

## [GEK303] ELECTRICAL DRIVES

### GENERAL INFORMATION

<b>Studies</b>	DEGREE IN INDUSTRIAL ELECTRONICS ENGINEERING		<b>Subject</b>	?
<b>Semester</b>	1	<b>Course</b>	3	<b>Mention / Field of specialisation</b>
<b>Character</b>	COMPULSORY		<b>Language</b>	EUSKARA/CASTELLANO/ENGLISH
<b>Plan</b>	2022	<b>Modality</b>	Face-to-face	<b>Total hours</b> 68 class hours + 44.5 non-class hours = <b>112.5 total hours</b>
<b>Credits</b>	4,5	<b>Hours/week</b>	3.78	

### 2030 AGENDA GOALS



### PROFESSORS

ITURBE BERISTAIN, ION

### REQUIRED PREVIOUS KNOWLEDGE

Subjects	Knowledge
ELECTROTECHNICS	(No previous knowledge required)
MODELLING, SIMULATION AND CONTROL OF MULTI-PHYSICAL SYSTEMS	

### LEARNING RESULTS

LEARNING RESULTS	KC	SK	AB	ECTS
<b>GER301</b> - To know and apply electrical engineering		x		3,78
<b>G-RTR1</b> - To develop interdisciplinary projects specific to their specialty and of gradual complexity, - becoming aware of respect for human rights and fundamental rights, and analyzing and assessing the impact of the proposed solutions on the SDGs - to acquire and/or apply basic, advanced and/or avant-garde, demonstrating the ability to work in multidisciplinary teams and/or undertake further studies with a high degree of autonomy		x		0,4
<b>G-RTR2</b> - To express information, ideas and the arguments that support them in an orderly, clear and coherent manner, orally and in writing, based on quality information, self-made or obtained from different sources, using inclusive and non-discriminatory language			x	0,32
<b>Total:</b>				<b>4,5</b>

KC: Knowledge or Content / SK: Skills / AB: Abilities

### ENAAE LEARNING RESULTS

**ENA102** - Knowledge and comprehension: Knowledge and comprehension of the engineering disciplines of their speciality, at the level necessary to acquire the rest of the competencies of the degree, including notions of the latest advances.

**ENA104** - Analysis in engineering: The ability to analyse complex products, processes and systems in their field of study; choose and apply relevant analytical, calculation and experimental methods in a suitable way; and correctly interpret the results of such analyses.

**ENA105** - Analysis in engineering: The ability to identify, formulate and solve engineering problems in their speciality; choose and apply adequately established analytical, calculation and experimental methods; and acknowledge the importance of social, health and safety, environmental, economic, and industrial restrictions.

**ENA106** - Engineering projects: Ability to project, design and develop complex products (parts, components, finished products, etc.), processes and systems of their speciality, which meet the established requirements, including awareness of the social, health and safety, environmental, economic and industrial aspects, as well as selecting and applying appropriate project methods.

**ENA107** - Engineering projects: Project capacity some state-of-the-art knowledge of their engineering speciality.

**ENA108** - Research and innovation: Ability to carry out bibliographic searches and consult and use databases and other information sources with discretion, in order to carry out simulation and analysis with the aim of conducting research on technical topics of their speciality.

**ENA109** - Research and innovation: Ability to consult and apply codes of good practice and security in their speciality.

**ENA110** - Research and innovation: Capacity and ability to project and carry out experimental investigations, interpret results, and reach conclusions in their field of study.

**ENA111** - Practical application of engineering: Understanding of the applicable techniques and methods for analysis, design and research and their limitations in the field of their speciality.

**ENA112** - Practical application of engineering: Practical competency to solve complex problems, carry out complex engineering projects, and conduct investigations specific to their speciality.

**ENA113** - Practical application of engineering: Knowledge of application of materials, equipment and tools, engineering technology and processes, and their limitations in the field of their speciality.

**ENA115** - Practical application of engineering: Knowledge of the social, health and safety, environmental, economic and industrial implications of engineering practice.

**ENA118** - Preparation of judgements: Ability to manage complex technical or professional activities or projects of their speciality, taking responsibility for decision making.

**ENA119** - Communication and Teamwork: Ability to effectively communicate information, ideas, problems and solutions in the field of engineering and with society in general.

**ENA120** - Communication and Teamwork: Ability to operate effectively in domestic and international contexts, individually and as a team,

and to cooperate with both engineers and people from other disciplines.

**ENA121** - Continued training: Ability to acknowledge the need for their own continued training and to undertake this activity throughout their professional life independently.

**ENA122** - Continued training: Ability to stay up to date on science and technology innovations.

## SECONDARY LEARNING RESULTS

### **RGE301** [!] *Analiza, modela y controla accionamientos basados en motores DC.*

#### LEARNING ACTIVITIES

	CH	NCH	TH
Conducting tests, giving presentations, presenting defences, taking examinations and/or doing checkpoints	1 h.	3 h.	4 h.
Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects	8 h.	1 h.	9 h.
Carrying out exercises and solving problems individually and/or in teams	3 h.	3 h.	6 h.

#### EVALUATION SYSTEM

W

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

Individual written and/or oral tests or individual coding/programming tests

**Comments:** - Control point: minimum grade 5. - Courseworks: minimum grade 5.

#### MAKE-UP MECHANISMS

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

Individual written and/or oral tests or individual coding/programming tests

**Comments:** - Students with less than a 5 at the control point must retake the exam. - Final note of the control point: control point 25% and retake 75%. - For the courseworks, their correction will be asked. The maximum mark for the corrected courseworks will be 5.0.

**CH - Class hours:** 12 h.

**NCH - Non-class hours:** 7 h.

**TH - Total hours:** 19 h.

### **1RGE390** (1 sem)

#### LEARNING ACTIVITIES

	CH	NCH	TH
Carrying out/resolving projects/challenges/cases, etc. to provide solutions to problems in interdisciplinary contexts, real and/or simulated, individually and/or in teams	2 h.	2 h.	4 h.

#### EVALUATION SYSTEM

W

Observation (technical capacity, attitude and participation) 100%

#### MAKE-UP MECHANISMS

Observation (technical capacity, attitude and participation)

**Comments:** Continuous assessment.

**CH - Class hours:** 2 h.

**NCH - Non-class hours:** 2 h.

**TH - Total hours:** 4 h.

### **1RGE394** (1 sem)

#### LEARNING ACTIVITIES

	CH	NCH	TH
Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams	2 h.	2 h.	4 h.

#### EVALUATION SYSTEM

W

Presentation and defence of exercises, case studies, computer practical work, simulation practical work, laboratory practical work, term projects, end of degree

#### MAKE-UP MECHANISMS

Presentation and defence of exercises, case studies, computer practical work, simulation practical work, laboratory practical work, term projects, end of degree project, master's thesis, challenges

project, master's thesis, challenges and problems

and problems

**Comments:** - Continuous assessment.

**CH - Class hours:** 2 h.

**NCH - Non-class hours:** 2 h.

**TH - Total hours:** 4 h.

**RGE303 [!]** *Selecciona los accionamientos eléctricos adecuados y diseña, monta y valida un sistema de tracción*

**LEARNING ACTIVITIES**

Carrying out work experience in real environments and writing the corresponding report

**CH**

**NCH**

**TH**

17 h.

10 h.

27 h.

**EVALUATION SYSTEM**

**W**

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

50%

Individual written and/or oral tests or individual coding/programming tests

Prototype / Product

30%

**Comments:** - PBL project grade: 30% product, 20% technical content of the report and 50% individual technical defense.

**MAKE-UP MECHANISMS**

Prototype / Product

**Comments:** - There will not be any retake of the individual defense.

**CH - Class hours:** 17 h.

**NCH - Non-class hours:** 10 h.

**TH - Total hours:** 27 h.

**1RGE391 (1 sem)**

**LEARNING ACTIVITIES**

Carrying out/resolving projects/challenges/cases, etc. to provide solutions to problems in interdisciplinary contexts, real and/or simulated, individually and/or in teams

**CH**

**NCH**

**TH**

2 h.

1 h.

3 h.

**EVALUATION SYSTEM**

**W**

Observation (technical capacity, attitude and participation)

100%

**MAKE-UP MECHANISMS**

Observation (technical capacity, attitude and participation)

**Comments:** Continuous assessment.

**CH - Class hours:** 2 h.

**NCH - Non-class hours:** 1 h.

**TH - Total hours:** 3 h.

**RGE302 [!]** *Analiza, modela y controla accionamientos basados en motores AC.*

**LEARNING ACTIVITIES**

Conducting tests, giving presentations, presenting defences, taking examinations and/or doing checkpoints

**CH**

**NCH**

**TH**

2 h.

5,5 h.

7,5 h.

Presentation by the teacher in the classroom, in participatory classes, of concepts and procedures associated with the subjects

20 h.

4 h.

24 h.

Carrying out exercises and solving problems individually and/or in teams

7 h.

10 h.

17 h.

**EVALUATION SYSTEM**

**W**

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

25%

Individual written and/or oral tests or individual

75%

**MAKE-UP MECHANISMS**

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

Individual written and/or oral tests or individual

coding/programming tests

coding/programming tests

**CH - Class hours:** 29 h.

**NCH - Non-class hours:** 19,5 h.

**TH - Total hours:** 48,5 h.

### **1RGE393 (1 sem)**

#### **LEARNING ACTIVITIES**

Development and writing of records, reports, presentations, audiovisual material, etc. on projects/work experience/challenges/case studies/experimental investigations carried out individually and/or in teams

**CH**

2 h.

**NCH**

2 h.

**TH**

4 h.

#### **EVALUATION SYSTEM**

**W**

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

100%

#### **MAKE-UP MECHANISMS**

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

**Comments:** - Continuous assessment. - It may be asked to redo the document.

**CH - Class hours:** 2 h.

**NCH - Non-class hours:** 2 h.

**TH - Total hours:** 4 h.

### **1RGE392 (1 sem)**

#### **LEARNING ACTIVITIES**

Carrying out/resolving projects/challenges/cases, etc. to provide solutions to problems in interdisciplinary contexts, real and/or simulated, individually and/or in teams

**CH**

2 h.

**NCH**

1 h.

**TH**

3 h.

#### **EVALUATION SYSTEM**

**W**

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

100%

#### **MAKE-UP MECHANISMS**

Reports on the completion of exercises, case studies, computer exercises, simulation exercises, laboratory exercises, term projects, challenges and problems

**Comments:** - Continuous assessment. - It may be asked to redo the document.

**CH - Class hours:** 2 h.

**NCH - Non-class hours:** 1 h.

**TH - Total hours:** 3 h.

## **CONTENTS**

### 0. INTRODUCTION

### 1. DRIVE COMPONENT SELECTION

### 2. SENSORS FOR ELECTRIC DRIVES

Current sensors

Position and velocity sensors

CW1: drive component selection

### 3. MODELING ELECTRIC MACHINES

#### 1. Torque models

- + DC machine
- + Brushless AC
- + Brushless DC

#### 2. Electrical models

- + DC machine
- + Brushless AC

### 4. CONTROL OF ELECTRIC MACHINES

#### 1. Torque control

- + DC machine
- + Brushless AC (vector control)

#### 2. Speed control

## LEARNING RESOURCES AND BIBLIOGRAPHY

### Learning resources

(No resources)

### Bibliography

Leonhard, Werner. Control of Electrical Drives (3th edition). Springer-Verlag. Alemania. 2001. ISBN:3-540-41820-2  
Mohan, Ned. Electric Machines and Drives, A First Course. John Wiley & Sons. USA. 2012. ISBN: 978-1-118-07481-7  
Sang-Hoon Kim, &#8220;Electric Control Motor: DC, AC, and BLDC Motors&#8221;, Amsterdam, Elsevier , 2017, ISBN 9780128121382  
Gonzalo Abad and Fernando Briz, &#8220;Power Electronics and Electric Drives for Traction Applications&#8221;, John Wiley & Sons Ltd , 2016, ISBN 9781118954454