Polytechnic Institute of Coimbra (P COIMBRA 02)
Coimbra Institute of Engineering - ISEC
Chemical and Biological 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, exams and bibliography in English.

The BioEngineering Bachelor is taught mainly in Portuguese.

The ECTS catalogue includes subject' contents in English Language.
Students can choose subjects from this Catalogue. The study plan may be adjusted after student's arrival.

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
Chemical and Biological Engineering Department
ECTS CATALOGUE

BACHELOR BioEngineering

New Code	Title - Portuguese	Title - English	ECTS	Term
1.º ano / 1st Year				
60026599	Biologia Celular	Cell Biology	4	Winter
60026577	Física	Physics	6	Winter
60026602	Introdução à Bioengenharia	Introduction to Bioengineering	4	Winter
60026613	Laboratório Integrado I	Integrated Laboratory I	6	Winter
60026566	Matemática I	Mathematics I	5	Winter
60026588	Química	Chemistry	5	Winter
60026630	Bioquímica e Biologia Molecular	Biochemistry and Molecular Biology	6	Spring
60026659	Ciência dos Materiais em Bioengenharia	Materials Science in Bioengineering	5	Spring
60026665	Laboratório Integrado II	Integrated Laboratory II	8	Spring
60026624	Matemática II	Mathematics II	5	Spring
60026641	Termodinâmica	Thermodynamics	6	Spring
2.º ano / 2nd Year				
60026698	Instrumentação	Instrumentation	5	Winter
60026714	Laboratório Integrado III	Integrated Lboratory III	8	Winter
60026676	Mecânica de Fluidos	Fluid Mechanics	6	Winter
60026687	Métodos Numéricos e Estatísticos	Statistics and Numerical Methods	6	Winter
60026703	Microbiologia	Microbiology	5	Winter
60026758	Análise Instrumental	Instrumental Analysis	5	Spring
60026769	Laboratório de Análise Instrumental	Instrumental Analysis Laboratory	8	Spring
60026731	Processos de Separação	Separation Processes	6	Spring
60026720	Transferência de Calor e Massa	Heat and Mass Tansfer	6	Spring
60026742	Reatores Químicos e Biológicos	Chemical and Biological Reactors	5	Spring
60026832	Sistemas de Gestão Ambiental	Environmental Management Systems	5	Spring
3.º ano / 3rd Year				
60026797	Organização e Gestão	Organization and Management	4	Winter
60026775	Engenharia Enzimática	Enzymatic Engineering	5	Winter
60026804	Laboratório de Processos de Separação	Separation Processes Laboratory	8	Winter
60026810	Laboratório de Tecnologias Biológicas	Biological Technologies Laboratory	8	Winter
60026786	Processos de Separação e Purificação de Produtos Biológicos	Separation and Purification Processes of Biological Products	5	Winter
60026821	Estágio/Projeto em Engenharia Biológica	Internship/Project in Bioengineering	30	Spring
3.º ano / 3rd Year-Ramo de Tecnologia Ambiental/Specialization in Environmental Technology				
60026797	Organização e Gestão	Organization and Management	4	Winter
60026879	Laboratório de Tecnologias Ambientais	Environmental Technologies Laboratory	8	Winter
60026843	Poluição Atmosférica e Tratamento de Efluentes Gasosos	Atmospheric Pollution and Air Emissions Treatment	5	Winter
60026857	Poluição da Água e Tratamento de Efluentes Líquidos	Water Pollution and Wastewater Treatment	5	Winter
60026868	Tratamento de Resíduos Sólidos	Solid Wastes Treatment	4	Winter
60026885	Valorização de Recursos	Resource Recovery	4	Winter
60026896	Estágio/Projeto em Tecnologia Ambiental	Internship/Project in Environmental Technology	30	Spring

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Signature of Teacher:

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit SEPARATION PROCESSES

Specialization (s) COMMON CORE

Subject type Mandatory **Research Area** Chemical and Biological Engineering

Year 2 **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		
Project		
Total of Working Hours		150

Unaccompanied Working Hours

Activity Type	Total Hours
Study	90
Works / Group Works	
Project	
Evaluation	
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria João da Anunciação Moreira	Ph.D.	Professor Adjunto
	Luís Miguel Moura Neves de Castro	Ph.D.	Professor Adjunto
Theoretical-Practical Lectures	Maria João da Anunciação Moreira	Ph.D.	Professor Adjunto
	Luís Miguel Moura Neves de Castro	Ph.D.	Professor Adjunto
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria João da Anunciação Moreira
Luís Miguel Moura Neves de Castro

Goals

The objectives to be achieved in this curricular unit are:
- Study four commonly used unit operations at the industrial level: filtration, sedimentation, distillation and drying.
- Apply heat and mass transfer concepts in the unit operations studied.
- Know the equipment used in these operations and learn the concepts and equations that allow characterizing the operation and size of equipment.
- Develop problem-solving skills that involve the separation processes studied;

Skills

With this course we intend to develop some generic and specific competences, of which we highlight the following: i) equip students with the ability to communicate, exposing ideas, problems, information, with a diverse target audience; ii) create concern for quality; iii) create the capacity to collect, select and interpret relevant information in the area of its formation, combined with the capacity for analysis, synthesis and formulation of opinions.

Signature of Teacher: 

Program Contents

FILTRATION
- Constant pressure and constant flow filtration
- Conventional filtration and crossflow filtration
- Porosity of a packed bed and specific surface of bed particles
- Darcy's Law and Carman-Kozeny's Equation
- Specific resistances of a cake and filter media
- Compressibility of a cake
- Selection of laboratory and industrial equipment
- Factors with greater influence on the filtering flow
- Washes and filtration cycles

SEDIMENTATION
- Stokes law and limitations in its applicability
- Gravitational field and centrifugal field
- Laboratory centrifuges and industrial centrifuges. Scale-up
- Ultracentrifugation
- Thickeners
- Flocculation

DISTILLATION
- Stationary distillation with discontinuous contact
- Balance walk
- Calculation of ideal number of floors: McCabe-Thiele method.
- Total and partial condenser and total and partial re-boiler.
- Calculation of the minimum number of floors and the minimum reflux ratio
- Floor columns design
- Efficiency of walking.

DRYING
- Classification of drying processes
- Drying equipment
- Material equilibrium humidity. Moisture bound and unbound in the solid. Free moisture in the solid.
- Drying speed curves. Methods of calculation

Bibliography

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- Coulson, J. M. e Richardson, J. F., "Chemical Engineering", vol. 2, 2nd edition, Pergamon Press Inc., New York, USA, 1968
- Foust, A. S., Wenzel, L. A., Clump, C. W. Maus, L., Anderson, L. B., "Principles of Unit Operations", 2ª ed., John Wiley & Sons, Inc., New York, USA, 1980.
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- Ibarz A. e Barbosa-Cánovas G. V., "Unity Operations in Food Engineering", Food Preservation Technology Series, CRC Press, Boca Raton, Florida, USA, 2003. ISBN 1566769299.
- Metcalf & Eddy, "Wastewater Engineering – Treatment and Reuse", 4th edition, McGraw-Hill, New York, USA, 2003. ISBN 0071122508.
- Gregg S. J. e Sing K. S. W., "Adsorption, Surface Area and Porosity", 2nd edition, Academic Press, London, 1991. ISBN 0123009561
- McCabe, W.L.; Smith, J.C. e Harriott, P., Unit Operations of Chemical Engineering", 6ª ed., Mc Graw-Hill, 2001. ISBN 0071181733.
- Seader, J. D. e Henley, E. J., Separation Process Principles. 2ª Ed. John Wiley & Sons Inc., 2006. ISBN 0471464805.
- Webb P. A. e Orr C., "Analytical Methods in Fine Particle Technology", Micromeritics, Norcross, USA, 1997
- Castro L. M., http://intranet.isec.pt/sites/DEQ/PS1, 2019
- Moreira, M. J., http://intranet.isec.pt/sites/DEQ/PS1, 2019

Access Conditions and Attendance Excuse

There are no limits of absence for theoretical and theoretical-practical classes.

Signature of Teacher:_____

Conditions for Exam Admission

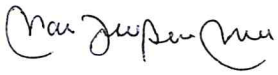
All students enrolled in the course have access to the exam, although those who register for the distributed evaluation can only access the second exam - see "Evaluation Methodology".

Evaluation Method

Students, up to the second week of classes, must choose by one of the two planned assessment systems.
In the first, traditional assessment, the students are evaluated by means of a final exam, in the form of written test without consultation, lasting 3 hours. The exams consist of four problems, one from each of the four chapters of the program: filtration, sedimentation, distillation and drying.
In the second continuous evaluation system, students are evaluated through four written tests (minimum grade of 7.5 values, planned for the days of 19/03/2019, 09/04/2019, 14/05/2019 and the date of the examination of this curricular unit) at the end of each of the four modules. Each test contributes 25% to the final grade. In case of success, the students acquire exemption of exam.
Students who chose the continuous assessment regime can only improve the classification or do the exam (if they failed during the semester because they did not reach the minimum mark in at least one of the assessment tests) in the appeal exam

Conditions for Results Improvement

In accordance with the Regulation for the Evaluation of Knowledge and Year Transition of Undergraduate Students of the Engineering Institute of Coimbra (REACTA).

Date	**Signature from the lecturer responsible for the course**
21/01/2019	

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Signature of Teacher: MP

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit HEAT AND MASS TRANSFER

Specialization (s) Common core

Subject type Elective **Research Area** Chemical and Biological Engineering

Year 2 **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		
Project		
Total of Working Hours		150

Unaccompanied Working Hours

Activity Type	Total Hours
Study	90
Works / Group Works	
Project	
Evaluation	
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria Nazaré Coelho Marques Pinheiro	PhD	Prof. Coordenador
Theoretical-Practical Lectures	Maria Nazaré Coelho Marques Pinheiro	PhD	Prof. Coordenador
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria Nazaré Coelho Marques Pinheiro

Signature of Teacher: NP

Goals

- Understand the physical and mathematical fundamentals of heat and mass transfer mechanisms.
- Develop microscopic and macroscopic energy and mass balances in steady state for mediums of different geometries.
- Combine heat transfer resistances in series and parallel.
- Analyze situations involving convective heat transfer in internal and external flow for both forced and natural convection processes.
- Apply the knowledge acquired in design applications of simple equipment, like heat-exchangers.
- Solve steady state problems with one-dimensional diffusion using Fick's first law.
- Solid knowledge in mass transfer in multi-phase systems, individual mass transfer coefficients and overall mass transfer coefficient.
- Capacity to solve problems including heat and mass transfer.

Skills

This course intends to develop some specific and generic competences, being the most important:
- development of personal skills in order to guarantee learning autonomously during the professional life;
- development of knowledge and ability of understanding engineering science fields, like heat and mass transfer, based in the secondary knowledge and in scientific information from different sources;
- provide the students with capacity for applying knowledge in solving specific problems and improve self-analysis and critical abilities

Program Contents

1. HEAT TRANSFER - INTRODUCTION
Thermodynamics and heat transfer. Mechanisms and regimes of heat transfer. Conduction: the first law of Fourrier. Convection: The Newton's law. Radiation.

2. ONE-DIMENSIONAL STEADY STATE CONDUCTION
Thermal conductivity. Heat conduction in plane walls, cylinders and spheres. Insulation materials: The R-value of insulation. Thermal resistance concept and thermal resistance network. Critical radius of insulation.

3. HEAT EXCHANGERS
The overall heat transfer coefficient. The fouling factor. Analysis of heat exchangers. The logarithmic mean temperature difference method. Multipass and cross-flow heat exchangers: use of a correction factor. The effectiveness – NTU method.

4. CONVECTIVE HEAT TRANSFER CORRELATIONS
Correlations for external and internal forced convection. Correlations for natural convection.

5. MASS TRANSFER - INTRODUCTION
Mechanisms and regimes of mass transfer.

6. MASS DIFFUSION
Fick's law of diffusion. Steady mass diffusion in plane walls, cylinders and spheres.

7. INTERFACIAL MASS TRANSFER
Convective mass transfer. The equilibrium at the interface. Individual mass transfer coefficients and overall mass transfer coefficients. Mass resistance concept and dominant resistance.

Bibliography

- Yunus A. Çengel, Heat Transfer – A Practical Approach, 2nd edition, McGraw-Hill, 2003.
- Franck P. Incropera, David P. DeWitt, Theodore L. Bergman e Adrienne S. Lavine, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, 6th edition, 2007.
- James R. Welty, Charles E. Wicks, Robert E. Wilson e Gregory L. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, John Wiley & Sons, 5th edition, 2008.
- J. P. Holman, Heat Transfer, McGraw-Hill, 9th edition, 2002.

Signature of Teacher: NP

Access Conditions and Attendance Excuse
N.A.

Conditions for Exam Admission

N.A.

Evaluation Method

Assessment by final exam.

Conditions for Results Improvement

Accomplishment of an exam to improve classification

Nazaré Coelho Pinheiro

Date

January 21, 2019

Signature from the lecturer responsible for the course

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: Ana Veloso

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit INTEGRATED LABORATORY III

Specialization (s) COMMON BODY

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 2 **Semester** 1 **ECTS** 8.0

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures		
Theoretical-Practical Lectures		
Practical-Laboratoty Lectures	6	90
Tutorial Orientation		
Project		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	25
Works / Group Works	80
Project	
Evaluation	5
Additional	

Total of Working Hours 200

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures			
Practical-Laboratoty Lectures	Ana Cristina Araújo Veloso	PhD	Prof. Adjunto
	António Luís Pereira do Amaral	PhD	Prof. Adjunto
	Vera Lúcia Machado Veloso	Graduated	Assistente conc.
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Ana Cristina Araújo Veloso
António Luís Pereira do Amaral

Goals

The main objective of the course is to introduce the student into the Microbiology laboratory techniques, with particular emphasis on basic procedures such as the preparation of culture media, sterilization and aseptic techniques and inoculation techniques.

Skills

It is intended that students acquire the following competencies:
(i) Ability to transfer and isolate cultures under aseptic conditions;
(ii) Ability to prepare culture media, quantify microbial growth, evaluate the effectiveness of antimicrobial agents and perform microbiological analysis of water and food;
(iii) Ability to conduct group work;
(iv) Ability to organize and manage work execution;
(v) Ability to report the work (both orally and in written form) and discuss and analyze the experimental results.

Program Contents

The syllabus consists of experimental work in groups of two students. The experimental work includes the execution of experiments, preparation of the written report, and analysis and discussion of experimental results.

Experimental work to be carried out:
1. Methods for quantification of microbial growth.
2. Cultivation of microorganisms: study of physical factors (pH and temperature) that affect its growth.
3. Bacterial growth curve and rate. Substrate consumption curve.
4. Assessment of the efficiency of physical and chemical agents for the control of microbial growth.
5. Microbiological analysis of water.
6. Microbiological analysis of food products.

Bibliography
1. W.F.C. Ferreira, J.C.F. de Sousa e N. Lima, Microbiologia,1ª edição, Lidel, Lisboa, 2010.
2. P.S. Bisen, Laboratory Protocols in Applied Life Sciences, 1st edition, CRC Press, 2014.
3. J.G. Black, Microbiology: Principles and Explorations, 6th edition, John Wiley & Sons, NJ, 2005.
4. M.T. Madigan and J.M. Martinko, Brock biology of microorganisms, 11th edition, Pearson Education, Inc., San Francisco, 2006.
5. F. Alcântara, M.A. Cunha e M.A. Almeida, Microbiologia – Práticas Laboratoriais, 2ª edição, Universidade de Aveiro, Aveiro, 2001.
6. H.W. Seeley, P.J. VanDemark and J.J. Lee, Microbes in action: a laboratory manual of microbiology, 4th edition, W.H. Freeman and Company, New York, 1991.
7. S. Isaac and D. Jennings, Microbial culture. The Introduction to Biotechniques Series, Taylor & Francis, London, 1995.
8. J.G. Cappuccino and N. Sherman, Microbiology: A Laboratory Manual, 5th edition, Benjamin/Cummings Science Publishing, Menlo Park, 1999.
9. S. Isaac e D. Jennings, Microbial Culture (Introduction to Biotechniques), 1st edition, Taylor & Francis, 1995.

Access Conditions and Attendance Excuse
Frequency of laboratory classes required.

Conditions for Exam Admission
n.a.

Evaluation Method
A continuous evaluation is performed taking into account: (i) 6 Reports concerning the experimental works (A-50%), (ii) Performance in laboratory classes (B-20%) and (iii) individual practical test (held at 04/01/2019) with a minimum score of 9 points in a 0-20 scale (C-30%). The final classification is obtained by summing the contributions of the various components (0,50xA+0,20xB+0,30xC and C≥9).

Conditions for Results Improvement
Adopted rules by ISEC.

Date

17/09/2018

Signature from the lecturer responsible for the course

Ana Cristina Anacleto Veloso

Instituto Superior de Engenharia de Coimbra
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Signature of Teacher:_____

Licenciatura – BsC Bioengenharia (Português)

Licenciatura – BsC Bioengineering (Inglês)

Academic Year: **2018/2019**

Program Contents

Course Unit MICROBIOLOGY

Specialization (s) JOINT BODY

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 2 **Semester** 1 **ECTS** 5

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures		
Practical-Laboratoty Lectures	3	45
Tutorial Orientation		
Project		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	62
Works / Group Works	
Project	
Evaluation	3
Additional	

Total of Working Hours 125

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	António Luís Pereira do Amaral	PhD	Adjunt professor
Theoretical-Practical Lectures			
Practical-Laboratoty Lectures	Maria José Capelas de Moura	PhD	Adjunt professor
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s)
António Luís Pereira do Amaral

Goals
The main objective of the curricular unit is to introduce students, in an integrated way, into the fundamentals of Microbiology. The aim is for students to acquire the following knowledge and skills: i) identify and characterize the main groups of microorganisms; (ii) know the nutritional requirements and metabolic diversity of microorganisms; iii) interpret the kinetics of microbial growth and the factors that influence it; iv) know the importance of microorganisms in the environment and their applications with food, environmental, industrial and medical relevance.

Skills
1. Identify the main methodologies for the study of microorganisms.
2. Recognize the nutritional requirements and metabolic diversity of microorganisms.
3. Recognize and interpret the kinetics of microbial growth and the factors that influence it.
4. Characterize the main groups of microorganisms
5. Recognize the importance of microorganisms in the environment and their applications with food, environmental, industrial and medical relevance.
6. Execute practical laboratory work on the isolation, conservation, revival, characterization and identification of microorganisms

Signature of Teacher:_____

Program Contents

LECTURES:

1. Methodologies for the study and characterization of microorganisms. Fundamentals of microbial control. Physical and chemical control agents (antimicrobials).
2. Nutrition and microbial culture. Nutritional requirements and metabolic diversity of microorganisms.
3. Microbial growth. Substrate dependence and effect of environmental factors. Quantification of the growth of microorganisms.
4. Main groups of microorganisms. Diversity of microorganisms: prokaryotes, eukaryotes and viruses.
5. Microorganisms of natural environments. Soil microbiology. Biogeochemical cycles. Microorganisms contaminating water and food.
6. Microorganisms of biotechnological interest. Microbiology of food, environmental, industrial and medical.

PRACTICE:

Microorganisms in the environment. Isolation techniques. Methods for conservation and revival of microorganisms. Metabolic and biochemical characterization of microorganisms. Microorganisms' identification by API20E tests.

Bibliography

1. Amaral, A.L. – Sebenta da disciplina, ISEC, Coimbra, 2017.
2. Madigan e Martinko, Brock biology of microorganisms, Pearson Education, Inc., San Francisco, 2006.
3. Montville e Matthews. Food microbiology: an introduction, ASM Press, Washington, 2008.
4. Pelczar, Chang e Krieg, Microbiologia – conceitos e aplicações, Makron Books, 1996.
5. Willey, Sherwood, Woolverton, Microbiology, McGraw Hill, New York, 2008.
6. Black. G., Microbiology – principles and explorations, John Wiley & Sons, New Jersey, 2005.
7. Ferreira, Sousa e Lima. Microbiologia, Lidel, Lisboa, 2010

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Access Conditions and Attendance Excuse

Compulsory attendance for the laboratory classes in order to be able to be approved to the students that haven't fulfilled the attendance conditions in the years before.

Conditions for Exam Admission

Those in force at ISEC

Evaluation Method

The evaluation will be distributed and will have two components: i) Theoretical grade (Nt): Nt = (Average of two mini-tests or final exam grade). The 1st mini-test will take place in November, 14th and the 2nd in the Normal final exam); ii) Laboratorial grade (Np): Np = (0,2 × Evaluation of laboratory performance) + (0,2 × Evaluation of Reports) + (0,4 + x Laboratorial component test (January, 3rd)).

The students that have fulfilled, in years before, the attendance conditions, may opt to attend the laboratory classes and be evaluated as described above, or just perform the laboratorial component test (for 100% of the laboratorial grade, in this case).

The final classification (CF) will be: CF = (0.4 × Nt) + (0.6 × Np). To obtain final approval to the course unit the student has to fulfill the following requirements: The minimum grade of each component of the evaluation is 9.5 values.

The grade of the laboratorial component will be valid throughout all the examination stages within the school year in which it was obtained.

Conditions for Results Improvement

Those in force at ISEC

Date

06/09/2018

Signature from the lecturer responsible for the course

Instituto Superior de Engenharia de Coimbra
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Signature of Teacher: 

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit INSTRUMENTATION

Specialization (s) COMMON BODY

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 2 **Semester** 1° **ECTS** 5

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures	1	15
Practical-Laboratoty Lectures	2	30
Tutorial Orientation		
Project		
Total of Working Hours		125

Unaccompanied Working Hours

Activity Type	Total Hours
Study	50
Works / Group Works	10
Project	
Evaluation	5
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Laura Maria Teixeira Santos	Graduated	Professor Adjunto
Theoretical-Practical Lectures	Laura Maria Teixeira Santos	Graduated	Professor Adjunto
Practical-Laboratoty Lectures	Laura Maria Teixeira Santos	Graduated	Professor Adjunto
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Laura Maria Teixeira Santos

Goals

Raise awareness on the importance of metrology. Know the industrial instrumentation associated with the measurement of temperature, flow, level, pressure, viscosity, density and humidity of a gas. Recognize how a biospecific interaction can be used in the development of biosensors. Describe and critically evaluate the application of a particular biosensor.

Skills

Ability to use the knowledge in the field of instrumentation and control, in order to select and integrate this knowledge in a real problem measurement of control variables associated with the operation of biological processes. Ability to program in the LabVIEW graphical platform and build a virtual instrument for data acquisition. Ability to think about systems in open loop and closed loop feedback control and take appropriate actions to improve the control's quality and stability. Ability to identify the instrumentation and control loops from an industrial plant in a P&ID diagram.

Program Contents

1. Introduction. Motivation. Introduction to Metrology. Scientific Metrology, Industrial Metrology and Legal Metrology. International vocabulary of metrology. The NP EN ISO 10012. Requirements for measurement processes and measuring equipment. Definitions. Instrument classification. P&ID diagrams.
2.Sensors and Transducers. Generalities. Measurement standards. Temperature measurement. Viscosity measurement. Pressure measurement. Flow measurement. Level measurement. Humidity measurement. Density measurement.
3. Controllers. Classification of controllers. Controller without auxiliary power. Electrical, Hydraulic and Pneumatic controller. Open loop and closed loop feedback control.
4. Final control element. Classification. Pneumatic control valve. Types of valves.
5. Biosensors. Sensors and biosensors. Composition of biosensors. Classification of biosensors. Application of biosensors.
6. LabView

Bibliography

1. Considine, D. M., Process instruments and controls handbook, 4ªed., McGraw-Hill, New York, 1993.
2. Coulson, J. M., Richardson, J. F., Tecnologia química, vol 1, Fundação Calouste Gulbenkian, Lisboa, 1983.
3. Dunn, W. C., Fundamentals of industrial and process control, McGraw-Hill, New York, 2005.
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5. Fraden, J., Handbook of Modern Sensors –Physics, Designs and Applications, 4ªed., Springer, New York, 2010.
6. Johnson, C. D., Process control instrumentation technology, Prentice Hall, New York, 2006.
8. Lipták, B. G., Instrument engineering.'s handbook – Process measurement and analysis, 4ªed., CRC Press. B.2, 2009.
9. Santos, L. T., Sebenta de Instrumentação e Controlo, Coimbra, 2015.
10. Solé, A. C., Instrumentacion industrial, 7ªed., Marcombo, Barcelona, 2005.
11. NP EN ISO 10012:2005 - Sistemas de gestão da medição. Requisitos para processos de medição e equipamento de medição.

Access Conditions and Attendance Excuse

Not applicable

Conditions for Exam Admission

Not applicable

Evaluation Method

Lectures for presentation of the formal bases of the course unit, accompanied by show sessions of real instruments and problems solving classes, and practical classes involving laboratory work. The student has to choose one of two assessment methodologies: the distributed evaluation or assessment by a single exam.
Distributed evaluation involves four components: i) evaluation of theoretical concepts (evaluated by 2 mini exams about instrumentation, A (25%), and a 3rd exam about control, D (30%)), ii) lab activities made in group in practical classes, B (20 %), iii) a research work on the selection of an instrument or a program made in LabView , with oral presentation, C (15%) and iv) activities initiated in theoretical-practical classes, made individual or in group, and concluded at home E (10%). The final classification is obtained by adding the contributions of the various components in a scale of 0 to 20:

$$(0{,}25 \times A + 0{,}20 \times B + 0{,}15 \times C + 0{,}30 \times D + 0{,}10 \times E).$$

The date for the 2 mini exams are 2 of november and 14 of December, and for the presentation 21 of December.

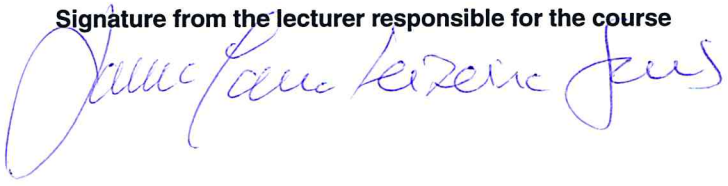
Conditions for Results Improvement

Final Exam with all the matter.

Date

10/09/2018

Signature from the lecturer responsible for the course



Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: 

Licenciatura – BsC *Bioengenharia* (Português)

Licenciatura – BsC *Bioengineering* (Inglês)

Academic Year: **2018/2019**

Program Contents

Course Unit STATISTICS AND NUMERICAL METHODS

Specialization (s) JOINT BODY

Subject type Compulsory **Research Area** Mathematics

Year 2 **Semester** 1 **ECTS** 6.0

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures	1	15
Practical-Laboratoty Lectures	2	30
Tutorial Orientation		
Project		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	55
Works / Group Works	32
Project	
Evaluation	3
Additional	

Total of Working Hours 150

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria Filomena Araújo Canova Belmiro Pereira Mota Duarte	Master Science PhD	Prof. Coordenador Prof. Adjunto
Theoretical-Practical Lectures	Maria Filomena Araújo Canova Belmiro Pereira Mota Duarte	Master Science PhD	Prof. Coordenador Prof. Adjunto
Practical-Laboratoty Lectures	Maria Filomena Araújo Canova Belmiro Pereira Mota Duarte	Master Science PhD	Prof. Coordenador Prof. Adjunto
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria Filomena Araújo Canova

Signature of Teacher: _____

Goals

This Course Unit (UC) intends to transmit the fundamental concepts and methods of Statistics and Numerical Analysis contributing to the development of practical skills at the level of data analysis applied to the area of Bioengineering. The student should be able to apply fundamental knowledge of statistics: descriptive statistics, correlation and simple linear regression, main probability distributions, confidence intervals and hypothesis tests.
Concerning the Numerical Methods module, the students are expected to solve equations and systems of linear and non-linear algebraic equations, as well as interpolating functions expressed in tabular, analytical or graphical form. Finally they should be able to compute numerically integrals of functions defined from parametrized functions or analytically expressed functions. Students should also be able to use statistical software and numerical methods (eg MS Excel, SPSS, Matlab) to automate the application of the methodologies covered in the course. In addition to these computational tools, students should be able to interpret the results obtained. It is also intended to develop skills in systems modeling, problem analysis and problem solving, applying the knowledge acquired, as well as developing autonomy for learning and teamwork.

Skills

The students are provided skills that allow them to identify and appropriately use techniques of data analysis and statistical inference using statistical software tools. It is also intended that students acquire skills that allow them to solve linear and non-linear algebraic equations, as well as perform the interpolation of values from explicit or tabularly represented functions and compute integrals. Finally, it is intended that they master a set of computational tools that allow them to take advantage of the acquired knowledge in an automated way.

Program Contents

1. Descriptive Statistics
1.1 Describing data sets. Data types and measurement scales. Graphical representation.
1.2 Summarizing data sets. Localization measures and dispersion measures. Measures of asymmetry and kurtosis.
1.3 Two-dimensional descriptive statistics - Contingency tables and dispersion diagrams. Covariance and correlation. Simple linear regression. Minimum squares method. Regression line. Correlation coefficient and coefficient of determination.

2. Special Probability Distributions
2.1 Binomial distribution. Poisson distribution.
2.2 Normal distribution.
2.3 Approaches between distributions. The Central Limit Theorem.
2.4 Sampling distributions from a Normal population.

3. Introduction to Statistical Inference
3.1 Point and interval estimates. Confidence intervals for population parameters.
3.2 Hypothesis Testing. Introduction. Significance levels. Tests concerning the mean and the variance of a Normal population.

4. Numerical Methods - Introduction/motivation for the use of numerical methods in Bioengineering.
4.1 Solution non-linear equations (scalar case). The use of the secant method. Newton-Raphson method.
4.2 Solution of systems of linear equations and the problem of of eigenvalues. Methodologies of elimination of Gauss, Gauss-Jordan, and pivoting.
4.3 Solution of systems of non-linear equations (vector case). Newton-Raphson method. Convergence.
4.4 Interpolation of functions (tabulated, analytically expressed and graphically expressed). The use of Lagrange polynomials and divided differences. Special cases.
4.5. Numerical integration into definite intervals. Newton-Coates rules. Gaussian quadrature rules.

• Use of MS-Excel and SPSS as tools to support the practical teaching of the Statistical modules.
• Use of Matlab as a tool to support the practical teaching of the Numerical Analysis module.

Bibliography

- Lecture notes and exercises sheets of the theoretical-practical and laboratory classes.
- Guimarães, R.C. e Cabral, J., Estatística (2009), 2.ª edição – Mc Graw Hill
- Marôco, J. Análise Estatística com utilização do SPSS, Edições Sílabo.
- Montgomery, D.C. and Runger, G.C. (2003) – Applied Statistics and Probability for Engineers, 3rd Edition, Wiley

- Murteira, B. J., Ribeiro, C.S., Andrade e Silva, J. and Pimenta, C. (2002) – Introdução à Estatística, McGraw Hill
- Pedrosa, A. and Gama, S. (2004) – Introdução Computacional à Probabilidade e Estatística, Porto Editora
- Ross, S.M. (2004) – Introduction to Probability and Statistics for Engineers and Scientists, 3rd Edition. Elsevier/Academic Press, Burlington, MA.
- Atkinson, K.E. (1989) - An Introduction to Numerical Analysis, John Wiley & Sons Australia, Limited.
- Burden, R.L. and Faires, J.D. (2005) - Numerical Analysis, Thomson Brooks/Cole.
- Constantinides A. and Mostou, N. (1999) - Numerical Methods for Chemical Engineers with MATLAB Applications, Prentice-Hall international Series in the Physical and Chemical Engineering sciences, Prentice Hall PTR.
- Gerald, C.F. (2006) - Applied Numerical Analysis: with Maple 10, Pearson Education, Limited.

- http: // www alea-estp.ine.pt Dossiers Didácticos IV Estatística com o Excel. Uma aplicação das noções.
- http:// www. pordata.pt Base de Dados sobre Portugal Contemporâneo

Access Conditions and Attendance Excuse
Not applicable.

Conditions for Exam Admission
Those of Regulation of Frequency, Assessment of Knowledge and Transition of Year (effective as of 2009 - 2010) (Internal Order no. 17523.2009).

Evaluation Method

1. Distributed assessment: Two practical tests to be carried out in the academic period (30% of the mark), the first test will be held on November 23 and 25 and the second will be on December 18 and 20.
   Final exam (70% of the mark). The students may attend the exam in first and second call.

2. Students with a proven status of student worker will be subject to the same exam that in this case is 100% of the final mark.
3. Conditions of approval: The student is approved in the discipline if he has a minimum final classification of 10.0 points over 20.0 (50%).

Conditions for Results Improvement
Those set out in Article 24 of the Frequency, Knowledge Assessment and Year Transition Regulations (in force from 2009-2010) (Order no. 17523.2009).

Date

2018.09.06

Signature from the lecturer responsible for the course

Maria Filomena Araújo Gamboa

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit ***FLUID MECHANICS***

Specialization (s) CHEMICAL AND BIOLOGICAL ENGINEERING

Subject type compulsory **Research Area**

Year 2 **Semester** 1 **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		
Project		
Total of Working Hours		150

Unaccompanied Working Hours

Activity Type	Total Hours
Study	90
Works / Group Works	
Project	
Evaluation	
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria Nazaré Coelho Marques Pinheiro	PhD	Prof. Coordenador
Theoretical-Practical Lectures	Maria Nazaré Coelho Marques Pinheiro	PhD	Prof. Coordenador
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria Nazaré Coelho Marques Pinheiro

Goals

- Understand the basic principles of fluid mechanics like viscosity, pressure, continuity equation, principle of conservation of energy, viscous dissipation and boundary layer.
- Ability to apply fundamental principles to derive governing equations in fluid flow, namely Bernoulli equation.
- Understand the flow of fluids through pipes and distinction between laminar and turbulent regimes.
- Calculation of head losses in pipes and accidents and selection of pumps for incompressible fluids

Skills

This course intends to develop some specific and generic competences, being the most important:
- development of personal skills in order to guarantee learning autonomously during the professional life;
- development of knowledge and ability of understanding engineering science fields, like momentum, heat and mass transfer, based in the secondary knowledge and in scientific information from different sources;
- provide the students with capacity for applying knowledge in solving specific problems and improve self-analysis and critical abilities.

Signature of Teacher: NP

Program Contents

1. **INTRODUCTION TO FLUID MECHANICS**
   What is a fluid? Properties of a fluid. The viscosity. Newtonian fluids. Non-Newtonian fluids: apparent viscosity.
2. **STATICS**
   Pressure variation in a fluid: - how does the pressure change at a point of the fluid with direction? - How does the pressure vary from point to point? Pressure measurement: piezometric tube, U-tube manometer and inclined tube manometer. The barometer. The buoyancy.
3. **FLUID DYNAMICS**
   Description of flow patterns. The equation of continuity. Acceleration of a fluid particle. The Bernoulli equation (obtaining by application of the principle of conservation of momentum, and application of the principle of conservation of energy to steady state flow system). Examples of applications of Bernoulli equation: Pitot tube, Venturi meter, orifice meter, tank discharge.
4. **FLOW IN PIPES**
   Laminar and turbulent flow. Laminar flow in pipes. Turbulent flow in pipes. Calculation of pressure drops and head losses. The Moody diagram. Piping systems with pumps and turbines.
5. **TURBOMACHINES**
   Turbomachines: classification and terminology. Pump performance curves. Determination of the operation conditions. Pump cavitation and net positive suction head. Pumps operating in series and parallel.

Bibliography

- Bruce R. Munson, Donald F. Young E Theodore H. Okiishi, Fundamentals of Fluid Mechanics, John Wiley & Sons, 5th edition, 2006.
- Yunus A. Çengel E John M. Cimbala, Fluid Mechanics: Fundamentals and Applications, McGraw-Hill Companies, Inc., 2006.
- B. S. Massey, Mecânica dos Fluidos, Fundação Calouste Gulbenkian, 2002 (J. R. Guedes de Carvalho traduction of the original Mechanics of Fluids, 6th edition).
- Clayton T. Crowe, Donald F. Elger E John A. Roberson, Engineering Fluid Mechanics, John Wiley & Sons, 8th edition, 2005.

Access Conditions and Attendance Excuse

N.A.

Conditions for Exam Admission

N.A.

Evaluation Method

The students in the second week of classes can choose one of the following evaluation methods:
1. distributed evaluation;
2. assessment by final exam.

Students who have chosen distributed evaluation will have four tests on dates to be defined jointly with the teacher, students and course director. The date for the last test is the same of the first exam. Dates defined for the three first tests to be performed were: October 12th, November 5th and December 3rd. The tests contribute 25% each to the final classification. The students integrated in this evaluation methodology must attend to 80% of the classes, regardless of their typology, and at the same time, have a grade of 7.5 or higher (in a scale from 0 to 20 values) in the tests they will perform. When the limit of classification in the tests and / or the final average grade of 9.5 values is not attained or if the classes' attendance is not reached, the student can only appeal to the second exam. Students who choose this evaluation scheme only can improve the classification by performing the entire second exam.
Students who have chosen the evaluation with the final exam are subject to the traditional evaluation method, with the possibility to perform two exams at the end of the semester in different dates.

Conditions for Results Improvement

Accomplishment of an exam to improve classification.

Date
1st October, 2018

Signature from the lecturer responsible for the course

Nazaré Coelho Pinheiro

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: Ana Veloso

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit INTEGRATED LABORATORY II

Specialization (s)

Subject type **Research Area** Chemical and Biological Engineering

Year 1st **Semester** 2nd **ECTS** 8.0

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures		
Theoretical-Practical Lectures		
Practical-Laboratoty Lectures	6	90
Tutorial Orientation		
Project		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	16
Works / Group Works	86
Project	
Evaluation	8
Additional	

Total of Working Hours 200

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures			
Practical-Laboratoty Lectures	Ana Cristina Araújo Veloso Anabela Marcolino Moreira	PhD MSc	Prof. Adjunto Assistente conv.
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Ana Cristina Araújo Veloso

Goals

The main objective of the curricular unit is to enable students to learn basic concepts studied in disciplines such as Chemistry, Thermodynamics and Biochemistry, also giving continuity to the learning begun in the first semester, in the Integrated Practices I course, on the safety rules and use of laboratory equipment and materials. It is intended, therefore, that students: i) understand and know how to make simple and successive dilutions of solutions; ii) understand the importance of absorption spectrophotometry and determine the absorption spectrum of biomolecules; iii) understand the pH concept of buffer solution and determine pKas; iv) understand the enzymatic kinetics; v) know the extraction technique and vi) understand the concept of phase equilibrium; vii) can report the work done (orally and in the form of a report), discuss and analyze the experimental results obtained.

Skills

It is intended that students acquire the following competencies:
(1) Work in groups with responsibility and with safety, realizing the risks involved in the different laboratory practices;
(2) Schedule experiments;
(3) Handling diverse materials and laboratory equipment;
(4) Prepare solutions by dilution;
(5) Determine absorption spectra;
(6) Determine pKas and the isoelectric point;
(7) Determine the kinetic constants of the enzymatic kinetics of Michaelis-Menten;
(8) Apply the extraction technique;
(9) Determine liquid-vapor equilibrium curves.

Signature of Teacher:_____

Program Contents

The syllabus consists of experimental work in groups of two students. The experimental work includes the experimental realization, the preparation of the written report, the analysis and discussion of results.
Experimental work carried out:
1. Handling of micropipettes and dilutions.
2. Determination of protein concentration: biuret method.
3. pH, buffers and physiological buffer systems.
4. Enzymes and enzymatic kinetics.
5. Extraction: simple and multiple extraction and determination of distribution coefficient.
6. Extraction: extraction of natural dyes from plants for the textile industry
7. Determination of the liquid-vapor equilibrium in a binary system.

Bibliography

1. D.A. Skoog, D.M. West, F.J. Holler, S.F. Crouch. Química Analítica, McGraw-Hill, 7ªEd, 2000.
2. D. L. Nelson, M. M. Cox. Lehninger Principles of Biochemistry, W.H. Freeman, 6th edition, 2012.
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4. E.G. Azevedo. Termodinâmica Aplicada, Escolar Editora, 2º edição, 2010.
5. A. Halpern, G. McBane. Experimental Physical Chemistry: A Laboratory Textbook, W.H. Freeman, 3rd edition, 2006.
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8. F. Rouessac and A. Rouessac. Chemical Analysis: Modern Instrumentation Methods and Techniques, John Wiley & Sons, 2000.

Access Conditions and Attendance Excuse

n.a.

Conditions for Exam Admission

n.a.

Evaluation Method

A continuous evaluation is made and it takes into account: (i) Reports of Security Procedures (A-5%); (ii) Reports concerning the experimental works (B-50%), (iii) Performance in laboratory classes (C-20%) and (iv) individual practical test (to be held at the end of the semester) with a minimum score of 9 points in a 0-20 scale (D-25%). The final classification is obtained by summing the contributions of the various components (0.05×A+0.50xB+0.20xC+0.25xD and D≥9).

Conditions for Results Improvement

Adopted rules by ISEC.

Ana Cristina Araújo Veloso

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

20/01/2019 | **Ana Cristina Araújo Veloso**

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC Bioengenharia (Português)

Licenciatura – BsC Bioengineering (Inglês)

Academic Year: **2018/2019**

Program Contents

Course Unit MATERIALS SCIENCE IN BIOENGINEERING

Specialization (s)

Subject type Speciality unit **Research Area** Chemical and Biological Engineering

Year 1º **Semester** 2º **ECTS** 5.0

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures	1	15
Practical-Laboratoty Lectures	2	30
Tutorial Orientation		
Project		
Total of Working Hours		125

Unaccompanied Working Hours

Activity Type	Total Hours
Study	48
Works / Group Works	15
Project	
Evaluation	2
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria José Capelas de Moura	PhD	Prof. Adjunto
Theoretical-Practical Lectures	Maria José Capelas de Moura	PhD	Prof. Adjunto
Practical-Laboratoty Lectures	Maria José Capelas de Moura	PhD	Prof. Adjunto
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria José Capelas de Moura

Goals

This course unit is intended to provide students with knowledge and skills on the fundamental principles of Materials Science, including the state of the art of biomaterial development, particularly with regard to the most relevant medical applications. It is also intended that students acquire a thorough knowledge about the various types of materials and their use in the pharmaceutical and medical areas. It will underline the relationship between material science and fundamental concepts of chemistry, physics, biology and engineering.

Skills

At the end of the course, students should be able to:

i) identify the various types of materials;

ii) select the materials that best fit a given application;

iii) to know the state of the art in terms of development of biomaterials;

iv) understand how the properties of biomaterials condition the interaction with the organism;

v) recognize the contribution of biomaterials to improving the quality of human life;

vi) to be aware of the multidisciplinary character of the area.

Signature of Teacher:_____

Program Contents

I - Introduction to materials science and engineering

Materials and engineering; classification of materials; future trends in the use of materials.

II – The structure of solids

Electrons in atoms; atomic and molecular bonding; crystal structure; atomic positions and unit cells; polymorphism or allotropy; types of defects; diffusion in solids.

III - Mechanical properties of metals

Concepts of stress and strain; stress-strain test; metal alloys; plastic deformation; fracture mechanics. Evaluation of the mechanical behavior of metals by stress-strain test.

IV - Phase diagrams

Binary phase diagrams; determination of phase amounts; lever rule; invariant reactions.

V - Ceramic materials

Structures and properties of ceramics; mechanical behavior; bioceramic materials.

VI - Polymeric materials

Polymerization reactions; molecular weight; degree of polymerization; polymer crystallinity; thermoplastics; thermosetting; elastomers (rubbers). Evaluation of the mechanical behavior of polymers by stress-strain test. Synthesis of a polymer. Modification of a natural polymer.

VII - Composites

Particle/fiber-reinforced composites; complex composite structures; mechanical behavior. Comparison of the mechanical behavior of composites with non-reinforced materials.

VIII - Biomaterials

Definition; classification; historical perspective; state of art; materials used as biomaterials; hydrogels; controlled release systems; biocompatibility; biomedical applications. Synthesis of a hydrogel.

Bibliography

1. Callister, W.D. Materials science and engineering: an introduction; John Wiley & Sons, 6ª edição (2003). ISBN: 0-471-22471-5.
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6. Wong, Joyce Y.; Bronzino, Joseph D. Biomaterials; CRC Press, Taylor & Francis Group (2007). ISBN-13: 978-0-8493-788-1.

Signature of Teacher: 

Access Conditions and Attendance Excuse

According to the REACTA.

Conditions for Exam Admission

All students are admitted to the final exam.

Evaluation Method

Students will be subject to summative assessment with a quotation between 0 and 20 values. The student who achieves at least the classification of 9.5 values in the total of the summative assessment components is approved in the course unit.

Summative assessment results from the contribution of two elements, P1 and P2, with respective weights of 90% and 10%.

P1 refers to the theoretical and theoretical-practical component and results from the final exam to be done at the end of the semester.

P2 refers to the laboratory component, of an experimental nature or of treatment / interpretation of experimental results to be performed during the semester.

Some laboratory classes will be dedicated to the application of concepts, clarification of doubts and resolution of some practical exercises, in order to stimulate the interest for the subjects taught.

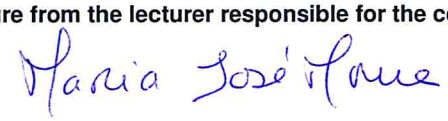
Conditions for Results Improvement

According to the REACTA.

Date

15-01-2019

Signature from the lecturer responsible for the course



Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC em Bioengenharia (Português)

Licenciatura – BsC Bioengineering (Inglês)

Academic Year: **2018/2019**

Program Contents

Course Unit THERMODYNAMICS

Specialization (s)

Subject type Speciality unit **Research Area** Chemical and Biological Engineering

Year 1º **Semester** 2º **ECTS** 6.0

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	30
Theoretical-Practical Lectures	2	30
Practical-Laboratoty Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		150

Unaccompanied Working Hours

Activity Type	Total Hours
Study	87
Works / Group Works	
Project	
Evaluation	3
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria José Capelas de Moura	PhD	Prof. Adjunto
Theoretical-Practical Lectures	Maria José Capelas de Moura	PhD	Prof. Adjunto
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria José Capelas de Moura

Goals

As main objectives is intended that students learn the basics principles and laws of thermodynamics, that acquire theoretical knowledge about the thermodynamics of Phases Equilibrium, who are unaware of its wide applicability and how, through logical developments, one can establish relations between various physical properties.

Skills

At the end of the semester students should be prepared to work with:

i. the different systems of units in the solution of problems;
ii. know how to consult the tables of properties;
iii. how to apply the 1st Law of Thermodynamics for closed systems and control volumes (steady-flow process);
iv. how to acquire knowledge about thermodynamics of ideal solutions and ideally diluted solutions and how to employ Raoult's law and Henry's law;
v. have the notion of the concepts of activity and activity coefficient and its applicability in non-ideal solutions;
vi. how to apply the Clapeyron equation to phases equilibrium;
vii. drawing equilibrium diagrams of binary systems and have ability to use the lever rule.

Program Contents

MODULE ONE - SYSTEMS FIXED COMPOSITION

1. BASICS CONCEPTS OF THERMODINAMICS
1.1. Thermodynamics and Energy
1.2. Systems and Phases
1.3. Forms of Energy
1.4. Properties of a System
1.5. State and Equilibrium
1.6. Processes
1.7. Zeroth Law of Thermodynamics
2. PROPERTIES OF PURE SUBSTANCES
2.1. Pure Substance
2.2. Phase-Change Processes of Pure Substances
2.2.1. Compressed liquid and saturated liquid
2.2.2. Saturated vapor and superheated vapor
2.2.3. Saturation temperature and saturation pressure
2.3. Property Diagrams for Phase-Change Processes
2.3.1. The T-v diagram
2.3.2. The P-v diagram
2.3.3. Extending the diagrams to include the solid phase
2.3.4. The P-T diagram
2.4. Property Tables
2.4.1. Enthalpy- a combination property
2.4.2. Saturated liquid and saturated vapor states
2.4.3. Saturated liquid-vapor mixture
2.4.4. Superheated vapor
2.4.5. Compressed Liquid
2.4.6. Reference state and reference values
2.4.7. Property tables for ideal gases
3. THE FIRST LAW OF THERMODYNAMICS: CLOSE SYSTEMS
3.1. Introduction to the First Law of Thermodynamics
3.2. Heat Transfer
3.3. Work
3.4. Formulation of the First Law of Thermodynamics
3.5. Specific Heats
3.6. Internal Energy, Enthalpy and Specific Heats of Ideal Gases
3.6.1. Specific-heat relations of ideal gases
3.7. Internal Energy, Enthalpy and Specific Heats of Solids and Liquids
4. THE FIRST LAW OF THERMODYNAMICS: CONTROL VOLUMES
4.1. Thermodynamic Analysis of Control Volumes/The Steady-Flow Process
4.1.1. Conservation of Mass
4.1.2. Energy Balance
5. THE SECOND LAW OF THERMODYNAMICS
5.1. Concept of Entropy
5.2. The Increase of Entropy Principle (Second Law of Thermodynamics)

MODULE TWO - SYSTEMS OF VARIABLE COMPOSITION

1. SYSTEMS OF VARIABLE COMPOSITION
1.1. Criteria for Equilibrium
1.2. Chemical Potentials
1.3. Conditions for Equilibrium
2. IDEAL SOLUTIONS
2.1. Thermodynamic Properties of Ideal Solutions
2.1.1. Chemical potential for ideal solution
2.1.2. Raoult's law
3. IDEALLY DILUTE SOLUTIONS
3.1. Thermodynamic Properties of Ideally Dilute Solutions
3.1.1. Standard states
3.1.2. Henry's law

3.1.3. Solubilities of gases in liquids
4. NON-IDEAL SOLUTIONS
4.1. Activities and Activity Coefficients
4.2. Convention I and Convention II
5. ONE-COMPONENT PHASE EQUILIBRIUM
5.1. Gibb's Phase Rule
5.2. Clapeyron Equation
5.2.1. Liquid-vapor and solid-vapor equilibrium
5.2.2. Solid-liquid equilibrium
6. MULTICOMPONENT PHASE EQUILIBRIUM
6.1. Gibb's Phase Rule to Two-Component Systems
6.2. Liquid-Vapor Equilibrium
6.2.1. Ideal solution at fixed temperature
6.2.2. Lever rule
6.2.3. Ideal solution at fixed pressure
6.2.4. Non-ideal solutions
6.2.5. Azeotropic point

Bibliography

1. Çengel, Y. A.; Boles, M. A. "*Thermodynamics: An Engineering Approach*", 8th Edition, International Editions, McGraw-Hill Companies, Inc., 2015.
2. Atkins, P.; Paula, J. "*Physical Chemistry*", 10th Edition, Oxford University Press, Oxford, 2014.
3. Lobo, L. Q.; Ferreira, A. G. M. "*Termodinâmica e Propriedades Físicas*", Vol.1, Imprensa da Universidade de Coimbra, Coimbra, 2006.
4. Moran, M. J.; Shapiro, H. N.; Boettner, D. D.; Bailey, M. B. "*Fundamentals of Engineering Thermodynamics*", 3rd Edition, John Wiley & Sons, Inc., New York, 2011.
5. Haynie, D. T. "*Biological Thermodynamics*", 2nd Edition, Cambridge University Press, New York, 2008.
6. Azevedo, E. G. "*Termodinâmica Aplicada*", 3ª Edição, Escolar Editora, Lisboa, 2011.
7. Abbott, M. M., Van Ness, H. C. "*Termodinâmica*", McGraw-Hill de Portugal, Lisboa, 1992.
8. Levine, I. N. "*Physical Chemistry*", 4th Edition, McGraw-Hill, Inc., New York, 2007.

Access Conditions and Attendance Excuse

According to the REACTA.

Conditions for Exam Admission

All students are admitted to the final exam.

Evaluation Method

At the end of the semester students will take a final exam where they will have to obtain a grade of 9.5 or higher.

Conditions for Results Improvement

According to the REACTA.

Date

11-01-2019

Signature from the lecturer responsible for the course

Maria José Maia

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:

Licenciatura – BsC Bioengenharia
Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit MATHEMATICS II

Specialization (s)

Subject type Sciences of speciality **Research Area** Mathematics

Year 1st **Semester** 2nd **ECTS** 5

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	30
Theoretical-Practical Lectures	2	30
Practical-Laboratory Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		125

Unaccompanied Working Hours

Activity Type	Total Hours
Study	62
Works / Group Works	
Project	
Evaluation	3
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Rui Manuel Carreira Rodrigues	PhD	Professor Coordenador
Theoretical-Practical Lectures	Rui Manuel Carreira Rodrigues		
Practical-Laboratory Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Rui Manuel Carreira Rodrigues

Goals
Present an introduction to ordinary differential equations, numerical series and power series, and present the differential and integral calculus of real functions of several real variables. Learning takes place simultaneously in the theoretical classes and in the theoretical-practical classes, where the topics, included in the syllabus contents of the curricular unit, are presented and discussed, through the resolution of exercises and the use of the following software: GeoGebra and WolframAlpha. Classes presented in Portuguese language.

Skills
Autonomous learning and rigor in the interpretation, use and description of the mathematical concepts.

Signature of Teacher: _____

Program Contents

1. **Introduction to the study of ordinary differential equations**

   Introduction and motivation. First order differential equations - Existence and uniqueness of solution, llinear equation. Bernoulli equation, separable equation and homogeneous equation. Slope field and Euler's method.

2. **Differential and integral calculus in Rn**

   Curves in Rn. Conics and quadrics surfaces. Real functions of several real variables – Notions of Topology in IRn. Domain, level set and graph of a two-variable function. Limit and continuity. Partial derivatives and gradient vector. Partial derivatives of higher order. Differentiable function. Directional derivative, tangent plane and normal straight line. Linear approximation. Maxima, minima and saddle points, extrema with constraints, Lagrange's multipliers.

   Double integral - Definition, properties, geometric interpretation and calculation. Applications of the double integral. Double integral in polar coordinates. Triple integral - Calculation of the triple integral. Triple integral in cylindrical and spherical coordinates.

3. **Infinite series**

   Numerical sequences. Properties. Numerical series. Nature and properties. Geometric series and telescoping series. Necessary condition for convergence. Series of nonnegative terms. Tests for convergence. Integral test. Root and ratio test. Conditional and absolute convergence. Alternating series. Leibniz's rule.

4. **Real power series**

   Definition. Radius and interval of convergence. Properties of functions represented by power series. Taylor series. Power series expansions.

Bibliography

- Hamilton Luiz Guidorizzi, "Um curso de cálculo", volume 1, volume 2 e volume 4. Livros técnicos e científicos editora.
- Ron Larson, Robert P. Hostetler e Bruce H. Edwards, "Cálculo", volume 1 e volume 2. McGraw-Hill.
- James Stewart, "Cálculo". Thomson Learning.
- João Cardoso, "Apontamentos de apoio às aulas de Cálculo II".
- Rui Rodrigues - notas teóricas de análise matemática e exercícios de análise matemática.

Access Conditions and Attendance Excuse
Not applicable.

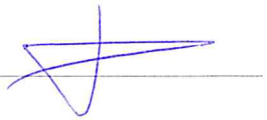
Conditions for Exam Admission
Access to the exam allowed to all students duly enrolled in the course unit. In particular, access to the appeal period requires enrollment in the academic services.

Evaluation Method
Evaluation by final exam (in the first and the second seasons). Students have access to two tests: one exam in the first season and one exam in the second season quoted for 20 values. The student is approved if he or she obtains a classification of 10 values or higher in any of the tests. A supplementary test is mandatory for students with a score of 17 values or higher.

Conditions for Results Improvement
Conditions for the improvement of classification defined in the REACTA (regulation of frequency, assessment of knowledge and transition of year).

Date	Signature from the lecturer responsible for the course
18.01.2019	Rui Manuel Carreira Rodrigues

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: 

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit INTEGRATED LABORATORY I

Specialization (s) COMMON BODY

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 1º **Semester** 1º **ECTS** 6

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures		
Theoretical-Practical Lectures		
Practical-Laboratoty Lectures	4	60
Tutorial Orientation		
Project		
Total of Working Hours		150

Unaccompanied Working Hours

Activity Type	Total Hours
Study	40
Works / Group Works	50
Project	
Evaluation	
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures			
Practical-Laboratoty Lectures	Laura Maria Teixeira Santos	Graduated	Professor Adjunto
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Laura Maria Teixeira Santos

Goals

The main objective of the course is to provide the student with the theoretical foundations and practical learning of Laboratory and Analytical Chemistry, allowing him to put in practice basic concepts taught in theoretical disciplines such as Chemistry.

Skills

It is intended that students acquire the following competencies: i) ability to conduct group work; ii) ability to organize and manage the work in process; iii) ability to describe (orally and in report form) the performed work and to discuss and analyze the experimental results; iv) ability to correctly use the material and laboratory equipment; v) ability to prepare and standardize solutions used in chemical analysis.

Program Contents

Safety rules in laboratory. Graduated glassware and commonly used equipment handling. Statistical evaluation, presentation, interpretation and validation of analytical results. Preparation of solutions. Acidbase, Oxidation reduction, precipitation and complexation titrations.
Experimental work to be done:
1. Calibration of a pipette
2. Preparation and standardization of an aqueous solution of HCl
3. Preparation and standardization of an aqueous solution of NaOH
4. Preparation and standardization of an aqueous solution of silver nitrate and determination of chlorides in milk
5. Preparation and standardization of an aqueous solution of EDTA and determination of calcium and magnesium in milk
6. AcidBase titration to determine the percentage of acid acetilsalicilic in an Aspirin tablet.
7. Standardization of an aqueous solution of Iodine to determine by Oxidation Reduction titration the percentage of ascorbic acid in a commercial tablet.

Bibliography

1. Skoog, D.A, West, DM.,Holler, F.J., Crouch, S.F. Química Analítica, McGrawHill, 7ªEd, 2000.
2. Aléxeev, V. Análise Quantitativa, Ed Lopes da Silva, 3ªEd, 1980.
3. Harris, D.C., Exploring Chemistry Analysis, Freeman Ed, 2001.
4. Simões, J.M., Lampreia, I., Santos, F., Norberto, M.F., Pamplona, M.T., Meireles, M.M. Guia de Laboratório em Química e Bioquímica, Lidel, 2ª Ed, 2008.
5. Vidal, M.M., Filipe, O. e Costa, M.C. Química no Laboratório, 2ª edição, 100luz., 2010.
6. Patnaik, P. Deans's Analytical Chemistry Handbook, McGraw-Hill, 2004.
7. Kenkel,J. Analytical Chemistry for Technicians, CRC Press, 2003.
8. Rouessac, F. and Rouessac, A. Chemical Analysis: Modern Instrumentation Methods and Techniques, John Wiley & Sons, 2000.

Access Conditions and Attendance Excuse

not applicable

Conditions for Exam Admission
without final exam

Evaluation Method

The classes take place in the Laboratory where each group perform an experimental work. Initially the protocol to be followed is introduced and the validity of the preparatory calculations, performed by the students, is checked. Then the students put into practice, with autonomy, the protocol and perform the results treatment, under teacher supervision. During the class the students are asked to evaluate their preparation and to improve the understanding of the acquired knowledge. At the end of the practical work an oral discussion takes place where the theoretical concepts and results are discussed. The written reports are further analyzed and discussed. The evaluation is continuous and takes into account: i) diagnostic assessment **A** (10%); ii) safety procedures report **B** (5%); iii) written reports **C**(40%); iv) performance evaluation in class **D**(20%) and v) individual practical exam with a minimum score of 9 values **E** (25%). The final classification is obtained by adding the contributions of the various components. The five components are obtained in the scale of 0 to 20 and are the average of all the contribution during the semester.

$$CF = 0{,}1\,A + 0{,}05\,B + 0{,}4\,C + 0{,}2\,D + 0{,}25\,E$$

The date for the final exam is 4 of January of 2019.

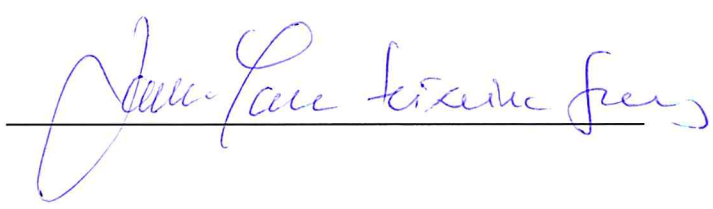
Conditions for Results Improvement

not applicable

Date

10/09/2018

Signature from the lecturer responsible for the course



Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC Bioengenharia

Licenciatura –BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit INTRODUCTION TO BIOENGINEERING

Specialization (s) COMMON BODY

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 1º **Semester** 1º **ECTS** 4

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures	2	30
Practical-Laboratory Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		100

Unaccompanied Working Hours

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

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria João da Anunciação Moreira	Ph.D.	Professor Adjunto
Theoretical-Practical Lectures	Maria João da Anunciação Moreira	Ph.D.	Professor Adjunto
Practical-Laboratory Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria João da Anunciação Moreira

Goals

The main objective of the course unit is to provide the student with an integrated view of Bioengineering and its various fields of application, focused on the analysis of engineering concepts and design of biological processes and systems. Thus, it is intended that students be able to: i) understand the concepts of the new paradigms of engineering and life sciences and identify current areas of technological importance, industrial and environmental biotechnological processes, and recombinant DNA technology; ii) understand the importance of innovation and entrepreneurship in bioengineering and the organization of a biotechnology company; iii) identify business opportunities by analyzing innovative processes; iv) analyze, schematize and define the processes and their variables; v) perform mass balances to chemical and biological processes.

Skills

1. Understand the concepts of the new paradigms of engineering and life sciences and identify the current areas of technological importance.
2. Recognize the innovative processes to identify business opportunities and the organization of a biotechnology company.
3. Analyze, outline and define the bioprocesses and their variables.
4. Perform mass balances to chemical and biological processes

Signature of Teacher:_____

Program Contents

1. BIOENGINEERING AS THE RESULT OF THE INTEGRATION OF PHYSICAL, ENGINEERING AND LIFE SCIENCES.
Introduction to bioprocesses. Bioprocess engineering. Industrial, environmental and energy applications.
2. INTRODUCTION TO ENGINEERING CALCULATIONS
Definition of process. Process Variables. Manufacturing, flow and block diagrams.
3. UNITS, DIMENSIONS, MIXTURE COMPOSITIONS AND ESTEQUIOMETRY
Ways of expressing compositions of mixtures and solutions.
Chemical reactions: stoichiometry, limiting reagent, degree of advancement and conversion of a reaction.
A stoichiometric excess of a reagent.
4. IDEAL GASES
Law of ideal gases. Gas analysis. Standard conditions of pressure and temperature. Density and gas density.
5. MATERIAL BALANCES
The concept of material balance.
Selection of a calculation basis in problems of mass balances.
Connecting element.
Mass balances in processes with and without chemical reaction.
System of process independent equations.
Variation of inventory in a chemical process.
Mass balances in processes with bypass, with recycling of products and / or inert to the feed and with purge.

Bibliography

1. Doran, P., Bioprocess Engineering Principles, Elsevier, 2012.
2. Bailey, J.E., Ollis, D.F., Biochemical Engineering Fundamentals, McGraw-Hill., 1987.
3. Bygrave, W., Zacharakis, A., Entrepreneurship. 2011.
4. Seider, W.D., Seader, J.D., Lewin, D.R., Product and process design principles, 2008.
5. Cortassa, S., Aon, M.A., Iglesias, A.A., Lloyd, D., An introduction to metabolic and cellular engineering. World Scientific Publishing Co. Pte. Ltd, 2002.
6. Neumann, K-H., Kumar, A., Imani, J., Plant cell and tissue culture – a tool in biotechnology, Springer-Verlag Berlin, 2009.
7. Blank, S.G., and Bob, D., The startup owner's manual: the step-by-step guide for building a great company. K&S Ranch, Incorporated, 2012.
8. Osterwalder, A., and Yves, P., Business model generation: a handbook for visionaries, game changers, and challengers. Wiley, 2010.
9. Ghosh, Raja, Principles of Bioseparations Engineering, World Scientific Publishing, 2006.

Access Conditions and Attendance Excuse

There are no limits of absence for theoretical and theoretical-practical classes.

Conditions for Exam Admission

All students enrolled in the course have access to the exam.

Evaluation Method

At the end of the semester students will take a final exam where they will have to obtain a grade of 9.5 or higher.

Conditions for Results Improvement

Adopted rules by ISEC.

Date	**Signature from the lecturer responsible for the course**
23/09/2018	

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:_____

Licenciatura – BsC Bioengenharia (Português)

Licenciatura – BsC Bioengineering (Inglês)

Academic Year: **2018/2019**

Program Contents

Course Unit CELL BIOLOGY

Specialization (s) JOINT BODY

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 1 **Semester** 1 **ECTS** 4

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures	1	15
Practical-Laboratoty Lectures	1	15
Tutorial Orientation		
Project		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	52
Works / Group Works	
Project	
Evaluation	3
Additional	

Total of Working Hours 100

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	António Luís Pereira do Amaral	PhD	Adjunt professor
Theoretical-Practical Lectures	António Luís Pereira do Amaral	PhD	Adjunt professor
Practical-Laboratoty Lectures	António Luís Pereira do Amaral	PhD	Adjunt professor
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s)
António Luís Pereira do Amaral

Goals
The main objective of this curricular unit is to provide the students with the fundamental concepts of Cell Biology, so that they are able to understand the concepts addressed in the following Biological related curricular units in the Bioengineering curricular plan.
It is intended, therefore, that students will be able to: i) recognize and apply in practice methodologies for studying cells; ii) identify and distinguish cellular structures and functions in prokaryotic and eukaryotic cells; iii) recognize the structure of cell membranes and the main transport mechanisms; iv) to identify the cellular reproduction processes in eukaryotes and prokaryotes.

Skills
1. Recognize and apply in practice methodologies for studying cells, such as microscopy techniques.
2. Recognize cell structures, and their functions in prokaryotic and eukaryotic cells.
3. Recognize the structure of cell membranes and the main transport mechanisms.
4. Identify and characterize cell reproduction processes in eukaryotes and prokaryotes.
5. Execute practical laboratory work using microscopy techniques to identify the cellular morphology and structure of various organisms

Signature of Teacher:_____

Program Contents

1. The study of the cell
Origin, evolution and cellular diversity. The prokaryotic (archaea and bacteria) and eukaryotic cells. Methodologies of cell study. Fundamentals of optical and electronic microscopy. Main applications of microscopy.
2. Structure of prokaryotic and eukaryotic cells
Morphological characteristics of prokaryotic microorganisms. Cellular structures and function in prokaryotic cells. Cellular structures and function in eukaryotic cells. Latent forms.
3. Cell processes
The plasma membrane and the transmembrane transport. Constitution and function of biological membranes. Mobility and asymmetry. Dynamics of membranes. Transport through the membrane: Simple diffusion, facilitated diffusion, active transport and group translocation. Mechanisms of cell division. Reproduction of prokaryotic microorganisms. Cell cycle of eukaryotic organisms. Reproduction in eukaryotic organisms: mitosis, meiosis and gametogenesis.

Laboratory work will include the following:
0. Adaptation to the microscope
1. Visualization of live unstained samples
2. Simple coloring techniques
3. Differential coloring techniques

Bibliography

1. Amaral, A.L. – Sebenta da disciplina, Coimbra, 2016.
2. Azevedo, C., Biologia Celular e Molecular, Lidel, Lisboa, 2005.
3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. & Walter, P., Molecular Biology of the Cell, Garland Science, 2002.
4. Pelczar, Chang e Krieg, Microbiologia – conceitos e aplicações, Makron Books, 1996.
5. Willey, Sherwood, Woolverton, Microbiology, McGraw Hill, New York, 2008.
6. Black. G., Microbiology – principles and explorations, John Wiley & Sons, New Jersey, 2005.
7. Ferreira, Sousa e Lima. Microbiologia, Lidel, Lisboa, 2010

Access Conditions and Attendance Excuse

Compulsory attendance for the laboratory classes when attending the discipline for the first time in order to be able to opt for continuous assessment.

Conditions for Exam Admission

The students must choose between attending the continuous examination or the "Normal" period examination. Access to the "Recurso" period examination without conditions

Evaluation Method

The student can choose one of the following modes of evaluation: i) continuous or ii) final evaluation.
Continuous evaluation will be performed through three written mini-tests (14/11 and 19/12, for 7.5 values each) and a practical laboratory test (03/01, for 5 values).
Final evaluation is carried out at the end of the semester by means of a written exam (15 values) and a practical laboratory test (5 values),
The students need approval (minimum of 9.5 values in 20) in both the written and practical laboratory tests to be approved in the curricular unit.
The grade of the laboratorial component will be valid throughout all the examination stages within the school year in which it was obtained.

Conditions for Results Improvement

Those in force at ISEC

Date

06/09/2018

Signature from the lecturer responsible for the course

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura –BsC Bioengenharia (Português)

Licenciatura – BsC Bioengineering (Inglês)

Academic Year: **2018/2019**

Program Contents

Course Unit	**Chemistry**				
Specialization (s)	**Common body**				
Subject type	**Compulsory**	**Research Area**		**Chemical and Biological Engineering**	
Year	1	**Semester**	1	**ECTS**	5

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	**2**	**30**
Theoretical-Practical Lectures	**2**	**30**
Practical-Laboratoty Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		**125**

Unaccompanied Working Hours

Activity Type	Total Hours
Study	**58**
Works / Group Works	
Project	
Evaluation	**7**
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria Dolores das Dores Ramos Franco Moreira	Master	Assistant teacher
Theoretical-Practical Lectures	Maria Dolores das Dores Ramos Franco Moreira	Master	Assistant teacher
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria Dolores das Dores Ramos Franco Moreira

Goals

The main objective of the curricular unit is to provide the student with a global view of Chemistry, in order to consolidate and deepen the knowledge previously acquired. It is also intended to introduce the student in the fields of Organic Chemistry, giving a special emphasis to the structure, nomenclature and physical-chemical characteristics of the main families of organic compounds.

Skills

i) Understand the basic concepts of chemistry, chemical bonds and mass relations in chemical reactions, state of matter, thermochemistry and chemical equilibrium;
ii) Identify precipitation, acid-base, oxidation-reduction reactions and reactions with oxygen;
iii) Identify the functional groups of the organic compounds and their properties;
iv) Determine the structure of an organic compound from its name and vice versa and
v) Identify and classify different isomers of organic compounds.

Signature of Teacher:

Program Contents

1. Basic concepts
Composition and structure of the atom. Classification and periodic properties. Chemical bonding. Chemical reactions and equations. Stoichiometry.
2. States of matter: gases, liquids and solids
Characteristics and properties of gaseous, liquid and solid state.
3. Chemical and physical changes of reactions: Energy, kinetics and equilibrium
Thermochemistry. Kinetics of chemical reaction. Chemical balance. Energy of reactions.
4. Reactions and solutions
Types of reactions: precipitation, acid-base, oxidation-reduction and reactions with oxygen. Properties of aqueous and colloidal solutions. Solubility of gases.
5. Origins and importance of Organic Chemistry
Electronic and molecular structure of organic compounds. Electronic relocation. Hybrids of resonance.
Physical and chemical properties.
6. Functional groups and nomenclature
Properties.
7. Stereochemistry
Constitutional isomers and stereoisomers.

Bibliography

1. Chang, R., "Química", 8ª edição, McGraw-Hill Interamericana, 2005.
2. Atkins, P., Overton, T., Rourke, J., Weller, M., Armstrong, F., "Inorganic Chemistry", 4th ed., Oxford, 2006.
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6. Santos, P.P., Química Orgânica, volume 1, 1ª edição, IST Press, Lisboa, 2011.
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Access Conditions and Attendance Excuse

Not applicable.

Conditions for Exam Admission

All students have access to exam.

Evaluation Method

The trainees will be subject to summative evaluation in which the final result will be defined in a scale of 0 and 20 values. Obtains approval in the training unit of the trainee that attains a minimum of 10 values in the total of the summative assessment components. The proficiency of the trainee results from a continuous summative evaluation, taking into account the performance of interim evaluations and also assiduity, punctuality, behavior, relationship and performance in class.

The Final Classification of the Curricular Unit will result from the application of the following equation:

$CFinal = 0.425 \times T1 + 0.425 \times T2 + 0.15 \times Out$

in which T1 is the grade obtained in the 1st test, T2 is the grade obtained in the 2nd test and Out the grade obtained in the attendance, punctuality, behavior, relationship and performance in the classes.

Testing dates:
1st test - November 9th
2nd Test - December 14th

Students who do not obtain the minimum grade of 9.5 values in the total components of continuous summative assessment are admitted to the exam. At any time of examination students are assessed through a written test for 20 values.

Conditions for Results Improvement

The improvement of the classification and / or the performance of the tests of recourse are foreseen in an overall evaluation process, which allows for the possibility of gauging the expectations of self-assessment of the trainees and / or the approval in the Training Unit. The trigger sequence of the test procedure is provided in REACTA.

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

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC Bioengenharia (Português)

Licenciatura – BsC Bioengineering (Inglês)

Academic Year: 2018 / 2019

Program Contents

Course Unit PHYSICS

Specialization (s) COMMON TRAINING

Subject type Mandatory **Research Area** Physics

Year 1 **Semester** 1 **ECTS** 6.0

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	30
Theoretical-Practical Lectures	1	15
Practical-Laboratoty Lectures	1	15
Tutorial Orientation		
Project		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	75
Works / Group Works	12
Project	
Evaluation	3
Additional	

Total of Working Hours 150

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Jorge Miguel Tavares Couceiro de Sousa	PhD	Adjunct Professor
Theoretical-Practical Lectures	Jorge Miguel Tavares Couceiro de Sousa	PhD	Adjunct Professor
Practical-Laboratoty Lectures	Hugo Sérgio Sousa Costa	PhD	Adjunct Professor
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Jorge Miguel Tavares Couceiro de Sousa

Goals

- Understanding the fundamental laws of Nature in the field of Classical Mechanics.
- Assimilation of the contents described in the program.
- Application of the knowledge acquired in solving problems and interpreting results.

Skills

- Ability to understand the theoretical concepts of physical laws and to relate them to practical situations and problem solving, along with a critical analysis of the results obtained.
- Autonomous acquisition of knowledge.
- Interpretation of physical phenomena.
- In the execution of laboratory work, technical skills are acquired by operating measurement instruments and interpersonal skills are acquired from the exchange of ideas and decisions taken in group.

Program Contents

1. Systems of Units
   1.1. Base units and derived units of the International System of Units;
   1.2. Equations of dimensions and principle of dimensional homogeneity;
   1.3. Units of the International System used in engineering;

Signature of Teacher:_____

1.4. Change of system of units.

2. Vector Calculus
   2.1. Scalars and vectors;
   2.2. Graphical representation of vectors;
   2.3. Bound, sliding and free vectors;
   2.4. Graphical operations with free vectors: multiplication by a scalar, addition and subtraction;
   2.5. Unit vectors;
   2.6. Projection of a vector along an arbitrary direction;
   2.7. Cartesian representation of vectors: components of a vector, position vector, module of a vector, directing cosines;
   2.8. Analytical operations with vectors: multiplication of a vector by a scalar, addition and subtraction of vectors, dot product, cross product, scalar triple product, and derivative of a vector.

3. Kinematics of Particles
   3.1. Coordinate reference systems;
   3.2. The notion of rest and movement;
   3.3. Position, velocity and acceleration vectors;
   3.4. Tangential and normal components of the acceleration vector;
   3.5. One-dimensional movement laws';
   3.6. Circular motion: angular position, velocity and acceleration;
   3.7. Relation between angular and linear parameters;
   3.8. Bi-dimensional movement: projectiles;
   3.9. Movement in three dimensions.

4. Particle Linear Dynamics
   4.1. Newton's Laws;
   4.2. Principle of independence of simultaneous forces;
   4.3. Directly applied, connecting and friction forces;
   4.4. Linear momentum: conservation principle of linear momentum;
   4.5. Impulse of a Force.

5. Rotational Dynamics
   5.1. Angular momentum of a particle
   5.2. Torque of a force about a point;
   5.3. Torque of a force about a line;
   5.4. Couple (force couple);
   5.5. Conservation of the angular momentum;
   5.6. Angular momentum of a rigid body: moment of inertia
   5.7. Equation of the dynamics of rotation of a rigid body

6. Statics
   6.1. Condition for equilibrium of a particle;
   6.2. Conditions for equilibrium of a rigid body;
   6.3. Free body diagrams.

7. Work and Energy
   7.1. Definition of work: general case and particular cases;
   7.2. Definition of power;
   7.3. Kinetic energy;
   7.4. Kinetic energy theorem;
   7.5. Conservative forces fields: gravitational and electric;
   7.6. Potential energy;
   7.7. Non-conservative forces.

Signature of Teacher:

Bibliography

- Paul A. Tipler, Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Vol. 1, W. H. Freeman, 2007. ISBN: 978-1-4292-0132-0.
- D. Halliday, R. Resnick, J. Walker, *Fundamentals of Physics*, 10th Edition (Extended Edition), John Wiley & Sons, Inc., 2014. ISBN: 978-1-1182-3072-5.
- Hugh D. Young, Roger A. Freedman, *Sears & Zemansky's University Physics*, 13th Edition, Vol. 1, Addison-Wesley, 2011. ISBN: 978-0-3217-3338-2.
- Marcelo Alonso, Edward Finn, Physics, Revised Edition, Addison Wesley, 1992. ISBN: 978-0-2015-6518-8.

Access Conditions and Attendance Excuse

Not applicable

Conditions for Exam Admission

In order to have access to the final exam, students will have to obtain approval to the laboratory component (minimum of 2.00 in 4.00 values).
Students covered by the statute of the student worker (Law no. 07/2009, Law no. 59/2008 and the ISEC regulation of the student worker) who, due to their working hours, cannot attend the laboratory classes, will have to agree with the teacher of the practical laboratory classes, an appropriate time table for the practical classes.
The grade obtained in the laboratory component is valid for any of the examination seasons of the academic year in which it was obtained.

Evaluation Method

The evaluation is carried out by: practical laboratory works, regulated by the annexed rules, and final written examinations that are compulsory or optional that are contained in the regulations in force in ISEC.
Students who obtain a grade of 2.00 or more in the practical laboratory works will obtain approval if $C = E \times 0.8 + P \geq 9.50$, where E is the final exam classification, from 0 to 20 values, and P is the classification of practical laboratory works (0 to 4 values). Otherwise, the final classification will be C if $C < 9.00$, or 9 if $C \geq 9.50$.
The exams are with consultation of an A4 sheet with arbitrary content.

Conditions for Results Improvement

Those that are in force in ISEC, with no improvement in the practical component.

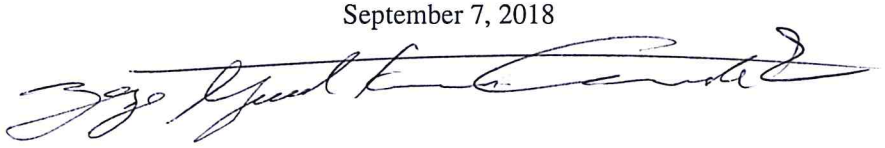
Date	Signature from the lecturer responsible for the course
07/09/2018	

Rules of Practical Classes

Academic Year of 2018/2019

1. In the first week of classes, students are enrolled in groups (of two or three) and informed of the schedule for the practical works.
2. Four practical works will be carried out, consisting of:
   2.1. Experimental determination of the acceleration of an object in a frictionless inclined plane;
   2.2. Calibration of a dynamometer and experimental setup of a concurrent force system at equilibrium using two masses, the dynamometer and an angular scale;
   2.3. Experimental determination of gravity's acceleration using a gravitational pendulum;
   2.4. Experimental determination of the moment of inertia of: a rotational apparatus, point particles and cylinders.
3. In order to have access to each laboratory work, each group must deliver and obtain approval on a pre-report (available on the course website), which is similar in nature to the final report, but with data pre-acquired by the teachers. Any doubts concerning the pre-reports and the practical works must be clarified by students, prior and in time, in the office hours of the teachers of laboratory classes.
4. At the end of each practical work, and during the practical class, each group will present a single report of the work done, which will be graded between 0 and 1 values, the classification of the practical works being the sum of the classifications of the four works (therefore with a maximum of 4 values).
5. Unrealized work is graded with 0 values. In those situations where the work is carried out by a group in which one or more elements are missing, missing elements will have a grade of zero in that work.
6. Any situation not covered by these rules will be dealt directly with the teacher responsible for the discipline.

September 7, 2018



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www.isec.pt

Signature of Teacher:

Licenciatura – BsC *Bioengenharia* (Português)

Licenciatura – BsC *Bioengineering* (Inglês)

Academic Year: **2018/19**

Program Contents

Course Unit MATHEMATICS I

Specialization (s)

Subject type Compulsory **Research Area** MATHEMATICS I

Year 1 **Semester** 1 **ECTS** 5

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	30
Theoretical-Practical Lectures	2	30
Practical-Laboratoty Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		125

Unaccompanied Working Hours

Activity Type	Total Hours
Study	62.5
Works / Group Works	
Project	
Evaluation	2.5
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Pascoal Martins da Silva	Ph-D	Adj. Prof.
Theoretical-Practical Lectures	Pascoal Martins da Silva	Ph-D	Adj. Prof.
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Pascoal Martins da Silva

Goals

Understanding and applying the concept of integral of a real function of a real variable. Acquisition of knowledge about Linear Algebra tools.

Skills

The aim is to develop personal skills that enable autonomous lifelong learning, drawing on secondary level knowledge and specialty texts. Instill concern for quality and develop knowledge and understanding in the fields of engineering sciences.

Program Contents

1. Real Functions on IR - Hyperbolic functions; Inverse trigonometric functions.
2. Antiderivatives - Techniques of calculus by decomposition, parts and substitution, and of trigonometric and rational functions.
3. Integral Calculus on IR - Definite integral (Riemann's integral); Fundamental theorem of calculus; Applications of integrals to the calculus of areas, volumes and length; Indefinite and improper integrals.
4. Linear Algebra - Matrices, Linear Equations Systems and Determinants.

Signature of Teacher: _____

Bibliography

- R. Larson, R.P. Hostetler e B.H. Edwards, *Cálculo Vol. 1*, McGraw-Hill (Capítulos 1,2,3).
- Rui Rodrigues, *Notas Teóricas de Análise Matemática*, Departamento de Física e Matemática, Secção de textos do ISEC (Capítulos 1,2,3).
- Manuel Alberto M. Ferreira e Isabel Amaral, *Álgebra Linear: Matrizes e Determinantes, Vol.1*, Edições Sílabo (Capítulo 4).
- Carla Fidalgo, *Álgebra Linear*, Departamento de Física e Matemática, Secção de textos do ISEC (Capítulo 4).
- Acetatos das aulas teóricas de Matemática I, Patrícia Santos, ISEC/DFM.

Access Conditions and Attendance Excuse

Not applicable

Conditions for Exam Admission

All students duly enrolled in the course.

Evaluation Method

Lectures presentation of the formal bases of the course, with the presentation of examples and applications, and practical classes. It uses a platform moodle, where are all the acetates of lectures and support worksheets every lesson TP. Regarding the assessment students can opt for a final exam, worth 20 values, or the following method of distributed evaluation: A. Test 1 with 6 values; B. Test 2 with 3 values; C. Final exam with 11 values. The final grade will be the grade of A + B + C. Students that opt for distributed evaluation need a minimum of 75% attendance in practical classes taught. The completion of the first test assumes that the student has opted for distributed evaluation.

Conditions for Results Improvement

The conditions for improvement of classification are defined in the REFRACTA (regulation of frequency, evaluation of knowledge and transition of year).

Date	**Signature from the lecturer responsible for the course**
01/10/18	Manuel Martins da Silva

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www.isec.pt

Signature of Teacher: 

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit ENVIRONMENTAL MANAGEMENT SYSTEMS

Specialization (s) ENVIRONMENTAL TECHNOLOGY

Subject type Optional **Research Area** Biological and Chemical Engineering

Year 2 **Semester** 2 **ECTS** 5

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	30
Theoretical-Practical Lectures	2	30
Practical-Laboratory Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		125

Unaccompanied Working Hours

Activity Type	Total Hours
Study	30
Works / Group Works	35
Project	
Evaluation	
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Luís Miguel Moura Neves de Castro	Ph.D.	Professor Adjunto
Theoretical-Practical Lectures	Luís Miguel Moura Neves de Castro	Ph.D.	Professor Adjunto
Practical-Laboratory Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Luís Miguel Moura Neves de Castro

Goals

This course unit provides students with knowledge on Environmental Management Systems (EMS). After a historical introduction to the theme, it is presented the standard - ISO 14001: 2015. Then, the students do a simulation approach for the implementation of an EMS in an industrial company.
It is intended that students i) acquire knowledge that will enable them to understand the EMS, as well as master the requirements and fundamentals of implementing an EMS in industry according to ISO 14001: 2015; ii) learn methodologies to identify and evaluate the main environmental aspects and environmental impacts resulting from a given activity; iii) acquire the ability to solve environmental problems; iv) develop interpersonal skills at the level of interaction with other students; iv) develop communication skills in the presentation and discussion of the work done.

Skills

With this curricular unit it is intend to develop some generic and specific competences, being the most importants:
- development of students ability to communicate, exposing ideas, problems, information, with a diverse target audience;
- development of students ability to work in groups, developing interpersonal relationships;
- instill in the students the quality concerns
- create the capacity to collect, select and interpret relevant information in the area of students formation, combined with the capacity for analysis, synthesis and formulation of opinions.

Signature of Teacher:_____

Program Contents

1. Fundamentals of Environmental Management Systems (EMS). Historical background.
2. Motivation for the implementation of an EMS and for Environmental Certification
3. The standard NP EN ISO 14001: 2015. Relationship with other management systems.
4. Identification and evaluation of environmental aspects and impacts
5. Main environmental legal requirements applicable to industry
6. The requirements of NP EN ISO 14001: 2015
7. Community Eco-Management and Audit Scheme - EMAS. Main features. Legal support. EMAS versus ISO 14001
8. Fundamentals of Environmental Auditing

Bibliography

1. Miller, Jr,G.T. e Spoolman, S.E., Living in the Environment: Concepts, Connections, and Solutions, Cengage Learning, 16ª edição, 2008 ISBN 978-0495556718.
2. Whitelaw, K., ISO 14001 Environmental Systems Handbook, Elsevier Butterworth-Heinemann, Oxford, 2ª edição, 2004, ISBN 0 7506 4843 0.
3. Guimarães Sá, J., Santos, João; de Sousa, Teresa Carvalho e de Sousa, Rita Ribeiro. Guia do Utilizador ISO 14001:2015. APCER 2016...
4. Norma NP EN ISO 14001:2015. Sistemas de gestão ambiental. Requisitos e linhas de orientação para a sua utilização (ISO 14001:2015).
5. Norma Portuguesa. NP EN ISO 19011 2012. Linhas de orientação para auditorias a sistemas de gestão (ISO 19011:2011)
6. Regulamento (CE) n.º 1221/2009, de 25 de novembro (EMAS III).
7. Diverse environmental legislation.
8. Castro L. M., http://intranet.isec.pt/sites/DEQB/SGA, 2019

Access Conditions and Attendance Excuse

There are no limits of absence for theoretical and theoretical-practical classes.

Conditions for Exam Admission

All students enrolled in the course have access to the exam, although those applying for continuous assessment may only have access to the appeal period - see "Evaluation Method

Evaluation Method

In an initial period of the curricular unit the exposition of the content of framing of the theme is promoted, often using examples. Subsequently, the subjects related to the normative requirements are taught according to a system of teaching by project, in which each group of students, after choosing a sector of industrial activity simulates the implementation of the requirements of planning of the EMS according to norm ISO 14001.
Students up to the second week of classes must opt for one of two permitted assessment systems. In the first (traditional evaluation), the students are evaluated through a final exam, without consultation. In the second (distributed evaluation), the students are evaluated by means of a test (minimum score of 7.5 values) at the time of the normal exam (which is worth 30% of the final mark) and the performance in classes (70%) , in the resolution of the group work that is presented along the curricular unit.

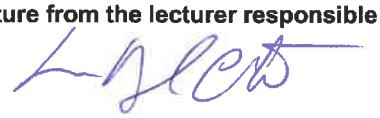
Conditions for Results Improvement

In accordance with the provisions of the Regulation for the Evaluation of Knowledge and Year Transition of Undergraduate Students of the Higher Institute of Engineering of Coimbra (REACTA).

Date

21/01/2019

Signature from the lecturer responsible for the course



Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC Bioengenharia (Português)

Licenciatura – BsC Bioengineering (Inglês)

Academic Year: **2018/2019**

Program Contents

Course Unit INTERNSHIP/PROJECT IN BIOLOGICAL ENGINEERING

Specialization (s) BIOLOGICAL ENGINEERING

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 3 **Semester** 2 **ECTS** 30

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures		
Theoretical-Practical Lectures		
Practical-Laboratory Lectures		
Tutorial Orientation		15
Project		600

Unaccompanied Working Hours

Activity Type	Total Hours
Study	
Works / Group Works	
Project	
Evaluation	1
Additional	134

Total of Working Hours 750

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures			
Practical-Laboratory Lectures			
Tutorial Orientation	Lecturer responsible for each internship/project		
Project			

Responsible(s) Lecturer (s) António Luís Pereira do Amaral
Lecturer responsible for each internship/project

Goals

The Internship allow the students to be integrated in an industrial or company environment where they will have the opportunity to apply the knowledge and techniques learned in the academic course, to work in teams and to envisage a professional career. This opportunity is fundamental to fulfill the profile required for the graduates: to qualify individuals in the Bioengineering area with a high quality and a markedly professional profile.

Skills

The student that makes an internship must:

- Acquire work experience in the industrial or institution context;
- Apply in the field, the knowledge and techniques acquired previously;
- Work in teams and be an effective communicator;
- Plan his work, fix targets and goals and establishing priorities in order to accomplish deadlines;
- Have an interdisciplinary and integrative perspective;
- Develop personal skills to grow up professionally;
- Carry on the work in a professional way, respecting the internal rules of the hosting company;
- Be able to write a clear and objective final report, using a rigorous technical-scientific language.

In some cases, and whenever this is the student preference, the Internship can be replaced by a Project to be developed in ISEC as an initiation for research and development, preferably with an applied nature, keeping the main learning objectives.

Signature of Teacher:_____

Program Contents

Internship in an industrial/business environment or initiation project for research and development in the field of Biological Engineering or related areas

Bibliography

The proposed literature will depend on the internship subject.

Access Conditions and Attendance Excuse
Not applicable

Conditions for Exam Admission
Not applicable.

Evaluation Method
Each internship/project has associated one or more supervisors, according to the areas involved in the fieldwork, including an industry/business supervisor if applicable. The student and the supervisors agree on a work plan, which includes a framework, objectives and an activities schedule. During the internship/project period there will be follow-up meetings between the student and the supervisor to ensure that the established objectives are being met.
The internship/project evaluation has a distributed component, resulting from the work performed by the student, a final report of the internship and an oral presentation and defense of the internship report. The final evaluation will take into account the student's work (TD), the Internship Report (RE), and the oral presentation of the work (AD). The final classification will be given as an integer value in a range of 0 to 20 values, by the formula (10 * TD + 7 * RE + 3 * AD) / 20. A final classification of 9.5 or more is required to be approved.

Conditions for Results Improvement
Not applicable

Date	**Signature from the lecturer responsible for the course**
17/01/2019	

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: NP

Licenciatura – BsC Bioengineering

Licenciatura – BsC Bioengenharia

Academic Year: **2018/2019**

Program Contents

Course Unit CHEMICAL AND BIOLOGICAL REACTORS

Specialization (s) CHEMICAL AND BIOLOGICAL ENGINEERING

Subject type **Research Area**

Year 2 **Semester** 2 **ECTS** 5

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	30
Theoretical-Practical Lectures	2	30
Practical-Laboratoty Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		125

Unaccompanied Working Hours

Activity Type	Total Hours
Study	65
Works / Group Works	
Project	
Evaluation	
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria Nazaré Coelho Marques Pinheiro	PhD	Prof.Coordenador
Theoretical-Practical Lectures	Maria Nazaré Coelho Marques Pinheiro	PhD	Prof.Coordenador
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria Nazaré Coelho Marques Pinheiro

Signature of Teacher: NP

Goals

The learning outcomes of this course pass through to provide students with the ability to:

- determine kinetic equation for simple reactions, by applying the integral method of data analysis;
- design and analyze the operation of constant-volume ideal reactors (DSTR, CSTR and PFR), in isothermal operation;
- design and to analyze the operation of ideal reactors for non-isothermal operation (CSTR in adiabatic or non adiabatic operation and DSTR and PFR in adiabatic operation);
- use the Michaelis-Menten equation and Monod equation;
- evaluate the type of inhibition in a enzymatic reaction;
- design and analyze ideal reactors (DSTR and CSTR) for enzymatic and microbial reactions, in isothermal operation.

Skills

This course intends to develop some specific and generic competences, being the most important:
- development of personal skills in order to guarantee learning autonomously during the professional life;
- development of knowledge and ability of understanding engineering science fields, like heat and mass transfer, based in the secondary knowledge and in scientific information from different sources;
- provide the students with capacity for applying knowledge in solving specific problems and improve self-analysis and critical abilities, namely:

obtain a kinetic equation for simple reactions using the integral method of data analysis;
design and analyze ideal reactors (DSTR, CSTR and PFR), in isothermal operation for constant volume of reaction mixture;
design and analyze DSTR and PFR in adiabatic operation and CSTR in adiabatic or non adiabatic operation;
manipulate the Michaelis-Menten equation and the Monod equation and determine the respective kinetic constants from experimental data;
evaluate the type of inhibition in an enzymatic reaction;
design and analyze the operation of an ideal reactor (DSTR and CSTR) for enzymatic and microbial reactions, in isothermal operation

Program Contents

1. Chemical Reactors

1.1. Kinetics of homogeneous reactions

Classification of reactions regarding: the number of phases; the presence of catalysts; the stoichiometry.
The rate of reaction. Rate law for a reaction. Order of reaction. The Arrhenius law.
Mode of operation of reactors: discontinuous, semicontinuous and continuous.
Constant-volume batch reactor. Extent of a reaction and conversion of a reactant. Kinetic data analysis. The integral method and application to the following reactions: irreversible unimolecular-type first-order reactions; irreversible bimolecular type second-order reactions and irreversible elementary n-order reactions. The half-life method.

1.2. Ideal Reactors

Mole balances on (ideal) discontinuous, continuous stirred tank and plug flow reactors. Non-isothermal ideal reactors. The energy balance. Adiabatic operation (DSTRs, CSTRs and PFRs). Non adiabatic operation (CSTRs).

2. Biological Reactors

2.1 Kinetics of enzymatic reactions. Michaelis-Menten equation and its application to ideal reactors in isothermal operation. Lineweaver-Burk equation. Inhibition of enzymatic activity. Competitive, noncompetitive, anticompetitive inhibition. Application to DSTR and CSTR.

2.2 Stoichiometry and kinetics of microbial processes. Equation of Monod. Kinetics of growth, death, consumption and production. Yield factors. Model of Luedking and Piret. Mass balance equations to biomass, substrate, product, dead cells and oxygen. Application to DSTR and CSTR.

Bibliography

- Dunn, I.J., Heinzle, J.I., Prenosil, J. E., "Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples", 2ª ed., VCH Publishers, New York, 2003.
- Fogler, H.S., "Essentials of Chemical Reaction Engineering", International edition, Prentice Hall, 2011.
- Fonseca, M., Teixeira, J., "Reatores Biológicos – Fundamentos e aplicações", 1º ed., Lidel, 2007.
- Froment, G.F., Bischoff, K.B., De Wilde J., "Chemical Reactor Analysis and Design", 3ª ed., John Wiley, 2010.
- James, E.B., David, F.O., "Biochemical Engineering Fundamentals", 2ª ed., Mc Graw-Hill, 1986.
- Lemos, F., Lopes, J.M., Ribeiro, F.R., "Reatores Químicos", 3ª ed., IST Press, Lisboa, 2014.
- Levenspiel, O., "Chemical Reaction Engineering", 3ª ed., John Wiley & Sons, New York, 1999.
- Missen, M.S., "Introduction to Chemical Reaction Engineering", John Wiley & Sons, inc., New York, 1999.
- Schmidt, L.D. "The Engineering of Chemical Reactions", 2ª ed., Oxford University Press, Oxford, 2004

Signature of Teacher: MP

Access Conditions and Attendance Excuse
N.A.

Conditions for Exam Admission

N.A.

Evaluation Method

The students in the second week of classes can choose one of the following evaluation methods:
1. distributed evaluation;
2. assessment by final exam.
Students who have chosen distributed evaluation will have five tests on dates to be defined jointly with the teacher, students and course director. Dates defined for the four first tests to be performed were: March 11th, March 25th, April 17th and May 20th. The date for the last test is the same of the first exam (June 14th). The tests contribute 20% each to the final classification. The students integrated in this evaluation methodology must attend to 80% of the classes, regardless of their typology, and at the same time, have a grade of 7.5 or higher (in a scale from 0 to 20 values) in the tests they will perform. When the limit of classification in the tests and / or the final average grade of 9.5 values is not attained or if the classes attendance is not reached, the student can only appeal to the second exam. Students who choose this evaluation scheme only can improve the classification by performing the entire second exam.
Students who have chosen the evaluation with the final exam are subject to the traditional evaluation method, with the possibility to perform two exams at the end of the semester in different dates.

Conditions for Results Improvement

Accomplishment of an exam to improve classification

Date

January 21, 2019

Signature from the lecturer responsible for the course

Nazaré Coelho Pinheiro

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher:_____

Licenciatura – BsC Bioengenharia (Português)

Licenciatura – BsC Bioengineering (Inglês)

Academic Year: **2018/2019**

Program Contents

Course Unit BIOLOGICAL TECHNOLOGIES LABORATORY

Specialization (s) BIOLOGICAL ENGINEERING

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 3 **Semester** 1 **ECTS** 8

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures		
Theoretical-Practical Lectures		
Practical-Laboratoty Lectures	6	9
Tutorial Orientation		
Project		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	
Works / Group Works	104
Project	
Evaluation	6
Additional	

Total of Working Hours 200

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures			
Practical-Laboratoty Lectures	António Luís Pereira do Amaral	PhD	Adjunt professor
	Maria Paula Pinto Amador	PhD	Adjunt professor
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s)
António Luís Pereira do Amaral

Goals
The main objective of this course undergoes introducing the student in the field of Biological and Enzyme Technology, with special emphasis on the main biological and enzyme uses in industry, enzyme kinetics, biocatalysts immobilization methods and application in reactors.
It is intended that students acquire the following skills: i) recognize the main biological and enzymatic processes in industry; ii) experimentally determine the Michaelis-Menten model kinetic parameters in both free and immobilized enzymes; iii) experimentally determine the parameters of empirical models for continuous reactors with immobilized enzymes; iv) operate biological processes and enzymatic industrial production; **v) know the flow of genetic information vi) explain the recombinant mechanisms that generate genetic diversity;** vii) organize and conduct group work and vii) report the performed work, discuss and analyze the experimental results.

Skills
1. Recognize the main biological and enzymatic processes in industry.
2. Determine the Michaelis-Menten model kinetic parameters in both free and immobilized enzymes.
3. Determine the parameters of empirical models for continuous reactors with immobilized enzymes.
4. Operate biological processes and enzymatic industrial production
5. Carry out DNA extraction and analysis by electrophoresis;
6. Perform the digestion of plasmid DNA with restriction enzymes;
7. Construct restriction maps;
8. Perform bacterial transformation with plasmid DNA;
9. Perform PCR amplification of DNA.

Signature of Teacher:_____

10. Determine the titer of a phage lysate
11. Solve application exercises
12. Organize and conduct group work. Report the performed work, discuss and analyze the experimental results

Program Contents

The theoretical bases that conform this curricular unit include those that are transmitted at other UC of this degree (biological and enzymatic technology concepts), consisting of module I, as well as of the ESAC Molecular Biology UC (modules II and III).
Module I
1. Biological and enzymatic industrial transformations. 2. Enzymatic kinetics. 3. Temperature dependence. 4. Biocatalysts immobilization. 5. Application in continuous reactors (CSTR and PBR).
Module II
Basic techniques of nucleic acids manipulation. 1. Restriction and modification of DNA. 2. Electrophoresis on agarose gel. 3. Bacteria transformation. 4. PCR. 5. Basic concepts of Bioinformatics
Module III
1. Recombination in bacteria: transformation, transduction and conjugation.
Execution of laboratory work, analysis and discussion of results.

Experimental group work, including the laboratorial execution, preparation of written report, and results analysis and discussion.
Experimental works to be performed:
1. Determination of the kinetic constants of *Saccharomyces cerevisiae* invertase in free cells
Determination of the kinetic constants and specific activity in free cells. Dependence with temperature.
2. Immobilization of *Saccharomyces cerevisiae* in alginate
Immobilization by an ionotropic gelation process.
3. Determination of the kinetic constants of *Saccharomyces cerevisiae* invertase in immobilized cells
Determination of the kinetic constants and specific activity in alginate immobilized cells.
4. Continuous operation of enzymatic reactors with immobilized cells
Operation of a continuous stirred reactor (CSTR). Operation of a continuous plug bed reactor (PBR). Determination of the kinetic constants of immobilized cells operated on CSTR and PBR. Determination of the empirical models.
5. Alcoholic fermentation (vinification)
Microbiological processing in wine production. Determination of the content of reducing sugars and of alcohol percentage.
6. Lactic fermentation (yoghurt production)
Microbiological processing in the production of yogurt. Determination of pH, lactic acid and lactose contents.
7. Saccharolytic activity (amylase)
Demonstration of the enzymatic activity of the amylase enzyme (starch hydrolysis)
8. Proteolytic activity in cheese.
Enzymatic processing in cheese production. Determination of casein contents and coagulant strength.
9. DNA extraction and its analysis by electrophoresis
10. Digestion of plasmid DNA with restriction enzymes
11. Construction of restriction maps
12. Bacterial transformation with plasmid DNA
13. Amplification of DNA by PCR
14. Titration of phage lysates
15. Resolution of application exercises on bacterial recombination

Bibliography

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3. Lima, N, Mota, M., Biotecnologia: Fundamentos e aplicações, Lidel, Lisboa, 2003.

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5. Rehm, H. J., Reed, G.,«Enzyme Technology» in Biotechnology, VCH, 1987.

6. Messing, R. A., Immobilized enzymes for industrial reactors, Academic Press, 1976.

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Signature of Teacher:_____

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16. Hartl, D., Ruvolo & Maryellen. Genetics. Analysis of Genes and Genomes. 8ª ed., Jones and Bartlett Learnig, Sudbury, 2011.

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20. Pesquisa de sequências homólogas: http://www.ncbi.nlm.nih.gov/BLAST/

Access Conditions and Attendance Excuse
Compulsory attendance for the laboratory classes in order to be able to be approved.

Conditions for Exam Admission
Those in force at ISEC

Evaluation Method
The evaluation of the works corresponding to module I (works 1 to 8) corresponds to 60% of the final evaluation of this Course Unit and the evaluation of the works corresponding to modules II and III (works 9 to 13) corresponds to 40%.
For module I, at the end of each group of works, an oral discussion is held on the theoretical concepts and the obtained results. The report is also analyzed. The evaluation is continuous and takes into account: (i) Performance in laboratory classes (A-15%); (ii) Evaluation of experimental reports (B-35%) and oral discussion (C-30%); (iii) Oral presentation of the results of a work, in 17/12 (D-20%). Thus, the final classification of the module I (AM_I) is obtained by: AM_I = (0.15xA + 0.35xB + 0.30xC + 0.20xD).
For modules II (Genetic information flow) and III (Genetic diversity), the evaluation is carried out as follows: Module II evaluated through 2 written tests (29/10 and 26/11); Module III evaluated through 1 written test (17/12). The final classification of this component is obtained by: AM_II-III = (0.6xModule II + 0.4xModule III).
The final classification of this curricular unit is given by 0,6xAM_I + 0,4xAM_II-III.
In order to obtain final approval to the Course Unit, the student must have a minimum grade of, at least, 9,5 (in 20).

Conditions for Results Improvement
Those in force at ISEC

Date

06/09/2018

Signature from the lecturer responsible for the course

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC BioEngenharia

Licenciatura – BsC BioEngineering

Academic Year: **2018/2019**

Program Contents

Course Unit ***SEPARATION PROCESSES LABORATORY***

Specialization (s) BIOLOGICAL ENGINEERING

Subject type-Compulsory **Research Area** Chemical and Biological Engineering

Year 3 **Semester** 1º **ECTS** 8

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures		
Theoretical-Practical Lectures		
Practical-Laboratoty Lectures	6	90
Tutorial Orientation		
Project		
Total of Working Hours		200

Unaccompanied Working Hours

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

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures			
Theoretical-Practical Lectures			
Practical-Laboratoty Lectures	Maria João da Anunciação Moreira	Ph.D	Professor Adjunto
	Luís Miguel Moura Neves de Castro	Ph.D	Professor Adjunto
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria João da Anunciação Moreira
Luís Miguel Moura Neves de Castro

Goals

With this curricular unit it is intended that the students:
• Develop the ability to work in group with responsibility and safety, realizing the risks involved in different laboratory practices.
• Acquire laboratory practice in laboratory-scale and pilot-scale units applying the unitary operations used in the processes of the chemical and biological industry.
• Aapply the knowledge of transport phenomena, thermodynamics and separation processes, acquired in previous curricular units.
• Be able to program experiences in order to achieve a certain goal.
• Be able to analyze and critique the experimental results obtained.
• Get practice in writing written reports and in your oral discussion.

Skills

With this curricular unit we intend to develop several generic and specific competences, of which we highlight the following:
• Provide students with the ability to communicate, exposing ideas, problems, information, with a diverse target audience.
• Provide students with the ability to work in groups, developing interpersonal relationships.
• Give students concerns with quality.
• Create the capacity to collect, select and interpret relevant information in the area of its formation, combined with the ability to analyze, synthesize and formulate opinions.

Signature of Teacher: _____

Program Contents

The students will carry out eight experimental works:

Work 1: SOLID-LIQUID EXTRACTION
Determination of the solid-liquid extraction yield to obtain the soluble fraction present in cork industry wastes.

Work 2: DISTILLATION OF AN AZEOTROPIC BINARY MIXTURE
Distillation of a homogeneous mixture of n-propanol in water at atmospheric pressure. Performing material balances on the spine. Determination of the number of theoretical equilibrium stages required to obtain the desired separation from the McCabe and Thiele Method. Identification of the optimal floor to introduce the feed and determination of the reflux ratio.

Work 3: EXPERIMENTAL DETERMINATION OF RUGOSITY IN A PIPE
Experimental determination of the roughness of a galvanized iron pipe and a PVC pipe from the measurement of pressure loss of a fluid along the pipe for different flow values.

Work 4: EVALUATION OF PERFORMANCE OF A PUMP AND A PUMP SYSTEM ASSOCIATED IN SERIES AND PARALLEL
Performance study of two centrifugal pumps. Determination of the characteristic curves of two pumps and their combinations in series and in parallel; Experimental determination of the curve of the efficiency of a pump and determination of the point of maximum efficiency (BEP); Experimental determination of the system curve.

Work 5: STUDY OF THE CONSTANT PRESSURE FILTRATION PROCESS
Study of the filtration process, at constant pressure, using calcium carbonate suspensions. Preparation of the specific resistance of the cake and resistance of the filter medium. Determination of the compressibility factor of the filter cake from three tests performed at different pressures.

Work 6: STUDY OF THE SEDIMENTATION PROCESS OF CALCIUM CARBONATE SUSPENSIONS
Determination of the sedimentation curve for calcium carbonate suspensions. Evaluation of the influence of the initial suspension concentration.

Work 7: STUDY OF THE HEAT TRANSFER PROCESS IN A CONCENTRIC TUBE EXCHANGER
Study of the operation of a concentric tube heat exchanger operating countercurrent and co-current. Analysis of the influence of the heat exchanger configuration, the variation of the hot water inlet temperature and the cold water flow rate variation in the heat transfer process. Obtaining the film coefficients and the overall heat transfer coefficient. Determination of process efficiency.

Work 8: DRYING A SOLID IN A TRAY DRYER
Determination of drying curves and drying rate of a moist solid when using hot air at constant temperature and humidity.

ORAL PRESENTATION OF WORK
At the end of each group of 4 experimental works (weeks 7 and 14) there will be a session for oral presentations, where each group presents one of the experimental works carried out and which may include the analysis of experimental results from other groups. After the presentation there will be a discussion period that will consist of a set of questions / answers made individually to each member of the group.

Bibliography

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Access Conditions and Attendance Excuse
Considering the characteristics of the course unit its frequency is obligatory.

Conditions for Exam Admission
This course has no final exam.

Evaluation Method
Although there are no prerequisites for enrollment in this curricular unit, it is advisable to know the subjects taught in the subjects of Introduction to Processes, Thermodynamics, Transport Phenomena I and II, Separation Processes I and Instrumentation and Control.

The evaluation is distributed throughout the semester, resulting from the average of 9 evaluations: 8 related to the practical assignments and one corresponding to the oral presentation at the end of the semester.
The evaluations of the work take into account the parameters: performance / coordination of the experimental realization, quality of the results obtained and delivered on the day of the experimental realization, answers to written questions and appreciation of the report and discussion thereof.
In the evaluation of the experimental class, the following aspects will be taken into account: behavior, responsibility, team functioning, compliance with laboratory and discipline rules, use with class time use, theoretical knowledge reviewed before experimental performance and quality of results.

To be approved in the course unit the student should have cumulatively positive average in the 9 evaluations, not having more than 2 negative evaluations.

Conditions for Results Improvement
The student will have to repeat all the evaluation components that are included in the Evaluation Method

Date
23/09/2018

Signature from the lecturer responsible for the course

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC Bioengenharia_____(Português)

Licenciatura – BsC Bioengineering_____(Inglês)

Academic Year: **2018/ 2019**

Program Contents

Course Unit ORGANIZATION & MANAGEMENT

Specialization (s)

Subject type Mandatory **Research Area** Industrial Engineering and Management

Year 3rd **Semester** 1st **ECTS 4.0**

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures	2	30
Practical-Laboratoty Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		45

Unaccompanied Working Hours

Activity Type	Total Hours
Study	50
Works / Group Works	24
Project	
Evaluation	3.5
Additional	
	77.5

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Jorge Alexandre C. G. Almeida	MSc./Specialist	Adjunct Prof.
Theoretical-Practical Lectures	Jorge Alexandre C. G. Almeida	MSc./Specialist	Adjunct Prof.
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Jorge Alexandre C. G. Almeida

Goals

Understand the basic principles of business management capital investment decisions and operation/quality management in several aspects, developing shared domain knowledge between engineers and managers. At the end of this course students should be able to:
Understand management principles and framework theories
Analyze the business environment and apply some of the main business analysis tools and frameworks
Propose marketing policies for a given case study
Understand and analyze the financial statements
Analyze capital investment decisions
Understand and apply techniques and methods for production planning and scheduling and inventory management
Understand and apply methods of production design, focusing on both technical and human aspects
Understand the basic principles of quality management and the requirements of the reference standard
Evaluate various alternatives and justify the proposed solutions
Prepare a written report and an oral presentation in a clear way, working in a group

Signature of Teacher:

Skills

Understand the basic principles of business management capital investment decisions and operation/quality management in several aspects,
developing shared domain knowledge between engineers and managers. At the end of this course students should be able to:
Understand management principles and framework theories
Analyze the business environment and apply some of the main business analysis tools and frameworks
Propose marketing policies for a given case study
Understand and analyze the financial statements
Analyze capital investment decisions
Understand and apply techniques and methods for production planning and scheduling and inventory management
Understand and apply methods of production design, focusing on both technical and human aspects
Understand the basic principles of quality management and the requirements of the reference standard
Evaluate various alternatives and justify the proposed solutions
Prepare a written report and an oral presentation in a clear way, working in a group

Program Contents

1. Introduction to management and organizations.
2. Business analysis and Marketing concepts.
3. Financial statements
4. Capital investment decisions. Economic evaluation of investment proposals
5. Production processes planning and management
6. Procurement and inventory management
7. Quality management and the NP EN ISO 9001: 2015 standard

Bibliography

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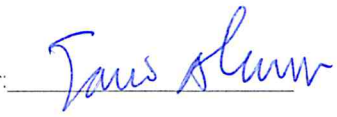
LISBOA, J. & GOMES, C F - Gestão de Operações. 2ª Edição, Vida Económica, 2010
PIRES, A R - Sistemas de Gestão da Qualidade. 2a. ed., Edições Sílabo, Lda., Lisboa, 2000.
RUSSEL, R S & TAYLOR III, B W - Operations management: along the supply chain. 6th ed, Hoboken, NJ : John Wiley & Sons, cop. 2009
TEIXEIRA, S. - Gestão das Organizações. Mc Graw Hil, 2001

Access Conditions and Attendance Excuse

Those provided for in the legislation. Students are advised to systematically follow classes as a prerequisite to school achievement and to the correct understanding of the subjects.

Signature of Teacher: 

Conditions for Exam Admission

All students who have done the practical work with grade> 40% and that are legally enrolled in the course unit.

Evaluation Method

Teaching methodologies include theoretical lectures as well as discussion of small case studies and resolution of exercises. The interrogative process is widely used to encourage the student to reflect on the topics exposed. The students should develop an autonomous work outside the class, on a relevant subject of the discipline (business plan), that results in a report and a presentation / defense in the class. The participation of the students in the classes is strongly encouraged and valued.

The final grade will be obtained by the formula: 25% Practical Work note + 75% Frequency note. There is a minimum mark of 40% for each component.

Conditions for Results Improvement

Those provided for in the legislation and can not be carried out in the Normal Season.

Date	**Signature from the lecturer responsible for the course**
23.9.2018	

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: _____

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit SEPARATION AND PURIFICATION PROCESSES OF BIOLOGICAL PRODUCTS

Specialization (s) COMMON BODY

Subject type Compulsory **Research Area** Chemical and Biological Engineering

Year 3º **Semester** 1º **ECTS 5.0**

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures	2.5	37.5
Practical-Laboratoty Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		125

Unaccompanied Working Hours

Activity Type	Total Hours
Study	72.5
Works / Group Works	
Project	
Evaluation	
Additional	

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Maria João da Anunciação Moreira	Ph.D.	Professor Adjunto
Theoretical-Practical Lectures	Maria João da Anunciação Moreira	Ph.D.	Professor Adjunto
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Maria João da Anunciação Moreira

Goals

With this curricular unit, students are expected to: i): know some of the main separation techniques used in Biotechnology in order to be able to size the equipment to be used in the solid-liquid and liquid-liquid extraction operations, membrane filtration , adsorption and ion exchange; ii) become aware of the equipment used in these unit operations; iii) acquire the concepts and develop the equations that allow to characterize the operation and dimension the equipment; iv) acquire an overview of the requirements in the handling and validation of processes involving biological products; v) are able to solve problems involving the separation processes studied.

Skills

Students should acquire an integrated view of the processes of separation and purification of biological products. This objective is achieved through the study of the theoretical foundations of the various unit operations used in the different stages of their recovery, with a view to obtaining a final product with a high degree of purity and added value. In the end, students should be able to define a strategy for the purification of different biological products, at different scales of operation (from the laboratory to the industrial scale), including the appropriate equipment for each selected unit operation

Signature of Teacher:_____

Program Contents

1. Introduction to the processes of separation and purification of biomolecules.
   1.1 Biological processes of industrial interest.
   1.2 Main stages of biological processes: initial processing, bio-reaction and final processing.
   1.3 Final processing: cell removal, isolation and purification.
2. Properties of biological products. Intracellular and extracellular products.
3. Liquid-liquid and solid-liquid extraction.
   3.1 Extraction process in a single step.
   3.2 Multi-step extraction by continuous counter-current and cross-flow processes.
   3.3 Calculation of the number of equilibrium stages in a countercurrent cascade by the graphical method.
   3.4 Effect of solvent flow (minimum flow).
4. Membrane separation processes.
   4.1 Nomenclature and basic concepts.
   4.2 Dialysis, gas permeation, reverse osmosis (RO), ultrafiltration (UF), microfiltration (MF).
   4.3 Design of RO, MF and UF systems.
5. Adsorption and ion exchange.
   5.1 Adsorbents and ion exchange resins.
   5.2 Adsorption equilibrium and ion exchange kinetics: internal and external mass transport.
6. Separation of biological products by electrophoresis.
   6.1 Separation of biological products by electrophoresis.
   6.2 Effect of electric charge and solute size.
   6.3 Problems of scaling by heat release
   6.4 Isoelectric focusing.
   6.5 Use of amphoteric substances for the generation of pH gradients.
   6.6 New developments in isoelectric focusing without the use of amphoteric compounds.

Bibliography

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2. Azevedo, E. G. e Alves, A. M., Engenharia de processos de separação. 1ª edição, IST Press. Lisboa, 2009.
3. Harrison, R. G.; Todd, P.; Rudge, S. R. e Petrides, D. P., Bioseparations Science and Engineering, Oxford University Press, USA, 2003.
4. Geankoplis, Christie J.,Transport processes and separation process principles (includes unit operations), 4ª edição, Upper Saddle River, NJ : Prentice Hall PTR, 2003.
5. McCabe W.L., Smith J.C., Harriote P., Unit Operations of Chemical Engineering, 6ª edição, Mc Graw-Hill, 2001.
6. Baker, R.W.,Membrane Technology and Applications, John Wiley & Sons, 2004.
7. Mulder, M.,Basic principle of membrane technology, Kluwer Academic Publishers, 1991.

Access Conditions and Attendance Excuse

There are no limits of absence for theoretical and theoretical-practical classes.

Conditions for Exam Admission

All students enrolled in the course have access to the exam.

Evaluation Method

At the end of the semester students will take a final exam where they will have to obtain a grade of 9.5 or higher.

Conditions for Results Improvement

Adopted rules by ISEC.

Date

23/09/2018

Signature from the lecturer responsible for the course

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: Ana Veloso

Licenciatura – BsC Bioengenharia

Licenciatura – BsC Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit ENZYMATIC ENGINEERING

Specialization (s) BIOLOGICAL ENGINEERING

Subject type compulsory **Research Area** Chemical and Biological Engineering

Year 3 **Semester** 1 **ECTS** 5.0

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	1	15
Theoretical-Practical Lectures	2.5	37.5
Practical-Laboratoty Lectures		
Tutorial Orientation		
Project		

Unaccompanied Working Hours

Activity Type	Total Hours
Study	40
Works / Group Works	30
Project	
Evaluation	2.5
Additional	

Total of Working Hours 125

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Ana Cristina Araújo Veloso	PhD	Prof. Adjunto
Theoretical-Practical Lectures	Ana Cristina Araújo Veloso	PhD	Prof. Adjunto
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Ana Cristina Araújo Veloso

Goals

The learning objectives in this course is to provide students with the ability to understand and describe the fundamental characteristics of processes involving enzymes. It is intended that students be able to model the enzymatic kinetics and apply this knowledge in the design of reactors to operate with free and immobilized enzymes.

Skills

It is intended that students acquire the following competencies:
i) understand the role of enzymes in biotechnological applications;
ii) understand the properties and functions of enzymes;
iii) describe the biocatalysis process in unconventional means;
iv) identify the types of enzymatic catalysis mechanisms;
v) understand and describe the main types of enzyme inhibition;
vi) determine the effect of enzyme immobilization on their kinetics;
vii) understand and model the main types of reactors with immobilized enzymes.

Program Contents

1. Enzymes properties
Classification and nomenclature. Specificity of enzymes. Enzyme catalysis mechanisms.

2. Enzyme technology
Main industrial applications of enzymes. Biosensors and enzymatic clinical diagnostics. Enzymes for industrial, pharmaceutical, food and environmental use.
3. Biocatalysis in non-conventional systems
Biocatalysis in aqueous systems, organic solvents, ionic liquids, supercritical fluids, solid-solid systems and liquid-solid systems.
4. Kinetics and enzymatic stability. Michaelis-Menten model. Alternative and complementary models. Graphical determination of kinetic constants. Enzymatic activity and stability. Effect of pH and temperature on enzyme kinetics. Types of enzyme inhibition.
5. Immobilization of enzymes
Support media types and immobilization techniques. Effects on the enzymatic properties and kinetics.
6. Reactors with immobilized enzymes
Classification. Main types of reactors with immobilized enzymes and respective kinetic models.

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1. J.M.S. Cabral, M.R. Aires-Barros, M. Gama, Engenharia Enzimática, Lidel - edições técnicas, Lda., 2003.

2. M.M. Fonseca, J.A. Teixeira, Reatores Biológicos:fundamentos e aplicações, Lidel – edições técnicas, Lda, 2007.

3. A.S. Bommarius, B.R. Riebel, Biocatalysis, Wiley-VCH, 2004.

4. J.M. Lee, Biochemical Engineering, Prentice Hall, 2001.

5. L, Hilterhaus, A. Liese, U, Kettling, G. Antranikian, Applied Biocatalysis: from fundamental science to industrial applications, Wiley-VCH, 2016.

Access Conditions and Attendance Excuse
Attendance excuse of theoretical and theoretical-practical classes to student workers.

Conditions for Exam Admission
Students will only be able to take examinations as long as they are properly enrolled in the course unit.

Evaluation Method
The evaluation will be distributed with final exam and will take into account:
(C1) Final Exam:
Achievement of a final exam at the time of exams whose classification must be higher than 7 values (50% of the final mark).
(C2) Seminar:
Elaboration and presentation of a written work on enzymatic technologies. The presentation of the work must be done until December 6, 2018. The presentation will be on January 3, 2019. (30% of the final grade).
(C3) Presentation and discussion of scientific articles:
Presentation and discussion of scientific articles on enzymatic kinetics, enzymatic reactors or an industrial technology involving enzymes. The presentation and discussion will be on October 25, 2018 (20% of the final grade).

The final classification is obtained by the sum of the contributions of the various components.

In order to pass the Enzymatic Engineering course, students must obtain a minimum overall mark of 10 values. However, as already mentioned, the final exam classification must be higher than 7 values.
For ordinary students the classification of components C2 and C3 of the evaluation will be valid throughout the academic year and can not be replaced by another type of evaluation.
The student workers may be exempted from the work, in which case the final exam classification will be 100%.

Conditions for Results Improvement
Adopted rules by ISEC.

Date

17/09/2018

Signature from the lecturer responsible for the course

Ana Cristina Araújo Veloso

Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: Luis J. A. Martins

Licenciatura – BEng Bioengenharia

Licenciatura – BEng Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit LABORATORY OF INSTRUMENTAL ANALYSIS

Specialization (s) BASIC ENGINEERING SCIENCE

Subject type Laboratory **Research Area** Instrumental Methods of Analysis

Year 2nd **Semester** 2nd **ECTS** 8

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures Theoretical-Practical Lectures Practical-Laboratoty Lectures Tutorial Orientation Project	6	90
Total of Working Hours		90

Unaccompanied Working Hours

Activity Type	Total Hours
Study Works / Group Works Project Evaluation Additional	110
	110

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures Theoretical-Practical Lectures Practical-Laboratoty Lectures Tutorial Orientation Project	Luis J. A. Martins	PhD	Prof. Coordenador

Responsible(s) Lecturer (s) Luis Jorge Assunção Martins

Goals

Provide hands-on experience and practical knowledge in both (molecular and atomic) absorption spectrometry and spectrofluorimetry, as well as in gas and liquid analytical chromatography. Get students aware of current methods of sample preparation, while solving real-world analytical problems. Train students with the required skills and ability to operate equipment in widespread use in the analytical laboratory and to adopt good laboratory practices.

Skills

Ability to operate laboratory instruments commonly used in spectroscopic and chromatographic analysis
Ability to understand the capabilities and limitations of instrumental methods of chemical analysis
Ability to describe the instrumental components and the underlying principles of operation

Program Contents

Sixteen laboratory experiments:

1. Determination of ethanol in two regional red table wines (Douro and Verde of the same year) by gas-liquid chromatography on a packed column with temperature-programmed elution and FID detection (with 4-methyl-2-pentanol as internal standard)
2. Determination of acetaldehyde, methanol, ethanol, ethyl acetate, 1-propanol, 2-methyl-1-propanol, 2-methyl-1-butanol,

3-methyl-1-butanol and ethyl lactate in two regional red table wines (Douro and Verde of the same year) by gas-liquid chromatography on a packed column with temperature-programmed elution and FID detection (with 4-methyl-2-pentanol as internal standard)
3. Determination of organic acids (L(+)-tartaric, L(-)-malic, citric, L(+)-lactic, succinic and acetic acids) in two regional red table wines (Douro and Verde of the same year) by reversed phase-ion exclusion high performance liquid chromatography with isocratic elution and UV detection
4. Determination of 3-methyl-1-butanol, 3-hydroxy-2-butanone, ethyl lactate, γ-butyrolactone, diethyl succinate, 2-phenylethanol, diethyl malate, monoethyl succinate and 5-hydroxymethyl-2-furaldehyde in two regional red table wines (Douro and Verde of the same year) by capillary gas-liquid chromatography with split injection, temperature-programmed elution and mass spectrometry detection (scan mode) (with 4-methyl-2-pentanol as internal standard)
5. Determination of glycerol, D(-)-fructose and D(+)-glucose in two regional red table wines (Douro and Verde of the same year) by high performance liquid chromatography with isocratic elution and differential refractometry detection
6. Determination of the total extract and pH of wine in two regional red table wines (Douro and Verde of the same year)
7. Determination of caffeine, theobromine and theophyline in coffee, tea and cocoa by reversed-phase high performance liquid chromatography with isocratic elution and UV detection
8. Determination of lactose, citric acid and L(+)-lactic acid in milk by ion exclusion high performance liquid chromatography with isocratic elution and UV detection
9. Determination of the fatty acid residues (of palmitic, stearic, oleic, linoleic and linolenic acids) in vegetable cooking oils and olive oil by gas-liquid chromatography with isothermal elution and FID detection (with ethyl laurate as internal standard)
10. Measurement of the compositional parameters of cheese water, fat and protein in two regional cheeses using a moisture balance (for water) and by Fourier transform infrared spectrometry (FT-MIR-ATR) (for water, fat and protein)
11. Spectrophotometric determination of sodium nitrite in processed meat
12. Spectrofluorimetric determination of quinine in tonic water
13. Simultaneous spectrophotometric determination of acetylsalicylic and L(+)-ascorbic acids in a pharmaceutical tablet
14. Determination of sodium and potassium in two regional table red wines (Douro and Verde of the same year) by atomic absorption spectrophotometry with flame atomization
15. Determination of calcium in milk by atomic absorption spectrophotometry with flame atomization
16. Determination of calcium in green vegetables by atomic absorption spectrophotometry with flame atomization

Bibliography
Lab handouts provided by the academic staff responsible for developing the laboratory experiment. Lab handouts are given to students well in advance of the scheduled lab session.

Access Conditions and Attendance Excuse
There is no substitute for having to perform the sixteen experiments assigned at the beginning of the semester, and submitting a formal report for each experiment done.

Conditions for Exam Admission
This question is not raised since no examination is required to pass this course unit.

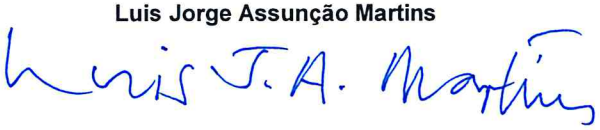
Evaluation Method

Assessment items: Lab reports (18/20) and final test (2/20).

In order to pass this course unit, each student must attend all scheduled lab sessions, turn in lab reports (of the required format) for all executed experiments and must achieve an overall grade/mark of 10 or more. Students are required to hand in their lab reports on time. The report with a maximum of 2 pages must include the sample chromatogram or spectrum as an appendix. The schedule of lab reports due dates is as follows: 8th April reports # 1-6; 6th May reports # 7-10; 14th June reports # 11-14. The final test will be held on the last class period of the semester.

Conditions for Results Improvement
No grade appeal procedure is contemplated. Only limited experiment repeat is possible, for exceptional and justifiable reasons and which could lead to grade improvement.

Date	**Signature of the lecturer responsible for the course**
04/02/2019	**Luis Jorge Assunção Martins**



Instituto Superior de Engenharia de Coimbra
www.isec.pt

Signature of Teacher: Luis J. A. Martins

Licenciatura – BEng Bioengenharia

Licenciatura – BEng Bioengineering

Academic Year: **2018/2019**

Program Contents

Course Unit INSTRUMENTAL ANALYSIS

Specialization (s) BASIC ENGINEERING SCIENCE

Subject type Theoretical **Research Area** Instrumental Methods of Analysis

Year 2nd **Semester** 2nd **ECTS** 5

Working Hours

Activity Type	Working Hours Per Week	Total Hours
Theoretical Lectures	2	30
Theoretical-Practical Lectures	2	30
Practical-Laboratoty Lectures		
Tutorial Orientation		
Project		
Total of Working Hours		60

Unaccompanied Working Hours

Activity Type	Total Hours
Study	65
Works / Group Works	
Project	
Evaluation	
Additional	
	65

Lecturer

Activity Type	Name	Qualifications	Category
Theoretical Lectures	Luis J. A. Martins	PhD	Prof. Coordenador
Theoretical-Practical Lectures	Luis J. A. Martins	PhD	Prof. Coordenador
Practical-Laboratoty Lectures			
Tutorial Orientation			
Project			

Responsible(s) Lecturer (s) Luis Jorge Assunção Martins

Goals

Get students acquainted with the fundamentals and range of application of spectroscopic and chromatographic techniques to solve analytical problems. Provide the necessary grounding for students to keep abreast of the latest applications of these techniques as brought about by new instrumentation development.

Skills

Ability to describe and understand the capabilities and limitations of instrumental methods
Ability to explain the instrument components and principles of operation
Ability to correctly select an analytical method and instrument meeting their use objectives
Ability to use and interpret signal-to-noise ratio and signal processing as required for chemical analysis

Program Contents

1.Classification of analytical methods (Classical and Instrumental methods).
Overview of the main methods of instrumental analysis.
2. Terms and quantitative relationships in spectrochemical analysis and in column (elution) analytical chromatography.
3. Spectrochemical methods of analysis.

3.1 Molecular (and atomic) energy levels, electromagnetic spectrum and spectroscopy (ESR and NMR spectroscopy; rotational, vibrational and electronic spectroscopy; Mossbauer spectroscopy); elastic scattering spectroscopy and Raman vibrational and rotational spectroscopy.
3.2 Optical molecular spectroscopy.
3.2.1 Electronic absorption (ultraviolet-visible) spectroscopy.
3.2.2 Vibrational absorption spectroscopy (absorption spectroscopy in the infrared and vibrational Raman spectroscopy).
3.3 Optical atomic absorption (and emission) spectroscopy.
3.4 Analytical applications of conventional molecular and atomic spectroscopy.
3.4.1Qualitative spectroscopy.
3.4.2 Quantitative spectroscopy.
3.5 Instrumentation for molecular and atomic spectrochemical analysis in the optical region.
4. Chemical separations (for analytical purposes).
Overview of chemical separation methods.
4.1 Chemical separations involving extraction.
4.2 Chromatography.
4.2.1 Chromatographic separations (chromatographic techniques, fundamentals and configuration of chromatographic systems).
4.2.2 Instrumentation in analytical GC and HPLC column (elution) chromatography.
4.2.3 Sample preparation in analytical chromatography (derivatization, SPE and SPME, sample clean-up and sample concentration, membrane ultrafiltration).

Bibliography

I.N. Levine, "*Physical Chemistry*", McGraw Hill, NY, 1995, ISBN:0-07-113472-7
D.G. Peters, J.M. Hayes and G.M. Hieftje "*Chemical Separations and Measurements*" W.B. Saunders, 1974, ISBN:0-7216-7203-5
F.Rouessac & A. Rouessac "*Chemical Analysis*" John Wiley, 2000, 0-471-97261-4
D.A. Skoog & J.J.Leary "*Principles of Instrumental Analysis*" 4th Edition, Saunders, 1992, ISBN: 0-03-023343-7

Access Conditions and Attendance Excuse

The student must register for taking this course unit. No minimum attendance is required.

Conditions for Exam Admission

Just have registered for taking the exam.

Evaluation Method

Assessment is based on the outcome of a final examination (at the end of the semester). A grade of 10/20 or more is required to get a pass. Exams will be held on 25th June, 8th July and 10th September.

Conditions for Results Improvement

No grade appeal procedure is contemplated. Grade improvement is possible by retaking the exam (either in July or September).

Date	**Signature of the lecturer responsible for the course**
04/02/2019	**Luis Jorge Assunção Martins**