development: Introduction

Full-or-part-time: 6h
Theory classes: 2h
Self study: 4h

Topic development: Network applications

Full-or-part-time: 16h 30m
Theory classes: 4h 30m
Practical classes: 2h
Self study: 10h

Network applications laboratory

Description:
Understand the HTTP, SMTP, POP3 and DNS protocols. Use system tools to monitor system activity and study system format and features.

Specific objectives:
3

Full-or-part-time: 3h 42m
Laboratory classes: 1h 42m
Self study: 2h

Topic development: IP networks

Full-or-part-time: 31h 30m
Theory classes: 9h
Practical classes: 4h 30m
Self study: 18h

Laboratory on basic commands for IP level configuration with UNIX

Description:
Interface configuration, adding entries to the routing table, /etc/hosts files and basic commands (ping, traceroute, tcpdump). Face-to-face laboratory session.

Specific objectives:
5

Full-or-part-time: 3h 42m
Laboratory classes: 1h 42m
Self study: 2h

CISCO routers laboratory and IOS

Description:
Router structure, IOS configuration modes, interface configuration, entries in the routing table and the show running-config command.

Specific objectives:
5, 6

Full-or-part-time: 3h 42m
Laboratory classes: 1h 42m
Self study: 2h

Dynamic routing laboratory: RIPv1 and RIPv2

Description:
Configuring RIP in a Cisco router. Record update messages and build routing tables.

Specific objectives:
6

Full-or-part-time: 3h 42m
Laboratory classes: 1h 42m
Self study: 2h

ACLs and NAT with IOS laboratory

Description:
Configuring standard and extended ACLs in IOS. NAT configuration.

Specific objectives:
7

Full-or-part-time: 3h 42m
Laboratory classes: 1h 42m
Self study: 2h

Topic development: TCP

Full-or-part-time: 22h 30m
Theory classes: 6h
Practical classes: 4h 30m
Self study: 12h

TCP and tcpdump practical

Specific objectives:
8, 9, 10, 11

Full-or-part-time: 3h 42m
Laboratory classes: 1h 42m
Self study: 2h

Topic development: Local area networks

Full-or-part-time: 18h
Theory classes: 4h
Practical classes: 4h
Self study: 10h

Switches laboratory

Description:
Configuring VLANs and trunk links between Cisco switches and routers.

Full-or-part-time: 3h 42m
Laboratory classes: 1h 42m
Self study: 2h

Laboratory mini-test on networked applications

Description:
15-minute test issued at the end of the laboratory session.

Specific objectives:
1, 2, 3

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 0h 18m
Guided activities: 0h 18m

Laboratory mini-test on basic commands for IP level configuration with UNIX

Description:
15-minute test issued at the end of the laboratory session.

Specific objectives:
1, 2, 3, 5, 6

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 0h 18m
Guided activities: 0h 18m

Laboratory mini-test on CISCO routers and IOS

Description:
15-minute test issued at the end of the laboratory session.

Specific objectives:
1, 2, 3, 4, 5, 6

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 0h 18m
Guided activities: 0h 18m

C: Control 1

Description:
Evaluation of the units Introduction and IP Networks.

Specific objectives:
1, 2, 5, 6, 7

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 7h 30m
Guided activities: 1h 30m
Self study: 6h

Laboratory mini-test on dynamic routing: RIPv1 and RIPv2

Description:
15-minute test issued at the end of the laboratory session.

Specific objectives:
1, 2, 3, 4, 5, 6

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 0h 18m
Guided activities: 0h 18m

Laboratory mini-test on ACLs and NAT with IOS

Description:
15-minute test issued at the end of the laboratory session.

Specific objectives:
1, 2, 3, 4, 5, 6, 7

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 0h 18m
Guided activities: 0h 18m

Laboratory mini-test on TCP and tcpdump

Description:
15-minute test issued at the end of the laboratory session.

Specific objectives:
1, 2, 3, 4, 5, 8, 9, 10, 11

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 0h 18m
Guided activities: 0h 18m

Laboratory mini-test on switches

Description:
15-minute test issued at the end of the laboratory session.

Specific objectives:
1, 2, 3, 4, 5, 10, 11, 12, 13, 14

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 0h 18m
Guided activities: 0h 18m

EL: Final laboratory exam

Description:
This exam will be issued in the last week of face-to-face classes as a directed activity (AD) (i.e. separate from the face-to-face laboratory sessions).

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 11, 13

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 6h
Guided activities: 1h
Self study: 5h

EF: Final theory exam

Specific objectives:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

Related competencies :
G7. AUTONOMOUS LEARNING: to detect deficiencies in the own knowledge and overcome them through critical reflection and choosing the best actuation to extend this knowledge. Capacity for learning new methods and technologies, and versatility to adapt oneself to new situations.

Full-or-part-time: 14h
Guided activities: 3h
Self study: 11h

GRADING SYSTEM

The evaluation of the subject will have two components: laboratory, NL, (30%) and theory, NT, (70%), that is: NF = 0.3 * NL + 0.7 NT

The laboratory grade, NL, will be calculated as: NL = 0.5 * CL + 0.5 * EL

Where CL is the average of the laboratory mini-assessments, and EL is the final laboratory exam. In order to be able to do the mini-assessments, a previous report must be delivered at the beginning of the session. If not delivered, the mini-assessment cannot be done, and the mark will be 0.

The theory note, NT, will have 2 parts. An assessment, C1, and a final exam, EF. These exams will be held during the midterm and final exam sessions scheduled by the faculty. C1 can release part of the EF.

The theory note will be calculated as: NT = 0.3 * max (C1, EF) + 0.7 * EF

Incentive to study. The final mark (NF) will be increased up to 1 point to students who meet the conditions below. The increase will be proportional to the NF obtained and the number of problems delivered as NFinc = NF + max(0, min(1, (NF-5)/2) * B), where B is the proportion of delivered problems.
1) Deliver on time the tracking problems that will be proposed during the course.
2) Have a grade NF greater to 5.

The mark of the transversal competence is computed as the average of the final exam marks of the presential and non presential labs.

BIBLIOGRAPHY

Basic:
- Kurose, J.F.; Ross, K.W. Computer networking: a top-down approach. 7th ed. Boston (Mass.) ; London ; Paris [etc.]: Pearson, 2017. ISBN 9781292153599.
- Stallings, W. Data and computer communications. 10th ed. Pearson/Prentice Hall, 2014. ISBN 0133506487.
- Tanenbaum, A.S.; Feamster, N.; Wetherall, D.J. Computer networks. Sixth edition. Harlow: Pearson, 2021. ISBN 9781292374062.
- Cerdà Alabern, L. Xarxes de computadors: conceptes bàsics. Barcelona: Edicions UPC, 2007. ISBN 9788483019344.

Complementary:
- Fall, K.R.; Stevens, W.R. TCP/IP illustrated: Vol. 1: the protocols. 2nd ed. Addison-Wesley, 2012. ISBN 9780321336316.
- Comer, D.E. Internetworking with TCP/IP: vol.1: principles, protocols and architecture. 6th ed. Upper Saddle River: Prentice-Hall International, 2014. ISBN 9780136085300.
- Møller, A.; Schwartzbach, M.I. An introduction to XML and Web technologies. Addison-Wesley, 2006. ISBN 9780321269669.

RESOURCES

Hyperlink:
- http://www.isoc.org/- ftp://ftp.upc.es/pub/doc/rfc/
- http://www.ietf.org/- http://www.w3.org/Consortium- http://www.cisco.com/en/US/docs/internetworking/technology/handbook/ito_doc.html