



POLITÉCNICA

INTERNATIONAL
CAMPUS OF
EXCELLENCE

COORDINATION PROCESS OF
LEARNING ACTIVITIES
PR/CL/001



E.T.S. de Ingeniería de
Sistemas Informáticos

ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

615000547 - Coding Of Information

DEGREE PROGRAMME

61SI - Grado En Sistemas De Informacion

ACADEMIC YEAR & SEMESTER

2021/22 - Semester 1

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1. Description

1.1. Subject details

Name of the subject	615000547 - Coding Of Information
No of credits	6 ECTS
Type	Optional
Academic year of the programme	Fourth year
Semester of tuition	Semester 7
Tuition period	September-January
Tuition languages	English
Degree programme	61SI - Grado en Sistemas de Informacion
Centre	61 - Escuela Tecnica Superior De Ingenieria De Sistemas Informaticos
Academic year	2021-22

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Ana Isabel Lias Quintero (Subject coordinator)	2006	anaisabel.lias@upm.es	Sin horario. Office hours will be published before the beginning of the term, both in moodle and the bulletin boards

Luis Miguel Pozo Coronado	2004	lm.pozo@upm.es	Sin horario. Office hours will be published before the beginning of the term, both in moodle and on the bulletin boards
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* 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

- Handling modular arithmetics and matrix calculus with ease.
- Understanding and writing simple mathematical proofs.

4. Skills and learning outcomes *

4.1. Skills to be learned

CB1 - Capacidad para la resolución de los problemas matemáticos que puedan plantarse en la ingeniería. Aptitud para aplicar los conocimientos sobre: algebra, cálculo diferencial e integral y métodos numéricos; estadística y optimización.

CB3 - Capacidad para comprender y dominar los conceptos básicos de matemática discreta, lógica, algorítmica y complejidad computacional, y su aplicación para el tratamiento automático de la información por medio de sistemas computacionales y su aplicación para la resolución de problemas propios de la ingeniería.

CT1 - Análisis y síntesis: Descomponer la información en unidades más pequeñas separando los componentes fundamentales de los no relevantes e identificando las relaciones existentes entre ellos. Síntesis: Combinar

información para construir un todo a partir de las entidades previamente analizadas.

CT12 - Uso de tecnologías de la información y las comunicaciones : Usar las tecnologías de la información y las comunicaciones en el ámbito de la ingeniería.

CT2 - Resolución de problemas: Identificar, analizar y definir los elementos significativos que constituyen un problema para resolverlo con criterio y de forma efectiva.

CT5 - Organización y planificación: Identificar y definir eficazmente las metas, objetivos y prioridades de una tarea o proyecto a desempeñar estipulando las actividades, los plazos y los recursos requeridos y controlando los procesos establecidos.

4.2. Learning outcomes

RA359 - Determina la complejidad computacional de algoritmos sencillos que involucren operaciones aritméticas elementales

RA362 - Codifica, detecta y corrige errores utilizando los códigos lineales

RA420 - Analiza y aplica el algoritmo Elgamal para el cifrado y el descifrado de datos.

RA417 - Analiza y aplica el algoritmo Elgamal para la firma digital.

RA358 - Distingue criptosistemas de clave pública y clave privada. Cifra y descifra utilizando los criptosistemas de traslación, afín y matricial afín

RA361 - Utiliza adecuadamente software para la resolución de problemas de codificación de la información, describiendo con precisión los protocolos utilizados

RA360 - Aplica los principales resultados de la teoría de números a la Criptología, cifrando y descifrando con los criptosistemas RSA y ElGamal

RA363 - Comprime ficheros, usando códigos compresores adecuados

RA42 - Conoce conceptos básicos de la codificación y manipulación de la información.

RA415 - Analiza y aplica el algoritmo RSA para el cifrado y el descifrado de datos.

RA125 - Resuelve problemas abiertos, barajando varias alternativas, justificando las decisiones tomadas de manera razonada y crítica, expresando con precisión las argumentaciones necesarias y las conclusiones. Identifica situaciones en las que el planteamiento del problema exija una aproximación que no permita distintos niveles de abstracción o no sea posible una jerarquización de los mismos y su solución.

* 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

The subject of this course is the study of the different possibilities to encode the information numerically, depending on the intended goal: conciseness (data compression), integrity (error detection codes) or security (cryptography).

The general objectives are:

- a) Understand the different mathematical concepts and tools underlying the models under consideration; and
- b) Implement these models, with special attention to efficiency and security issues.

5.2. Syllabus

1. Introduction to Information Coding. Cryptology
 - 1.1. Trasmisión of Information
 - 1.2. Types of codes
 - 1.3. Cryptography and cryptosystems
 - 1.4. Private key cryptosystems
 - 1.5. Cryptanalysis
2. Computational complexity
 - 2.1. Problems and algorithms
 - 2.2. Complexity of elemental arithmetic operations
 - 2.3. Classification of problems regarding its complexity
3. Number theory
 - 3.1. The multiplicative group of integers mod n
 - 3.2. Euler's totient function

- 3.3. Euler and Fermat Theorems
- 3.4. Order of an element. Primitive root
- 3.5. Discrete logarithm
- 4. Public key cryptosystems
 - 4.1. Diffie- Hellman key exchange protocol
 - 4.2. RSA cryptosystem
 - 4.3. ElGamal cryptosystem
 - 4.4. Digital signature
 - 4.5. Other applications
- 5. Primality tests
 - 5.1. Deterministic tests: Erathostenes' sieve and trial division
 - 5.2. Probabilistic tests: Fermat, Miller and Miller-Rabin
- 6. Compression codes. Error-detection codes
 - 6.1. Compression with variable-length codes: Huffman codification
 - 6.1.1. Introduction to information theory
 - 6.1.2. Huffman codification
 - 6.1.3. Minimal variance Huffman codification
 - 6.2. Error-detection with Cyclic redundancy codes
 - 6.2.1. Linear codes
 - 6.2.2. Polynomials. CRC

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Distant / On-line	Assessment activities
1	Theory and/or exercises class. Introduction to the subject. Chapter 1 Duration: 02:00 Lecture	Lab session: Introduction to maxima Duration: 02:00 Laboratory assignments		Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 02:00
2	Theory and/or exercises class. Chapter 1 Duration: 04:00 Lecture			Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00
3	Theory and/or exercises class. Chapter 1 Duration: 02:00 Lecture	Lab session: Lab project 1 Duration: 02:00 Laboratory assignments		Lab project 1 (RA361,363) Group work Continuous assessment Not Presential Duration: 00:00 Moodle test. Chapter 1 Online test Continuous assessment Not Presential Duration: 00:20 Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 02:00
4	Theory and/or exercises class. Chapter 2 Duration: 04:00 Lecture			Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00
5	Theory and/or exercises class. Chapter 2 Duration: 04:00 Lecture			Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00 Moodle test. Chapter 2 Online test Continuous assessment Not Presential Duration: 00:20

6	<p>Theory and/or exercises class. Chapter 2 Duration: 04:00 Lecture</p>			<p>Written test, chapters 1 and 2 (Face-to-face; continuous assesment) Written test Continuous assessment Presential Duration: 01:30</p> <p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p>
7	<p>Theory and/or exercises class. Chapter 2 Duration: 04:00 Lecture</p>			<p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p>
8	<p>Theory and/or exercises class. Chapters 3 and 4 Duration: 02:00 Lecture</p>	<p>Lab session: Lab project 2 Duration: 02:00 Laboratory assignments</p>		<p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 03:00</p> <p>Moodle test. Chapter 3 (RA360). Online test Continuous assessment Not Presential Duration: 00:20</p> <p>Lab project 2 (RA360, RA361 and RA354) Group work Continuous assessment Not Presential Duration: 00:00</p>
9	<p>Theory and/or exercises class. Chapter 4 Duration: 04:00 Lecture</p>			<p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p>
10	<p>Theory and/or exercises class. Chapters 4 and 5 Duration: 02:00 Lecture</p>	<p>Lab session: Lab project 3 Duration: 02:00 Laboratory assignments</p>		<p>Lab project 3 (RA360, RA361 and RA354) Group work Continuous assessment Not Presential Duration: 00:00</p> <p>Moodle test. Chapter 4 (RA360 , RA354) Online test Continuous assessment Not Presential Duration: 00:20</p> <p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 03:00</p>

11	<p>Theory and/or exercises class. Chapter 5 Duration: 04:00 Lecture</p>			<p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p>
12	<p>Theory and/or exercises class. Chapter 5 and 6 Duration: 02:00 Lecture</p>	<p>Lab session: Lab project 4 Duration: 02:00 Laboratory assignments</p>		<p>Lab project 4 (RA361, RA360, 354) Group work Continuous assessment Not Presential Duration: 00:00</p> <p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p> <p>Moodle test. Chapter 5 (RA356) Online test Continuous assessment Not Presential Duration: 00:20</p>
13	<p>Theory and/or exercises class. Chapter 6 Duration: 02:00 Lecture</p>			<p>Written test, chapters 3,4, and 5 (RA360, RA354, RA356 and RA357). Written test Continuous assessment Presential Duration: 02:00</p> <p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p>
14	<p>Theory and/or exercises class. Chapter 6 Duration: 02:00 Lecture</p>	<p>Lab session: Lab project 5 Duration: 02:00 Laboratory assignments</p>		<p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p> <p>Lab project 5 (RA361, RA356) Group work Continuous assessment Not Presential Duration: 00:00</p>
15	<p>Theory and/or exercises class. Chapter 6 Duration: 04:00 Lecture</p>			<p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p> <p>Moodle test. Chapter 6 (RA356) Online test Continuous assessment Not Presential Duration: 00:20</p>

16			<p>Written test, chapter 6 (Face-to-face) Written test Continuous assessment Presential Duration: 02:00</p> <p>Lab test (Face-to-face) Group work Continuous assessment Presential Duration: 01:00</p>
17			<p>Final exam (RA354,RA355,RA356,RA357, RA358,RA359,RA360,RA361,RA362, RA363) Written test Final examination Presential Duration: 04:00</p> <p>Final Lab project (Toolbox) Problem-solving test Final examination Presential Duration: 01:00</p> <p>Autonomous study. Group work. Other assessment Continuous assessment Not Presential Duration: 04:00</p>

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.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
1	Autonomous study. Group work.	Other assessment	No Presential	02:00	0%	0 / 10	
2	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
3	Lab project 1 (RA361,363)	Group work	No Presential	00:00	6%	/ 10	
3	Moodle test. Chapter 1	Online test	No Presential	00:20	2%	7 / 10	CB1 CB3
3	Autonomous study. Group work.	Other assessment	No Presential	02:00	0%	0 / 10	
4	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
5	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
5	Moodle test. Chapter 2	Online test	No Presential	00:20	2%	7 / 10	
6	Written test, chapters 1 and 2 (Face-to-face; continuous assesment)	Written test	Face-to-face	01:30	12%	/ 10	CB1 CT2 CB3 CT1
6	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
7	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
8	Autonomous study. Group work.	Other assessment	No Presential	03:00	0%	0 / 10	
8	Moodle test. Chapter 3 (RA360).	Online test	No Presential	00:20	2%	7 / 10	
8	Lab project 2 (RA360, RA361 and RA354)	Group work	No Presential	00:00	6%	/ 10	CT5
9	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
10	Lab project 3 (RA360, RA361 and RA354)	Group work	No Presential	00:00	6%	/ 10	

10	Moodle test. Chapter 4 (RA360 , RA354)	Online test	No Presential	00:20	2%	7 / 10	
10	Autonomous study. Group work.	Other assessment	No Presential	03:00	0%	0 / 10	
11	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
12	Lab project 4 (RA361, RA360, 354)	Group work	No Presential	00:00	6%	/ 10	CT5 CT12
12	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
12	Moodle test. Chapter 5 (RA356)	Online test	No Presential	00:20	2%	7 / 10	
13	Written test, chapters 3,4, and 5 (RA360, RA354, RA356 and RA357).	Written test	Face-to-face	02:00	20%	0 / 10	CB1 CT2 CB3 CT1
13	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
14	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
14	Lab project 5 (RA361, RA356)	Group work	No Presential	00:00	6%	0 / 10	CT5 CT12
15	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	
15	Moodle test. Chapter 6 (RA356)	Online test	No Presential	00:20	0%	7 / 10	CB1 CT1
16	Written test, chapter 6 (Face-to-face)	Written test	Face-to-face	02:00	8%	0 / 10	
16	Lab test (Face-to-face)	Group work	Face-to-face	01:00	20%	0 / 10	
17	Autonomous study. Group work.	Other assessment	No Presential	04:00	0%	0 / 10	

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final exam (RA354,RA355,RA356, RA357,RA358,RA359,RA360,RA361,RA362, RA363)	Written test	Face-to-face	04:00	70%	5 / 10	CB3 CT1 CB1 CT2
17	Final Lab project (Toolbox)	Problem-solving test	Face-to-face	01:00	30%	/ 10	CT2 CT5 CT12

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Final exam (RA290, RA291, RA292, RA293, RA294 RA295, RA296, RA297, RA298, RA299)	Written test	Face-to-face	03:30	100%	5 / 10	

7.2. Assessment criteria

Continuous evaluation:

Online tests: One for each chapter; 10 multiple choice questions. If the result is at least 7/10, the test will add 2% to the final grade, **up to 10%** altogether.

Written tests: They are face-to-face and take place out of lecture hours. The students must answer to questions regarding subject contents (including definitions, statements of theorems, exercises and problems). At least 70% of assessment will correspond to basic contents. Language precision and rigour in the results will be demanded.

Lab projects: 5 lab projects must be done along the term. Work will be done in pairs. The contribution of each project to the final grade will be 6%. Project assessment: Procedures, 50% (efficiency, clarity, documentation); solved problems, 40%; mathematical rigour, elegance, language precision, 10%.

Lab test: A validation test will take place in the lab, where some problems must be solved by using the functions programmed in the lab projects. This test will weigh a 20% of the total grade.

Final exam only, and july examination session

Students choosing the final exam option must apply for it before November 24th, using the tool in Moodle. Final exam will take place as scheduled by the school administration. The exam will have two parts: a written test regarding subject contents (including definitions, statements of theorems, exercises and problems), and a lab test where some problems must be solved by means of the functions listed in the lab projects (which each student must do in advance and bring to the exam). Each part will weigh 70% and 30% of the final grade, respectively. The function list and specifications will be published in Moodle.

Addendum

Developing the UPM Evaluation Policy, subject teachers state that:

1. For a student to be examined on a date other than the scheduled exam, it must necessarily be verified the following circumstances:

(a) The reason the student is unable to attend the exam must be overselling and force majeure, legally established or sufficiently estimated by the Head of Studies. The concept of force majeure must be understood as the existence of an unpredictable external cause affecting the sufferer by preventing the fulfilment of an obligation.

(b) In these cases, in order for the test to take effect on a different date and time than the scheduled one, affected students must notify the coordinator, via email or telephone, no later than 48 hours and send the documents that prove the reason he/she were unable to attend. Otherwise, the test will not be re-tested.

2. If a copy is detected on any ongoing evaluation test, the students involved will have zero rating in the ordinary call. In addition, they will need to conduct a review defense in a oral procedure in the extraordinary call. In the event of a copy in the extraordinary examination, the facts will be reported to the Rector for the opening of a disciplinary file.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Buchmann, Johannes A: "Introduction to Cryptography". Second Edition. Springer-Verlag. 2004.	Bibliography	
Koblitz, Neal: "A Course in Number Theory and Cryptography". Second Edition. Springer-Verlag. 1994	Bibliography	

Lucena, Manuel José: "Criptografía y Seguridad en Computadores". 1999. wwwdi.ujaen.es/~mlucena	Web resource	
Munuera, Carlos; Tena, Juan: "Codificación de la Información". Universidad de Valladolid. 1997	Bibliography	
Ramió, Jorge: "Aplicaciones Criptográficas". Escuela Universitaria de Informática. U. Politécnica de Madrid. 1998	Bibliography	
Trappe, Wade; Washington, Lawrence C.: "Introduction to Cryptography with Coding Theory". Prentice-Hall. 2002	Bibliography	
Rincón, Félix; García, Alfonso; Martínez, Ángeles: "Cálculo científico con Maple". RA-MA. 1995	Bibliography	
Maxima handbook: http://maxima.sourceforge.net/docs/manual/es/maxima.html	Web resource	
UPM Moodle environment: http://moodle.upm.es/titulaciones/oficiales/	Web resource	Containing course info and additional resources
Lab resources: PCs	Equipment	
Software: Maxima, Maple	Equipment	