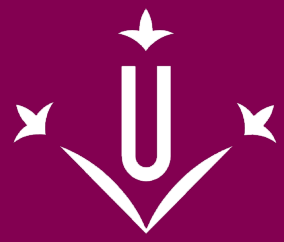

Universitat de Lleida

DEGREE CURRICULUM

MACHINE DESIGN AND TESTING I

Coordination: NOGUES AYMAMI, MIQUEL

Academic year 2020-21

Subject's general information

<table>
<tr><td>Subject name</td><td>MACHINE DESIGN AND TESTING I</td></tr>
<tr><td>Code</td><td>14522</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION / UNDEFINED</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Master's Degree in Industrial Engineering</td><td>1</td><td>COMPULSORY</td><td>Attendance-based</td></tr>
</table>
</td></tr>
<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>3</td><td>3</td></tr>
<tr><td>Number of groups</td><td>1</td><td>1</td></tr>
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</td></tr>
<tr><td>Coordination</td><td>NOGUES AYMAMI, MIQUEL</td></tr>
<tr><td>Department</td><td>COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>40% lectures in class
60% independent student work</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Catalan.
However some material could be also in Spanish or English</td></tr>
</table>

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
CASTELL CASOL, ALBERT ORIOL	albert.castell@udl.cat	0	
NOGUES AYMAMI, MIQUEL	miquel.nogues@udl.cat	4	
TERRIBAS SALA, XAVIER	xavier.terribas@udl.cat	2	

Subject's extra information

The main background needed to take advantatge of this subject are:

Skills in the use of a 3D CAD software

Knowledge of Elasticity and Strength of Materials

Knowledge of Theory of Mechanisms

In relation to the safety rules established in laboratories, it is required to state

It is **COMPULSORY** that the students bring the following elements of individual protection (EPI) to the practices at the laboratory.

- Blue laboratory gown from UdL (unisex)
- Protection glasses
- Mechanical protection gloves

They can be purchased through the shop Údels of the UdL:

C/ Jaume II, 67 baixos
Centre the Cultures i Cooperació Transfronterera

http://www.publicacions.udl.cat/

The use of other elements of protection (for example caps, masks, gloves of chemical or electrical risk, etc.) will depend on the type of practice to be done. In that case, the teacher will inform of the necessity of specific EPI.

Not bringing the EPI's described or not fulfilling the norms of general security that are detailed below imply that the student can not access to the laboratories or have to go out of them. The no realisation of the practices for this reason imply the **consequences in the evaluation** of the subject that are described in this course guide.

GENERAL NORMS OF SECURITY IN LABORATORY PRACTICES

- Keep the place of realisation of the practices clean and tidy. The table of work has to be free from backpacks, folders, coats...
- No short trousers or short skirts are allowed in the laboratory.
- Closed and covered footwear is compulsory in the laboratory.

- Long hair needs to be tied.
- Keep the laboratoy gown laced in order to be protected from spills of chemicals.
- Bangles, pendants or wide sleeves are not allowed as they can be trapped.
- Avoid the use of contact lenses, since the effect of the chemical products is much bigger if they enter between the contact lense and the cornea. Protection over-glasses can be purchased.
- No food or drink is allowed in the laboratory.
- It is forbidden to smoke in the laboratories.
- Wash your hands whenever you have contact with a chemical product and before going out of the laboratory.
- Follow the instructions of the teacher and of the laboratory technicians and ask for any doubt on security.

For further information, you can check the following information at the *UdL Servei de Prevenció de Riscos Laborals* web pages:

- http://www.prevencio.udl.cat/ca/integracio-a-la-docencia/
- http://www.sprl.udl.cat/ca/capsules-formatives/

Learning objectives

Provide students with the basic knowledge and techniques, tools, skills and abilities to effectively develop professionals activities involved in conducting machine designs. For this reason, the topics considered to be developed are both kinematics and dynamics in three dimensions, in order to carry out a proper assessment of stress of any machine part. In addition, the vibratory motion is introduced, and the bases of balancing rotors and multicylindrics machines are exposed.

The achivement of the above objectives can be specified in:

- Improve both vision and skills on the spatial movement
- Learning to use CAD for kinematic and dynamic analysis
- Introducing vibrational moviment analysis
- Achieve basic knowledge in balancing devices
- Improve skills in mechanical design

Competences

Basic competences

- **CB2** To be able to applytheknowledgegainedand to solve problems in new environments in wider contexts (or multidisciplinary) relatedwiththearea of study.

General competences

- **CG4** Capacity to conceive, design and implement projects and/or provide new solutions, using the tools that the engineering offers.
- **CG6** To have suitable knowledge of the scientific and technologic alissues of: mathematical, analytical and numerical methods in engineering, electrical engineering, energetic engineering, chemical engineering, mechanical engineering, mechanics of continuous means, industrial electronics, automation, manufacture, material, quantitative methods of management, industrial computing, urbanism, infrastructures, etc.
- **CG7** To project, calculate and design products, processes, installations and plants.
- **CG9** To do research, development and innovation in products, processes and methods.

Specific competences

- **CE3** Capacity for the design and testing of Machines.

Cross-disciplinarycompetences

- **CT3** Mastering ICT's.

Subject contents

Unit 1. 3D Rigid Body Kinematics

1.1 Vector time derivative in a mobile coordinate system

1.2 Common coordinate systems in mechanical analysis.

1.3 Three-dimensional position analysis

1.4 Three-dimensional velocity analysis

1.5 Instant rotation centers and centrodes

1.5 Three-dimensional acceleration analysis

1.6 Kinetic energy

Unit 2. 3D Rigid Body Dynamics

2.1 Linear and angular momentum

2.2 Inertia tensor and its properties

2.3 Free-body diagrams

2.4 Newton-Euler equation of motion

2.5 Gyroscopic effects

2.6 Virtual work

Unit 3. Introduction to Vibration mechanics

3.1 Fundamentals of vibration

3.2 Free vibration of single degree of freedom systems

3.2 Harmonically excited vibration

3.4 Determination of natural frequencies and mode shapes

Unit 4. Balancing rotors and engine cylinder

4.1 Balancing rotors introduction

4.2 Static balancing

4.3 Dynamic balancing

4.4 Balancing multicilindrical systems.

Methodology

Lectures: theoretical contents and proposal and/or resolution of some practical examples. In the 2020-21 academic year, these sessions will be held online using the "Videoconference" tool of the virtual campus (SAKAI).

Problems: Presentation and discussion of problems that will eventually solve by the students in a individual way or in groups.Such lessons can be developent presenciatly or in a telematic way depending on the pandemic situation.

Group work: Development of a study in groups o individualy depending on the pandemic situation on a set of mechanical system.

Practices: 4 laboratory sessions. The first one, three-dimensional kinematics analysis, second session inertia tensor evaluation and dynamic analysis, third session is balancing rotors session and finally vibration analysis of a multi-cylindrical device.If this lessons are done presencially will be held in the CREA 1.19 class, while if are telematic, can carryed out by a remot access to the lab computers or throught the AppsAnywhere, in the link https://virtlabs-udl.csuc.cat/login

Development plan

Week	Methodology	Unit	Attendance hours	Autonomous work hours
1	Lectures	Unit1: Theory Unit 1: Problems	2 0	0 0
2	Lectures Problems	Unit1: Theory Unit 1: Problems	2 2	3 3
3	Lectures Problems	Unit1: Theory Unit 1: Problems	2 2	3 3
4	Lectures Problems	Unit1: Theory Unit 1: Problems	2 2	3 3
5	Lectures Practice	Unit1: Theory Practice 1	2 2	3 3
6	Lectures Problems	Unit 2: Theory Unit 2: Problems	2 2	3 3
7	Lectures Problems	Unit 2: Theory Unit 2: Problems	2 2	3 3
8	Lectures Practice	Unit 2: Theory Practice 2	2 2	3 3
9	Evaluation	Exam 1	2	4
10	Lectures Problems	Unit 3: Theory Unit 3: Problems	2 2	3 3
11	Lectures Problems	Unit 3: Theory Unit 3: Problems	2 2	3 3
12	Lectures Problems	Unit 3: Theory Unit 3: Problems	2 2	3 3
13	Lectures Problems	Unit 4: Theory Unit 4: Problems	2 2	3 3
14	Lectures Practice	Unit 4: Theory Practice 3	2 1	3 3
15	Lectures Practice	Unit 4: Theory Practice 4	2 2	3 3
16-17	Evaluation	Exam 2	2	4

18	Tutoring	Tutoring	1	2
19	Evaluation	Recovery exam	2	2

Evaluation

Several evaluation activities will be carried out:

• 1st Individual written exam focused on theory/practical work developed along of the midterm. The exam will be done on the date scheduled in the academic calendar (approx. week 9th).

• 2nd individual written exam will assess the part related with the problems and experimental part carried out until the midterm. The exam will be done just after the 1st exam.

• Attendance at laboratory and experimental parts is mandatory. The student could only get in the laboratory if he/she is wearing the corresponding PPE indicated in the laboratory exercise guidance.

• Several works in groups will be proposed, which must be delivered in the period scheduled for evaluation.

• 3rd individual written exam which will be focused on the theory/practical work developed in the second quarter. The exam will be done on the scheduled date in the academic calendar (approx. week 17th or 18th).

• 4th individual written exam will assess the part related with the problems and experimental part carried out in the second part of the term. The exam will be done just after the 3rd exam.

• In case that the weighted grade of the written exams, based on the relative weight of each of them, is less than 3, the student will not pass the subject, and its grade will be the minimum of the average percentage based on the relative weight of each of exam (which are shown in the table) or 3.

• Recovery exam (week 20th), In order to attend to these exam, it will be required that the weighted note based on the 4 written exams must be equal to or greater than 3. This exam will assess all the theory and work developed throughout the term. The exam will have both theoretical and problems resolution. If a student attends to this exam, the grade achieved replaces the previous grades from written exams, whether is higher or lower. In case the grade of recovery exam is less than 3, the student will not be pass the subject, and the grade will be the minimum between the recovery exam grade and 3.

The weight stablished to each evaluation activity, out of a total of 100, is as follows:

Activity	**Weight**
1a written exam	15
2a written exam	25
3a written exam	15
4a written exam	25
Work in groups	20
Recovery exam	80

Note: Grades achieved in work developed in groups are not recoverable.

Note: in case of a student does not attend or do in a unsatisfactorily way, the grade of the subject will be Not Presented.

Bibliography

"Diseño de maquinaria", Robert L. Norton, Edicions Mc Graw Hill

"MECÀNICA de la partícula i del sòlid rígid", Joaquim Agulló i Batlle, Publicacions OK punt

"Disseny de màquines I. Mecanismes", Carles Riba Romeva, Edicions UPC.

"Mecanismes i màquines I. El frec en les màquines", Carles Riba Romeva, Edicions UPC.

"Mecanismes i màquines II. Transmissions d'engranatges", Carles Riba Romeva, Edicions UPC.

"Mecanismes i màquines III. Dinàmica de màquines", Carles Riba Romeva, Edicions UPC.

"Teoria de màquines" Salvador Cardona Foix i Daniel Clos Costa, Edicions UPC

"Mechanical design", Peter R.N. Childs, Arnold Publishers