PORTUGUÊS	INGLÊS

S10. Subject Sheet/Course Syllabus – R5/R6

Institution:	**Instituto Superior de Engenharia do Porto**
Course:	**licenciatura em Engenharia Informática**
Subject/Unit:	**Redes de Computadores**

I – IDENTIFICATION				
Academic Year – 2025/26		**Subject Area/Group * - B**		**Internal Code – RCOMP**
Year:	**Sem:**	**Contact Time - Hours/Week:**	**ECTS:**	**Level (B/I/A)**:**
2	2	**1T; 1TP; 3PL (TOTAL: 12T; 12 TP; 36PL)**	6	B
Formal Prerequisites: approval in PRCMP course				
Subject Website URL: moodle.isep.ipp.pt				

Teaching Staff

	Name	**Position**	**Academic Background**	**% Occ.**
In charge	André Moreira (ASC)	Prof. Adjunto	MSc	100
Others				

*Fundamental Subjects (B), Engineering Science (C), Specialty (S), Option (O), Complementary subjects (P).

S11. Subject Sheet/Course Syllabus – R5/R6

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In charge	André Moreira (ASC)	Prof. Adjunto	MSc	100
Others				

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** Basic/Intermediate/Advanced

II – PROPÓSITOS, RESUMO, CARATERIZAÇÃO
Enquadramento (max. 600 caracteres) No contexto da Engenharia Informática, as comunicações de dados e redes de computadores são uma área fundamental com várias ramificações. Esta UC pretende ser uma abordagem abrangente, começando pela transmissão de dados digitais, projeto e gestão de redes até ao desenvolvimento de aplicações de rede. Em cada edição da UC os conteúdos são revistos para refletir as práticas tecnológicas no mundo real. Uma vez concluída com sucesso, esta UC proporciona também as competências necessárias para o envolvimento em UC mais específicas, como por exemplo Administração de Sistemas (ASIST).
Conhecimentos prévios assumidamente adquiridos - Física (FISAP) - Tecnologia informática (PRCMP). - Algoritmia, programação em C e Java (APROG e ARQCP).
Propósitos e objetivos (max. 750 caracteres) No final desta unidade curricular o estudante deve ser capaz de: **CO1.** Descrever os fundamentos teóricos da transmissão de dados digitais e detalhes técnicos sobre os *standards* LAN e WAN mais importantes, com ênfase na pilha TCP/IP. (Nível de Bloom: 2) **CO2.** Aplicar os protocolos de infraestrutura de rede associados à gestão, *routing* dinâmico, resolução de nomes e outros protocolos de aplicação. (NB: 3) **CO3.** Planear, implementar, configurar e gerir sistemas de cablagem estruturada e dispositivos de rede de nível 2 e nível 3. (NB: 4) **CO4.** Criar soluções de endereçamento e *routing* IPv4 para estruturas de rede complexas e gerir os respetivos serviços de rede. (NB: 4) **CO5.** Desenvolver protocolos e implementar aplicações de rede em linguagens C e Java. (NB: 3)

** Basic/Intermediate/Advanced

II – PURPOSES, OVERVIEW, DESCRIPTION
Framework (max. 600 characters) Computer communications and computer networks are key areas in Informatics Engineering, with several branches. This course intends to be a comprehensive approach to data communications and computer networks. Starting with digital data transmission, network project and management and up to network applications development. In each course edition, contents are revised to reflect the most important technological practices in the real world. After achieving approval at the RCOMP course students are also ready to enroll in more advanced and specific courses in related areas, for instance, the ASIST course (Systems Administration).
Required previous knowledge. - Physics of information and transmission technologies (FISAP course). - Computer technology (PRCMP course). - Algorithms, C and Java programming (APROG and ARQCP courses).
Purposes and objectives (max. 750 characters) By the end of this course, the student must be able to: **CO1.** Describe the theoretical fundamentals of digital data transmission and the technical details of the most important LAN and WAN standards, with emphasis on the TCP/IP. (Bloom level: 2) **CO2.** Apply the network infrastructure protocols, related to management, dynamic routing, names resolution, and other application protocols. (BL: 3) **CO3.** Design, implement and manage structured cabling systems and layer 2 and layer 3 devices. (BL: 4) **CO4.** Create IPv4 address and routing configuration solutions for complex network structures and manage the required network services. (BL: 4) **CO5.** Design network application protocols, develop and implement network applications in C and Java languages. (BL: 3)

Programa (max. 1000 caracteres)

CP1. Transmissão de dados digitais - 5%.
(Problemas associados à transmissão de sinais. Codificação e modulação. Projeto de sistemas de cablagem estruturada.)

CP2. Comunicação em rede - 5%.
(Topologias, endereçamento e encaminhamento. Deteção de erros, controlo de fluxo e erros.)

CP3. Arquiteturas de rede - 5%.
(MR-OSI, IEEE802, TCP/IP e outros. Modelo Cliente/Servidor.)

CP4. Tecnologias de rede de nível 2 - 20%.
(Redes locais comutadas. VLAN. Redes locais sem fios. Configuração de dispositivos de nível 2. Tecnologias WAN: ATM, DSL e outras.)

CP5. Pilha de protocolos TCP/IP - 45%
(IP, ARP, ICMP e IGMP. Endereçamento e encaminhamento. Mascaras de rede. UDP e TCP. Desenvolvimento de aplicações de rede UDP e TCP. Protocolos de encaminhamento dinâmico. Configuração de "routers". Firewall estático e NAT. IPv6.)

CP6. Protocolos de aplicação - 20%
(Resolução de nomes: NetBIOS e DNS. HTTP, web services, AJAX e REST. SMTP, POP3 e IMAP4. SNMP. VPN - PPTP, L2TP e outros.)

OBJETIVOS DE DESENVOLVIMENTO SUSTENTÁVEL (MIN. 1 - MAX. 4)

4 - Educação de qualidade

5 - Igualdade de género

12 - Consumo e produção responsáveis

Programme (max. 1000 characters)

CP1. Digital data transmission – 5%.
(Issues associated with signals' transmission. Codification and modulation. Structured cabling systems design.)

CP2. Network communication – 5%.
(Topologies, addressing and routing. Error detection, flow and error control.)

CP3. Network architectures – 5%.
(MR-OSI, IEEE802, TCP/IP, and others. Client/server model.)

CP4. Layer 2 network technologies – 20%.
(Switched local area networks. VLAN. Wireless local area networks. Layer 2 network devices configuration. WAN technologies: ATM, DSL, and others.)

CP5. TCP/IP protocol stack – 45%
(IP, ARP, ICMP and IGMP. Address and routing, network prefix. UDP and TCP. TCP and UDP network applications development. Dynamic routing protocols. Routers configuration. Static firewall and NAT. IPv6.)

CP6. Application protocols – 20%
(Name resolution: NetBIOS and DNS. HTTP, web services, AJAX and REST. SMTP, POP3 and IMAP4. SNMP. VPN – PPTP, L2TP, and others.)

SUSTAINABLE DEVELOPMENT GOALS (MIN. 1 – MAX. 4)

4 – Quality education

5 – Gender equality

12 – Responsible consumption and production

Material e ferramentas de ensino mais importante Documentos: - Documentação específica elaborada para a unidade, incluindo apresentações e guias para cada aula (disponibilizada no serviço Moodle). - Apresentações adicionais, vídeos e artigos, também disponibilizados através do serviço Moodle. Ferramentas: - Moodle ISEP (https://moodle.isep.ipp.pt) - Ferramentas e matérias de montagem de cablagens (Laboratório de Redes). - Cisco Packet Tracer. - Cisco 2811 routers e Cisco 2950 switches (Laboratório de Redes). - Bitbucket e GitHub. - Ambientes de desenvolvimento em linguagens C e Java. - *Cloud* privada de servidores virtuais do DEI.	**Most important studying material and tools** Documents: - Specific support documentation for the course, including presentations and scripts for each lecture and class. (Made available to students at the Moodle service). - Additional presentations, videos, and articles, also made available to students at the Moodle service. Tools: - ISEP Moodle (https://moodle.isep.ipp.pt) - Cabling mounting and testing tools (Networking Laboratory). - Cisco Packet Tracer. - Cisco 2811 routers and Cisco 2950 switches (Networking Laboratory). - Bitbucket and GitHub. - Java and C development environments. - DEI Virtual servers private cloud.
Material de ensino complementar - Monteiro, E., & Boavida, F. (2011). Engenharia de Redes Informáticas (10th Edition), FCA Editora - Dordal, P. (2020). An Introduction to Computer Networks (Edition 2.0.1), Department of Computer Science, Loyola University Chicago. http://intronetworks.cs.luc.edu/ - Tanenbaum, A., Feamster, N., & Wetherall, D. (2021). Computer Networks (6th Edition), Pearson - Kurose, F., & Ross, K. (2017). Computer Networking: A Top-Down Approach (7th Edition), Pearson - Stevens, R., Fenner, B., & Rudoff, A. (2004) UNIX Network Programming, The Sockets Networking API, Volume 1 (3rd Edition), Addison-Wesley	**Supplementary studying material** - Monteiro, E., & Boavida, F. (2011). Engenharia de Redes Informáticas (10th Edition), FCA Editora - Dordal, P. (2020). An Introduction to Computer Networks (Edition 2.0.1), Department of Computer Science, Loyola University Chicago. http://intronetworks.cs.luc.edu/ - Tanenbaum, A., Feamster, N., & Wetherall, D. (2021). Computer Networks (6th Edition), Pearson - Kurose, F., & Ross, K. (2017). Computer Networking: A Top-Down Approach (7th Edition), Pearson - Stevens, R., Fenner, B., & Rudoff, A. (2004) UNIX Network Programming, The Sockets Networking API, Volume 1 (3rd Edition), Addison-Wesley
Metodologia de ensino-aprendizagem E ARTICULAÇÃO COM MODELO PEDAGÓGICO (max. 500 carateres) T: Os alunos realizam o seu próprio estudo. Materiais adicionais nas aulas: filmes, apresentações e questionários (Active Student, Explore yourself, Reflection, Linking Old to New, Feedback, Early Warning, Embrace Correction).	**Teaching-learning methodology AND COORDINATION WITH PEDAGOGICAL MODEL** (max. 500 characters) T: Students make own study. Additional materials in lectures: films, presentations, questionnaires (Active Student, Explore yourself, Reflection, Linking Old to New, Feedback, Early Warning, Embrace Correction).

TP: Bases para as aulas PL. Apresentações e exercícios (Real world experience, Solution before abstraction) PL: Ensino baseado em problemas e projetos com acompanhamento e feedback contínuo pelo docente (Real world experience, Active student, Explore yourself, Groups work, Feedback, Early Warning, Embrace Correction).	TP: PL classes background. Presentations and exercises (Real world experience, Solution before abstraction). PL: Problems-based and projects-based learning with a close teacher's assistance and continuous feedback (Real world experience, Active student, Explore yourself, Groups work, Feedback, Early Warning, Embrace Correction).
Distribuição percentual estimada dos conteúdos • Componente científica – 30% • Componente tecnológica - 70 % • Componente contexto envolvente - 0 %	**Estimated percentage distribution of the contents.** • Scientific component – 30% • Technological component – 70 % • Surrounding context component- 0 %
Resultados expectáveis (em conformidade com os critérios EUR-ACE) **Knowledge and Understanding (#KU)** CO1 e CO2 **Engineering Analysis (#EA)** CO3, CO4 e CO5 **Engineering Design (#ED)** CO3, CO4 e CO5 **Investigations (#IN)** CO1, CO2, CO4 e CO5 **Engineering Practice (#EP)** CO3, CO4 e CO5 **Making Judgments (#MJ)** CO3, CO4 e CO5 **Communication and Team-working (#CT)** CO1 e CO2 **Lifelong Learning (#LL)** CO1, CO4 e CO5	**Outcomes** (according with the EUR-ACE criteria) **Knowledge and Understanding (#KU)** CO1 and CO2 **Engineering Analysis (#EA)** CO3, CO4, and CO5 **Engineering Design (#ED)** CO3, CO4, and CO5 **Investigations (#IN)** CO1, CO2, CO4, and CO5 **Engineering Practice (#EP)** CO3, CO4, and CO5 **Making Judgments (#MJ)** CO3, CO4, and CO5 **Communication and Team-working (#CT)** CO1 and CO2 **Lifelong Learning (#LL)** CO1, CO4, and CO5
III – PROCEDIMENTOS DE AVALIAÇÂO	**III – EVALUATION PROCEDURES**

 # Avaliação durante o semestre com avaliação final obrigatória

M1: Projeto1 (não repetível)
M2: Projeto2 (não repetível)
ADS: Avaliação Durante o Semestre
ADS = M1*0,8 + M2*0,2
Mínimo ADS = 9,50/20

EF: Exame Final
Mínimo EF = 7,00/20
Classificação Final = ADS*0,7 + EF*0,3

A avaliação em épocas de recurso e especiais segue o Regulamento de Avaliação dos Estudantes do Instituto Superior de Engenharia do Porto.

Observações

Todas as datas-limite de entrega devem ser cumpridas. Atrasos nas entregas podem ser impossíveis ou penalizadas de acordo com as instruções disponíveis na página da UC no Moodle.

#Código de conduta:
- cf. Regulamento Disciplinar dos Estudantes do IPP
- Nenhum estudante ou grupo pode assumir pertença de trabalho realizado por outrem ou desenvolvido em conluio.
- É expressamente proibido o uso de materiais, artefactos ou código de outrem sem a devida, e explícita e ostensiva indicação de origem (e.g. Internet, estudante, etc.).
- Código de outras fontes deve ser claramente identificado no próprio código, indicando o autor ou a fonte.
- Em caso de deteção de partilha entre grupos de materiais, artefactos e/ou código sujeito a avaliação, todos os grupos e estudantes envolvidos serão penalizados com nota zero, sendo tal reportado ao Presidente do ISEP para ações consequentes.
- Casos de apropriação ilícita (sem cooperação do(s) autores) de materiais, artefactos e ou código sujeito a avaliação, serão reportados ao Presidente do ISEP.

#Evaluation during the term with mandatory final evaluation

M1: Project1 (non-repeatable)
M2: Project2 (non-repeatable)
EDT: Evaluation During Term
EDT = M1*0.8 + M2*0.2
Minimum EDT = 9.50/20

FE: Final Exam
Minimum FE = 7.00/20
Final Grade = EDT* 0.7 + FE*0.3

The assessment during resit and special exams follows the *Regulamento de Avaliação dos Estudantes do Instituto Superior de Engenharia do Porto*.

Comments

All deadlines are to be honored. Late delivery of assignments/components may be impossible or penalized, according to the instructions available on Moodle.

#Code of conduct:
- cf. *Regulamento Disciplinar dos Estudantes do IPP*
- No individual or group can assume ownership of work that was not his own or was developed in collusion.
- Is strictly forbidden the use of unreferenced code and/or diagrams of other groups or other sources (e.g., Internet, etc.).
- Code from external sources must be clearly identified in the code itself, indicating the author or source.
- In case of detection of code sharing between groups, all groups involved will be penalized with grade zero, and the President of ISEP will be notified for further actions.
- Cases of theft of code (without the cooperation of the author) will be reported to the President of ISEP.

*) em Pedagogical Patterns: Advice for Educators; Pedagogical Pattern Editorial Board: Joseph Bergin, Jutta Eckstein, Markus Völter, Marianna Sipos, Eugene Wallingford, Klaus Marquardt, Jane Chandler, Helen Sharp, Mary Lynn Manns (Eds.); Published by Joseph Bergin Software Tools; 2012.

The ENAEE/IEA Glossary of Terminology (http://www.enaee.eu/publications/enaeeiea-glossary-of-terminology) is used to verify terms used in this document.

Melhoria de nota de avaliação

Depois de obterem aprovação, os alunos podem optar por efetuar melhoria apenas da nota do EF, ou do EF e da ADS. A melhoria da nota do EF consiste num exame escrito, a melhoria da nota da ADS consiste na escrita de um relatório formal sobre os dois projetos M1 e M2. O cálculo da nota de melhoria é baseado nas regras anteriormente estabelecidas para o apuramento da nota final. Se, e apenas se, o aluno optar por não realizar melhoria da nota da ADS, será usada a classificação anteriormente obtida nesse componente para calculo da nota final.

Nota biográfica do responsável da UC

Professor Adjunto do ISEP, Licenciado em Engenharia (FEUP) e Mestre em Ciências da Computação (Universidade do Minho). Exerce funções docentes no ISEP desde 1990 predominantemente em unidades curriculares da área de redes de computadores e administração de sistemas. Exerce no Departamento de Engenharia Informática do ISEP funções de administração de redes e sistemas. É, desde 2021, diretor do Laboratório de Redes do DEI. É, desde 2020, o coordenador da pós-graduação em Administração Avançada de Redes e Sistemas.
https://orcid.org/0000-0002-0523-336X

IV – INFORMAÇÃO PARA A3ES

Demonstração da coerência dos conteúdos programáticos com os objetivos da UC

Objetivo da UC <- Conteúdo programático promotor do objetivo

CO1 <- CP1, CP2, CP3, CP4, CP5

*) in Pedagogical Patterns: Advice for Educators; Pedagogical Pattern Editorial Board: Joseph Bergin, Jutta Eckstein, Markus Völter, Marianna Sipos, Eugene Wallingford, Klaus Marquardt, Jane Chandler, Helen Sharp, Mary Lynn Manns (Eds.); Published by Joseph Bergin Software Tools; 2012.
The ENAEE/IEA Glossary of Terminology (http://www.enaee.eu/publications/enaeeiea-glossary-of-terminology) is used to verify terms used in this document.

Grade improvement

After approval, students can choose to improve only the FE grade, or both the FE grade and the EDT grade. The improvement of the FE grade comprises a written exam, the improvement of the EDT grade consists in writing a formal report about the two projects M1 and M2. The final grade is calculated based on the previously established rules for the final course mark. If, and only if, the student chooses not to improve the EDT grade, then the previously attained classification in that component will be used to calculate the final course mark.

Biographical note of responsible of the course

Professor Adjunto at ISEP, Degree in Engineering (FEUP) and Master in Computer Sciences (*Universidade do Minho*). Teacher at ISEP since 1990, mostly in computer networking and systems administration courses. Plays an active role on systems and networks administration at *Departamento de Engenharia Informática*. Since 2021, is the director of the DEI Networking Laboratory. Since 2020, is the coordinator of the postgraduate course in Networks and Systems Advanced Administration.
https://orcid.org/0000-0002-0523-336X

IV – INFORMATION FOR A3ES

Demonstration of the syllabus coherence with the course objectives

Course Objective <- Programme's content promoting the objective/outcome

CO1 <- CP1, CP2, CP3, CP4, CP5

CO2 <- CP5, CP6 CO3 <- CP4, CP5, CP6 CO4 <- CP5, CP6 CO5 <- CP6	CO2 <- CP5, CP6 CO3 <- CP4, CP5, CP6 CO4 <- CP5, CP6 CO5 <- CP6
Demonstração da coerência das metodologias de ensino com a avaliação e os objetivos de aprendizagem da UC **CO1 e CO2** – Os alunos são levados a um papel ativo através do estudo das matérias e posterior envolvimento em discussões sobre esses temas nas aulas teóricas. Daqui resulta uma melhor compreensão dos assuntos do que a técnica expositiva simples. Para maior incentivo, as discussões realizadas nas aulas teóricas têm como base questionários semelhantes ao exame final no qual estes objetivos são avaliados. **CO3 e CO4** – O projeto 1 surge como um desafio do mundo real, organizado em 3 *sprints* e com avaliação individual de cada aluno no final de cada sprint, incluindo feedback imediato. Em cada *sprint*, um membro diferente assume o papel de sprint master, sendo o responsável pelas reuniões de *sprint planning* e *sprint review*. Estas estratégias visam consolidar a produtividade da equipa através da promoção da competitividade, mas também a entreajuda. **CO5** – O projeto 2 é o último sprint do "Projeto Integrador do 4º Semestre da LEI", com um trabalho colaborativo intenso através de ferramentas de controlo de versões e repositórios de código partilhados. Os membros do grupo implementam *user stories* relativas à programação em rede no contexto de um projeto de software mais vasto. A avaliação assenta sobre os *commits* realizados durante o projeto e na demonstração final das *user stories* que cada aluno implementou.	**Demonstration of the coherence between the teaching methodologies with the assessment and the learning outcomes** **CO1 and CO2** - Students are pushed into an active role by studying subjects on their own and then being subsequently enrolled in active discussions about the same subjects in lectures. This leads to a more comprehensive understanding of subjects than a traditional lecture. For further incentive, discussions undertaken in lectures are based on questionnaires simulating the final exam in which these outcomes are assessed. **CO3 and CO4** – The team project 1 is presented as a real-world challenge, organized in 3 sprints and with individual assessment after each sprint, including immediate feedback. In each sprint, one different team member takes a special role of sprint master, overseeing the sprint planning and review meetings. These strategies are aimed at consolidating the team's productivity by promoting competitiveness, but also assistance between team members. **CO5** - The team project 2 is the last sprint of the "Integrative Project of the 4th Semester of the LEI", with an intense collaborative work by using versions control tools and shared code hosting services. Team members implement user stories related to network programming in the context of much wider software project. The assessment is based on the commits during the project and in the final demonstration of the user stories implemented by each student.
DEMONSTRAÇÃO DA COMPATIBILIDADE DOS OBJETIVOS COM O MÉTODO DE ENSINO CO1 e CO2 (*Knowledge and Understanding*) – Os métodos expositivos combinados com debate sobre os temas promove a reflexão crítica dos alunos resultado numa melhor consolidação dos conhecimentos (Aulas T e TP)	**DEMONSTRATION OF COMPATIBILITY OF OBJECTIVES WITH THE TEACHING METHOD** CO1 and CO2 (Knowledge and Understanding) – The presentation of the subjects by the teacher and debate with students promotes a critical reflection by the students, resulting in a better consolidation of knowledge (T and TP classes).

CO3, CO4 e CO5 (*Engineering Practice*) – As técnicas PBL (*Problem-Based Learning and Project-Based Learning*) aplicadas nas aulas PL, permitem a aquisição das competências práticas abrangidas por estes objetivos.

CO3, CO4, and CO5 (Engineering Practice) – The PBL (Problem-Based Learning and Project-Based Learning) techniques enforced in PL classes, allow the acquisition of practical skills encompassed by these objectives.

V – PLANNING

W	T (1 HORAS/SEMANA)	TP (1 HORAS/SEMANA)	PL (2.5 HORAS/SEMANA)
1	Digital data transmission. Signals and transmission mediums. Digital signals and line coding. Analogue signals and digital modulation. Network communication. Network nodes and node addresses. Switching networks and shared medium networks. The packet concept. Payload and control information. Virtual circuits.	Transmission cables and physical medium. Network topologies. Structured cabling.	Cisco Packet Tracer tool installation. Project 1 enrolment. Project 1/Sprint 1 – structured cabling systems – development steps. Introduction to Ethernet LAN technology. Introduction to basic IPv4 addressing. ICMP – IP connectivity testing. Packet Tracer practice – shared medium networks and packet-switch networks.
2	Error detection. Network delays. Flow control. Error control. Network architectures. The OSI model. IEEE 802 Architecture (ISO 8802). TCP/IP Architecture. The client-server model.	Networking active devices. Hubs and repeaters. Switches and bridges. Routers. LAN Ethernet networks (802.3). LAN wireless networks (802.11).	Project 1/Sprint 1 follow-up. LAN and virtual LAN. IPv4 addressing. ARP tables. IPv4 packets routing. Classful IPv4 addressing. IPv4 static routing. Cisco Packet Tracer practice. Practical exercises. Shielded and unshielded twisted pairs copper cables. CAT6 copper patches wiring. Ethernet technology. IPv4 basic addressing. IPv4 connectivity testing with

V – PLANNING

W	T (1 HOURS/WEEK)	TP (1 HOURS/WEEK)	PL (2.5 HOURS/WEEK)
1	Digital data transmission. Signals and transmission mediums. Digital signals and line coding. Analogue signals and digital modulation. Network communication. Network nodes and node addresses. Switching networks and shared medium networks. The packet concept. Payload and control information. Virtual circuits.	Transmission cables and physical medium. Network topologies. Structured cabling.	Cisco Packet Tracer tool installation. Project 1 enrolment. Project 1/Sprint 1 - structured cabling systems – development steps. Introduction to Ethernet LAN technology. Introduction to basic IPv4 addressing. ICMP – IP connectivity testing. Packet Tracer practice – shared medium networks and packet-switch networks.
2	Error detection. Network delays. Flow control. Error control. Network architectures. The OSI model. IEEE 802 Architecture (ISO 8802). TCP/IP Architecture. The client-server model.	Networking active devices. Hubs and repeaters. Switches and bridges. Routers. LAN Ethernet networks (802.3). LAN wireless networks (802.11).	Project 1/Sprint 1 follow-up. LAN and virtual LAN. IPv4 addressing. ARP tables. IPv4 packets routing. Classful IPv4 addressing. IPv4 static routing. Cisco Packet Tracer practice. Practical exercises. Shielded and unshielded twisted pairs copper cables. CAT6 copper patches wiring. Ethernet technology. IPv4 basic addressing. IPv4 connectivity testing with

			ICMP echo messages. Mounting copper CAT6 patch panels and sockets.				ICMP echo messages. Mounting copper CAT6 patch panels and sockets.
3	Ethernet local area network technologies. Virtual local area networks (VLAN). Wireless local area networks.	Virtual LAN (VLAN). VLAN Trunking Protocol (VTP). Multiple VLAN Registration Protocol (MVRP). Spanning Tree Protocol (STP). Link Aggregation – LACP. Ethernet flow control.	Command Line Interface (CLI) management of network devices. A VLAN based layer two platform. VLAN Trunking Protocol (VTP). Spanning Tree Protocol (STP). Packet Tracer practice.	3	Ethernet local area network technologies. Virtual local area networks (VLAN). Wireless local area networks.	Virtual LAN (VLAN). VLAN Trunking Protocol (VTP). Multiple VLAN Registration Protocol (MVRP). Spanning Tree Protocol (STP). Link Aggregation – LACP. Ethernet flow control.	Command Line Interface (CLI) management of network devices. A VLAN based layer two platform. VLAN Trunking Protocol (VTP). Spanning Tree Protocol (STP). Packet Tracer practice.
4	WAN technologies: ATM/ISDN. Local loop: WLL, DSL, and cable.	Introduction to IPv4 operation. IPv4 addressing and network masks.	Project 1/Sprint 1 review presentations. Classless IPv4 addressing. IPv4 networks dimensioning with classless addressing (VLSM).	4	WAN technologies: ATM/ISDN. Local loop: WLL, DSL, and cable.	Introduction to IPv4 operation. IPv4 addressing and network masks.	Project 1/Sprint 1 review presentations. Classless IPv4 addressing. IPv4 networks dimensioning with classless addressing (VLSM).
5	The TCP/IP protocol stack. IPv4, ARP, UDP, BOOTP/DHCP, ICMP, TCP, and IGMP.	IPv4 routing and static routing tables. IPv4 dynamic routing.	VLAN support in Cisco routers – switching module or sub interfaces. Packet Tracer practice. DHCP service configuration in Cisco routers. Packet Tracer activities. Simplifying IPv4 routing tables.	5	The TCP/IP protocol stack. IPv4, ARP, UDP, BOOTP/DHCP, ICMP, TCP, and IGMP.	IPv4 routing and static routing tables. IPv4 dynamic routing.	VLAN support in Cisco routers – switching module or sub interfaces. Packet Tracer practice. DHCP service configuration in Cisco routers. Packet Tracer activities. Simplifying IPv4 routing tables.
6	IPv4 routing. Static routing and dynamic routing. Routing protocols: RIP, RIPv2, EIGRP and OSPF. Autonomous systems and route redistribution.	Static firewall. Cisco IOS standard and extended Access Control Lists. IP Named Access Control Lists.	Layer three redundancy. Dynamic routing with RIP, EIGRP and OSPF. Autonomous systems. Autonomous systems interconnection – routes redistribution. Cisco IOS Telephony Services (ITS). Packet Tracer activities. Accessing and managing a device through the console serial port. Initial	6	IPv4 routing. Static routing and dynamic routing. Routing protocols: RIP, RIPv2, EIGRP and OSPF. Autonomous systems and route redistribution.	Static firewall. Cisco IOS standard and extended Access Control Lists. IP Named Access Control Lists.	Layer three redundancy. Dynamic routing with RIP, EIGRP and OSPF. Autonomous systems. Autonomous systems interconnection – routes redistribution. Cisco IOS Telephony Services (ITS). Packet Tracer activities. Accessing and managing a device through the console serial port. Initial

			configuration and basic security of a device. Enabling SSH access to a Cisco device. Resetting a Cisco 2811 router to factory defaults.				configuration and basic security of a device. Enabling SSH access to a Cisco device. Resetting a Cisco 2811 router to factory defaults.
7	IPv6 and ICMPv6. Name resolution. DNS.	Network Address Translation (NAT). Static and dynamic NAT. Network Address Port Translation (NAPT).	Static firewall. Cisco IOS Access Control Lists. Network Address Translation. Static and dynamic NAT in Cisco IOS. Network Address and Port Translation (NAPT). Packet Tracer activities.	7	IPv6 and ICMPv6. Name resolution. DNS.	Network Address Translation (NAT). Static and dynamic NAT. Network Address Port Translation (NAPT).	Static firewall. Cisco IOS Access Control Lists. Network Address Translation. Static and dynamic NAT in Cisco IOS. Network Address and Port Translation (NAPT). Packet Tracer activities.
8	UDP and TCP network applications development.	Berkeley sockets API, C and Java. Address families and address storing. Basic functions/methods for UDP applications. UDP client and server. Setting a receive timeout. Using broadcast.	Project 1/Sprint 2 review presentations. DNS and HTTP services in Packet Tracer. Practical exercises – DNS, NAT, and ACLs. Packet Tracer activities. Reflexive ACLs.	8	UDP and TCP network applications development.	Berkeley sockets API, C and Java. Address families and address storage. Basic functions/methods for UDP applications. UDP client and server. Setting a receive timeout. Using broadcast.	Project 1/Sprint 2 review presentations. DNS and HTTP services in Packet Tracer. Practical exercises – DNS, NAT, and ACLs. Packet Tracer activities. Reflexive ACLs.
9	The HTTP application protocol. Web UI. Web services.	Berkeley sockets API, C and Java. Basic functions/methods for TCP applications. TCP client and server. Asynchronous reception.	Berkeley Sockets. Introduction to used environments: C/UNIX and JAVA. Simple UDP clients and servers.	9	The HTTP application protocol. Web UI. Web services.	Berkeley sockets API, C and Java. Basic functions/methods for TCP applications. TCP client and server. Asynchronous reception.	Berkeley Sockets. Introduction to used environments: C/UNIX and JAVA. Simple UDP clients and servers.
10	Network security and security layers, SSL/TLS and Ipsec. Virtual Private Networks, types and technologies, PPP, L2TP, PPTP and SSTP.	HTTP. Web services, RESTful web services, AJAX and Web UI. Analysing a simple HTTP server with AJAX support in C language.	UDP clients with timeout. UDP clients using broadcast. Implementing TCP clients and servers (C and Java).	10	Network security and security layers, SSL/TLS and IPsec. Virtual Private Networks, types and technologies, PPP, L2TP, PPTP and SSTP.	HTTP. Web services, RESTful web services, AJAX and Web UI. Analysing a simple HTTP server with AJAX support in C language.	UDP clients with timeout. UDP clients using broadcast. Implementing TCP clients and servers (C and Java).
11	Network management. The SNMP application protocol. Monitoring systems.	Network security. SSL/TLS network programming.	Project 1/Sprint 3 review presentations. Asynchronous reception. The select function	11	Network management. The SNMP application protocol. Monitoring systems.	Network security. SSL/TLS network programming.	Project 1/Sprint 3 review presentations. Asynchronous reception. The select function

			(C language). Implementing a TCP chat client and server (C and Java).
12	Electronic mail. SMTP, POP and IMAP. Webmail. MIME.	SNMP and services monitoring. Practical exercise with Packet Tracer.	Implementing a peer-to-peer UDP chat application (C and Java).
13	-	-	Implementing an HTTP server with AJAX support (C and Java).
14	-	-	Implementing a generic TLS client to test TCP servers. Securing network applications with SSL/TLS.
15	-	-	Project 2 review presentations.

Assessment Tools (one table for each)

NAME	Projeto 1
TOOL TYPE	Projeto em grupo, 3 ou 4 alunos por grupo.
ASSESSMENT TYPE	Sumativo e formativo
IMPLEMENTATION	Tem início na 1ª semana e termina na 10ª semana.
DESCRIPTION	Este projeto está organizado em três *sprints* com a duração de três ou quatro semanas cada. No primeiro sprint as equipas vão desenvolver um sistema de cablagem estruturada para um contexto físico dado. Nos segundo e terceiro sprints, vão desenvolver e testar no simulador a correspondente infraestrutura de rede de nível dois e nível três, incluindo todos os serviços de rede fundamentais. Após cada *sprint* o docente dá feedback durante a apresentação dos resultados do *sprint*. O progresso e avaliação do projeto é baseado no *Bitbucket*, embora seja um projeto em equipa, cada membro terá tarefas bem definidas e será avaliado individualmente. O esforço de cada aluno é estimado em um ECTS e meio, isso inclui nove horas de trabalho durante as aulas PL e trabalho adicional fora das aulas.

			(C language). Implementing a TCP chat client and server (C and Java).
12	Electronic mail. SMTP, POP and IMAP. Webmail. MIME.	SNMP and services monitoring. Practical exercise with Packet Tracer.	Implementing a peer-to-peer UDP chat application (C and Java).
13	-	-	Implementing an HTTP server with AJAX support (C and Java).
14	-	-	Implementing a generic TLS client to test TCP servers. Securing network applications with SSL/TLS.
15	-	-	Project 2 review presentations.

Assessment Tools (one table for each)

NAME	Project 1
TOOL TYPE	Group project, 3 or 4 students per group.
ASSESSMENT TYPE	Summative and formative
IMPLEMENTATION	It starts on the 1st week and ends on the 10th week.
DESCRIPTION	This project is organized in three sprints, three or four weeks long each. In the first sprint teams will design a structured cabling system for a given physical context. In the second and third sprints, the corresponding layer two and layer three network infrastructure with all fundamental network services will be designed and tested in a simulator. After each sprint, feedback by the teacher is given during the sprint review presentation. The project progress and assessment are based on Bitbucket, while it's a group project, each team member's tasks are well defined and will be individually assessed. Each student's effort is estimated to be one and a half ECTS, this includes nine hours of work during laboratory classes and additional extra classes work.

CRITERIA, RUBRICS, RATING SCALES	A contribuição de cada aluno, em cada *sprint* será avaliada através de critérios bem definidos. Todos os *sprints* terão o mesmo peso na classificação final individual do aluno. A classificação individual do projeto é expressa de 0 a 20, arredondada a duas casas decimais.

NAME	Projeto 2
TOOL TYPE	Projeto em grupo, 3 ou 4 alunos por grupo.
ASSESSMENT TYPE	Sumativo e formativo
IMPLEMENTATION	Tem início na 11ª semana e termina na 14ª semana.
DESCRIPTION	Este projeto faz parte do "Projeto Integrador do 4º Semestre da LEI", a cada membro do grupo serão atribuídas um conjunto de *user stories* relacionadas com a programação em rede, no contexto de um projeto de software muito mais abrangente. Os alunos são avaliados individualmente através das *user stories* que implementaram. O esforço de cada aluno é estimado em meio ECTS, isso inclui 3 horas de trabalho durante as aulas PL e trabalho fora das aulas.
CRITERIA, RUBRICS, RATING SCALES	A contribuição de cada aluno será avaliada através de critérios bem definidos. A classificação individual do projeto é expressa de 0 a 20, arredondada a duas casas decimais.

NAME	Exame
TOOL TYPE	Prova escrita.
ASSESSMENT TYPE	Sumativo.
IMPLEMENTATION	Fim do semestre, durante a época de exames.
DESCRIPTION	O objetivo é avaliar os conhecimentos de cada aluno sobre os temas teóricos e teórico-práticos. O exame é composto por dezassete questões de escolha múltipla, cada uma com uma resposta certa em quatro apresentadas. As respostas erradas são classificadas com zero, não existem penalizações adicionais por respostas erradas. Os alunos são encorajados a escrever um pequeno texto a justificar cada uma das respostas dadas.
CRITERIA, RUBRICS, RATING SCALES	O exame é classificado de 0 a 20 valores, arredondado a duas casas decimais. A nota mínima de exame para aprovação na UC é de 7,00.

CRITERIA, RUBRICS, RATING SCALES	The student contribution and performance in each sprint are assessed through specific grading criteria. All sprints have the same weight on the student's project individual grade. The Project's individual grade is rated from 0 to 20, rounded to two decimal places.

NAME	Project 2
TOOL TYPE	Group project, 3 or 4 students per group.
ASSESSMENT TYPE	Summative and formative
IMPLEMENTATION	Starts on the 11th week and ends on the 14th week.
DESCRIPTION	This project is part of the "Integrative Project of the 4th Semester of the LEI", each team member is assigned with a set of user stories related to network programming in the context of much wider software project. Students are individually assessed by the implemented user stories. Each student's effort is estimated to be half an ECTS, this includes three hours of work during laboratory classes and additional extra classes work.
CRITERIA, RUBRICS, RATING SCALES	The student contribution and performance are assessed through specific grading criteria. The project's individual grade is rated from 0 to 20, rounded to two decimal places.

NAME	Exam
TOOL TYPE	Written exam.
ASSESSMENT TYPE	Summative.
IMPLEMENTATION	End of semester, during the final exams period.
DESCRIPTION	The objective is to assess the student's knowledge about the all theoretical and theoretical-practical contents of the course. The exam is composed of seventeen multiple-choice questions, each having a single correct answer among the four given alternatives. Wrong answers are graded at zero, there are no additional penalties for wrong answers. Students are encouraged to write a small, non-mandatory, statement sustaining each answer.
CRITERIA, RUBRICS, RATING SCALES	The exam is rated from 0 to 20, rounded to two decimal places. The minimum exam mark for final course approval is 7.00.

Assessment Tools versus Outcomes

OUTCOME	PROJETO 1	PROJETO 2	EXAME
CO1			X
CO2			X
CO3	X		
CO4	X		
CO5		X	

Assessment Tools versus Outcomes

OUTCOME	PROJECT 1	PROJECT 2	EXAM
CO1			X
CO2			X
CO3	X		
CO4	X		
CO5		X	