Polytechnic Institute of Coimbra (P COIMBRA 02)
Coimbra Institute of Engineering - ISEC
Mechanical Engineering Department

ECTS CATALOGUE

The main language of instruction at Coimbra Institute of Engineering is Portuguese. However, some courses from degree and master programs can be offered in English and/or with a tutorial support in English.

The ECTS catalogue includes subject contents in English Language. The Students can choose subjects from this Catalogue to the study plan proposal (Learning Agreement) to be analyzed carefully by the Departmental Coordinators and to be adjusted, after the student's arrival, if necessary.

This ECTS catalogue contains information which is valid for this academic year. ISEC reserves the right to adjust the courses offered during the academic year and is not responsible for typing errors or printing mistakes.

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Polytechnic Institute of Coimbra (P COIMBRA 02)
Coimbra Institute of Engineering - ISEC
Mechanical Engineering Department

ECTS CATALOGUE 2021-2022

MASTER Mechanical Engineering Course

Old Code	New Code	Title - Portuguese	Title – English	ECTS	Term
1.º ano / 1st Year					
636101	60011488	Métodos Computacionais em Engenharia	Computational Methods in Engineering	6	Autumn
636102	60011499	Instrumentação e Controlo	Instrumentation and Control	6	Autumn
636103	60011507	Estruturas Mecânicas	Mechanical Structures	6	Autumn
636104	60011518	Desgaste e Corrosão	Wear and Corrosion	6	Autumn
636111	60011582	Termodinâmica Aplicada	Applied Thermodynamics	6	Autumn
636113	60011608	Comportamento Térmico e Acústico de Edifícios	Thermal and Acoustic Behaviour of Building*	6	Autumn
636105	60011529	Análise de Vibrações	Vibration Analysis	6	Autumn
636112	60011593	Energias Alternativas	Alternative Energies	6	Autumn
636109	60011560	Comportamento dos Materiais em Serviço	Mechanical Behavior of Materials in Service	6	Spring
636118	60011653	Redes de Fluidos	Fluid Networks	6	Spring
636106	60011535	Tecnologias de Fabrico	Manufacturing Technologies	6	Spring
636107	60011546	Seleção de Materiais	Materials Selection	6	Spring
636108	60011554	Cálculo Automático de Sistemas Mecânicos	Computer Aided Analysis of Mechanical Systems	6	Spring
636110	60011571	Equipamentos Industriais	Industrial Equipments	6	Spring
636114	60011619	Equipamentos Térmicos	Thermal Equipments	6	Spring
636115	60011625	Instalações de AVAC	HVAC Installations	6	Spring
636116	60011636	Instalações Frigoríficas	Refrigeration Systems	6	Spring
636117	60011647	Energia e Ambiente	Energy and Environment	6	Spring
2.º ano / 2nd Year					
636119	60011664	Projeto	Project**	60	Anual
	60011670	Estágio	Internship**	60	Anual
	60011681	Dissertação	Dissertation**	60	Anual

*These subjects are related to Portuguese Legislation. Not recommended for all nationality's students. (Exceptions: students with good Portuguese language understanding)

**ISEC accept student for works/researches related with these subjects without ECTS attribution. At the end of the work, student will receive an evaluation report within the total of working hours. The presentation and defense will be done at home university.

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

Mestrado - MSc em Engenharia Mecânica
MSc in Mechanical Engineering
Academic Year: 2018 / 2019

Program Contents

Course Unit PROJECT, INTERNSHIP OR DISSERTATION (PIMST)

Subject type Specialty Curricular Unit **Research Area** Mechanical Engineering

Year 2nd **Semester** 1st and 2nd **ECTS** 60

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures		
Theoretical-Practical Lectures		
Practical-Laboratory Lectures		
Tutorial Orientation		105

Unaccompanied Working Hours

Activity Type	Total Hours
Study	
Works / Group Works	
Project	1455
Evaluation	
Additional	

Total of Working Hours 1560

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures			
Practical-Laboratory Lectures			
Tutorial Orientation	Anabela Duarte de Carvalho	PhD	Adjunct Professor
	António Manuel de Morais Grade	MSc	Adjunct Professor
	Gilberto Cordeiro Vaz	PhD	Coordinator Professor
	João Carlos Antunes Ferreira Mendes	PhD	Coordinator Professor
	João Manuel N. Malça de Matos Ferreira	PhD	Adjunct Professor

Responsible(s) Lecturer (s) António Manuel de Morais Grade

Goals / Skills

The main aims of the Project / Dissertation are:

- To provide the student the opportunity to demonstrate autonomy and originality;
- To develop the capacity to plan and organize a large project / dissertation over a long period;
- To apply the knowledge and techniques acquired throughout the course.

The main aims of the Internship are:

- To gain relevant work experience that will aid the access and integration of the student into professional life;
- To provide the required knowledge and transferable skills which enables the students to pursue their careers;
- To put into practice the knowledge and techniques acquired throughout the course.

Program Contents

Development of an individual oriented project, internship or dissertation privileging subjects that embrace several areas of mechanical engineering and related to real world cases. The project, internship or dissertation culminates in the elaboration of a final report or thesis written on the work developed, that meets the academic requirements of the level of a Masters.
Project / Dissertation:
The subject of the project may be proposed by a member of the teaching staff or by the student. Each project / dissertation is assigned to one or more guiding teachers, according to the areas involved in the project / dissertation, which will provide tutorial guidance to the student throughout the year. The student and the guiding teachers will agree a project work plan that should be approved by the school Technical-Scientific Council. The work plan includes the project / dissertation objectives, scope and time schedule. The project / dissertation may eventually be conducted in collaboration with companies or other entities outside the school.
Internship:
Instead of a project, students have the possibility to undertake an internship program. The internship may be proposed by a member of the teaching staff, by a company/institution or by the student. Each internship work program is assigned to one or more guiding teachers, according to the areas involved in the internship, and one company/institution supervisor. The student, the guiding teachers and the supervisor will agree a work plan that should be approved by the school Technical-Scientific Council. The work plan includes the internship objectives, the internship activities and the time schedule. The ISEC establishes an internship protocol with the company / institution and with the student, to carry out the internship.

Work Done

N.A.

Teaching Methodology

The teaching methodologies to be used throughout the different stages of the project, internship or dissertation should be defined by the teaching guiding staff, in accordance with the intended objectives.

Bibliography

The bibliography and other specific study elements for each project, internship or dissertation will be indicated by the respective teaching guiding staff.

Evaluation Method

Public oral presentation and discussion of the project / internship report or the dissertation thesis before a 3 to 5 member jury, including one guiding teacher.

Conditions for Exam Admission

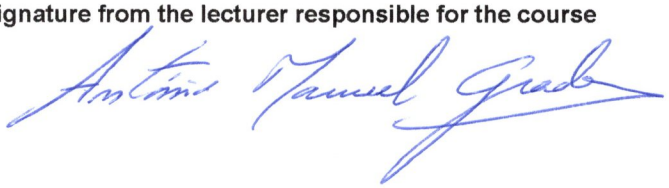
N.A.

Access Conditions and Attendance Excuse

N.A.

Conditions for Results Improvement

N.A.

Date	Signature from the lecturer responsible for the course
12/10/2018	

Program Contents

Course Unit PROJECT, INTERNSHIP OR DISSERTATION (CMEM)

Subject type Specialty Curricular Unit **Research Area** Mechanical Engineering

Year 2nd **Semester** 1st and 2nd **ECTS** 60

Working Hours **Unaccompanied Working Hours**

Activity Type	Working Hours Per Week	Total Hours	Activity Type	Total Hours
Theoretical Lectures			Study	
Theoretical-Practical Lectures			Works / Group Works	
Practical-Laboratory Lectures			Project	1455
Tutorial Orientation		105	Evaluation	
			Additional	

Total of Working Hours 1560

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures			
Practical-Laboratory Lectures			
Tutorial Orientation	António Santos Simões	Doutoramento	Prof. Adjunto
	Carlos José de Oliveira Pereira e Jorge Alcobia	Doutoramento	Prof. Adjunto
	Fernando António Gaspar Simões	Doutoramento	Prof. Coordenador
	João Miguel Maia Carrapichano	Doutoramento	Prof. Coordenador
	Luís Filipe Pires Borrego	Doutoramento	Prof. Coordenador
	Luís Manuel Ferreira Roseiro	Doutoramento	Prof. Coordenador
	Pedro Jorge Borges Fontes Negrão Beirão	Doutoramento	Prof. Adjunto
	Pedro Miguel Soares Ferreira	Doutoramento	Prof. Adjunto
	Urbano Manuel Oliveira Ramos	Doutoramento	Prof. Adjunto

Responsible(s) Lecturer (s) Luís Filipe Pires Borrego

Goals / Skills

The main aims of the Project / Dissertation are:

- To provide the student the opportunity to demonstrate autonomy and originality;
- To develop the capacity to plan and organize a large project / dissertation over a long period;
- To apply the knowledge and techniques acquired throughout the course.

The main aims of the Internship are:

- To gain relevant work experience that will aid the access and integration of the student into professional life;
- To provide the required knowledge and transferable skills which enables the students to pursue their careers;
- To put into practice the knowledge and techniques acquired throughout the course.

Program Contents

Development of an individual oriented project, internship or dissertation privileging subjects that embrace several areas of mechanical engineering and related to real world cases. The project, internship or dissertation culminates in the elaboration of a final report or thesis written on the work developed, that meets the academic requirements of the level of a Masters.
Project / Dissertation:
The subject of the project may be proposed by a member of the teaching staff or by the student. Each project / dissertation is assigned to one or more guiding teachers, according to the areas involved in the project / dissertation, which will provide tutorial guidance to the student throughout the year. The student and the guiding teachers will agree a project work plan that should be approved by the school Technical-Scientific Council. The work plan includes the project / dissertation objectives, scope and time schedule. The project / dissertation may eventually be conducted in collaboration with companies or other entities outside the school.
Internship:
Instead of a project, students have the possibility to undertake an internship program. The internship may be proposed by a member of the teaching staff, by a company/institution or by the student. Each internship work program is assigned to one or more guiding teachers, according to the areas involved in the internship, and one company/institution supervisor. The student, the guiding teachers and the supervisor will agree a work plan that should be approved by the school Technical-Scientific Council. The work plan includes the internship objectives, the internship activities and the time schedule. The ISEC establishes an internship protocol with the company / institution and with the student, to carry out the internship.

Work Done

N.A.

Teaching Methodology

The teaching methodologies to be used throughout the different stages of the project, internship or dissertation should be defined by the teaching guiding staff, in accordance with the intended objectives.

Bibliography

The bibliography and other specific study elements for each project, internship or dissertation will be indicated by the respective teaching guiding staff.

Evaluation Method

Public oral presentation and discussion of the project / internship report or the dissertation thesis before a 3 to 5 member jury, including one guiding teacher.

Conditions for Exam Admission

N.A.

Access Conditions and Attendance Excuse

N.A.

Conditions for Results Improvement

N.A.

Date	Signature from the lecturer responsible for the course
12/10/2018	

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

Mestrado - MsC __ Engenharia Mecânica (Português)

Mestrado - MsC Mecanichal Engineering (Ingês)

Academic Year: 2018/2019

Program Contents

Course Unit INDUSTRIAL EQUIPMENTS

Subject type Sciences **Research Area** Mechanical Engineering

Year 1º **Semester** 2º **ECTS** 6

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	28
Theoretical-Practical Lectures	2	28
Practical-Laboratory Lectures		
Tutorial Orientation		
Total of Working Hours		156

Unaccompanied Working Hours

Activity Type	Total Hours
Study	97
Works / Group Works	
Project	
Evaluation	3
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Jorge Rafael Nogueira Raposo	PhD	
Theoretical-Practical Lectures	Jorge Rafael Nogueira Raposo	PhD	
Practical-Laboratory Lectures			
Tutorial Orientation			

Responsible(s) Lecturer (s) Jorge Rafael Nogueira Raposo

Goals / Skills

The objective of this course is to provide students with knowledge of the equipment installed in various sectors of industry. The student gets the knowledge to know how to select equipment in the various areas covered in the course.

Program Contents

1. Mechanical Power Transmission
Shaft unions; Types of joints; Operation principle; Selection of shaft joints; Transmission of motion; Transmission by belts; Roller chain transmission; Free and non-return wheels; Main constructive forms; Characteristics and constructive forms; Selection; Speed selector; Types of drives; Operation principle; Selection and main applications; Tensors; Tensioners of chains and belts; Applications; Selection method; Anti-vibration supports; Types of oscillation systems; Terminology used and Selection criteria; Clutches; Types of clutches; Operation principle; Fields of application; Brakes; Types of brakes; Torque Limiters; General features; Types of assemblies; Selection; Speed reducers; Types of reducers; Formation of a reducer; Most used assemblies; Loads applied; Sizing; Motion inverters; Operating mode; Main applications.
2. Industrial Pipes
Standards, codes and specifications; Main standards and codes on pipes; Specifications of materials used in piping; Examples of specifications; Application of industrial pipes; Types of pipe protection; Sizing of tubes; Pipe holders; Accessories used for the installation of pipes.
3. Pneumatic Systems

Air compressors; Types of compressors; Installation of compressors; Maintenance; Cylinders and actuators; Constitution of a cylinder; Materials used in cylinder construction (standardization); Dimensioning of cylinders and actuators; Equipment for the treatment of air; Principle of operation of an FRL system; Their physical characteristics; Selection; Pneumatic valves; Electropneumatic valves and distributors, electropneumatic; Pneumatic accessories.

4. Oil-hydraulic systems

Hydraulic pumps; Types of pumps; Its constitution and principle of operation; Sizing of a pump; Main applications; Hydraulic motors; Oil-hydraulic distributors; Valves; Accumulators; Cylinders; Filtering techniques; Oil-hydraulic pipes; Electropump groups.

5. Industrial Valves

Classification of valves; Constitution and characteristics; Means of operation; Materials used in the construction of valves; Rotary joints; Servo-motors; Pneumatic actuators; Traps; Expansion Compensators; Equipment used in the installation of valves.

6. Lifting of Materials

Lifting chains and accessories; Types of slings; Application rules; Selection; Lift Differentials; Claws and stingrays; Push cars; Double beam cars.

Work Done

Individual work on a topic related to the contents given in the course

Teaching Methododoly

The presentation of the contents is essentially carried out during the theoretical classes, using as main support the projection of slides. In the classes, student participation is often raised through the formulation of questions that lead them to reflect on the different subjects discussed and create opportunities for clarification of doubts.
In the theoretical-practical classes, application problems will be performed, allowing students to get in touch with practical questions and a critical analysis of the results obtained. some of the theoretical-practical classes will be used to carry out research work in order to prepare the individual work report.

Bibliography

Rodrigues, António Mário V. S. - Sebenta da Disciplina; Catálogos de Fabricantes

Evaluation Method

Development of a work related to a topic given in the course. Final exam in the specified data. (Final grade = 0.5 EN + 0.5 WN (EN- Examination note; WN- Work note)

Conditions for Exam Admission

NA

Access Conditions and Attendance Excuse

Conditions for Results Improvement

Date	Signature from the lecturer responsible for the course
24/01/2019	Jorge Rafael Nogueira Rufino

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:_____

Mestrado - MsC Engenharia Mecânica

Mestrado - MsC Mechanical Engineering

Academic Year: 2018/2019

Program Contents

Course Unit MECHANICAL BEHAVIOUR OF MATERIALS

Subject type Specialty Sciences **Research Area** Mechanical Engineering

Year 1 **Semester** 2 **ECTS** 6

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	30
Theoretical-Practical Lectures	2	30
Practical-Laboratoty Lectures		
Tutorial Orientation		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	97
Works / Group Works	
Project	
Evaluation	3
Additional	

Total of Working Hours 160

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Luis Filipe Pires Borrego	PhD	Prof. Coordenador
Theoretical-Practical Lectures	Maria de Fátima da Costa Paulino	MsC	Assistente Convidada
Practical-Laboratoty Lectures			
Tutorial Orientation			

Responsible(s) Lecturer (s) Luis Filipe Pires Borrego

Goals / Skills

The main objective of this unit is to understand the concepts and acquire the procedures about the fundamental tools in design and control of mechanical components failure, taking into account their service conditions. The application of these concepts and tools covers a wide area of application, namely, in aerospace, aeronautic and naval industries, in the design of transport vehicles and pressure vessels, and also in several other components and structures subjected to static or dynamic loadings.

Program Contents

1. Main rupture and failure modes in mechanical components.
Excessive elastic deformation, plastic deformation, ductile tear, wear, stress corrosion, fragile fracture, creep, fatigue.

2. Materials fatigue
High-cycle fatigue. Characterization of the fatigue process. Fatigue parameters. Representation of fatigue results. Fatigue tests. Low-cycle fatigue. Behaviour of metals to cyclic plastic deformation. Deformation-life curves. Experimental

determination of the basic parameters of fatigue. Life prediction of notched components. Conditions of initiation and propagation of fatigue cracks.

3. Linear elastic fracture mechanics
Introduction. Griffith's theory. Rupture modes. Definition of stress intensity factor. Stress field at the end of a crack in a linear elastic body. Critical value of the stress intensity factor. Plastic zone at the crack tip. Variation of tenacity with thickness. KIc variation with temperature. Experimental determination of KIc. Applications of Linear Elastic Fracture Mechanics.

4. Elastic-plastic fracture mechanics
Parameters COD and J integral. Experimental determination. Elastic-plastic fracture mechanics applications.

5. Stress corrosion
Stress corrosion tests. Curves da/dt-K. Application of the da/dt-K design curves.

6. Application of fracture mechanics to fatigue
Introduction. da/dN-ΔK curves. Threshold of a fatigue crack. Parameters of the crack propagation rate of fatigue cracks. Mean stress effect. The crack closure phenomenon. Influence of other parameters. Main crack propagation laws. Crack growth under variable amplitude loading. Application of da/dN-ΔK design curves

7. Creep and stress relaxation
Fundamental notions. Long duration creep tests. Equipment used in creep tests. Stress relaxation and recovery. Basic problems in creep design.

Work Done

Not applicable.

Teaching Methododoly

The theoretical content is developed and displayed using audio-visual means and didactic models. In theoretical-practical classes typical exercises are solved. Teachers provide discipline information in platform "Moodle".

Bibliography

- BORREGO, L. P. *Complementos da Fadiga de Materiais*, Textos Pedagógicos, ISEC, 2002.
- BORREGO, L. P. *Aplicação da Mecânica da Fractura à Fadiga*, Textos Pedagógicos, ISEC, 2002.
- BORREGO, L. P, BRANCO, R. S. *Colectânea de Problemas Teórico-Práticos*, ISEC, 2002.
- BRANCO, C.M., FERNANDES, A.A. CASTRO P. T. *Fadiga de Estruturas Soldadas*, Fundação Calouste Gulbenkian, 1986.
- HERTZBERG, R.W. - *Deformation and Fracture Mechanics of Engineering Materials*, Ed. John Wiley Sons, 1987. ISBN O-471-61722-9.
- DOWLING, N. - *Mechanical behavior of Materials: Engineering Methods for Deformation*, Fracture and Fatigue, Prentice-Hall, 1999. ISBN 0-13-905-720-X.
- ELLYN F. - *Fatigue Damage, Crack Growth and Life Prediction*, Chapman & Hall, 1997. ISBN 0-412-59600-8

Evaluation Method

The evaluation of this curriculum unit is performed through a written test at the end of the semester. This test includes two components, a theoretical component and a theoretical-practical one, corresponding each to 50% of the final grade. It is required to obtain a minimum of 25% in each component.

Conditions for Exam Admission

There are no limitations.

Access Conditions and Attendance Excuse

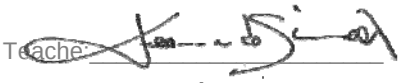
Not applicable.

Conditions for Results Improvement

Repeating the theoretical and theoretical-practical written test under the conditions described in item evaluation method.

Date	Signature from the lecturer responsible for the course
24.01.2019	Luis Filipe Borrego

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: 

Mestrado - MsC Mestrado em Engenharia Mecânica – Especialização em Construção e Manutenção de Equipamentos Mecânicos

Mestrado - MsC Master in Mechanical engineering - Specialization in Construction and Maintenance of Mechanical Equipments

Academic Year 2018/2019

Program Contents

Course Unit MATERIALS SELECTION

Subject type Engineenring Sciences **Research Area** Mechanical Engineering

Year 1 **Semester** 2 **ECTS** 6

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	28
Theoretical-Practical Lectures	2	28
Practical-Laboratoty Lectures		
Tutorial Orientation		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	97
Works / Group Works	3
Project	
Evaluation	
Additional	

Total of Working Hours 156

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Fernando António Gaspar Simões	PhD	Coordinator Prof.
	João Miguel Maia Carrapichano	PhD	Coordinator Prof.
Theoretical-Practical Lectures	Fernando António Gaspar Simões	PhD	Coordinator Prof.
	João Miguel Maia Carrapichano	PhD	Coordinator Prof.

Responsible(s) Lecturer (s) Fernando António Gaspar Simões

Goals / Skills

Characterization of the major classes of engineering materials, making a comparison of metallic materials with polymers, ceramics and composites
Presentation of the properties of different types of materials. Examples of the application of these materials in the industry.
Description and application of methods for selecting materials.
Selection of materials, depending on the requirements of the design, processing methods and economic requirements.

Program Contents

Metallic materials: Classification, properties and applications of non-alloy steels , alloy steels , cast irons , aluminum alloys, copper, magnesium , titanium, zinc and nickel .
Polymeric materials: Classification, properties and applications of thermoplastics , thermosets and elastomers used in engineering .
Ceramic materials: Classification, properties and applications of traditional and technic ceramics , and glasses. Processing of technical ceramics .
Composite materials: Classification of composites according with the type of matrix and reinforcement . Composite

reinforcements and matrices. Advanced Composites.
Presentation and correlation of the main properties and parameters that characterize the materials. Quantification of properties. Correlation between function, material , form and process .
Selection of candidate materials and manufacturing processes. Decision matrix for selection of materials. Analysis and selection of materials in case studies.

Work Done

Teaching Methododoly

In theoretical and theoretical-practical classes are presented the contents that allow the knowledge of the properties and applications of the studied materials, the manufacturing processes and methods of selection of materials. For this purpose, in theoretical-practical classes, commercial catalogs are often consulted, made the presentation of examples of materials in a wide range of materials gathered for the purpose, and also carried out some tests to determine mechanical properties. In the end, are presented different case studies of material selection for specific applications, taking into account the pre-requirements defined.

Bibliography

- SMITH, W.F. - Princípios da Ciência e Engenharia de Materiais, 3.ª edição, McGraw-Hill, 1998.
- BARRALIS, J.; MAEDER, G. - Prontuário de Metalurgia, Fundação Calouste Gulbenkian, 1997.
- HONEYCOMBE, R.W.K. - Aços, Microestrutura e Propriedades, Fundação Calouste Gulbenkian, 1981.
- MARCELO MOURA – Materiais Compósitos, Materiais, Fabrico e Comportamento Mecânico, 2ª edição, Publindústria.
- An Introduction to Advanced Composites and Prepeg Tecnologies, Centre of Composites Technology.
- ASHBY, M.F.; SHERCLIFF H.; CEBON, D. - Materials Enginnering, Science, Processing and Design, Elsevier Butterworth-Heinemann, 2007. ISBN: 978-0-7506-8391-3.
- ASHBY, M.F. - Materials Selection in Mechanical Design, 3th edition, Elsevier Butterworth-Heineman, 2005.
- CARDELLI, F. - Materials Handbook, A Concise Desktop Reference, Second edition, Springer, 2000.

Evaluation Method

The evaluation of this course unit consists of an individual written exam (100% weight in the evaluation).

Conditions for Exam Admission

Access Conditions and Attendance Excuse

Conditions for Results Improvement

Date
25/01/2019

Signature from the lecturer responsible for the course

Program Contents

Course Unit MANUFACTURING TECHNOLOGIES

Subject type Specialty Sciences **Research Area** Mechanical Engineering

Year 1.º **Semester** 2.º **ECTS** 6

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	28
Theoretical-Practical Lectures		
Practical-Laboratoty Lectures	2	28
Tutorial Orientation		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	85
Works / Group Works	
Project	
Evaluation	3
Additional	12

Total of Working Hours 156

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Pedro Miguel Soares Ferreira	PhD	Adjunct Prof.
Theoretical-Practical Lectures			
Practical-Laboratoty Lectures	Fernando António Gaspar Simões	PhD	Coordinator Prof.
	Vitor Manuel Maranha Lopes	MSc	Invited Assist.
Tutorial Orientation			

Responsible(s) Lecturer (s) Pedro Miguel Soares Ferreira

Goals / Skills

Sensitize students and give them to know the advanced manufacturing processes and their main applications in the industry.

Program Contents

1. **3D Modeling**
   Importance of 3D modeling in manufacturing processes. Bases of 3D modeling. Creation of three-dimensional parametric models. From 3D geometry to 2D drawing. From 3D geometry to rendered view.
2. **EDM technology**
   Introduction; Types of EDM; Principles of operation; Work processes and factor regulation; Electrodes and their materials; Dielectric liquids; Washing or cleaning; Surface quality; Fixing of electrodes; Wire EDM; EDM group.
3. **Reverse Engineering**
   Introduction; Three-dimensional scanning; Surface scanning; Surface scanning and modeling; Continuous scanning; Interfaces for CAD systems; Coordinate measuring machines (CMM).
4. **Rapid Prototyping**
   Introduction; Traditional prototyping technologies; Rapid prototyping; Stereolithography (SL or SLA); Manufacture by layers (LOM); Selective sintering (SLS); Three-dimensional printing (TDP); Fused Melted Deposition (FDM); Thermojet; Conversion of prototypes to obtain functional prototypes; Conversion of prototypes into plastic pieces; Conversion of prototype without metallic parts; Execution of production tools (RT).

5. **Water Jet Technology**
   Historical Introduction; Fundamentals of the process; Operative parameters; Equipment characteristics; Applications: Water jet cleaning; Cutting and; Drilling; Comparison with other methods; Safety and environment.
6. **Laser Technology**
   Historical Introduction; Fundamentals of the process; Main types of lasers used industrially; Laser systems; Laser cutting and drilling; Operative parameters; Equipment characteristics; Applications; Safety and environment.
7. **Strategies adopted in the movement of the tool in CAM Systems**
   Definition of tolerance in tool trajectory calculation; Machining strategies used in CAM programs; Influence of the machining strategies on the cutting blade.
8. **High Speed Machining**
   Development and characterization of high speed machining; Machine tools for high-speed work; Programming and data transmission in high speed machining.
9. **Application of Manufacturing Technologies in the Production of Components for Mechanical Equipments**
   Degrees of freedom of the manufacturing equipment and nomenclature of the working axes. Computer Assisted Manufacturing: EDM; Drilling and Threading; Milling by planes and Multi-axes; Reverse Engineering and Rapid Prototyping.
   Dimensional and surface characterization of components manufactured by different manufacturing technologies.

Work Done

Not applicable.

Teaching Methododoly

The presentation of the contents is essentially carried out in the course of theoretical classes, using as main support the projection of slides or transparencies. In the practical classes are presented and explored parts of the program that, by their nature, provide a more applied approach, where experimental activities are implemented with students intervention that allow familiarization with equipment and software used in the manufacture and dimensional and superficial characterization of mechanical components.

Bibliography

- F. Alves, F. Braga, M. Simão, R. Neto e T. Duarte - Prototipagem Rápida, Protoclick, Porto, 2001. ISBN: 972-95376-1-5
- Centimfe, Ed. Manual do Projectista para Moldes de Injecção de Plástico: Fascículo 4 - Materiais para moldes e técnicas de fabrico, Marinha Grande, 2003-2004. ISBN: 972-98872-1-7
- J. Santos, L. Quintino e R. Miranda – Processamento de Materiais por Feixes de Electrões, laser e Jacto de Água, Instituto de Soldadura e Qualidade, 1991. ISBN: 972-9228-11-6
- J. Santos, L. Quintino e R. Miranda – Corte por Laser, Instituto de Soldadura e Qualidade, 1993. ISBN: 972-9228-38-8
- J. Paulo Davim e A. Esteves Correia, Maquinagem a alta velocidade, Publindústria, Edições Técnicas, 2006. ISBN: 972-8953-05-4
- L. Roseiro, V. Maranha, A. Gomes – Breves nota sobre engenharia inversa, ISEC, 2016.
- Solidworks 2016 – software manual.
- Geomagic Design X – software manual.
- Mastercam – software manual

Evaluation Method

The assessment of knowledge comprises a final examination of all theoretical and practical contents. The final mark is classified by assigning a grade in the scale of 0 to 20 values.

Conditions for Exam Admission

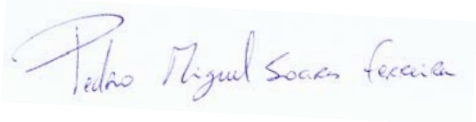
Not applicable.

Access Conditions and Attendance Excuse

Not applicable.

Conditions for Results Improvement

In accordance with the legislation and regulations.

Date	**Signature from the lecturer responsible for the course**
24/01/2019	

Program Contents

Course Unit WEAR AND CORROSION

Subject type Specialty Sciences **Research Area** Mechanical Engineering

Year 1 **Semester** 1 **ECTS** 6

Working Hours **Unaccompanied Working Hours**

Activity Type	Working Hours Per Week	Total Hours	Activity Type	Total Hours
Theoretical Lectures	2	30	Study	72
Theoretical-Practical Lectures	1	15	Works / Group Works	26
Practical-Laboratory Lectures	1	15	Project	
Tutorial Orientation			Evaluation	2
			Additional	
Total of Working Hours		160		

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Laura Maria Teixeira Santos João Miguel Maia Carrapichano	Grad. PhD	Adj. Prof. Coord. Prof.
Theoretical-Practical Lectures	Laura Maria Teixeira Santos João Miguel Maia Carrapichano	Grad. PhD	Adj. Prof. Coord. Prof.
Practical-Laboratory Lectures	Laura Maria Teixeira Santos João Miguel Maia Carrapichano	Grad. PhD	Adj. Prof. Coord. Prof.
Tutorial Orientation			

Responsible(s) Lecturer (s) João Miguel Maia Carrapichano

Goals / Skills

Upon completion of this unit, the student should be able to: Understand, measure and control wear phenomena in materials of mechanical components and systems; Use laboratory techniques and equipments in tribological studies and interpret experimental results; Understand the corrosion principles and common corrosion forms; Be aware of methods used to mitigate and prevent corrosion.

Program Contents

Part I – Wear
Introduction to tribology: significance, origins and objectives; economic impact.
Friction and wear: friction fundamentals; surface effects in tribology - adsorption, surface topography, measurement of surface roughness; friction models; friction values and friction influent parameters; energy dissipation by friction; wear mechanisms; wear laws; wear influent parameters; wear maps.
Materials for tribological applications: tribological and metallurgical compatibility; conventional and novel materials; surface preparation techniques for tribological applications; coatings and surface treatments.
Lubrication and lubricants: lubrication significance and objectives; lubrication regimes; dry or solid lubrication; self lubrication; lubricant types and application; lubricant oils proprieties; viscosity; mineral oils; synthetic oils; lubricant additives; solid lubricants and coatings; gaseous lubricants; greases; transportation and lubricants applications.
Mechanical components for tribological applications: bearings - journal and thrust bearings, plain and rolling bearings; seals - static, dynamic, pseudo-static.

Lubrication systems and components lubrication: plain and rolling bearings lubrication; gears and roller chain lubrication; turbines and motors lubrication.
Tribological tests - equipments and methods; standard tests; applications.
Part II - Corrosion
Introduction to corrosion: definition; classification; corrosive environments; corrosion damage; corrosion costs; corrosion engineering.
Electrochemical fundamentals of corrosion: electrochemical reactions; standard electrode potentials; Nernst equation; electrochemical cells.
Corrosion kinetics: corrosion rate units; Fraday's law; polarisation; passivation; effect of environmental variables on the corrosion rate.
Types of corrosion: uniform corrosion; galvanic corrosion; crevice corrosion; pitting corrosion; intergranular corrosion; selective corrosion; erosion corrosion; stress corrosion.
Corrosion prevention: materials selection; modification of environment; design; metallic coatings; non-metallic inorganic coatings; organic coatings; cathodic and anodic protection. High temperature corrosion: high temperature oxidation - protective oxide films, mechanisms of oxidation, oxidation kinetics, resistance of metals to oxidation; other mechanisms of high temperature corrosion.

Work Done

Based on measurement techniques, applications and laboratory work. Wear part, mainly at P classes, introduce the use of experimental methods in tribology - to study surfaces engineering and processes of interacting surfaces in relative motion, as friction, wear, lubrication and lubricants, and to study materials for tribological applications, lubrication systems and components lubrication. At corrosion TP and P classes are study and experimented the corrosion mechanisms and forms, as the different methods of corrosion control.

Teaching Methodology

The main contents are transmitted at theory classes used expositive techniques, as PowerPoint support, to developing skills through lectures accomplished with discussions. The iterative applications as the exercises resolution are conformed on theoretical-practical lectures. Practical classes, main to developing practical skills, through lectures with individual or group discussions, consist in experimental methods applications with students hand care, that aloud the sedimentation on wear and on corrosion theoretical fundaments and concepts and theoretical-practical bases.

Bibliography

Stachowiak GW, Batchelor AW, Engineering Tribology. 2nd Ed., Butterwort-Heinemann, 2001, ISBN 0750673044
Ludema KC, Friction, Wear, Lubrication: A Textbook in Tribology. CRC Press, 1996, ISBN 0849326850
Ferreira LA, Tribologia - Notas de Curso. Publindústria, Porto, 1998, ISBN 9729579458
Pina da Silva FA, Tribologia. Vol. I, Fundação Calouste Gulbenkian, Lisboa, 1985, ISBN 9723101904
Fontana MG, Corrosion Engineering. 3rd Ed., McGraw-Hill, New York, 1986, ISBN 0071003606
Gentil V, Corrosão. 5.ª Ed., LTC - Livros Técnicos e Científicos, Rio de Janeiro, 2007, ISBN 9788521615569
Valente AJM, Lobo VMM, Corrosão - Fundamentos, Prevenção e Efluentes. ECEMEI, Rio Tinto, 2000, ISBN 9729486042
Supporting texts (by course unit teachers).

Evaluation Method

Final written exam (75.0%); laboratory work or a case-study presented by written report or by oral presentation with discussion at wear (12.5%), and, at corrosion, practical written exam (12.5%). At wear, depending on the number of students by year, that compromises the limit of the conditioned level of practical work at laboratory plant, it will be possible the same situation - practical written question at the final exam instead of laboratory or case-study reports - and not doing the students directly and individually this laboratory practice, but watching the overall execution of the same. *To Erasmus student's progress assessment can be established by lectures as complementary meetings in English language, to develop parallel written project work in a predefined subject, with individual final presentation and discussion, complementing or replacing the final written test, whether in wear or corrosion, depending on the respective teacher*.

Conditions for Exam Admission

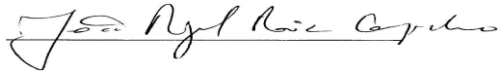
According to general rules used in the school.

Access Conditions and Attendance Excuse

It's necessary presence at 75% of practical classes. The students with positive classification on the last year at those practical examination parts, are dispensed of this presences.

Conditions for Results Improvement

Improving grades or retaking exams is allowed, according to general rules of the course and used in the school.

Date	**Signature from the lecturer responsible for the course**
12.10.2018	

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Lecturer's signature:_____

Mestrado - MsC Engenharia Mecânica (Português)

Mestrado - MsC Mechanics Engineering_ (Ingês)

Academic Year: 2018 / 2019

Program Contents

Course Unit MECHANICAL STRUCTURES

Subject type Speciality Sciences **Research Area** Engeneering Sciences

Year 1 **Semester** 1 **ECTS** 6

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	28
Theoretical-Practical Lectures	1	14
Practical-Laboratoty Lectures	1	14
Tutorial Orientation		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	55
Works / Group Works	42
Project	3
Evaluation	
Additional	

Total of Working Hours

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Luis Manuel Ferreira Roseiro	PhD	Coordinator Professor
Theoretical-Practical Lectures	Pedro Miguel Martins Miguens Amaro	MSc	Assistant
Practical-Laboratoty Lectures	Pedro Miguel Martins Miguens Amaro	MSc	Assistant.
Tutorial Orientation			

Responsible(s) Lecturer (s) Luis Manuel Ferreira Roseiro

Goals / Skills

This curricular unit is composed of three components: theoretical, theoretical/practical and laboratory, which interconnect. In the theoretical and theoretical/practical components is intended that students acquire knowledge and skills that allow them to understand the approach to problems involving various mechanical structures, using analytical and numerical methods. In the laboratory component will be developed the necessary experimental procedures to carry out tests involving this type of structures. This approach includes the experimental application of the concepts of experimental stress analysis in the structures to be analyzed. It is intended that the students apply the theoretical and experimental concepts, implementing various works in the course of the curricular unit.

Program Contents

1. Review: International Systems of Units (SI). Concept of the internal actions and stresses. Types of internal actions and stresses. Typical structural elements. Hypotheses and basic steps in the analysis of a structure. Dimensioning principles. Standardization applicable to mechanical structures and their importance.

Lecturer's signature:_____

2. Experimental Stress Analysis: Basic concepts and principle of procedure. Types of extensometers. Strain Rosette. Specifications and selection of extensometers. Techniques for gluing and assembling extensometers. Application examples.

3. Torsion: Torsion of members with non-circular cross section. Torsion of closed and open thin-walled sections of profiles. Multi-shape profiles.

4. Bending of composite beams; Biaxial bending and eccentric tensile/compressive. Bending in beams of strong curved axe.

5. Analysis of stress and strain: Principal Stresses and Maximum Shear Stresses. Mohr's Circle for Plane Stress. Hooke's Law for Plane Stress. Plane Strain. Applications of plane stress to Pressure Vessels. Study of mechanical structures submitted to combined loads. Dimensioning structural elements subjected to multiple actions by the Tresca and von-Mises criteria.

6. Energy methods: General equation of the potential energy of deformation. Castigliano Theorem. Mohr integrals. Determination of displacements and slopes in structures. Study of the structures submitted to impact.

7. Buckling: Stability of Structures. Euler formula, determination of critical load and it dependence on boundary conditions. Generalization of the Euler formula. The buckling sizing. Eccentric loads. Secant formula.

Work Done

The various items of this curricular unit include the execution by students of several demonstrative experimental works. The works, carried out in groups, involve analytical and/or numerical and/or experimental resolution, and comparison/discussion/interpretation of the results obtained. There may be the inclusion of research and study of the standard that involves the mechanical structure under study.

Teaching Methododoly

In the theoretical component, several methodologies will be used. In parallel with the acquisition of the theoretical knowledge will be executed application examples, privileging the exchange of ideas, approach and problem solving by the students themselves during the class. The experimental connection of the theoretical concepts and analytical resolution will be developed, in parallel, during the laboratory classes, with direct intervention of the students through the execution of experimental works. In addition, it is foreseen the identification and study of structures in real environment. The work to be carried out intends to deepen competences regarding the application of the described concepts and the ability to work as a team.

Bibliography

Gere & Timoshenko - Mechanics of Materials, ITP - 4ª Edição, 1997.

Hibbeler, R.C. – Mechanics of Materials, Ninth Edition, Pearson, cop. 2014.

Beer, Ferdinand P.; Johnston, E. Russell. Jr; Dewolf, John. T.. – Resistência dos Materiais – 4ª edição, McGraw Hill, 2006,

Evaluation Method

The evaluation of the curricular unit is done through a final written examination, the elaboration of works to be developed in the course and the elaboration/discussion of the various works developed. The written test will take place on the dates established by law, with a value of 12. During the course unit students will be asked to form work groups. The various groups will develop, in the course of the classes, some work involving research and experimentation, from which reports will be written and presented and discussed. The valorization of experimental part will be 8. Students' commitment, participation, resourcefulness and motivation will also be evaluated. It is necessary to obtain a minimum of 40% of quotation in the written part. To students with worker-student status, or who demonstrate that they cannot participate in the classes and thus carry out the work described above, will be distributed research and development work framed in the

Lecturer's signature:_____

subjects of the curricular unit, which will be submitted to a discussion. There are no presences imposed in the classes of the discipline, however, considering the surroundings, particularly with an experimental component, students are encouraged to participate in all classes.

Conditions for Exam Admission

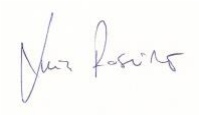
Students who have not done the experimental work or the research work, will be admitted to the exam, but for a global quotation of 15 values.

Access Conditions and Attendance Excuse

Nothing to add.

Conditions for Results Improvement

Nothing to add.

Date	Signature from the lecturer responsible for the course
15.10.2018	

Signature of Teacher:_____

Master in Mechanical Engineer
Academic Year 2018/2019

Course Unit Description

Course Unit Title INSTRUMENTATION AND CONTROL

Curricular Nature Engineering Sciences **Academic Area** Mechanical Engineering

Year 1.st **Semestre** 1.st **ECTS** 6

Contact Hours

Type of Teaching	Weekly Hours	Total Hours
Theorical classes	1	14
Theorical-Practical classes	1	14
Practic and Laboratory classes	2	28
Tutorial Guidance		

Hours of Unaccompanied Work

Type of Activity	Total Hours
Study	52
Written assignments/Group work	44
Project	
Assessment	4
Others	

Total Hours of Work

Teachers

Type of Activity	Name	Academic Degree	Position
Theorical classes	Pedro Jorge Borges Fontes Negrão Beirão	PhD.	Associate Professor
	Carlos Jose de Oliveira Pereira e Jorge Alcobia	PhD.	Associate Professor
Theorical-Practical classes	Pedro Jorge Borges Fontes Negrão Beirão	PhD.	Associate Professor
	Carlos Jose de Oliveira Pereira e Jorge Alcobia	PhD.	Associate Professor
Practic and Laboratory classes	Pedro Jorge Borges Fontes Negrão Beirão	PhD.	Associate Professor
	Carlos Jose de Oliveira Pereira e Jorge Alcobia	PhD.	Associate Professor
Tutorial Guidance			

Head Teacher Pedro Jorge Borges Fontes Negrão Beirão

Course aims / Skills acquired

Acquaint students to the importance that experimental methods can have in solving engineering problems as well as and to provide training that allows them to operate, configure and select measurement systems. To foster the development of new skills associated with experimental work, namely problem identification, assembly planning, analysis and synthesis of information.

Acquaint students with fundamental concepts about systems control theory. Apply acquired knowledge in the resolution of theoretical-practical exercises and several laboratorial works.

Analyse and design control systems.

Course contents

Instrumentation module:

Characterisation of measuring systems: functional description of a measuring system.

Characteristics of instrumentation: passive and active sensors, calibration, modifying and interfering inputs, accuracy and errors.

Operational modes of instrumentation: null instrument, deflection instrument, analogic and digital sensors.

Static and dynamic characteristics of instrumentation: output/input relation, drift, hysteresis and backlash, saturation, bias, nonlinearity error, dynamic states, response of different linear systems types, zero-order, first-order and second-order blocks, calibration.

Measurement of linear and angular displacement: resistive sensors: potentiometers, inductive sensors, linear and rotary variable reluctance

transducer, linear variable differential transformer (LVDT), rotary variable differential transformer, eddy current, capacitive sensors: pressure, accelerometers and force transducers, capacitive liquid level measurement, piezoelectric transducers, optical encoder displacement sensors: encoder signals, encoding principles, magnetic displacement sensors: magneto-resistive sensors: Hall effect sensor.

Measurement of force, torque and power: load cell, strain gauge and dynamometer. Measurement of flow: pitot tube, hot wire and hot film anemometry. Measurement of temperature: thermocouple, resistance thermometer, optical pyrometer.

Control module:

Introduction to control systems, mathematical principles, block diagram algebra, time domain response analysis, basic control actions, mathematical modelling of real systems, stability of linear systems, error analysis, design and implementation of simple control systems using Matlab and Simulink.

Written assignments

Transducers calibration report. Construction of control systems in Matlab/Simulink.

Teaching methodology

Theoretical-practical classes with computer support; Theoretical-practical classes with discussion; Laboratory classes with computer support; Group learning; Brainstorming.

Bibliography and Resources

- PowerPoints supplied by teachers
- DOEBELIN, E. O. - Measurement Systems: application and design, fourth edition, McGraw Hill, 1990. ISBN 0-07-017338-9
- SILVA, G. - Instrumentação Industrial, Vol. I, Escola Sup. de Tecnologia de Setúbal, 2004. ISBN 972-8431-22-8
- SILVA, G. - Instrumentação Industrial, Vol. II, Escola Sup. de Tecnologia de Setúbal, 2004. ISBN 972-8431-22-8
- Pedro Guedes, Metrologia Industrial, 2011, ISBN: 978-972-8480-27-1
- HOLMAN, J. P. - Experimental Methods for Engineers, sixth edition, McGraw Hill, 1994. ISBN 0-07-029666-9
- WEBSTER, J. G. - The Measurement, Instrumentation and Sensors Handbook, 1999, ISBN 0-84-938347-1
- OGATA, K. - Engenharia de Controle Moderno, Prentice Hall do Brasil, 1997. ISBN: 85-7054-074-4
- DORF, R.; BISHOP, R. - Modern Control Systems, Addison-Wesley, 1998. ISBN: 0-201-432677-9
- BISHOP, R. - Modern Control Systems Analysis and Design Using Matlab and Simulink, Addison-Wesley, 1997. ISBN: 0-201-49846-4
- LEONARD, N.; LEVINE, W. - Using Matlab to Analyze and Design Control Systems, Addison-Wesley, 1995. ISBN: 0-8053-2193-4
- KUO, B. - Sistemas de Control Automático, Prentice Hall, 1996. ISBN: 968-880-723-0
- OGATA, K. - Matlab for Control Engineers, Pearson Prentice Hall, 2008. ISBN: 0-13-615077-2

Grading procedures

Formal assessment exams, calibration report and Matlab/Simulink's theoretical-practical test (0 to 20 points in all assessments).

Weighting: Formal assessment exams (60%);
Calibration report (20%) sent to the teacher in paper and in digital format (e-mail) until the last week of classes;
Matlab/Simulink's theoretical-practical test (20%) to be held in the last week of Control module classes;

Course unit approval dependent of a weighted average of the three evaluation components equal to or higher than 9.5 points and to a grade equal to or higher than 9.0 points in the formal assessment exam.

Assignment conditioned to minimum frequency of 80% of lectured theoretical-practical and practical classes. Criterion of minimum attendance not applicable to students with worker-student status or similar.

Reference elements allowed in formal evaluation exams if provided by teachers. Computer use allowed in Matlab/Simulink theoretical-practical test.

Requirements for taking final exams

Students gain access to exams when they have a minimum frequency of 70% of theoretical-practical and laboratory classes.
For students with worker-student status or similar, the prior criterion of minimum attendance is not applicable.

Requirements for taking tests and other means of continuous evaluation

Not applicable.

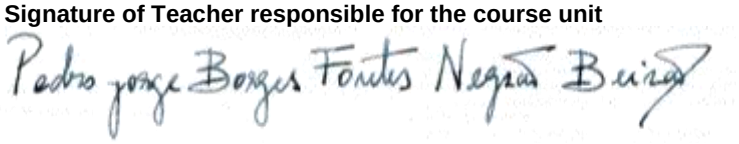
Procedures for improving grades or retaking exams

It is only allowed to improve grades to the component evaluated in the exam.

Date

11-10-2018

Signature of Teacher responsible for the course unit



Program Contents

Course Unit COMPUTATIONAL METHODS IN ENGINEERING

Subject type Complementary Sciences **Research Area** Mechanical Engineering and Mathematics

Year 1st **Semester** 1st **ECTS** 6

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures		
Theoretical-Practical Lectures	2	28
Practical-Laboratory Lectures	3	42
Tutorial Orientation		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	34
Works / Group Works	50
Project	
Evaluation	2
Additional	

Total of Working Hours 156

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures	Arménio António da Silva Correia	MSc	Adjunct Professor
Practical-Laboratory Lectures	António Manuel de Morais Grade	MSc	Adjunct Professor
Tutorial Orientation			

Responsible(s) Lecturer (s) António Manuel de Morais Grade

Goals / Skills

The objectives of this curricular unit are to strengthen, increase and apply fundamental knowledge in mathematics and programming, crucial to the understanding and scientific treatment of the subjects taught and used in other curricular units of Mechanical Engineering, grounded in an analytical and computational treatment, thus contributing to the following specific competences:
- To know how to use numerical modeling methods in the structural calculation of any mechanical component, making use of own programs or commercial software;
- To know how to apply computational methods in the analysis and resolution of engineering problems, especially in the areas of fluid mechanics and thermal systems.

Program Contents

THEORETICAL-PRACTICAL CLASSES

1. **Laplace transform**
   Definition and properties. Table of Laplace Transforms. Heaviside function or unit step and Dirac Delta function or unit impulse. Decomposition of a rational fraction into a sum of simple elements (expansion into partial fractions). Laplace Inverse Transformation. Convolution Theorem. Problem solving of initial values and systems of differential equations. Practical application problems - Dynamic Systems. Computational processing using Matlab and CAS programs.
2. **Polynomial interpolation**
   Polynomial: definition, operations and properties. Taylor's Formula and Polynomial. Interpolator polynomial: definition,

graphical interpretation and Newton's formula of divided differences.

3. **Differentiation and Numerical Integration**
   Formulas of progressive, regressive and centered differences. Trapeze rule and Simpson rule. Quad function of Matlab.
4. **Ordinary Differential Equations and Systems of Differential Equations. Initial Value Problem (PVI)**
   Euler and Runge-Kutta methods (RK2 and RK4). Functions of Matlab: ODE23, ODE45 and others. Introduction to Graphical User Interface (GUI) in Matlab and its application for interface and output of a PVI solution.
5. **Partial Differential Equations (PDEs)**
   Definition and properties. Equations of Laplace, Poisson, Diffusion / Heat, Convection / Transport and Wave. Differential problems with initial and boundary conditions. Numerical methods for solving equations with partial derivatives. Introduction to the Finite Difference Method (FDM) and the Finite Element Method (FEM). Weak Formulation (WF) of a differential problem and application of the Ritz-Galerkin method (R-G). Application problems, mathematical modeling by FDM and FEM, algorithms and its programming in Matlab.

PRACTICAL CLASSES

1. **Programming in Matlab**
   Review of fundamental programming in Matlab. One-dimensional and multidimensional arrays. Cell Arrays. Structures. Built-in functions. Creation of external and inline functions. Function handles. Data import and export. 2D and 3D graphics. Graphical User Interfaces (GUIs). Image processing. Applications of finite difference method.
2. **Applications to Mechanical Engineering**
   Final work with specific applications to mechanical engineering.

Work Done

Theoretical-practical activities of learning and evaluation distributed throughout the semester, programming of mathematical methods and application in Matlab and computer algebra system (CAS) programs, with different weights in the final assessment of the TP component. Final work related to a mechanical engineering theme.

Teaching Methodology

Classroom presentation teaching, analysis, resolution of exercises, problems of application and discussion of results obtained computationally.
Use of an e-learning platform (distance learning) as a complement and extension of the TP classes, emphasizing the use of thematic forums, as one more activity for exposure, discussion and resolution of doubts and application problems.

Bibliography

- MORAIS, V.; VIEIRA, C. – *MATLAB : Curso Completo*, Ed. FCA, 2013
- KREYSZIG, I.E. - *Advanced Engineering Mathematics*, 7a. Edic., J. Wiley
- GLYN, James - *Modern Engineering Mathematics*, Addison – Wesley
- ROSS, *S.* - *Differential Equations*, McGraw Hill
- BURDEN, Richard L., J. Douglas, *Numerical Analysis*, Pws-Kent Publishing Company
- HARMAN, T., DABNEY, J., RICHERT, N. - *Advanced engineering mathematics with MATLAB*, Ed. Brooks/Cole, 2000
- MOLER, Cleve B. - *Numerical computing with MATLAB*, Ed. Siam, 2004
- FAUSETT, Laurene V. - *Applied numerical analysis using MATLAB*, Ed. Prentice Hall, 1999
- JALURIA, Yogesh - *Computer Methods for Engineering*, Ed. Allyn and Bacon, Inc.
- HAHN - *Essential MATLAB for Scientists and Engineers*, 3e, Ed. Pearson Education, 2002
- CHAPMAN - *MATLAB Programming for Engineers*, 3e, Thomson Engineering, 2005
- GRADE, António - *Apresentações das Aulas Práticas de MCE*, ISEC, 2014
- CORREIA, Arménio - *Apontamentos de AM2 e Matemática Aplicada*, ISEC, 2008

Evaluation Method

There are two types of assessment:
1st Option:
- Application work to Mechanical Engineering, with final evaluation - Weight of 60%;
- Theoretical-practical learning activities, with evaluation distributed throughout the semester - Weight of 40%;
2nd Option:
- Only the application work to Mechanical Engineering, with final evaluation - Weight of 100%;
Students can choose any of the options.
The final application work to Mechanical Engineering is mandatory. For their accomplishment the students must group in groups of two elements. Exceptionally is possible to have works elaborated individually. Each group will be assigned a different theme; groups may propose themes. The groups should use the last practical classes to begin their work and to analyze and discuss specific problems of the same with the teachers. The evaluation of knowledge related to the application work is fundamentally based on the following factors:
- Report of the work, including the listing of the MATLAB program;
- Work presentation;
- Final discussion.
Each group will deliver 2 printed copies of the report and 2 CD's with Matlab files and the report file, until the limit dates

established at the beginning of the semester. The presentation and discussion of the work will be carried out before a jury of 2 teachers of the curricular unit, in oral public, until the end of the exam period. The presentation should not exceed 30 minutes (15 minutes per student) and the discussion of the entire work 1 hour and 30 minutes. Although all the students in the group have to know the totality of the work, each of the students is responsible for different parts of the work, presenting and defending their part in the final discussion. The final classification of the work is therefore individual.

Conditions for Exam Admission

N.A.

Access Conditions and Attendance Excuse

N.A.

Conditions for Results Improvement

N.A.

Date	Signature from the lecturer responsible for the course
12.10.2018