SYLLABUS

Course	
Name	Innovative Modern Engineering Design and Rapid Prototyping
Code	
Degree	Grado en Ingeniería Electromecánica, Grado en Ingeniería Telemática
Year	4
Semester	Second. Spring.
ECTS credits	3 ECTS
Character	Optative
Departament	Mechanical Engineering
Area	Design and Manufacturing
University	Pontificia Comillas
Schedule	2 hours per week
Instructors	Mariano Jiménez Calzado, Silvia Fernández Villamarín
Descriptor	

Instructor	
Professor	
Name	Silvia Fernández Villamarín
Departament	Mechanical Engineering
Area	Design and Manufacturing
Office	D-314
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Office hours	To be defined with the professor

COURSE SPECIFICS

Context of the course

Contribution to the professional profile

This subject has been designed to take students through the conception, design and implementation of products.

At the end of the season, the students will be able to apply fundamental engineering design principles and procedures, to design and optimize parts and assemblies using CADCAMCAE technology, and to implement rapid prototyping and reverse engineering complete processes.

This course is designed to provide theoretical and practical knowledge necessary to transform product ideas into viable products: hand sketching, computer-assisted design, analysis and design optimization, 3D digitizing, rapid prototyping and testing.

Pre-requisites

Knowledge of engineering drawings fundamentals.

Competences - Goals

Generic competences

CG3.	Knowledge on basic and technological matters that helps the learning of new method and theories. Student will be trained to be flexible in front of new challenges.
CG4.	Ability to solve new problems, make decisions, be creative, critical reasoning and to communicate knowledge and skills inside the Industrial Engineering field.
CG8.	Ability to apply principles and methodologies of quality.
CG10.	Ability to work and be active part of a multilingual and multidisciplinary team.

Specific Competences and Learning Results[1]

CE1. To learn about the development of new products.
- RA1. Stages of products lifecycle.
- RA2. Express product design ideas using 2D sketches.
- RA3. Role of CADCAMCAE technologies.
- RA4. Optimal design criteria.

CE2. To model complex parts and assemblies with a leading CAD software.
- RA5. Creation, dimensioning and manipulation.
- RA6. Parametric design and modeling criteria according to future changes and redesigns.
- RA7. Render the appearance of a product.

CE3. To learn about the analysis and optimization of a designed part or assembly with a leading CAE software.
- RA8. Role of a CAE software in the design stage to validate functional performance.
- RA9. Theory of finite element method.
- RA10. General phases of the process.

CE5. To learn about reverse engineering process.
- RA11. Main technologies and main applications identification.
- RA12. Stages and components of the process.
- RA13. Main brands and suppliers available.
- RA14. Use of a 3D digitalization scanner.
- RA15. Use of a point cloud editing software.

[1] Learning results are observable indicators of the competences acquired, which allow assessing the degree of competence of the students. The competences are usually more general and abstract. Learning results are observable indicators of competences.

CE4. To learn about rapid prototyping process. RA16. Main technologies and main applications identification. RA17. Stages and components of the process. RA18. Main brands and suppliers available. RA19. Use of FDM and DLP machines. RA20. Current status and future tendency of additive manufacturing.

CONTENTS AND MODULES

Contents
THEORY.
1. Conception, design and development of products.
New product development cycle. Introduction to CAD/CAM/CAE and product lifecycle management PLM. Design for manufacturing and assembly.
2. Computer Aided Design (CAD).
3D modeling. Parametric design. Assembly modeling.
3. Computer Engineering Analysis (CAE).
Finite element method general procedure. Solid and FEA models. Materials definition. Loading (loads, displacement constraints…). Post-processing, results and verifications. Static resistance design and fatigue resistance design.
4. Reverse engineering (RE).
Fundamentals. Methodologies and techniques. Hardware and software involved. Application and selection of reverse engineering system.
5. Rapid prototyping (RP).
Principles and applications. Prototypes in a product design process. Technologies and selection of rapid prototyping system. Configuration files (*. stl).
LABORATORY.
1. CAD lab practices.
3 sessions of 2 hours. Using CATIA system CAD tools, students will design and model functional parts and assemblies (creation, dimensioning and manipulation).
2. CAE lab practices.
2 sessions of 2 hours. Using CATIA system CAE tools, students will optimize designed parts and assemblies.
3. REVERSE ENGINEERING lab practices.
3 sessions of 2 hours. Students will be introduced to reverse engineering methodology through practical cases using 3D digitalization scanners and the point cloud editing software GEOMAGIC, a complete solution for transforming 3D scanned data into triangular faced mesh, highly accurate surface and native CAD models.
4. RAPID PROTOTYPING lab practices.
2 sessions of 2 hours. Students will be introduced to rapid prototyping methodology through practical cases using FDM and DLP machines to produce 3D physical models.

TEACHING METHODOLOGY

General methodological aspects

Both classroom and non-classroom activities are developed to imply the students within the learning activities. The subjects are developed to keep the student attention and following the competencies acquisition by the students. Student activities are key factors to develop this course.

Classroom methodology: Activities

1. **Lectures and general presentations**. The teacher will explain key concepts and procedures for every theme showing the more important aspects. Practical examples will be presented, discussed and solved to complete the understanding.
2. **Laboratory work.** Lectures and general presentations complement each other with the laboratory where the students solve problems using computers, machines and equipments. Cases will be open challenges that can be analyzed and solved by the use of the concepts already presented in class. The laboratory sessions will end up with a laboratory report to present the work performed.
3. **Team Work presentations**. The teacher will ask for team works of any proposed matter. Students will have to look for additional documentation to what was shown in class. Students must justify their conclusions and add value with their engineering mind. These works will be public presented in class.

Non-classroom methodology: Activities

1. **Self-learning** to understand the concepts and methodologies described in class and to apply them to different problems given by the instructor. Materials to be used are slides, multimedia files, personal and teacher notes, and recommended books.
2. **Laboratory preparation and reporting** revised and updated with the rest of information given in the subject.
3. **Team Works**. Preparation and presentation of team work project. Students must find the information sources to create outstanding works.

In addition, instructors will address the questions of students individually or in groups during their office hours, and will also help them orient their learning process.

SUMMARY OF THE STUDENT WORKING HOURS			
CLASSROOM ACTIVITIES			
Lectures general presentations	**Team work presentations**	**Lab sessions and problems solving**	
8	4	21	
NON-CLASSROOM ACTIVITIES			
Autonomous study on theory	**Autonomous work on team project**	**Autonomous work on practices**	
8	12	22	
		ECTS CREDITS:	**3 (75 hours)**

EVALUATION AND GRADING CRITERIA

Evaluation activities	Grading criteria	Weight
Laboratory Lab reports + Homework.	- Concepts understanding. - Application of concepts to problem solving. - Analysis and interpretation of problems results. - Analysis and interpretation of laboratory results.	40 %
Continous evaluation: End of term project and presentation.	- Concepts use to solve real cases. - Team working skills. - Presentation and writing skills.	60 %
Exams: July exam (paper+computer).	- Concepts understanding. - Application of concepts to problem solving. - Analysis and interpretation of problems results.	70 %

GRADING.

Grading method
Standard evaluation at the end of the term 40% Lab reports + Homework. 60% End of term project and presentation. Groups of 3-4 students. Attendance: minimum 85% to be allowed to take the exam. According to article 93 of the General Guidelines of the Universidad Pontificia Comillas, class attendance is compulsory for all students. Absence of more than 15% of the total amount of classes can result in the denial of the right to examination in the first exam session of the same academic year. The academic ruling of the University can be extended to the extraordinary exam session as well. **Additional evaluation during July (for those who do not pass at the end of the term)** 15% Lab reports + Homework. 15% End of term project and presentation. Groups of 3-4 students. 70% July exam (paper+computer)

REFERENCES AND RESOURCES

References

- Ulrich K.T., Eppinger S.D. (2012), Product Design and Development, McGraw-Hill.
- Raja V., Fernandes K.J., (2008), Reverse Engineering. An Industrial Perspective. Springer.
- Chua C. K., Leong K. F. and Lim C. S. (2010), Rapid Prototyping: Principles And Applications, World Scientific Publishing Co. Pte. Ltd