BIOM9541

Mechanics of the Human Body

Term Three // 2020

Graduate School of Biomedical Engineering // UNSW Engineering

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Matthew Brodie	a.m.brodie@unsw.edu.au	Please reach out by email to make an appointment about the current course or thesis research projects	Samuels Building (F25)	

Lecturers

Name	Email	Availability	Location	Phone
Lauren Kark	lauren.kark@unsw.edu.au	Former Convenor, please reach out to Dr Lauren Kark to discuss thesis research projects	Samuels Building (F25)	

Demonstrators

Name	Email	Availability	Location	Phone
Rachael Sharp	rachael.sharp@unsw.edu.au	Online chat through Moodle portal during T3	Samuels Building (F25)	
Kenny Wong	z5160591@unsw.edu.au	Online chat through Moodle portal during T3	Samuels Building (F25)	
Joy Guo	z5118038@unsw.edu.au	Online chat through Moodle portal during T3	Samuels Building (F25)	
Keng-Yin Lai	keng-yin.lai@unsw.edu.au	Online chat through Moodle portal during T3	Samuels Building (F25)	

School Contact Information

Student Services can be contacted via unsw.to/webforms.

Course Details

Credit Points 6

Summary of the Course

Ever wondered how Lord of the Rings or Avatar were created? Or how athletes can analyse the biomechanics of their movements to improve performance? Or about how wearable technology, phone apps and smart garments can be used to detect and analyse unstable gait patters and help with neurological conditions walk better? This course covers in depth the methods used in the analysis of the biomechanics of the musculoskeletal system. Methods to analyse body segment and joint kinematics, joint kinetics, work and power, muscle forces and associated energy cost will be covered. Applications of biomechanics in clinical, occupational and recreational areas will be presented. Highlights include access to Neuroscience Research Australia's state-of-the-art 3D motion capture lab for the MoCap laboratory sessions.

Course Aims

The aims of this course are to:
1. Introduce students to the fundamentals of anatomy and biomechanics and
2. relate these to mechanical actions to develop a deeper understanding of
the field of human movement science.
3. Develop the fundamentals of 3D motion capture, gait analysis and musculoskeletal modeling.
4. Introduce students to biomechanical analyses using data from wearable technology.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Students will be able to use mechanical principles to analyse human movement	PE1.2
2. Students will be able to design and perform experiments that evaluate human movement	PE2.1
3. Students will be able to critically analyse their experimental outcomes in the broader context	PE1.4
4. Students will be able to communicate their findings effectively using oral and written methods	PE3.2
5. Critically evaluate different types of wearable technologies used for analysing human movement	PE1.3

Teaching Strategies

Lectures will be delivered online and include concept development, problem solving and discussion sessions. These will cover the theory supporting experimental methods and the practical research problems. Laboratories and tutorials are designed to explain the concepts introduced in the online

lectures using practical approaches. These strategies are intended to support you in attaining the learning outcomes. Content, including notes and videos, will be available via Moodle. Assessments and feedback will be provided to you regularly.

Private Study	• Review lecture material and textbook • Do set problems and assignments • Join Moodle discussions of problems • Reflect on class problems and assignments • Download materials from Moodle • Keep up with notices and find out marks via Moodle
Online Lectures	• Find out what you must learn • See methods that are not in the textbook • Follow worked examples • Hear announcements on course changes
Tutorials	• Independent study • Practice solving set problems • Ask questions
Assessments (multiple choice questions, quizzes, tests, examinations, assignments, site visit reports, hand-in tutorials, laboratory reports etc.)	• Demonstrate your knowledge and skills • Demonstrate higher understanding and problem solving
Laboratory Work	• Hands-on work, to set studies in context
Feedback, reflection and discussion	• Optional Monday ZOOM catch ups • Online discussion forums • Post your feedback

Each week there will be 3-hours of learning comprising a lecture and small group exercises, MoCap and software laboratory sessions, group discussions, tutorials and other methods to facilitate student learning. The online lectures delivered through Moodle will examine the science and engineering involved in 3D motion capture, biomechanics analysis of human movement and advances in wearable technology. This will provide students with the knowledge required to solve the laboratory-based problems as well as complete assignments. Assessments and feedback on laboratory work will be regularly provided to the students. Additional course support includes online chat and discussion boards. For students in different time zones, online pre-recorded sessions will be provided for flexible learning.

Weekly Catch Up (optional). Monday 3:00pm – 3:30pm.
ZOOM. https://unsw.zoom.us/j/3615438618 Discuss the week ahead, feedback and problem solve any course related issues from chat forums.

Suggested approach to learning. This course requires you to understand the lecture material and then apply the knowledge to biomechanical applications. It is important to understand the fundamental concepts as soon as possible and to ask for help if you do not understand. Complete all the lectures and if something is unclear, please ask questions. Make sure you review lecture notes and read all material that is suggested or handed out. Class participation through attendance at tutorials, laboratories and group work is expected and will allow for alternative methods of absorbing the relevant information.

No previous biomechanics experience? Not a problem. As part of this course you also get access to an online Introductory Biomechanics course for your reference.

Additional Course Information

Biomechanics is the study of the effect of mechanical phenomena (forces, velocities, accelerations, energies, power, momenta, moments, friction, fatigue and failure) on human bodies. It relies on an understanding of mechanics and applies the fundamentals of mechanics to the structure and function of the human body.

Biomechanics is used in a diverse range of disciplines including biology, ergonomics, engineering, physiology, medicine, and mechanical physics. Many professionals – engineers, designers, physical therapists, oral and orthopaedic surgeons, cardiologists, and aerospace engineers – use practical applications of biomechanics.

Biomechanics has application in all areas of health care and medical problem solving that require physical manipulation. It may be the major area of concern in some instances (e.g. artificial joints, prosthetics and orthoses, mechanisms of physical injury) or it may be a vital adjunct to another area (e.g. design of an implantable pacemaker or specialist surgical tools).

This course covers in depth the methods used in the analysis of the biomechanics of the human musculoskeletal system. Methods to analyse body segment and joint kinematics, joint kinetics, work and power, muscle forces and associated energy costs will be covered. Applications of biomechanics in clinical, occupational and recreational areas will be presented.

OBJECTIVES

On completion of this course, you should:

- Have a broad understanding of the scope of biomechanics and its applications
- Understand the fundamental general mechanical principles used
- Be able to discuss, develop and apply mechanical principles to a range of problems and medical applications.
- Be able to describe and discuss the measurement, analysis and assessment of human movement.
- Critically review the literature in the area and apply knowledge gained from the course to analyse biomechanical applications
- Clearly summarise and communicate findings from literature research using oral and written methods.

Graduate attributes developed in this course include:

- The skills involved in scholarly inquiry
- An in-depth engagement with the relevant disciplinary knowledge in its inter-disciplinary context
- The capacity for analytical and critical thinking and for creative problem solving
- Information literacy – the skills to appropriately locate, evaluate and use relevant information
- An appreciation of and respect for diversity
- A capacity to contribute to and work within the international community
- The skills required for collaborative and multidisciplinary work
- A respect for ethical practice and social responsibility
- The skills of effective communication

Assessment

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Online Quizzes	7%	Continuous	1, 3, 5
Yay and Boo - OpenSim Posts	8%	Continuous	1, 2, 4
Software Laboratories	10%	Weeks 1, 3 & 7	1, 2, 3, 4
Computational Laboratories	15%	Weeks 9 & 10	1, 2, 3, 4
Wearable Technology Assignment	20%	Start of Week 7	1, 2, 3, 4, 5
Individual MoCap Project	20%	Week 10	1, 2, 3, 4
Final Examination	20%	Exam Week	1, 2, 3, 4, 5

Assessment Details

Assessment 1: Online Quizzes

Start date: Week 1

Details:

Weekly progress marks will ensure you are keeping up with content. The online content contains checkpoint questions to allow you to gauge your understanding. There are a variety of question types such as comprehension, true/false, multiple-choice and short answer. You can attempt the questions two times, but the lesson can be attempted as many times as you like. Your mark at the beginning of the tutorial or laboratory class of the week in question will be recorded in the grade book.

Completion you receive 100% for this task if you complete at least 7 topics on time and score at least 80%. Submitting fewer than 7 will result in a score of 0.

Assessment 2: Yay and Boo - OpenSim Posts

Start date: Week 1

Details:

Yay and Boo is a lighthearted assessment that will allow you to share your triumphs and failures with your colleagues. There will be three opportunities throughout the semester to participate in the Yay and Boo assessment. Involves posting to the forum with a complete and concise explanation of your post, including one or two sentences that describe one positive aspect (Yay) and one negative aspect (Boo) from the experience.

Completion you must post three times to receive the marks for this component of the assessment. Posting fewer than three times will result in a score of 0 regardless of the marks assigned to individual posts.

Assessment 3: Software Laboratories

Start date: Weeks 1, 3 & 7

Details:

Software Laboratories provide you with an opportunity to learn and use your own data collected from the Intro to MoCap laboratory to analyse and simulate human movement. Bring your own laptop. Includes:

- Scaling
- Inverse Kinematics
- Inverse Dynamics

Completion of assessment is based on short weekly demonstrations of your model to your demonstrator (for face to face students) or submitting a screen capture demonstration (for remote students). Also requires submitting a group report of your discussions.

Assessment 4: Computational Laboratories

Start date: Weeks 9 & 10

Details:

Theoretical Tutorials provide you will the opportunity to apply the theory you learned in the online units during weeks 1, 2, 3, 9 & 10 to analyse the data you collected during the laboratory class in week 2. You will use these data to calculate and analyse a number of human movement parameters such as joint centres, joint angles and coordinate systems, amongst others. Includes:

- Scaling
- Inverse Kinematics
- Inverse Dynamics

Completion there are two assessment items:

- CL1 Plotting (5%; Week 9)
- CL2 Calculation (10%; Week 10)

Assessment 5: Wearable Technology Assignment

Start date: Week 4

Details:

Wearables is a 2-page report (template supplied) based on the wearables laboratory experiment "texting is threatening" (week 4). You will use wearable technology to assess for example, how texting while walking may change a participant's gait pattern, cognitive processing speed and ability to recover avoid hazards. Data of human movement will be collected using wearable technology, which you will use to create and test a hypothesis of your own choosing.

Completion by submission of an individual report at the start of week 7 with bonus "innovation" marks awarded for identifying a novel question to tackle.

Assessment 6: Individual MoCap Project

Start date: Week 7

Details:

Individual MoCap Project will see you design (week 7), perform (week 8) and analyse (Weeks 9 & 10) an experiment of your choosing, using a published research paper to guide you. You will critically assess how you experiment compares to the published research paper and present your findings as a power point slide.

Completion includes multiple assessment items:

- Proposal (5%; Week 7)
- Presentation (15%; Week 10)

Assessment 7: Final Examination

Start date: Exam Week

Details:

Final Examination will help you to revise the course content enhancing longer term retention of the key learning goals. Practice Questions (PQs) are released throughout the course and sample questions are also provided to help with your revision.

Completion time to be advised. It will be an online exam with marks both for the correct answers and for the quality of your workings/diagrams submitted during the exam by uploading digital images.

Attendance Requirements

Welcome to BIOM9541 Mechanics of the Human Body. We know it is a tough time for students. The BIOM9541 team is dedicating to providing students with a world class, flexible and engaging learning experience. For students unable to attend face to face, online and distance options will be available.

Students are strongly encouraged to complete all learning activities on time and participate in all class discussions. Attendance at the tutorials and laboratories is compulsory. Non-attendance for reasons other than misadventure will preclude you from submitting the assignment related to the activity you missed. Your demonstrator will record attendance. Online students will have to submit a screen capture of their work to prove remote engagement.

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 14 September - 18 September	Module	Welcome & Gait Analysis via Moodle
	Homework	Practice Question 1
	Tut-Lab	Software Laboratory 1
Week 2: 21 September - 25 September	Module	Anthropometry
	Homework	Practice Question 2
	Tut-Lab	Into to MoCap at NeuRA
Week 3: 28 September - 2 October	Module	3D Mathematics
	Homework	Practice Question 3
	Tut-Lab	Software Laboratories 2/3
Week 4: 5 October - 9 October	Module	Wearable Technology I
	Homework	Wearable Question 1
	Tut-Lab	Wearables Lab (texting is threatening) at NeuRA
Week 5: 12 October - 16 October	Module	Wearable Technology II
	Homework	Wearable Question 2
Week 7: 26 October - 30 October	Module	3D Kinematics
	Homework	Practice Question 4
	Tut-Lab	Software Laboratory 4
	Assessment	1. Wearables 2. Individual Project Presentation
Week 8: 2 November - 6 November	Module	3D Kinetics
	Homework	Practice Question 5
	Tut-Lab	Individual MoCap Project at NeuRA
Week 9: 9 November - 13 November	Module	Muscle Mechanics
	Homework	Practice Question 6
	Tut-Lab	Computational Laboratory 1
Week 10: 16 November - 20 November	Module	Musculoskeletal Modelling
	Tut-Lab	Computational Laboratory 2
	Assessment	Presentation Individual MoCap Project

Resources

Prescribed Resources

Students should bring their own laptop computer to Software and Computational Laboratories.

Recommended Resources

The recommended text for this course are:

- Robertson, D.G.E. et al. Research methods in biomechanics. First (or second) edition, Human Kinetics, 2004 (or 2016).
- Winter, D.A. Biomechanics and motor control of human movement. Third edition, John Wiley & Sons, Inc., 2005.

Other useful reference books that are held in the UNSW Library are:

- Enderle, J.D. and J.D. Bronzino, Introduction to biomedical engineering, Third edition, Academic Press, 2012.
- Meriam, J.L. and L.G. Kraige, Engineering mechanics, Sixth edition, John Wiley & Sons, 2008.

Students seeking additional resources can also obtain assistance from the UNSW Library at **http://library.unsw.edu.au/**.

Additional readings and recommended websites will be listed on Moodle when required.

Course Evaluation and Development

Student feedback has helped to shape and develop this course, including feedback obtained from on-line evaluations as part of UNSW's myExperience process. Your feedback is much appreciated and taken very seriously. Continual improvements are made to the course based in part on such feedback and this helps us to improve the course for future students. Informal student feedback is also sought frequently throughout the semester and used to assist in the progression of the course.

Laboratory Workshop Information

Students will be required to sign COVID19 safe declarations before attending laboratory sessions.

Submission of Assessment Tasks

Laboratory reports and major assignments will require a Non Plagiarism Declaration Cover Sheet.

Late submissions will be penalised 10% of the mark for each calendar day late. If you foresee a problem in meeting the nominated submission date please contact the Course Convenor to make an appointment to discuss your situation as soon as possible.

Academic Honesty and Plagiarism

PLAGIARISM

Beware! An assignment that includes plagiarised material will receive a 0% Fail, and students who plagiarise may fail the course. Students who plagiarise will have their names entered on a plagiarism register and will be liable to disciplinary action, including exclusion from enrolment.

It is expected that all students must at all times submit their own work for assessment. Submitting the work or ideas of someone else without clearly acknowledging the source of borrowed material or ideas is plagiarism.

All assessments which you hand in must have a Non Plagiarism Declaration Cover Sheet. This is for both individual and group work. Attach it to your assignment before submitting it to the Course Coordinator or at the School Office.

Plagiarism is the use of another person's work or ideas as if they were your own. When it is necessary or desirable to use other people's material you should adequately acknowledge whose words or ideas they are and where you found them (giving the complete reference details, including page number(s)). The Learning Centre provides further information on what constitutes Plagiarism at:
https://student.unsw.edu.au/plagiarism

Academic Information

COURSE EVALUATION AND DEVELOPMENT
Student feedback has helped to shape and develop this course, including feedback obtained from on-line evaluations as part of UNSW's as part of UNSW's myExperience process. You are highly encouraged to complete such an on-line evaluation toward the end of Term. Feedback and suggestions provided will be important in improving the course for future students.

DATES TO NOTE
Refer to MyUNSW for Important Dates, available at:
https://my.unsw.edu.au/student/resources/KeyDates.html

ACADEMIC ADVICE
For information about:

- Notes on assessments and plagiarism,
- Special Considerations,
- School Student Ethics Officer, and
- BESS

refer to the School website available at
http://www.engineering.unsw.edu.au/biomedical-engineering/

Supplementary Examinations:

Supplementary Examinations for Term 3 2020 will be held on Monday 11th January – Friday 15th January (inclusive) should you be required to sit one.

Image Credit

Joseph Gatt as "Kratos" on the set of "God of War: Ascension". Posted on behalf of Joseph Gatt. This image is free to use under the Creative Commons Attribution-Share Alike 3.0 Unported license.

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	✓
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	✓
PE2.2 Fluent application of engineering techniques, tools and resources	
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in professional and lay domains	✓
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	