



## Teaching Guide

Identifying Data					2023/24
Subject (*)	Electrical Machines	Code	730G04050		
Study programme	Grao en Enxeñaría en Tecnoloxías Industriais				
Descriptors					
Cycle	Period	Year	Type	Credits	
Graduate	1st four-month period	Third	Obligatory	6	
Language	Spanish				
Teaching method	Face-to-face				
Prerequisites					
Department	Enxeñaría Industrial				
Coordinador	Castilla Pascual, Consuelo de los L.	E-mail	consuelo.castilla.pascual@udc.es		
Lecturers	Castilla Pascual, Consuelo de los L.	E-mail	consuelo.castilla.pascual@udc.es		
Web	www.moodle.udc.es				
General description	That the student knows the principles of the main electrical machines and their modeling through circuits and electromechanical diagrams. The study is done in 5 blocks: power transformers or static machines, the principles of rotating electrical machines, direct current machines, alternating current induction machines and synchronous machines.				

## Study programme competences

Code	Study programme competences
A23	TEE1 Capacidade para o cálculo e deseño de máquinas eléctricas.
B2	CB2 Que os estudantes saiban aplicar os seus coñecementos ao seu traballo ou vocación dunha forma profesional e posúan as competencias que adoitan demostrarse por medio da elaboración e defensa de argumentos e a resolución de problemas dentro da súa área de estudo
B7	B5 Ser capaz de realizar unha análise crítica, avaliación e síntese de ideas novas e complexas
C1	C3 Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.
C4	C6 Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben afrontarse.
C5	C7 Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.

## Learning outcomes

Learning outcomes	Study programme competences		
Poseer a capacidade para o cálculo e o deseño de máquinas eléctricas	A23	B2 B7	C1 C4 C5

## Contents

Topic	Sub-topic



<p>The two blocks that divide the five subjects, develop the contents established in the file of the Verification Report.</p>	<p>BLOCK I. STATIC MACHINES.</p> <ul style="list-style-type: none"><li>- Power transformers (CONTENTS: Basis of electrical machines and power transformers).</li></ul> <p>BLOCK II. ROTATING MACHINES.</p> <ul style="list-style-type: none"><li>- General principles of rotating electrical machines (CONTENTS: Basis of electrical machines).</li><li>- Direct current machines (CONTENTS: Direct current machines).</li><li>- Synchronous alternating current machines (CONTENTS: Alternating current machines).</li><li>- Induction alternating current machines (CONTENTS: Alternating current machines).</li></ul>
<p>Power transformers.</p>	<ul style="list-style-type: none"><li>* Need for the transformer.</li><li>* Transformer power and parts.</li><li>* Characteristic plate.</li><li>* Coil with iron core.</li><li>* Excitation or vacuum current of a transformer.</li><li>* Principle of operation of an ideal transformer (single-phase).</li><li>* Operation of a real transformer.</li><li>* Equivalent circuit of a transformer.</li><li>* Determination of homologous terminals.</li><li>* Vacuum test.</li><li>* Short circuit test.</li><li>* Voltage drop in a transformer, Ferranti effect. Load index.</li><li>* Losses and performance of a transformer.</li><li>* Connecting current of a transformer.</li><li>* Three-phase transformers.</li><li>* Harmonics in excitation currents (three single-phase).</li><li>* Connections of three-phase transformers.</li><li>* Hourly indexes.</li><li>* Parallel coupling of transformers.</li><li>* Autotransformers.</li><li>* Regulation sockets.</li><li>* Meter transformers.</li><li>* Voltage transformers.</li><li>* Current transformers.</li></ul>
<p>General principles of rotating electrical machines.</p>	<ul style="list-style-type: none"><li>* Basic elements of electrical machines</li><li>* Delgas collector and ring collector.</li><li>* Winding.</li><li>* Losses and heating.</li><li>* Rated or nominal power. Types of service</li><li>* Magnetic field and m.m.f. in the air gap of an electrical machine.</li><li>* Magnetic field and e.m.f. produced by a concentrated winding of diametral pitch.</li><li>* F.m.m. produced by a distributed winding</li></ul>



<p>Direct current machines.</p>	<ul style="list-style-type: none"> <li>* Constructive aspects.</li> <li>* Principle of operation.</li> <li>* Armature reaction.</li> <li>* Commutation.</li> <li>* DC generators: General aspects.</li> <li>* DC generators: Service characteristics.</li> <li>* DC motors: General aspects.</li> <li>* D.C. Motors: Operating characteristics curves.</li> <li>* DC motors with independent excitation and shunt.</li> <li>* DC motors with series excitation.</li> <li>* DC motors with compound excitation. Ward-Leonard system.</li> <li>* DC motor: Braking methods.</li> <li>* Single-phase AC motors with delgas collector.</li> <li>* Brushless DC motors (brushless motors).</li> </ul>
<p>Synchronous alternating machines.</p>	<ul style="list-style-type: none"> <li>* Construction principles.</li> <li>* Principle of alternator operation.</li> <li>* Armature reaction.</li> <li>* Equivalent circuit and vector diagram in the synchronous machine.</li> <li>* Characteristic curves.</li> <li>* Synchronous impedance. Vacuum and short-circuit test and Potier's method (or null fdp).</li> <li>* Regulation of outgoing pole machines.</li> <li>* Synchronous motor: generalities.</li> <li>* Coupling of an alternator to the network.</li> <li>* Active and reactive power developed by a synchronous machine coupled to an infinite power network.</li> <li>* Operation of a synchronous machine connected to an infinite power grid.</li> </ul>
<p>Asynchronous alternating or induction machines.</p>	<ul style="list-style-type: none"> <li>* F.m.m. produced by a three-phase winding. Rotating fields. Ferraris theorem.</li> <li>* Relationship between an alternating field and a rotating field. Leblanc's theorem.</li> <li>* Constructive aspects (slip).</li> <li>* Principle of operation (angular velocity of the magnetic field cutting the rotor conductors).</li> <li>* Approximate equivalent circuit of the asynchronous motor.</li> <li>* Asynchronous motor tests: Vacuum or free rotor test and short-circuit or locked rotor test.</li> <li>* Power (active) in the synchronous machine.</li> <li>* Rotation torque.</li> <li>* Characteristic curves.</li> <li>* Asynchronous machine as generator and in brake effect (types of operation).</li> <li>* Starting of the asynchronous machine (squirrel cage and wound rotor motors).</li> </ul>

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student's personal work hours	Total hours
Introductory activities	B2 B7 C1 C4 C5	0.5	0	0.5
Guest lecture / keynote speech	A23	32	32	64
Problem solving	A23	20	31.5	51.5
Mixed objective/subjective test	B2 C4	4	6	10
ICT practicals	A23 B2 B7 C1 C5	2	3	5
Laboratory practice	A23 B7 B2 C1 C4 C5	8	8	16



Personalized attention		3	0	3
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Introductory activities	Presentation of the subject in which the content of the teaching guide is explained.
Guest lecture / keynote speech	Explanation of contents by the teacher.
Problem solving	Students solve calculation problems proposed by the teacher.
Mixed objective/subjective test	<p>Students are faced with problems and practical theoretical questions, some of which may be of the multiple-choice type, which only score points if the justification is correct.</p> <p>There are two objective tests of 2 hours each, an eliminatory partial test and an official test, part of which can be eliminated by passing the partial test. The total weight of the objective tests is 60% of the final mark.</p> <p>The eliminatory partial will be after the first block (topic 1, transformer) and is voluntary.</p> <p>The subject cannot be passed without taking the official exams and it will be recorded as not having been taken regardless of what has been achieved in the other methodologies.</p>
ICT practicals	Simulations of practical results will be carried out in class on a portable computer (it can be requested in the center for the day indicated) and the upload of the simulation in moodle will be requested in similar cases.
Laboratory practice	<p>Simulations of practical results will be carried out in class on a laptop computer (this can be requested at the centre for the day indicated) and, in similar cases, the uploading of the simulation in moodle will be requested.</p> <p>The course cannot be passed without attending and passing at least one practical session.</p>

Personalized attention	
Methodologies	Description
Laboratory practice ICT practicals Problem solving	O profesor responde a las , ás preguntas ou consultas realizadas polos alumnos.

Assessment			
Methodologies	Competencies	Description	Qualification



<p>Mixed objective/subjective test</p>	<p>B2 C4</p>	<p>Students are faced with problems and practical theoretical questions, some of which may be of the multiple-choice type, which only score points if the justification is correct.</p> <p>There are two objective tests of 2 hours each, an eliminatory partial test and an official test, part of which can be eliminated by passing the partial test. The total weight of the objective tests is 60% of the final mark.</p> <p>The partial is eliminatory of the first block (subject 1, transformer), it is voluntary and it is added that weighs 24% of the final mark if minimum 5 out of 10 is reached. It eliminates 40% of the official test (first or second opportunity), weighing 24% as a sum in the final mark, and if the eliminatory partial is passed and not presenting again this part of the subject in the official ones, the duration is reduced from 2h to 1:15 h.</p> <p>If the compulsory official test is not taken with everything, due to having passed the eliminatory part and not wanting to obtain more marks in the eliminated subject, the 3.3 out of 10 (or 2 out of 6) must be passed for the other methodologies to add up (due to having eliminated 24% of the weighted subject) and the mark achieved in the official test would add up to 36% weight in the final mark. In this way, the partial eliminatory test adds up to 60% of the weight of this methodology in the final mark. If you do not take the partial eliminatory test, or if you do not pass the 5 out of 10, you must take the official test with all the material, which will last 2 hours, independently of what has been added in the other methodologies, and for the remaining methodologies to be added to the final mark, you must obtain 5 out of 10 in the official test (taking all the material) and it will add 60% of weight to the final mark.</p> <p>Note: in order for the other methodologies to add up to the final mark, students must have at least 66% attendance in lectures and problem classes and have completed and passed a laboratory practice session.</p> <p>Also, if the student exceeds 5 out of 10 in the partial eliminatory test, he/she can, depending on his/her needs, take the official test: in these cases, the mark of the eliminatory test will be maintained, if he/she does not improve it in the corresponding part of the official test.</p> <p>The other methods will only be added to the final mark if the student has a minimum attendance of 66% in problems and lectures and reaches or exceeds 5 out of 10 in the official compulsory test by taking the whole course (2 hours), or if he/she reaches or exceeds 2 out of 6, he/she can only take the part not eliminated in the eliminatory part (1:15 hours for the official test due to the elimination of the subject).</p> <p>The subject cannot be passed without taking the official exam and reaching or surpassing the minimum required and without having taken at least one practical session. If the student does not take the official exam, he/she will be recorded as failed regardless of what he/she has achieved in the eliminatory partial exam and in the other methodologies.</p> <p>Failure to attend at least one practice session and obtain a pass will result in a failing grade, regardless of what has been achieved in the other methodologies, including the compulsory official mixed exam.</p>	<p>60</p>
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Laboratory practice	A23 B7 B2 C1 C4 C5	<p>In each of the four practical sessions, active attendance, adjustment to the instructions received, correct use of measuring equipment (connection and measurements), correctness, cleanliness and organisation of the assemblies and correct expression of ideas and reasoning and collaboration between assembly supervisors will be assessed.</p> <p>The marks for this methodology are divided equally between the four 2-hour sessions.</p> <p>The laboratory practicals are of compulsory attendance in 25% and without it (attendance to at least one practical session) and if passed, the course cannot be passed and the final mark will be "not presented" regardless of what has been achieved in the other methodologies.</p> <p>The marks out of 10 in this methodology, in order to be added in the final grade, with its weight, requires that the minimums established for the compulsory mixed test of official call have been reached.</p>	8
Guest lecture / keynote speech	A23	<p>Regular attendance to the classes of the subject will be valued (including classes dedicated to the solution of problems) in the sense that it will allow, together with the condition of minimum grade in mixed test, that the other methodologies, except laboratory practices that have different attendance requirements, will be added in the final grade.</p> <p>Attendance will only be assessed when it represents a percentage greater than or equal to 66% of the number of attendance controls carried out. Students who can justify their inability to attend classes (at the discretion of the teacher of the subject), may have the condition of regular attendance so that the grade achieved in the remaining methodologies (except practices) are added to the final grade.</p>	0
ICT practicals	A23 B2 B7 C1 C5	<p>Simulations of practical results will be carried out in class on a laptop computer (this can be requested at the centre for the day indicated) and in similar cases the uploading of the simulation on moodle will be requested within a specified period of time.</p> <p>The mark for this methodology is distributed equally between the different simulations proposed (if more than one is carried out) and the mark achieved will only count towards the final mark if there is a minimum attendance of 66% in the master classes and in the problem classes, as well as reaching the minimum marks stipulated in the official mixed tests.</p>	2
Problem solving	A23	<p>After each topic, problems will be proposed in moodle to be handed in by the stipulated deadlines. All the problems to be handed in score equally, so that the maximum mark for this methodology is distributed equally among the number of problems to be handed in during the course. In order for the mark achieved to be added to the final mark, not only must the required mark be achieved in the mixed test, but also attendance must be at least 66% in both problems and lectures.</p>	30

Assessment comments



The final mark will be:

\* If at least one practice session is passed, attendance exceeds 66% and the eliminatory exam is passed:

$(\text{mark out of 10 mixed test}) \cdot 0.36 + (\text{mark out of 10 eliminatory partial exam}) \cdot 0.24 + (\text{sum of marks out of 10 for exercise uploads/no. of uploads}) \cdot 0.30 + (\text{sum of marks out of 10 for ICT simulations/no. of simulations}) \cdot 0.02 + (\text{sum of marks out of 10 for practical sessions}/4) \cdot 0.08$

if attendance is less than 66% of the total

$(\text{mark out of 10 for mixed test}) \cdot 0.36 + (\text{mark out of 10 for eliminatory partial test}) \cdot 0.24 + (\text{sum of marks out of 10 for practical sessions}/4) \cdot 0.08$

\* If at least one practical session is passed, attendance exceeds 66% and the eliminatory exam fails or is passed, it is decided to go with everything in the official exam:

$(\text{mark out of 10 for mixed test}) \cdot 0.60 + (\text{sum of marks out of 10 for exercise uploads/no. of uploads}) \cdot 0.30 + (\text{sum of marks out of 10 for ICT simulations/no. of simulations}) \cdot 0.01 + (\text{sum of marks out of 10 for practical sessions}/4) \cdot 0.8$

if attendance is less than 66%  $(\text{sum of marks out of 10 for practical sessions}/4) \cdot 0.8$

$(\text{sum of marks out of 10 for the mixed test}) \cdot 0.6 + (\text{sum of marks out of 10 for the practical sessions}/4) \cdot 0.08$

\* In case of going with all the material to the official mixed test and not reaching 5 out of 10, the grade reached over 10 will be the final grade in the material, regardless of the score in the other methodologies and regular attendance (higher than those required) if there was any.

\* In case of going with only part of the subject to the mixed test and not reaching 2 over 6, the grade reached over 10 affected by its weight of 36% will be added to the grade reached over 10 in the partial affected also by its weight of 24% and this will be the final grade over 6, so that the resulting proportion over 10 will be the final grade in the subject over 10, regardless of the score in the other methodologies and regular attendance (higher than those specified) if there was any.

\* If you do not show up and pass at least one practical session: NO SHOW regardless of what you have achieved in the other methodologies and the official compulsory test.

\* If you do not take the official compulsory test: NOT PRESENTED regardless of what you have achieved in the other methodologies.

WARNING: Without an approved practical session you cannot pass the subject.

In accordance with art.11.4.c of the UDC Student Disciplinary Regulations, in case of plagiarism in the exam or evaluation test, the qualification will be suspended in the call in which the fault is committed: the student will be qualified with "fail" (numerical grade 0) in the corresponding call of the academic year, whether the commission of the fault occurs in the first opportunity or in the second. For this, their qualification will be modified in the minutes, if necessary. Advance call

The evaluation criteria for the December advance call will be the same as those used for the second chance call of the previous year.

Academic dispensation

The evaluation procedures described are applicable to all students, whether or not they have academic dispensation, only that in case of dispensation and justification of impossible attendance, alternative activities to face-to-face activities may be established.

## Sources of information

<b>Basic</b>	<ul style="list-style-type: none"> <li>- Fraile Mora, Jesús (2008). Máquinas Eléctricas. McGraw-Hill</li> <li>- Fraile Mora, Jesús; Fraile Ardamuy, Jesús (2005). Problemas de Máquinas Eléctricas. McGraw-Hill</li> <li>- Ortega Jinéñez, Guillermo; Gómez Alós, Milagros; Bachiller Soler, Alfonso (2002). Problemas resueltos de Máquinas Eléctricas. Thomson-Paraninfo</li> <li>- Gomollón García, Jesús (2013). Apuntes de Máquinas Eléctricas. Moodle</li> <li>- Javier Andrés Martínez Román; Juan Pérez Cruz; Manuel Pineda Sanchez (2014). Ensayos de Máquinas Eléctrica. Universitat Politècnica de València</li> <li>- Chapman, S J (2005). Máquinas Eléctricas. Mc Graw Hill</li> </ul>
<b>Complementary</b>	<ul style="list-style-type: none"> <li>- Fitzgerald, A.E; Kingsley Jr., Charles; Umans, Stephen D. (2003). Máquinas Eléctricas. McGraw-Hill</li> </ul>

## Recommendations

Subjects that it is recommended to have taken before



Fields and Waves/730G04047

CÁLCULO/730G04001

FÍSICA I/730G04003

ÁLXEBRA/730G04006

FÍSICA II/730G04009

ECUACIÓNS DIFERENCIAIS/730G04011

FUNDAMENTOS DE ELECTRICIDADE/730G04012

Informática/770G02002

**Subjects that are recommended to be taken simultaneously**

**Subjects that continue the syllabus**

**Other comments**

Para unha contorna sostible e cumprir co obxectivo da actuación núm. 1: a entrega dos traballos documentais que se realicen na materia: For a sustainable environment and to comply with the objective of action nº 1: the delivery of the documentary works that are carried out in the material: 1.1. They will be requested in virtual format and / or computer support. 1.2. It will be done through Moodle, in digital format without the need to print them. 1.3. If made on paper: - Plastics will not be used. - Double-sided prints will be made. - Recycled paper will be used. - Printing of drafts will be avoided.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.