<table>
<tr><td>Course Title</td><td colspan="5">Apply Biomechanics – Health and performance</td></tr>
<tr><td>Course Code</td><td colspan="5">DLSEH522</td></tr>
<tr><td>Course type</td><td colspan="5">Compulsory</td></tr>
<tr><td>Level</td><td colspan="5">Master</td></tr>
<tr><td>Year / Semester of study</td><td colspan="5">1st / 2nd</td></tr>
<tr><td>Teacher's Name</td><td colspan="5"></td></tr>
<tr><td>ECTS</td><td>10</td><td>Lectures / week</td><td></td><td>Laboratories/week</td><td></td></tr>
<tr><td>Course Purpose</td><td colspan="5">The course seeks to familiarize students with the principles and techniques of biomechanics in order to improve performance and health and prevent injuries. It covers motion analysis, dynamometry, electromyography, clinical gait analysis, and applied sports movement analysis. In addition, it includes the introduction to musculoskeletal modeling and familiarization with relevant software. The aim is to transfer theory into practical applications in sports and clinical practice.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">Upon successful completion of the course, students will be able to:

● They formulate the most basic principles and laws in the field of biomechanics.
● They separate the branches of kinematics and kinetics.
● They contrast modern kinematic and kinetic analysis techniques used in the field of applied biomechanics.
● Demonstrate a comprehensive understanding of the process of recording, analyzing, presenting and interpreting kinematic and motor parameters in various activities.
● Justify the usefulness of supporting methods and biomechanical analysis techniques (e.g. isokinetic dynamometry, electromyography).
● They correlate biomechanical factors related to improving performance, preventing musculoskeletal injuries and maintaining health.
● They explain how the mechanical properties of biological tissues respond to external and internal forces.
● Demonstrate the critical ability to combine theoretical knowledge and technical skills to justify factors that influence the technique of various sports skills or are associated with pathological conditions and musculoskeletal injuries.
● They document how applied biomechanics can be combined with other scientific disciplines of sports science and medicine to improve athletic performance and protect health.</td></tr>
</table>

	They describe the biomechanics of basic joints of the human body (shoulder, elbow, wrist, hip, knee, and ankle).		
Prerequisites		Corequisites	
Course Content	**Unit 1:** Kinematics	In the 1st unit, students will initially understand the two main branches of Biomechanics, which are Kinematics and Kinetics. This will be followed by an overview of the main kinematic analysis techniques. There will be a detailed presentation of the principles and methodology followed in two-dimensional (2-D) and three-dimensional (3-D) analysis of motion. In addition, a brief reference will be made to motion analysis using Inertial Measurement Units (IMUs) and advanced kinematic analysis techniques in which markerless motion capture technologies are not required. Finally, the module will be completed with familiarization and practical training of students with open access software of two-dimensional (2-D) kinematic analysis (Kinovea).	
	Unit 2: Kinetics	The 2nd unit entitled "Kinetics" will initially include an overview of the main kinetic analysis techniques and then will focus on the methodology of recording and analyzing ground reaction forces using a dynamofloor. Applications of the above methodology in basic motor activities related to both health and athletic performance will be presented, including walking, running, vertical jumping and landing. Next, students will learn how the reaction forces of the ground are combined with the kinematic parameters recorded with techniques taught in the 1st unit, in order to achieve the calculation of moments and forces through inverse dynamics (Inverse Dynamics). The next objective of the 2nd unit will be the practical training of students in the analysis of dynamofloor data during walking and vertical jumping, by applying Microsoft Excel software. Subsequently, students will be taught the methodology for assessing balance and plantar pressures using a dynamo floor and a foot scanner, respectively. The 2nd module will conclude with students understanding the construction steps and the use of orthotic insoles in the treatment of pathological conditions and in maintaining the health of the foot.	
	Module 3: Supporting methods and techniques of biomechanical analysis	This unit will teach methods and technical approaches that cannot be integrated entirely into the field of kinematics or kinetics, but act as a support and complement to them. Initially, the biomechanical and physiological principles of isokinetic dynamometry (Isokinetic dynamometry I) will be presented. As part of this presentation, students will acquire the basic theoretical background regarding the production and evaluation of force. They will be taught the mechanical properties of the biological materials of the myotendon system and the role that muscle architecture plays in force production. Following the 3rd section, there will be a thorough presentation of the methodology for measuring and evaluating muscle function with an isokinetic dynamometer (Isokinetic dynamometer II). Measurement errors will be analyzed and applications of isokinetic dynamometer in	

		performance evaluation and injury prevention and rehabilitation will be presented. This will be followed by a discussion with the students regarding the creation and interpretation of reports of isokinetic dynamometry results. The 3rd module will conclude with a presentation of applications of electromyography (EMG) in the study of human movement.
	Module 4: Applied biomechanical analysis in everyday activities and sports	The 4th module will focus on the applied biomechanical analysis of daily activities (related to health) and specialized sports movements. Initially, there will be an introductory presentation of gait analysis (normal and pathological) and running. This will be followed by an interactive lecture on the methodology of recording and analyzing motion with the simultaneous use of a three-dimensional (3-D) optoelectronic system, load plates and EMG. Specifically, by applying the Vicon Nexus software, students will become familiar with a) the patterns of walking and running in healthy populations, b) with the biomechanics of specialized sports movements (e.g. landing, changing direction, kicking in football, strengthening exercises with external resistance). Then, an interactive training will take place in the analysis and presentation of kinematic and kinetic data of the optoelectronic system using the Vicon Polygon & Procalc software, while a brief overview of the free OpenCap software for motion analysis using smart mobile devices will be included. The 4th module will conclude with an introduction to musculoskeletal modeling and simulation, where there will be a brief overview of free software such as OpenSim and Scone.
Teaching Methodology	The course is structured and developed based on the principles of distance learning, good practices as well as the guidelines of the Evaluation Body and finally the Pedagogical Framework developed and implemented by our University. Also, through the design and development of distance learning courses, synchronous and asynchronous interaction, communication and collaboration are taken into account at 3 levels: 1) between instructor and student, 2) between students, and 3) between students and content. The course is taught entirely online through the electronic platform Moodle LMS. Mandatory, optional and additional bibliography (e.g. books, articles, links, open educational resources, case studies) in combination with notes, course presentations and suggestions for reading study (bibliography) are available to students through an electronic platform. Also, a variety of appropriate educational material is given through the online platform in the form of presentations with notes, presentations with narration, interactive presentations and videos, interactive learning scenarios, gamification activities, avatars, digital twins, audio files, online quizzes). Various online tools, new and emerging technologies are being exploited: communication tools (e.g. video conferencing, chat rooms), collaboration tools (e.g. discussion forums, blogs, wikis), as well as content development tools. Students are encouraged through the platform and various technological tools to interact with their fellow students and the instructor, in order to become active members of the online learning community created within the framework of the course. Finally, with the use of various technological tools, each student is expected to create his own online learning community. More information about distance learning at Frederick University, the Pedagogical	

<table>
<tr><td></td><td colspan="2">Background developed and implemented, as well as the toolkit used, can be found at the following link.

About Distance Learning - Frederick University</td></tr>
<tr><td>Bibliography</td><td>Week 1
- 2 -
UNIT 1</td><td>Mandatory Bibliography

Book chapters (International Bibliography)

● Richards, J. (2018). Motion and Joint Motion. In The Comprehensive Textbook of Clinical Biomechanics (pp. 79-103): Elsevier Health Sciences.
● Richards, J. (2018). Methods of Analysis of Movement. In The Comprehensive Textbook of Clinical Biomechanics (pp. 156-179): Elsevier Health Sciences.

Book chapters (Greek Bibliography)

● Kellis, E. (2015). Chapter 2: Principles of Kinematic Analysis. In Sports Biomechanics (pp. 31-54): Greek Academic Electronic Textbooks and Aids.
● Kellis, E. (2015). Chapter 3: Kinematic Analysis Methods. In Sports Biomechanics (pp. 55-81): Greek Academic Electronic Textbooks and Aids.

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● Balsalobre-Fernández, C., Tejero-González, C. M., Campo-Vecino, J. D., & Bavaresco, N. (2014). The concurrent validity and reliability of a low-cost, high-speed camera-based method for measuring the flight time of vertical jumps. Journal of Strength and Conditioning Research, 28(2), 528-533. doi:10.1519/JSC.0b013e318299a52e
● Fernández-González, P., Koutsou, A., Cuesta-Gómez, A., Carratalá-Tejada, M., Miangolarra-Page, J. C., & Molina-Rueda, F. (2020). Reliability of kinovea® software and agreement with a three-dimensional motion system for gait analysis in healthy subjects. Sensors (Switzerland), 20(11). doi:10.3390/s20113154
● Hughes, G. T. G., Camomilla, V., Vanwanseele, B., Harrison, A. J., Fong, D. T. P., & Bradshaw, E. J. (2021). Novel technology in sports biomechanics: some words of caution. Sports Biomechanics. doi:10.1080/14763141.2020.1869453
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</table>

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Digital Multimedia Material

- Simple presentations in PowerPoint format by the instructor:

- Kinematic Analysis of Motion.

		• Practice with Open Access Software of Two-Dimensional (2-D) Kinematic Analysis (Kinovea). - Video lecture of the 1st week teleconference. - Interactive presentation & videos of the 2nd week. - Link & User Guide for Kinovea: https://www.kinovea.org/help/en/# -Video tutorials on Kinovea: https://www.youtube.com/@kinovea
	Week 3 - 5 - UNIT 2	**Mandatory Bibliography** Book chapters (International Bibliography) • Richards, J. (2018). Forces, Moments and Muscles. In *The Comprehensive Textbook of Clinical Biomechanics* (pp. 24-44): Elsevier Health Sciences. • Richards, J. (2018). Ground Reaction Forces and Plantar Pressure. In *The Comprehensive Textbook of Clinical Biomechanics* (pp. 45-78): Elsevier Health Sciences. • Richards, J. (2018). Measurement of Force and Pressure. In *The Comprehensive Textbook of Clinical Biomechanics* (pp. 138-155): Elsevier Health Sciences. Book chapters (Greek Bibliography) • Kellis, E. (2015). Chapter 4: Principles of Kinetic Analysis. In *Sports Biomechanics* (pp. 82-105): Greek Academic Electronic Textbooks and Aids. • Kellis, E. (2015). Chapter 5: Kinetic Analysis Methods. In *Sports Biomechanics* (pp. 106-126): Greek Academic Electronic Textbooks and Aids. Linage: • Bishop, C., Jordan, M., Torres-Ronda, L., Loturco, I., Harry, J., Virgile, A., . . . Comfort, P. (2023). Selecting Metrics That Matter: Comparing the Use of the Countermovement Jump for Performance Profiling, Neuromuscular Fatigue Monitoring, and Injury Rehabilitation Testing. *Strength and Conditioning Journal, 45*(5), 545-553. doi:10.1519/SSC.0000000000000772 • Chavda, S., Bromley, T., Jarvis, P., Williams, S., Bishop, C., Turner, A. N., . . . Mundy, P. D. (2018). Force-time characteristics of the countermovement jump: Analyzing

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Digital Multimedia Material

- Simple presentations in PowerPoint format by the instructor:

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<tr><td></td><td></td><td>

A) Recording and Analysis of Ground Reaction Forces using a Dynamofloor, B) Calculation of Moments and Forces through Inverse Dynamics.
Practical Training in the Analysis of Ground Reaction Forces during Walking and Vertical Jumping using Microsoft Excel software.
A) Assessment of Balance and Plantar Pressures using Dynamofloor and Foot Scanner, B) Orthotic Insoles

- Video lecture of the 3rd week teleconference.

- Interactive presentation & video of the 4th week.

- A narrated presentation by the instructor for the 5th week.
</td></tr>
<tr><td></td><td>Week 6 - 8 - UNIT 3</td><td>
Mandatory Bibliography
<u>Book chapters (International Bibliography)</u>

Baltzopoulos, V. (2017). Isokinetic dynamometry. In Biomechanical evaluation of movement in sport and exercise (pp. 140-167): Routledge.
Richards, J. (2018). Electromyography. In The Comprehensive Textbook of Clinical Biomechanics (pp. 208-239): Elsevier Health Sciences.

<u>Book chapters (Greek Bibliography)</u>

Kellis, E. (2015). Chapter 6: Neuromuscular activation and electromyography. In Sports Biomechanics (pp. 127-149): Greek Academic Electronic Textbooks and Aids.
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Babakhani, F., Hatefi, M., & Balochi, R. (2023). Is there a relationship between isometric hamstrings-to-quadriceps torque ratio and athletes’ plyometric performance? PLoS ONE, 18(11 November). doi:10.1371/journal.pone.0294274
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Digital Multimedia Material
- Simple presentations in PowerPoint format by the instructor:

Isokinetic dynamometry I.
Isokinetic dynamometry II.
Applications of Electromyography (EMG) in the study of Human Movement.

- Video lecture of the teleconference of the 7th week.

- Two narrated presentations by the instructor for weeks 6 and 8.
</td></tr>
<tr><td>Week 9 - 12 - UNIT 4</td><td>
Mandatory Bibliography
<u>Book chapters (International Bibliography)</u>

Richards, J. (2018). Anatomical Models and Marker Sets. In The Comprehensive Textbook of Clinical Biomechanics (pp. 180-207): Elsevier Health Sciences.
Uchida, T. K., &; Delp, S. L. (2020). Biomechanics of Movement. The Science of Sports, Robotics, and Rehabilitation: THE MIT PRESS

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		Book chapters (Greek Bibliography) ● Kellis, E. (2015). Chapter 9: Walking and Running. In *Sports Biomechanics* (pp. 200-226): Greek Academic Electronic Textbooks and Aids. ● Kellis, E. (2015). Chapter 11: Team Sports. In *Sports Biomechanics* (pp. 268-294): Greek Academic Electronic Textbooks and Aids. Linage: ● Camomilla, V., Cereatti, A., Cutti, A. G., Fantozzi, S., Stagni, R., & Vannozzi, G. (2017). Methodological factors affecting joint moments estimation in clinical gait analysis: A systematic review. *BioMedical Engineering Online, 16*(1). doi:10.1186/s12938-017-0396-x ● Delp, S. L., Anderson, F. C., Arnold, A. S., Loan, P., Habib, A., John, C. T., . . . Thelen, D. G. (2007). OpenSim: Open-source software to create and analyze dynamic simulations of movement. *IEEE Transactions on Biomedical Engineering, 54*(11), 1940-1950. doi:10.1109/TBME.2007.901024 ● Fukuchi, C. A., Fukuchi, R. K., & Duarte, M. (2018). A public dataset of overground and treadmill walking kinematics and kinetics in healthy individuals. *PeerJ, 2018*(4). doi:10.7717/peerj.4640 ● Fukuchi, C. A., Fukuchi, R. K., & Duarte, M. (2019). Effects of walking speed on gait biomechanics in healthy participants: A systematic review and meta-analysis. *Systematic Reviews, 8*(1). doi:10.1186/s13643-019-1063-z ● Fukuchi, R. K., Fukuchi, C. A., & Duarte, M. (2017). A public dataset of running biomechanics and the effects of running speed on lower extremity kinematics and kinetics. *PeerJ, 2017*(5), 3298. doi:10.7717/peerj.3298 ● Hart, H. F., Culvenor, A. G., Collins, N. J., Ackland, D. C., Cowan, S. M., Machotka, Z., & Crossley, K. M. (2016). Knee kinematics and joint moments during gait following anterior cruciate ligament econstruction: A systematic review and meta-analysis. *British Journal of Sports Medicine, 50*(10), 597-612. doi:10.1136/bjsports-2015-094797 ● Hewett, T. E., Myer, G. D., Ford, K. R., Heidt Jr, R. S., Colosimo, A. J., McLean, S. G., . . . Succop, P. (2005).

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Exercise-Induced Muscle Damage. *Sports, 9*(2). doi:10.3390/sports9020024

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- Al Borno, M., O’Day, J., Ibarra, V., Dunne, J., Seth, A., Habib, A., . . . Delp, S. (2022). OpenSense: An open-source toolbox for inertial-measurement-unit-based measurement of lower extremity kinematics over long durations. *Journal of NeuroEngineering and Rehabilitation, 19*(1). doi:10.1186/s12984-022-01001-x
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Digital Multimedia Material

- Simple presentations in PowerPoint format by the instructor:

- Introduction to Gait and Running Analysis.
- Practical Training in the Combined Use of Three-Dimensional (3-D) Optoelectronic System, Load Plates and EMG, with the Vicon Nexus software.

		● Analysis and Presentation of Kinematic and Kinetic Data of the Optoelectronic System, using Vicon Polygon & Procalc software. ● Introduction to Musculoskeletal Modeling and Simulation of Movement. - Video lecture of the 10th week teleconference. - Interactive presentation & video of the 11th week. - Two narrated presentations by the instructor for weeks 9 and 12. - Link & User Guide for the Vicon Nexus: https://docs.vicon.com/display/Nexus215 - Link & User Guide to Vicon Polygon: https://docs.vicon.com/display/Polygon446 - Link & User Guide to Vicon Procalc: https://docs.vicon.com/display/ProCalc16 -Video tutorials for all software of the company Vicon: https://www.youtube.com/c/vicon - Link & user guide for OpenCap: https://www.opencap.ai/get-started - Link & user guide for OpenSim: https://simtk.org/projects/opensim - Link & User Guide for Scone: https://simtk.org/projects/scone
Assessment	The evaluation of the course includes activities of continuous / formative assessment (formative), self-evaluation (self-evaluation and debriefing / final evaluation (summative). Specifically, the evaluation of this course includes the following: final written exam, 2 evaluation assignments, 2 evaluative online interactive discussions, various weekly educational activities such as interactive activities, interactive presentations/ videos and self-assessment activities. From the above, the following are scored: • Final exam (**50%**) • 2 evaluation papers (15% + 20% = 35%) • 2 evaluation activities (7.5% + 7.5% = **15%**) All assignments (except the final exam) are assigned and delivered to the online platform, as well as a plagiarism check through the turnitin tool. The final exam is developed by the instructor and completed by the students on a special platform used exclusively for the exams.	
Language	English / Greek	