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Hello dear participant,

In this document you will find everything you need to know about the classes, round tables and workshops that you will attend in this summer course. You will find a short description of what will happen in each class and the effect expected by each one. For a better preparation for all the classes, we provide the bibliography recommended by professors.

I hope you have a good read. See you in August, 23.

Your Academic Responsible of Summer Course 2016,
Sílvia Reis

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Name of activity	Medical devices
Number of working hours	1hour and 30minutes
Type of activity	Lecture
Lecturer	António Ramos
Short summary of content	This lecture aims to introduce the students to the medical devices area in general and after in devices for orthopedics applications. The introduction of medical devices is focused on the classification according two main classifications, the European with CE mark and the American classification with FDA rules. Other important topic of the lecture is the development process of biomechanical device. This includes the steps to start with the idea until to the market, including the different phases and the responsibilities until reach the market. Finally, some examples will be presented of development in Biomechanics research group in medical devices in different development stages.
Bibliography	• Karen Becker Witkin, Clinical Evaluation of Medical devices, Humana Press, Totowa, New Jersey, 1998 • Van C. Mow, Wilson C. Hayes , Basic Orthopaedic Biomechanics, Publisher: Lippincott Williams & Wilkins Publishers; 2nd edition (1997); • D. A. WINTER, The biomechanics and motor control of human gait: Normal, elderly and pathological, University of Waterloo Press, 1991.
Expected effect	At the end of this lecture the student should understand the area of biomechanical devices, the importance of factors that influence the performance of the implant and the development of biomechanical device from idea to have a finished product. And finally classify the different types of medical devices according different countries.

Name of activity	Fiber optic sensors for biomechanical applications
Number of working hours	1 hour and 30 minutes
Type of activity	Lecture
Lecturer	Paulo Roriz
Short summary of content	In this class, a lecture about fiber optic sensors for biomechanical applications is addressed. Firstly, is present an overview of the fiber optical systems. In the particular case of fiber optic sensors, the properties and drawbacks are first discussed, followed by an brief exposition of the story of these sensors. The first part of the lecture ends with a discussion about the working principles of the fiber sensors. In the second part of the lecture, some of the biomechanical applications of these sensors are present. Among these applications one counts: applications for position and displacement measurements, strain and force measurements, and pressure measurements. Finally, the class ends with some final remarks about the topic.
Bibliography	• Roriz, P., Frazão, O., Lobo-Ribeiro, A., Santos, J., & Simões, J. (2013). Review of fiber optic pressure sensors for biomedical and biomechanical applications. Journal of Biomedical Optics, 18(5), 1-18. • Roriz, P., Carvalho, L., Frazão, O., Santos, J. L., & Simões, J. A. (2014). From conventional sensors to fibre optic sensors for strain and force measurements in biomechanics applications: A review. Journal of Biomechanics, 47(6), 1251-1261
Expected effect	At the end of this lecture the student should understand the main properties, advantages and drawbacks of fiber optic sensors for biomechanical applications. Should to know the main components of a fiber optic system and main working principles of fiber optic sensors, namely, for position, strain, force and pressure measurements. And finally become familiar with biomechanics research in the field through the examples that will be presented and discussed.

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Name of activity	Biophysical stimulation for bone remodeling
Number of working hours	1 hour and 30 minutes
Type of activity	Lecture
Lecturer	Marco Santos
Short summary of content	This lecture aims to introduce the student to the principles and applications of biophysical stimulation of bone cells and tissues. The content will be focused on analyzing: the biophysical phenomena governing bone growth and remodelling; physical signals stimulating bone cells and tissues and biophysical stimulation systems used to prevent or reverse musculoskeletal conditions.
Bibliography	• Stephen C. Cowin. Bone Mechanics Handbook, 2nd edition, CRC Press. • Jitendra Behari. Biophysical Bone Behavior, John Wiley & Sons. • William R. Thompson, Clinton T. Rubin, Janet Rubin. Mechanical regulation of signaling pathways in bone, Gene 503 (2012) 179-193. • Frédéric Padilla, Regina Puts, Laurence Vico, Kay Raum. Stimulation of bone repair with ultrasound: A review of the possible mechanic effects, Ultrasonics 54 (2014) 1125-1145. • Christian Schmidt, Ulf Zimmermann, Ursula van Rienen. Modeling of an Optimized Electrostimulative Hip Revision System Under Consideration of Uncertainty in the Conductivity of Bone Tissue, IEEE Journal of Biomedical and Health Informatics 19 (2015) 1321-1330.
Expected effect	Students are expected to recognize the potential of non-pharmacologic strategies based on biophysical stimulation for the treatment and prevention of musculoskeletal conditions.

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Name of activity	Biomechanics of Movement using VICON motion capture systems
Number of working hours	1 hour and 30minutes
Type of activity	Lecture/Tutorial
Lecturer	Mário Rodrigues
Short summary of content	This introductory class is designed to allow students to engage with the interactive technology of motion capture, AMTI forces platforms and EMG (Electromyography) in Human Movement Laboratory in ESSUA/UA. Motion Capture is the process of recording a live motion event and translating it into usable mathematical terms by tracking a number of key points in space over time and combining them to obtain a single 3D representation of the performance. MoCap is sampling and recording motion of humans, animals, and inanimate objects as 3D data. The data can be used to study motion or to give an illusion of live to 3D computer models. The Human Movement Laboratory is an I & D cross disciplinary effort whose mission is to develop and improve the core technologies for human motion modelling, simulation, analysis, and visualization of natural and synthetic behaviour. The research mission is optimizing the effectiveness of methodologies for the analysis of human motor pattern control. Conduct basic research into the biomechanics and animation of normal and abnormal motion.
Bibliography	• http://www.organicmotion.com/life-sciences/ • http://www.vicon.com • http://www.amti.biz • http://www.myon-prophysics.ch
Expected effect	At the end of classroom, the student should recognize all the process involved in analysis of gait biomechanics and its capture, using motion capture technology.

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Name of activity	Biomaterials, Processing, Properties and Applications
Number of working hours	1 hour and 30 minutes
Type of activity	Lecture
Lecturer	José M.F. Ferreira
Short summary of content	This lecture aims at conveying to the students the main types of materials (ceramics, glasses, metals, polymers, composites) used in different biomedical applications. Emphasis will be given on their relevant properties that justify their specific uses in this field, and especially, to the interdependent relationships within the important triangle Processing, Properties and Applications. The biomaterials will be classified according to their types of interactions with living tissues (bio-inert, bio-active, bio-resorbable). Examples will be given on how they can be applied in tissue engineering and regeneration to restore body functions.
Bibliography	• Biomaterials Science – An Introduction to Materials in Medicine, Ed, Buddy D. Ratner and Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Academic Press, San Diego, 1996. • Biomaterials Fabrication and Processing HANDBOOK, Ed. Paul K. Chu and Xuanyong Liu, CRC Press, Taylor & Francis Group, Boca Raton, FL 33487-2742, 2008.
Expected effect	At the end of this lecture the student should recognize the importance of biomaterials in healthcare and how the properties can be tailor made to the required applications taking into account the quality of raw materials and of processing methods.

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Name of activity	Bone cements
Number of working hours	45 minutes
Type of activity	Tutorial/Laboratory Work
Lecturer	Paula Torres
Short summary of content	Students will be involved in laboratorial tasks concerning the preparation and characterization of calcium phosphate cements for bone substitution. Two types (brushite- and apatite-based) cements will be prepared and some of their relevant properties will be evaluated.
Bibliography	• S. Dorozhkin, "Self-Setting Calcium Orthophosphate Formulations", Journal of Functional Biomaterials 2013, 4, 209-311.
Expected effect	Students will recognize the influence of the precursor powders, the setting liquid composition, and the liquid powder ratio on the properties of hardened cements.

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Name of activity	Additive manufacturing of porous scaffolds for bone regeneration by Robocasting
Number of working hours	45 minutes
Type of activity	Tutorial/Laboratory Work
Lecturer	Susana Olhero
Short summary of content	This classe aims at conveying to the student the essential concepts of additive manufacturing (AM) processes, namely of robocasting, which is an AM technique based on high concentrated and viscoelastic ceramic pastes. Being a colloidal based conformation technique, the essential concepts of colloidal processing, including dispersion of powders in liquids, the influence of the preparation conditions on rheological properties of suspensions, the coagulation of concentrated suspensions to obtain pastes high elastic modulus and their importance for robocasting, will be presented. The potentiality of AM to obtain porous scaffolds with different shapes, controlled porosity and size by using different compositions of calcium phosphate powders will be demonstrated. Finally, important applications of those scaffolds will be briefly presented, demonstrating the potential and limitations of robocasting in upcoming AM technologies for ceramics.
Bibliography	• Ian Gibson, David W. Rosen, Brent Stucker, "Additive Manufacturing Technologies- Rapid Prototyping to Direct Digital Manufacturing, ISBN: 978-1-4419-1119-3, Springer, 2010. • Joseph Cesarano (1998). A Review of Robocasting Technology. MRS Proceedings, 542, 133, 1998. doi:10.1557/PROC-542-133. • J. G. Dellinger, J. C. Iii, and R. D. Jamison, "Robotic deposition of model hydroxyapatite scaffolds with multiple architectures and multiscale porosity for bone tissue engineering," J. of Biomedical Materials Research, 383-394, 2007.
Expected effect	At the end of this lecture the student should understand the advantages of additive manufacturing techniques, in particular in fabrication of porous ceramic devices, when compared to other techniques. Basic concepts of colloidal processing should be also apprehended.

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Name of activity	Glasses, Processing, Properties and Applications
Number of working hours	1 hour and 30 minutes
Type of activity	Lecture
Lecturer	Hugo Fernandes
Short summary of content	This lecture aims to introduce the student to glass science and technology, with emphasis to glass structure and properties. The crystallization of glasses will also be addressed to explain how glass-ceramic materials are obtained. Diverse glass systems will be presented in order to illustrate how materials' chemistry and processing have a great influence on the unique properties featured by glasses and glass-ceramics. Finally, important applications of glasses and glass-ceramics will be briefly presented, demonstrating their potential and limitations in diverse technologies.
Bibliography	• James E. Shelby, Introduction to Glass Science and Technology, The Royal Society of Chemistry, 2005; • Wolfram Höland, George H. Beall, Glass Ceramic Technology, 2nd Edition, Wiley, 2012.
Expected effect	At the end of this lecture the student should recognize the importance of glass science and technology in all aspects related to the synthesis, properties and applications of these materials and their great importance and impact in our daily life.

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Name of activity	Preparation of bioactive glasses by melting
Number of working hours	45 minutes
Type of activity	Tutorial/Laboratory Work
Lecturer	Hugo Fernandes
Short summary of content	In this class the student will follow the procedure used to produce glass at laboratory scale by melt-quenching technique and will have the opportunity to see the glass melting and casting.
Bibliography	• Hugo R. Fernandes, Dilshat U. Tulyaganov, Maria J. Pascual, José M.F. Ferreira, "Structure–property relationships and densification-crystallization behaviours of simplified lithium disilicate glass compositions", Ceramics International 40 (2014) 129–140; • James E. Shelby, Introduction to Glass Science and Technology, The Royal Society of Chemistry, 2005.
Expected effect	After this practical class the student should understand the several steps of glass synthesis as well as the different ways to get a glassy material using the melt-quenching technique (i.e. bulk monolithic glass and frits).

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Name of activity	Preparation of granular bone filling materials
Number of working hours	45 minutes
Type of activity	Laboratory Work
Lecturer	Paula Torres
Short summary of content	Students will participate in the preliminary experimental tasks related to the dispersion of calcium phosphate powders to obtain a high solid loading suspension, the mixing of the as obtained suspension with a gelling agent to obtain mixed slurry. Dropping the mixed slurry in a setting ionotropic solution will then then lead to the formation of spherical granules with sizes suitable for bone filling applications.
Bibliography	• Digest Journal of Nanomaterials and Biostructures Vol. 5, No 1, March 2010, p. 241 – 248. • International Journal of Pharmacy and Pharmaceutical Sciences, Vol 4, Suppl 4, 2012.
Expected effect	Students will have the opportunity to recognize the effects of the slurry flow rate, the pressure of spraying compressed air and of the nozzle diameter on the size and morphology of the granules.

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Name of activity	Positron Emission Tomography (PET) systems
Number of working hours	1 hour and 30 minutes
Type of activity	Lecture
Lecturer	Filipe Castro
Short summary of content	The PET scanner is the medical imaging instrument of election for early detection of cancer and respective control throughout and after treatments. This functional imaging system, with a sensitivity on the molecular level, allows also to study brain function and evaluate neurodegenerative conditions. Today, preclinical PET systems for small animal imaging have also a fundamental role in the study and development of new pharmaceuticals and therapies for cancer treatment. During this activity the following subjects will be explored: the principle of PET imaging, the clinical usefulness of imaging the biodistribution of radionuclides connected to different molecules, and finally the working principle of a PET system, using a small didactic PET system developed at the University of Aveiro.
Bibliography	• D. Bailey, J. Karp, S. Surti (2005) Physics and Instrumentation in PET, In D. Bailey, D. Townsend, P. Valk, M. Maisey (eds), Positron Emission Tomography: Basic Sciences. Springer, London, pp 13-39. • P. Slomka, T. Pan, G. Germano (2016) Recent Advances and Future Progress in PET Instrumentation. Seminars in Nuclear Medicine 46, pp 5-19.
Expected effect	The students shall become acquainted with science of PET imaging and its clinical uses.

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Name of activity	Positron Emission Tomography (PET) systems
Number of working hours	1 hour and 30 minutes
Type of activity	Tutorial/Laboratory Work
Lecturer	Filipe Castro
Short summary of content	By observing and interacting directly with a didactic PET system they are expected to better understand the physical and technological principles behind PET imaging. In this session the participants will have the opportunity to observe and interact with this system, producing images of positron emitting sources and evaluating the impact of different PET acquisition parameters in the resulting image.
Bibliography	• D. Bailey, J. Karp, S. Surti (2005) Physics and Instrumentation in PET, In D. Bailey, D. Townsend, P. Valk, M. Maisey (eds), Positron Emission Tomography: Basic Sciences. Springer, London, pp 13-39. • P. Slomka, T. Pan, G. Germano (2016) Recent Advances and Future Progress in PET Instrumentation. Seminars in Nuclear Medicine 46, pp 5-19.
Expected effect	The students shall become acquainted with science of PET imaging and its clinical uses.

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Name of activity	Learning Computed Tomography
Number of working hours	1 hour and 30 minutes
Type of activity	Lecture
Lecturer	Lara Carramate
Short summary of content	The activity introduces the student to the computed tomography imaging modality. It will be focused the physical principle of X-ray computed tomography, its work principle and the type of information that can be obtained. Other addressed topics are basic concepts of image reconstruction, possible image artefacts and their origins.
Bibliography	• T. M. Buzug, "Computed Tomography: from Photon Statistics to Modern Cone-Beam CT", Springer-Verlag, 2008. • J. Hsieh, "Computed tomography: principles, design, artifacts, and recent advances", SPIE & Jonh Wiley & Sons, Inc., 2009.
Expected effect	The activity envisages to give the student an overview of the computed tomography imaging modality, with an understanding of its physical principles, image reconstruction, possible artefacts and technology.

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Name of activity	Learning Computed Tomography
Number of working hours	1 hour and 30 minutes
Type of activity	Tutorial/Laboratory Work
Lecturer	Lara Carramate
Short summary of content	The practical activity will include image analysis using adequate software. An introduction to the software tools will be done and, then, demonstrations followed by some practical exercises concerning image reconstruction and/or analysis will be performed.
Bibliography	• T. M. Buzug, "Computed Tomography: from Photon Statistics to Modern Cone-Beam CT", Springer-Verlag, 2008. • J. Hsieh, "Computed tomography: principles, design, artifacts, and recent advances", SPIE & Jonh Wiley & Sons, Inc., 2009.
Expected effect	The activity envisages to give the student an overview of the computed tomography imaging modality, with an understanding of its physical principles, image reconstruction, possible artefacts and technology.

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Name of activity	BITalino: Welcome to the biosignals (r)evolution
Number of working hours	2 hours
Type of activity	Workshop
Lecturer	PLUX - Wireless Biosignals, S.A. (Hugo Silva)
Short summary of content	Physiological data has had a transforming role on multiple aspects of society, which goes beyond the health sciences domains to which they were traditionally associated with. While biomedical engineering is a classical discipline where the topic is amply covered, today physiological data is a matter of interest for students, researchers and hobbyists in areas ranging from arts, programming, engineering, among others. Regardless of the context, the use physiological in experimental activities and practical projects is heavily bounded by the cost and limited access to adequate support materials. In this workshop we will get hands-on with BITalino, a versatile toolkit composed of low-cost hardware and software, and created to enable anyone to build cool projects and applications involving physiological data. The hardware consists of a modular wireless biosignal acquisition system that can be used to acquire data in real time, interface with other devices (e.g. Arduino or Raspberry PI), or perform rapid prototyping of end-user applications. The software comprehends a set of programming APIs, a biosignal processing toolbox, and a framework for real time data acquisition and postprocessing.
Bibliography	• H.Silva, A.Lourenço, A.Fred, R.Martins, "BIT: Biosignal Igniter Toolkit", computer methods and programs in biomedicine 2014, 115, p.20-32. • H.Silva, A.Fred, R.Martins, "Biosignals for Everyone", Feature: biomedical and engineering, University of Lisbon. • http://bitalino.com
Expected effect	The workshop aims to give students an overview of anatomy of a BITalino and show them how to collect and what to extract from each signal. The students should be able to identify different biosignal-based applications. They shall become acquainted with hardware and software previously named.

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Name of activity	Experimental methods in the evaluation of distress in human femoral hinges (knee and metatarsus) under axial load and transverse vibrations
Number of working hours	1 hour and 30 minutes
Type of activity	Round Table
Lecturer	Francisco Queirós de Melo
Short summary of content	Workers developing their activity in some hard tasks involving walking or simply standing on vibrating platforms, like large engines or some mining equipment are exposed to the harsh mechanical actions at the knee and metatarsus hinges interfaces. The persistence of such actions render the hinge interface tissues vulnerable to internal damage of cartilage and circulating vases. It is very important to characterize the dynamic effect of such actions. One important fact assigned to the transverse vibration of a femoral bone, like a structural beam, is that the axial force (resulting from the self weight and eventually from the transport of heavy objects) reduces the value of eigenfrequencies and increases the associated amplitude, which is hazardous to the hinge comfort. The discussion could be outlined in the behalf of the problem of subjecting our legs to the action of dynamic transverse loads while we have to stand and transmit our weight and in addition, the similar effect of carrying heavy objects.
Bibliography	Not applicable.
Expected effect	The audience should be able to discuss about how could we study the described load mode and the effect on the bone bio-structure.

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Name of activity	Assessment of Movement Disorder Patients based on Motion Analysis
Number of working hours	1 hour and 30 minutes
Type of activity	Round Table
Lecturer	Ana Rocha
Short summary of content	Movement disorders, such as Parkinson's disease and epilepsy, are often characterized by abnormal and/or involuntary movements. An accurate assessment of the patient's motor function is therefore of utmost importance not only for an early diagnosis, but also for providing the best possible treatment during the course of the disease. However, the assessment of movement disorder still relies mostly on subjective methods that consist on (in)direct observation of the patients' symptoms by the physicians. A more objective motor assessment based on motion analysis can be introduced in clinical practice by using affordable sensors available to everyone today (e.g., accelerometers, gyroscopes, and RGB-D cameras such as the Microsoft Kinect), with the aim of helping the physicians' in their decision regarding diagnosis and/or the best treatment for the patient.
Bibliography	• P. Rocha, H. Choupina, J. M. Fernandes, M. J. Rosas, R. Vaz, and J. P. S. Cunha, "Parkinson's disease assessment based on gait analysis using an innovative RGB-D camera system," in Annu. Int. Conf. of the IEEE Eng. in Medicine and Biol. Soc. (EMBC), Chicago, IL, USA, 2014, pp. 3126 - 3129. • P. Rocha, H. Choupina, J. M. Fernandes, M. J. Rosas, R. Vaz, and J. P. S. Cunha, "Kinect v2 based system for Parkinson's disease assessment," in Annu. Int. Conf. of the IEEE Eng. in Medicine and Biol. Soc. (EMBC), Milan, Italy, 2015, pp. 1279-1282. • J. P. S. Cunha, H. M. P. Choupina, A. P. Rocha, J. M. Fernandes, F. Achilles, A. M. Loesch, et al., "NeuroKinect: A novel low-cost 3Dvideo-EEG system for epileptic seizure motion quantification," PLoS One, vol. 11, p. e0145669, Jan. 2016.

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Expected effect	In this round table, an overview of the possible applications of sensors in healthcare will be presented, with a greater focus on the use of vision-based sensors for motion analysis in movement disorders. As a result of this round table, the participants should be able to identify the different types of available sensors, including their main advantages and disadvantages, as well as the main methods for vision-based human motion analysis.

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Name of activity	Surf Biomechanics: Development of sensors to evaluate surf in the ocean
Number of working hours	1 hour and 30 minutes
Type of activity	Round Table
Lecturer	Pedro Fonseca e Márcio Santos
Short summary of content	"When you can measure what you are speaking about, and express it in numbers, you know something about it. When you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely, in your thoughts. Advanced it to the stage of science." William Thomson, 1st Baron Kelvin (1824 – 1907) The first scientific investigations in the surfing world are faced with a classic difficulty in the world of science, the measure without interfering. The marine environment is extremely hostile to the electronic components, currently our largest source of obtaining quantitative information. The AllinSurf arose from a doctoral project, where the surf was investigated in a controlled environment. Researches were conducted in the laboratory, focusing in general performance analysis of physical activity and simulated surfing movements, as in pools equipped with the best in the context of biomechanical analysis. The real challenge came when there was the possibility of leaving the controlled environment, to be present in the true surf practice environment, the sea. We managed to gather a set of measuring sensors in one device, the "All in One Surf", our acquisition of aquatic navigation data system. This made possible for the first time quantify information that until now were subjective. We started well, evaluating the best surfer of giant waves in the world, Sebastian Steudtner, surfing in extreme conditions, the giant waves of Nazaré – Portugal, with registered vacancies with more than 30 meters high. Our mission today is to maximize the effectiveness of measures and facilitate the practical application of best available evidence, always looking for the improvement of sports, either through improved

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	training, building materials, equipment and everything that is involved with the sports activities of slide water.
Bibliography	• Alcantara, C. P. A., Prado, J. M., & Duarte, M. (2012). Analysis of the balance control in surfers during the erect posture. Revista Brasileira de Medicina do Esporte, 18(5), 318-321 • Barlow, M. J., Gresty, K., Findlay, M., & Cooke, C. (2015). Associations of Power at V̇O2peak and Anaerobic Threshold with Rank in British High Performance Junior Surfers. Human Movement,16(1), 28-32
Expected effect	The audience should be able to discuss about the topic presented.

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Name of activity	Project Work
Number of working hours	3 hours
Type of activity	Project Work
Lecturer	Professors responsible for the academic content of the Course
Short summary of content	During this time, the students will have the opportunity to work on their final project. The professors will be there to supervise and clarify any doubt the students may have.
Bibliography	Not applicable.
Expected effect	The students are expexted to progress on their projects.

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Name of activity	Projects evaluation
Number of working hours	3 hours
Type of activity	Evaluation
Lecturer	Professors responsible for the academic content of the Course
Short summary of content	During this time, the projects developed by the students throughout the course will be presented and evaluated.
Bibliography	Not applicable.
Expected effect	The students will improve their ability to communicate in English. They should be able to accompain the projects presented by the colleagues

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