



Universitat de Lleida

DEGREE CURRICULUM
**MACHINE DESIGN AND
TESTING I**

Coordination: NOGUES AYMAMI, MIQUEL

Academic year 2019-20

Subject's general information

Subject name	MACHINE DESIGN AND TESTING I			
Code	14522			
Semester	2nd Q(SEMESTER) CONTINUED EVALUATION / UNDEFINED			
Typology	Degree	Course	Character	Modality
	Master's Degree in Industrial Engineering	1	COMPULSORY	Attendance-based
Course number of credits (ECTS)	6			
Type of activity, credits, and groups	Activity type	PRAULA		TEORIA
	Number of credits	3		3
	Number of groups	1		1
Coordination	NOGUES AYMAMI, MIQUEL			
Department	COMPUTER SCIENCE AND INDUSTRIAL ENGINEERING			
Teaching load distribution between lectures and independent student work	40% lectures in class 60% independent student work			
Important information on data processing	Consult this link for more information.			
Language	Catalan. However some material could be also in Spanish or English			
Office and hour of attention	Miquel Nogués, Tuesday from 19:00 to 21:30, Thursday from 10:00 to 11:30			

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
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NOGUES AYMAMI, MIQUEL	miquel.nogues@udl.cat	6	

Subject's extra information

The main background needed to take advantage 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 laboratory 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 document of the *Servei de Prevenció de Riscos Laborals de la UdL*: <http://www.sprl.udl.cat/alumnes/index.html>

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 apply the knowledge gained and to solve problems in new environments in wider contexts (or multidisciplinary) related with the area 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-disciplinary competences

- **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.

Problems: Presentation and discussion of problems that will eventually solve by the students in a individual way or in groups.

Group work: Development of a study in groups 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.

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 developed along of the midterm. The test 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 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 4. 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 established to each evaluation activity, out of a total of 100, is as follows:

Activity	Weight
1a written exam	20
2a written exam	20
3a written exam	20
4a written exam	20
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

Adaptations to the methodology due to COVID-19

Because classes cannot be face-to-face, theory and problem classes will be conducted by videoconference.

The practices will be replaced by simulations with the CREO program

Adaptations to the development plan due to COVID-19

Due to the need for a period of adaptation by both students and teachers to the new tools have generated a certain delay in the development plan. Moreover, with the possible accumulation of work that students have to deal with, the deadlines for submitting works have been extended to the second half of June

Adaptations to the evaluation due to COVID-19

Because the realization of simulations instead of the face-to-face practices, a greater effort on the part of the student in the accomplishment of these works is required. Moreover, with the problems that were detected in the on-line exam, it has been agreed with the students to increase the weighting of the works in the evaluation process.

Work of moments of inertia 20 points

Kinematics and dynamics work 25 points

Vibration work and balancing 25 points

First written test first partial 10 points

Second partial written test 20 points

In order to pass the course, the student must obtain an average grade of 3 in the written tests, and if he does not get a grade above this mark, the student must go to the extraordinary exam.

If the average grade of the written tests is higher than 3, then the grade of the subject will be obtained according to the weights indicated.

The grade of the extraordinary exam will replace the mark of the written exams, and will have a weight of 30% of the overall grade of the subject. In order to pass the subject, the grade of the written extraordinary exam must be higher than 3 in order to be able to use the weightings with the deliverables's grade. In case that such grade is not reach, the grade of the subject will be the grade of the extraordinary exam.