ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

593000605 - Network Architecture And Protocols

DEGREE PROGRAMME

59AI - Master Universitario En Comunicaciones Inalámbricas

ACADEMIC YEAR & SEMESTER

2024/25 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	593000605 - Network Architecture And Protocols
No of credits	4.5 ECTS
Type	Compulsory
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	59AI - Master Universitario en Comunicaciones Inalámbricas
Centre	59 - Escuela Tecnica Superior De Ingenieria Y Sistemas De Telecomunicacion
Academic year	2024-25

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Antonio Perez Yuste (Subject coordinator)	8304	antonio.perez@upm.es	Sin horario.

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Linux OS

- Network protocols

4. Skills and learning outcomes *

4.1. Skills to be learned

CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación

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

CB8 - Que los estudiantes sean capaces de integrar conocimientos y enfrentarse a la complejidad de formular juicios a partir de una información que, siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos y juicios

CEM04 - Adquirir las destrezas que permitan analizar y diseÃ±ar la arquitectura, servicios y protocolos de la red de nÃºcleo de un sistema de comunicaciones mÃ³viles 4G y 5G.

CGI02 - Comprender el procedimiento, valor y límites del método científico, siendo capaz de identificar, localizar y obtener datos requeridos en un trabajo de investigación, de diseñar y guiar investigaciones analíticas, de modelado y experimentales, así como de evaluar datos de una manera crítica y extraer conclusiones.

CGI03 - Valorar la importancia de las fuentes documentales, manejarlas y buscar la información para el desarrollo de cualquier trabajo de investigación.

CGI04 - Leer y comprender publicaciones dentro de su ámbito de estudio/investigación, así como su catalogación y valor científico.

UPM1 - Uso de la lengua inglesa

UPM4 - OrganizaciÃ³n y planificaciÃ³n /

4.2. Learning outcomes

RA32 - Justify the use of SDN and NFV techniques in the central network of a modern mobile communications system

RA33 - Identify and distinguish between the interfaces and protocols of a modern mobile communications network

RA30 - Design and develop the components of a mobile communications network and its protocols based on technical specifications

RA31 - Analyze the control and traffic of mobile communications networks in the user and control planes

RA20 - RA05.- Interpret data derived from empirical observations and measurements in terms of their importance and relate them to the appropriate theory.

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

Network Architecture and Protocols (NAP) is aimed at studying he network architecture of modern mobile communication systems. as well as becoming familiar with the protocols used between the architecture components at both the control plane and the user plane, and mainly oriented to current 4G and 5G mobile communication networks.

While 4G commercial networks have been widely deployed by operators worldwide, year 2020 was the starting signal pointed out by relevant actors for 5G deployments. As 5G commercial networks are being deployed, 4G and 5G networks will coexist (both in core and radio networks). Thus, it is quite important to understand not only isolated 4G and 5G architectures but also their correspondence and merging opportunities available for operators.

Within this course, 4G and 5G architectures, interfaces, and protocols will be throughly presented, including basic procedures and low-level physical/local channels. In addition, the new Serviced Based Architecture paradigm will be introduced, and its relying technologies (SDN, NFV) will be presented.

5.2. Syllabus

1. IMT-2020, Introduction to the 5G System
    1.1. Why 5G is different?
    1.2. Roadmap of mobile communications
    1.3. Standardisation bodies
    1.4. 3GPP standardisation timeline
    1.5. 3GPP specification documents
    1.6. IMT-2020 and 3GPP usage scenarios
    1.7. Technical performance requirements
    1.8. The mobile market figures
    1.9. 5G use case study
2. System architecture evolution
    2.1. Public Land Mobile Networks (PLMNs)
    2.2. Architecture of GMS, UMTS, and LTE

6. Schedule

6.1. Subject schedule*

Week	Type 1 activities	Type 2 activities	Distant / On-line	Assessment activities
1	**U1. IMT-2020, Introduction to the 5G System** Duration: 04:00 Lecture	**U1. IMT-2020, Introduction to the 5G System** Duration: 02:00 Laboratory assignments		**U1. IMT-2020, Introduction to the 5G System** Online test Progressive assessment and Global Examination Not Presential Duration: 01:00 **U1. IMT-2020, Introduction to the 5G System** Individual work Progressive assessment and Global Examination Not Presential Duration: 02:00
2	**U2. System Architecture Evolution** Duration: 06:00 Lecture			**U2. System Architecture Evolution** Online test Progressive assessment and Global Examination Not Presential Duration: 01:00
3	**U3. Next Generation Core Network** Duration: 02:00 Lecture	**W1. Managing of Services in Linux** Duration: 04:00 Laboratory assignments		**W1. Managing of Services in Linux** Individual work Progressive assessment and Global Examination Presential Duration: 02:00
4	**U3. Next Generation Core Network** Duration: 04:00 Lecture	**W2. Open Files and Data Interchange Formats** Duration: 02:00 Laboratory assignments		**U3. Next Generation Core Network** Online test Progressive assessment and Global Examination Not Presential Duration: 01:00 **W2. Open Files and Data Interchange Formats** Individual work Progressive assessment and Global Examination Presential Duration: 02:00
5	**U4. Air Interface Layer 2** Duration: 04:00 Lecture	**W3. OPEN5GS CN + 5G UERANSIM in Linux** Duration: 02:00 Laboratory assignments		**U4. Air Interface Layer 2** Online test Progressive assessment and Global Examination Not Presential Duration: 01:00 **W3. OPEN5GS CN + 5G UERANSIM in Linux**

				Individual work Progressive assessment and Global Examination Presential Duration: 02:00
6	**U5. Registration Management** Duration: 02:00 Lecture	**W4. NF Service Registration and Subscription** Duration: 04:00 Laboratory assignments		**U5. Registration Management** Online test Progressive assessment and Global Examination Not Presential Duration: 01:00 **W4. NF Service Registration and Subscription** Individual work Progressive assessment and Global Examination Presential Duration: 02:00
7	**U6. Session Management** Duration: 02:00 Lecture **U7. Mobility management** Duration: 02:00 Lecture	**W5. PDU Session Setting-up Process** Duration: 02:00 Laboratory assignments		**U6-U7. Session Management and Mobility Management** Online test Progressive assessment and Global Examination Not Presential Duration: 01:00 **W5. PDU Session Setting-up Process** Individual work Progressive assessment and Global Examination Presential Duration: 02:00
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Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	U1. IMT-2020, Introduction to the 5G System	Online test	No Presential	01:00	5%	5 / 10	UPM5 CGI03 CGI02 CGI04 UPM1 CEM04 UPM4
1	U1. IMT-2020, Introduction to the 5G System	Individual work	No Presential	02:00	10%	5 / 10	CB6 CGI04 UPM1 CEM04
2	U2. System Architecture Evolution	Online test	No Presential	01:00	10%	5 / 10	CGI03 UPM1 CEM04 UPM4
3	W1. Managing of Services in Linux	Individual work	Face-to-face	02:00	10%	5 / 10	CGI03 CGI02 UPM1 CEM04 CB7 UPM4
4	U3. Next Generation Core Network	Online test	No Presential	01:00	10%	5 / 10	CGI03 CGI04 UPM1 CEM04
4	W2. Open Files and Data Interchange Formats	Individual work	Face-to-face	02:00	10%	5 / 10	CGI03 UPM1 CEM04 CB8
5	U4. Air Interface Layer 2	Online test	No Presential	01:00	10%	5 / 10	CGI02 CGI04 UPM1 CEM04 CB7

5	W3. OPEN5GS CN + 5G UERANSIM in Linux	Individual work	Face-to-face	02:00	10%	5 / 10	CGI03 CGI04 UPM1 UPM4
6	U5. Registration Management	Online test	No Presential	01:00	5%	5 / 10	CGI03 UPM1 CEM04 CB8
6	W4. NF Service Registration and Subscription	Individual work	Face-to-face	02:00	5%	5 / 10	UPM5 CGI02 UPM1 UPM4
7	U6-U7. Session Management and Mobility Management	Online test	No Presential	01:00	10%	5 / 10	UPM5 CGI04 UPM1 CEM04 UPM4
7	W5. PDU Session Setting-up Process	Individual work	Face-to-face	02:00	5%	5 / 10	UPM5 CB6 CGI02 UPM1 CEM04 CB8

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	U1. IMT-2020, Introduction to the 5G System	Online test	No Presential	01:00	5%	5 / 10	UPM5 CGI03 CGI02 CGI04 UPM1 CEM04 UPM4
1	U1. IMT-2020, Introduction to the 5G System	Individual work	No Presential	02:00	10%	5 / 10	CB6 CGI04 UPM1 CEM04
2	U2. System Architecture Evolution	Online test	No Presential	01:00	10%	5 / 10	CGI03 UPM1 CEM04 UPM4
3	W1. Managing of Services in Linux	Individual work	Face-to-face	02:00	10%	5 / 10	CGI03 CGI02 UPM1 CEM04 CB7 UPM4

4	U3. Next Generation Core Network	Online test	No Presential	01:00	10%	5 / 10	CGI03 CGI04 UPM1 CEM04
4	W2. Open Files and Data Interchange Formats	Individual work	Face-to-face	02:00	10%	5 / 10	CGI03 UPM1 CEM04 CB8
5	U4. Air Interface Layer 2	Online test	No Presential	01:00	10%	5 / 10	CGI02 CGI04 UPM1 CEM04 CB7
5	W3. OPEN5GS CN + 5G UERANSIM in Linux	Individual work	Face-to-face	02:00	10%	5 / 10	CGI03 CGI04 UPM1 UPM4
6	U5. Registration Management	Online test	No Presential	01:00	5%	5 / 10	CGI03 UPM1 CEM04 CB8
6	W4. NF Service Registration and Subscription	Individual work	Face-to-face	02:00	5%	5 / 10	UPM5 CGI02 UPM1 UPM4
7	U6-U7. Session Management and Mobility Management	Online test	No Presential	01:00	10%	5 / 10	UPM5 CGI04 UPM1 CEM04 UPM4
7	W5. PDU Session Setting-up Process	Individual work	Face-to-face	02:00	5%	5 / 10	UPM5 CB6 CGI02 UPM1 CEM04 CB8

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

The type of course and the approach described above make more convenient to select an assessment mechanism different to the traditional final exam. A progressive evaluation methodology is here proposed for this course, based on a set of short quizzes. This way, main concepts can be properly set up while the attractive of the contents are increased. In addition, the assessment of lab practices are based on the realisation of a report by the students. This report will be also evaluated in order to get the final grade.

Those students who do not meet the goals and do not pass the regular activities, will be able to attend an extraordinary exam organised on July. This will consist on two parts: firstly, a questionnaire selected among all topics in this course must be responded on-line and, secondly, a lab practice with several exercises related to the practical activities carried out along the course must be duly done. It is mandatory to pass the first part before moving to the second part, which also needs to be passed in order to get the final grade

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Cox, 2014	Bibliography	Cox, C., "An Introduction to LTE. LTE-Advanced, SAE, VoLTE and 4G Mobile Communications", 2nd ed, Ed. John Wiley & Sons, 2014.
Cox, 2021	Bibliography	Cox, C., "An Introduction to 5G. The New Radio, 5G Network and Beyond", Ed. John Wiley & Sons, 2021.
Dahlman, 2011	Bibliography	Dahlman, E. et al, "4G: LTE/LTE-Advanced for Mobile Broadband", Academic Press, 2011.
Dahlman, 2018	Bibliography	Dahlman, E. et al, "5G NR: The Next Generation Wireless Access Technology", Academic Press, Elsevier, 2018.

Yi, 2012	Bibliography	Yi, S. et al, "Radio Protocols for LTE and LTE-Advanced", S. Yi et al., Ed. John Wiley & Sons, 2012.
Sudhakar-2021	Bibliography	Sudhakar, R. et al, "5G Mobile Core Network. Design, Deployment, Automation, and Testing Strategies", Ed. Apress, 2021.