PM FOR THE BIOMECHANICS AND MOTOR CONTROL COURSE (15 CREDITS)

Welcome to the Biomechanics and Motor Control course (15 credits). The course is given in the discipline of sports, in the subject of sports science and is at advanced level. Course coordinator is Anna Bjerkefors, assistant professor and examiner is Professor Toni Arndt. During the semester, we will have a total of six teaching sessions of two to three full days. The first course session is on Thursday, January 24, with a mandatory call at 09.00 in lecture hall 2247 at GIH. The course ends with a written examination on June 4, 2019.

Learning objectives

The student should be able to:

- Have a deep understanding of the methodology used in biomechanics and motor control, and be able to evaluate the advantages and disadvantages of various methods,
- Integrate and use knowledge to handle complex problems in biomechanics and motor control for sports and everyday movements,
- Demonstrate basic mathematical skills in order to analyze human movements.

Content and structure

The course includes studies in the following thematic areas:

- Basic mathematical and mechanical theory,
- Motor control of voluntary movements: From neuron to behaviour.
- Basic measurement and analysis methods for force, motion, nerve and muscle function,
- Application of results in relevant research areas, e.g. in sports and health.

The focus of the course is related to the research field, the use of testing methods, theoretical connection, and the relationship between theory and sports.

Teaching and learning activities

Teaching consists of lectures, seminars, laboratory sessions and demonstrations. The students shall individually perform a literature review within a chosen field. The literature reviews will be presented orally and discussed within the group. The students shall in pairs/small groups perform a measurement in the laboratory within a self-chosen area using at least one of the following approaches: analyzing force, motion, nerve- or muscle function. The results and the analysis will be presented verbally within the group.

Progression

The course includes studies at an advanced level, which means a deepening of knowledge in relation to undergraduate education level. This means an increased level of complexity and abstraction in theoretical application, higher demands on communication skills, discussion of problems and integration of knowledge and increased independence regarding the implementation of written deepening in a chosen field.

Assessment

Requirements

Attendance at literature review seminars is obligatory. Any absence will result in the student being given a supplementary writing task.

Modes of assessment

- Final written examination on the course curricula (4/6)
- Written and oral presentation of a literature study (9/5)
- Measurement in the laboratory (29/3) and oral presentation (10/4)

Number of examination and practice

The examinations are held during the course as detailed in the course outline. Re-examinations will be offered no sooner than three weeks after the student has received results of the original examination. Re-examinations are held at the earliest three weeks after the completion of the relevant part of the course, before the start of the fall term and/or when the course is next offered.

For PhD students only (DABIOM1)

PhD assignment for Biomechanics and Motor Control

Extra examination

A written project plan (maximum five A4 pages, Times New Roman size 12, 1,5 spacing) in English.

- The research plan shall be based upon the methods within biomechanics and motor control presented in the course.
- The relevant methods specifically applied in the PhD student's own project shall be presented and their application described in detail from the choice of method to the presentation of results.
- For each part of the study, the student shall reflect over the theoretical background and practical application of the chosen methods and relate the choice of methods to national and international projects within the student's research field.

The study results expected for PhD students are:

- To be able to reflect on the theoretical background of methods applied in biomechanics and motor control,
- To show advanced knowledge of the present national and international research in biomechanics and motor control related to the student's own research project,
- To show independence in applying relevant methods for the student's own research project.

Other

The course is offered as optional within the Master's program and as an independent course as well as optional within the PhD program.

Grades

Possible grades include: Pass with Distinction, Pass or Fail. To obtain a Pass as a final grade the student must receive a Pass for both the final examination, literature review and the measurement in the laboratory. To obtain a Pass with distinction as a final grade, the student must receive a Pass for the literature study and the measurement in the laboratory and a Pass with distinction in the written examination.

Course evaluation

After completion of the course each student will have the opportunity to evaluate the course and the lecturer will complete a self-evaluation. These evaluations will be returned to the student group and the examiner within 3 weeks.

Student Influence

Student participation takes place through student representation on the Undergraduate Education committee.

Literature and other teaching aids

Required:

Enoka, Roger, M. (2015). *Neuromechanics of human movement*, 5th ed. Champaigne, Ill: Human Kinetics, 496 s.

PLEASE NOTE THAT ALL PAGES RECOMMENDED TO READ REFERES TO THE 5TH EDITION

Susskind, L. and Hrabovsky G. (2013). *The Theoretical Minimum, What You Need to Know to Start Doing Physics,* Basic Books, 256 pages.

Winter, David, A. (2009). *Biomechanics and Motor Control of Human Movement*, 4th ed. Hoboken, NJ: John Wiley & Sons, Inc, 384 pages.

Optional:

Additional original articles in their respective thematic areas in consultation with the teachers (~ 100-150 pages).

Schedule and learning objectives

<u>Meeting 1</u> Thursday 24/1, 09.00 – ca. 17.30.

09.00 – 09.45 Course introduction and overview of the schedule (Anna Bjerkefors) (lecture hall 2247)
10.00 – 11.30 Introduction to Biomechanics (Toni Arndt) (Chapter 1, page 1 – 13, Winter) (2247)
11.30 – 12.30 Lunch
12.30 – 13.15 Introduction to Motor Control (Maria Ekblom) (2247)
13.30 – 14.30 BMC Laboratories (Olga Tarassova and Anna Bjerkefors) (BMC lab)
14.50 – 16.10 BMC doctoral students present their thesis work (BMC)
14.50 Development of new Paralympic disciplines - classification and performance of paracanoe athletes (Johanna Rosén)
15.10 Towards evidence-based classification in Para-cycling (Johanna Liljedahl)
15.30 Sprint Start Biomechanics – the effect of step width on performance (Paul Sandamas)
15.50 Physical Activity and Neuroplasticity in the Motor Cortex (Emil Bojsen Moller)

Learning objectives:

- to introduce how human movement can be described, analyzed and assessed from a biomechanical and motor control perspective,
- to get on overview of different type of methods used in a biomechanics and motor control laboratory,
- to introduce different kind of research questions that can be evaluated in a biomechanics and motor control laboratory.

Chapter/s:

- Chapter 1, page 1 – 13, Winter

16.30 – 17.30 Information from the IT-department; email account, CANVAS etc (primarily for new students at GIH).

<u>Meeting 1</u> Friday 25/1, 09.00 – 16.15

09.00 – 12.00 Biomechanics 1. Trigonometry (1309)
Teacher: Karl Daggfeldt

Learning objectives:

- to be able to solve trigonometric mathematical problems

To read: Interlude 1 Spaces, Trigonometry, and Vectors, page 15 – 28, Susskind
More information can be find in the Mathematical PM.

12.00 – 13.00 Lunch

13.00 – 13.45 Forces, pressure and strength, theory (2247)
14.00 – 16.15 Forces, pressure and strength, practice (BMC)

Teacher: Toni Arndt and Olga Tarassova

Learning objectives:

- understand the implication of Newton's second Law
- describe the differences between force and pressure
- describe differences between force and pressure measurement
- basic understanding of the principles of isokinetic strength measurement

To read: Chapter 5, page 107 – 138, (Winter), Chapter 2, page 35-43, 50-55, 71-75, (Enoka)

<u>Meeting 2</u> Wednesday 13/2, 09.00 – 16.30

08.30 – 10.00 Biomechanics 2. Statics (1305)

Learning objectives:

- to be able to solve static mechanical problems

To read: Interlude 1 Spaces, Trigonometry, and Vectors, page 15 – 28 (Susskind).

10.30 – 12.00 Movement analysis, theory (2247)

Teacher: Johanna Rosén and Anna Bjerkefors

Learning objectives:

- basic knowledge of different types of movement analysis methods
- basic understanding of kinematic data processing
- understand the connections between displacement, velocity and acceleration

To read: Chapter 1, page 3 – 34 (Enoka), Chapter 3, page 45 – 81 (Winter),
Chapter 7 (Winter) 176-183.

12.00 – 13.00 Lunch

13.00 – 14.30 Biomechanics 2 (practice) (Strength training room)
Teacher: Karl Daggfeldt

15.00 – 16.30 Movement analysis, practice and data collection (BMC lab)
Teachers: Johanna Rosén and Anna Bjerkefors

<u>Meeting 2</u> Thursday 14/2, 09.00 – 16.00

09.00 – 12.00 Biomechanics 3. Limit values and Derivatives (part 1) (1309)
Teacher: Karl Daggfeldt

Learning objectives:

- to be able to derivate functions and describe their limits.

To read: Lecture 2: Motion, page 29 – 46, Susskind

12.00 – 13.00 Lunch

13.00 – 14.30 Walking and Running, practice (BMC)
Teachers: Toni Arndt and Olga Tarassova

Learning objectives:
- be able to identify differences in force curves between walking and running and describe different portions of the curve
- be able to describe requirements for 3D analysis of walking and running movement
- understanding of which data are required for calculating joint angles, moments and power
- basic interpretation of joint angles, moments and power

To read: Walking and running (chapter 4, page 129 – 145, Enoka)

14.45 – 15.15 Introduction to the **Literature assignment** (2247)
Teacher: Anna Bjerkefors

Learning objectives:
- to test the student's knowledge of the article content and ability to critically evaluate the scientific processes involved in the study's conception. Furthermore a well-researched evaluation of the presented study's positioning and impact in the relevant scientific field is expected.

This is an individual assignment in which each student shall write a two (A4) page critical summary of a chosen scientific publication. The submitted assignment is the basis of the students' oral presentation at the end of the course. Each student will also read two to three assignments from the other students in order to prepare questions for the oral presentations. More information will be given after April 28th when the assignment have been submitted.

Deadline for submission: April 28th in CANVAS. Oral presentations will be on the May 9th.

Article choice: Students are encouraged to search for a study within a personal area of research interest. Obviously the articles must be strongly based upon Biomechanics and/or Motor Control principles. If this choice is difficult, it is suggested that one of the articles used as course literature is chosen. A final means of choosing an article can be to discuss this with the course leader or a teacher. The article must be from a peer reviewed international scientific journal. If you are unsure of whether your chosen article is appropriate feel free to contact the course leader for input (contact details below).

Format: A two A4 page limit with 12 point Times font applies. The subheadings; Background, Aims (or Purpose), Methods, Results, Discussion and Conclusion are expected. Particular emphasis shall be placed on reflection of the appropriateness of the conclusion presented in relation to what had been shown in the study.

Guidelines to help you on your way:
Background: Have the authors performed an unbiased, relevant and comprehensive analysis of the present state of knowledge?
Aims: Is it clear how the presented background justifies the presented study? - Do the presented aims accurately address the following study?

Methods: Are the chosen subjects/patients and the number thereof appropriate? Are the groups compared appropriate? Are the methods clear? Can you find any methodological problems? Possible inaccuracies? Are the methods chosen valid and reliable? Are appropriate statistical methods chosen? Are ethical issues addressed?
Results: Is it clear how the results arose from the methods presented? Are the results clear?
Discussion: Is the discussion accurately reflected in the results? Are the consequences of the results within the broader field of knowledge appropriately presented? Are similarities or differences in the results compared to the referred literature described?
Conclusion: Is the conclusion valid with respect to all that has been presented?

Evaluation: Criteria for evaluation are presented separately. Possible grades are pass (G) or fail (U). A pass grade (G) is required for a pass in the complete course.

15.15 – 16.00 Introduction of data analysis in QTM.

If possible, please bring your own laptop (only PCs are compatible with the QTM program – free to download). If you don't have a PC laptop you will be able to use a computer in 1421 (datasalen).

Teachers: Johanna Rosén and Anna Bjerkefors

Learning objectives:

- basic knowledge of kinematic data processing in QTM

Short information about the data collection in the lab.

Meeting 3 Wednesday 6/3, 09.00 – 16.15

09.00 – 12.00 Biomechanics 4. Limit values and Derivatives (part 2) (1505)

Teacher: Karl Daggfeldt

Learning objectives:

- to be able to derivate functions and describe their limits.

To read: Lecture 2: Motion, page 29 – 46, Susskind.

12.00 – 13.00 Lunch

13.00 – 14.30 Neuronal control of Movement, theory (2247)

14.45 – 16.15 Neuronal control of Movement, practice (BMC)

Teacher: Maria Ekblom and Lina Lundgren, assistant professor at BMC (during the practical part)

Learning objectives:

- how motor control is organized and studied via spinal reflexes, automatic behaviors and voluntary actions.

To read: Chapter 7, page 255 – 313, Enoka.

<u>Meeting 3</u> Thursday 7/3, 09.00 – 16.30

09.00 – 10.30 Priming the nervous system for performance, theory (2247)

10.45 – 12.15 Priming the nervous system for performance, practice (BMC)

Teacher: Maria Ekblom and Lina Lundgren

Learning objectives:
- effects of warm up, fatigue and strength training

To read: Chapter 9, 377 – 414 (Enoka)

12.15 – 13.15 Lunch

13.15 – 14.45 Preparation for data collection (Group 1) (BMC)
Teachers: Anna Bjerkefors and Lina Lundgren

13.15 – 14.45 Data analysis in Visual 3D (Group 2) (computer lab 1421)
Teacher: Johanna Rosén

15.00 – 16.30 Preparation for data collection (Group 2) (BMC)
Teachers: Anna Bjerkefors and Lina Lundgren

15.00 – 16.30 Data analysis in Visual 3D (Group 1) (computer lab 1421)
Teacher: Johanna Rosén

Learning objectives:
- How to form research questions and find appropriate methods for answering these questions,
- How to structure an appropriate protocol for a data collection,
- Basic knowledge of how to analyze data in Visual 3D (building a model, writing a script for joint angle calculations, reporting results etc.)

<u>Meeting 3</u> Friday 8/3, 09.00 – 14.30

09.00 – 14.30 Clinical gait analysis in children with different type of impairments (Astrid Lindgren´s Children Hospital). Address to the laboratory: Karolinska Universitetssjukhuset, Karolinska vägen 37A Q-huset, Motoriklabbet plan 1.
Teachers: Professor Lanie Gutierrez Farewik and Elin Lööf, PhD.

Learning objectives:
- general knowledge of when and how to use gait analysis in children with impairments in a clinical setting, including clinical interpretation.
- be able to describe alternative gait patterns during walking in children with different kind of impairments and difficulties.

To read: Measuring walking. A handbook of Clinical gait analysis (Richard Baker, page 9 – 28, available on CANVAS).

<u>Meeting 4</u> Wednesday 27/3, 09.00 – 16.30

09.00 – 16.30 Motor control and electromyography, theory and practice (2247)

12.00 – 13.00 Lunch

Teacher: Associated Professor Eva Andersson

Learning objectives:

- to gain theoretical and practical knowledge about muscle activity measurements, i.e. electromyography, registration methods and analysis procedures.
- achieve examples of usefulness and interpretations of electromyographic results.

To read: Chapter 10, page 250 – 276 (Winter), chapter 5 page 195- 204. "The ABC of EMG - A Practical Introduction to Kinesiological Electromyography", Peter Konrad, Version 1.0 April 2005 (available in BOX).

<u>Meeting 4</u> Thursday 28/3, 09.00 – 16.15

09.00 – 12.00 Biomechanics 5. Integral calculus (1305)

Teacher: Karl Daggfeldt

Learning objectives:

- to be able to use the fundamental theorem of calculus to solve integrals.

To read: Interlude 2: Integral Calculus, page 47 – 57, and Lecture 3: Dynamics, page 58 – 73, Susskind.

12.00 – 13.00 Lunch

13.00 – 16.15 Jumping etc., theory and practice (BMC)

Teacher: Toni Arndt

Learning objectives:

- be able to identify different jumps from the force curves
- be able to calculate jumping height using different biomechanical procedures
- be able to explain biomechanical principles underlying different heights achieved with different jumps

To read: Moir, G. 2008. Three different methods of calculating vertical jump height from force platform data in men and women. Measurement in Physical Education, 12: 207-218. (Available in CANVAS).

Meeting 4 Friday 29/3, 09.00 – 16.30

09.00 – 16.30 Data collection in the lab (1.5 hour per group) (room 1455, 3305, 3306)

A detailed program will be posted later in CANVAS.

Teachers: Lina Lundgren, Olga Tarassova, Johanna Rosén, Anna Bjerkefors

Learning objectives:

- how to calibrate equipment needed for biomechanical and motor control research
- how to prepare participants for data collection
- basic knowledge on how to collect data, check for errors etc.

Meeting 5 Wednesday 10/4, 09.00 – 16.30

09.00 – 10.30 Physical activity, exercise and neuro plasticity in children, adults and elderly (2247)

Teacher: Maria Ekblom

Learning objectives:

- Basic knowledge of fMRI, TMS and volumetric imaging on how the brain adapts to physical activity and exercise.

To read: Chapter 9, 414 – 423, 436 – 450 (Enoka).

10.45 – 12.15 Physical activity, exercise and neuro plasticity in people with spinal cord injury (2247)

Teacher: Anna Bjerkefors

Learning objectives:

- basic knowledge on how the nervous system adapts to physical activity and exercise after a spinal cord injury.

To read: Chapter 9, page 424 – 435 (Enoka),

12.15 – 13.15 Lunch

13.15 – 16.30 Oral presentation of the data collection including introduction, method and results and interpretation of the results (group of 3 persons) (1309)

Teachers: Lina Lundgren, Anna Bjerkefors, Johanna Rosen

Learning objectives:

- understand the methodology used in the data collection project and be able to evaluate the advantages and disadvantages of your chosen method,
- interpreting data from the data collection
- presenting the findings in appropriate manner for your chosen method

<u>Meeting 5</u> Thursday 11/4, 09.00 – 16.00

09.00 – 16.00 Biomechanical measurements for performance evaluation (Riksidrottsförbundet Bosön, Idrottsfysiologiska laboratorium).

Teachers: Glenn Björklund, Juan Alonso, Mikael Swarén

12.00 – 13.00 Lunch

Learning objectives:

- general knowledge on different methods used in the evaluation of biomechanical parameters in various sports,
- to critically discuss the aspects of validity and reliability of the methods.

<u>Meeting 6</u> Thursday 9/5, 09.00 – 16.30

Literature assignment (1506)

Teacher: Anna Bjerkefors and Johanna Rosén

Learning objectives:

- to test the student's knowledge of the article content and ability to critically evaluate the scientific processes involved in the study's conception. Furthermore a well-researched evaluation of the presented study's positioning and impact in the relevant scientific field is expected.

Tuesday 4/6, 13.00 – 16.30

Examination (1505)

Date and time will be announced later

Re-examination