The two-year (120EC) programme Fundamental and Clinical Human Movement Sciences aims at training for so-called “translational research”; research on the cutting edge of fundamental and clinical human movement sciences that tries to integrate fundamental knowledge and clinical questions. This requires a strongly multidisciplinary approach, but also a well developed knowledge and experience of the workings of fundamental research and clinical practice. The Research Master’s offers a very broad, but human movement oriented programme, stretching from molecular biology to cognitive neuroscience and human motor behaviour. The programme intends to prepare students for a research career in the area of movement-related disorders.

Admission to the programme
The programme is open for students with a clinical, science or technical BSc diploma related to the field of Movement Sciences. The Master’s programme is a so-called selective master, which implies that the programme has a maximum intake of thirty students per year and that admission is linked to strict criteria such as the average grade (for either BSc-, or premaster programme), the quality of the premaster / bachelor research project and of course, motivation and proficiency in English.

Structure of the programme
The first year of the programme is dedicated to training for research, which embraces a core programme on subjects relevant for translational, interdisciplinary research, training in general research methods and methodology and selective courses to prepare especially for the research year.

The second year is dedicated to research and is spent as either one internship (60EC), or a combination of a minor (24EC) and major internship (36EC). The department offers ample possibilities for spending (part of the) internship abroad.

The research master programme coordinator serves as the advisor for all students. Approval of all study programmes has to be obtained from the Examination Board.

Master courses are taught in English. The course material is in English.

Overview of the programme
<table>
<thead>
<tr>
<th>Vak: Optional Courses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RM1 Optional Courses</td>
<td>1</td>
</tr>
<tr>
<td>RM1 Obligatory Courses</td>
<td>1</td>
</tr>
<tr>
<td>RM2 Obligatory programme</td>
<td>2</td>
</tr>
<tr>
<td>Vak: 3D-Kinematics</td>
<td>2</td>
</tr>
<tr>
<td>Vak: Advanced Methodology</td>
<td>3</td>
</tr>
<tr>
<td>Vak: Biophysics of Locomotion</td>
<td>4</td>
</tr>
<tr>
<td>Vak: Clinical Exercise Physiology</td>
<td>5</td>
</tr>
<tr>
<td>Vak: Coordination Dynamics: principles and clinical applications</td>
<td>6</td>
</tr>
<tr>
<td>Vak: Electromyography</td>
<td>8</td>
</tr>
<tr>
<td>Vak: Energy Flow Models</td>
<td>9</td>
</tr>
<tr>
<td>Vak: Exercise Immunology</td>
<td>10</td>
</tr>
<tr>
<td>Vak: Fatigue, Aging and Disuse</td>
<td>11</td>
</tr>
<tr>
<td>Vak: History and Theory of Movement Sciences</td>
<td>12</td>
</tr>
<tr>
<td>Vak: Intermuscular load Sharing</td>
<td>12</td>
</tr>
<tr>
<td>Vak: Introduction into the Clinic</td>
<td>14</td>
</tr>
<tr>
<td>Vak: Maximal Neuromuscular Performance</td>
<td>15</td>
</tr>
<tr>
<td>Vak: Mechanical and Adaptive Myology</td>
<td>16</td>
</tr>
<tr>
<td>Vak: Molecular Biology</td>
<td>17</td>
</tr>
<tr>
<td>Vak: Neurosciences</td>
<td>19</td>
</tr>
<tr>
<td>Vak: Perception for Action</td>
<td>20</td>
</tr>
<tr>
<td>Vak: Psychological Factors in Sport</td>
<td>21</td>
</tr>
<tr>
<td>Vak: Research Internship Research Master</td>
<td>22</td>
</tr>
<tr>
<td>Vak: Sport Biomechanics</td>
<td>23</td>
</tr>
<tr>
<td>Vak: Statistics for Experimental Research</td>
<td>24</td>
</tr>
<tr>
<td>Vak: Studentbegeleiding</td>
<td>25</td>
</tr>
<tr>
<td>Vak: Time Series Analysis</td>
<td>25</td>
</tr>
<tr>
<td>Vak: Tissue Engineering and Mechanobiology</td>
<td>27</td>
</tr>
<tr>
<td>Vak: Treating Locomotor Disease</td>
<td>28</td>
</tr>
</tbody>
</table>
### RM1 Optional Courses

#### Vakken:

<table>
<thead>
<tr>
<th>Naam</th>
<th>Periode</th>
<th>Credits</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D-Kinematics</td>
<td>Period 4</td>
<td>3.0</td>
<td>B_3DKIN</td>
</tr>
<tr>
<td>Biophysics of Locomotion</td>
<td>Period 5</td>
<td>3.0</td>
<td>B_BIOPHLOCO</td>
</tr>
<tr>
<td>Clinical Exercise Physiology</td>
<td>Period 3</td>
<td>3.0</td>
<td>B_CLINEXERC</td>
</tr>
<tr>
<td>Coordination Dynamics: principles and clinical applications</td>
<td>Period 2</td>
<td>3.0</td>
<td>B_CLINCORDYN</td>
</tr>
<tr>
<td>Electromyography</td>
<td>Period 4</td>
<td>3.0</td>
<td>B_ELECTROMYO</td>
</tr>
<tr>
<td>Energy Flow Models</td>
<td>Period 2</td>
<td>3.0</td>
<td>B_ENERFLOW</td>
</tr>
<tr>
<td>Fatigue, Aging and Disuse</td>
<td>Period 5</td>
<td>3.0</td>
<td>B_FATIGUE</td>
</tr>
<tr>
<td>Intermuscular load Sharing</td>
<td>Period 6</td>
<td>3.0</td>
<td>B_INMUSCLOAD</td>
</tr>
<tr>
<td>Introduction into the Clinic</td>
<td>Period 3, Period 6</td>
<td>6.0</td>
<td>B_INTROCLIN</td>
</tr>
<tr>
<td>Maximal Neuromuscular Performance</td>
<td>Period 2</td>
<td>3.0</td>
<td>B_MAXNEUR</td>
</tr>
<tr>
<td>Mechanical and Adaptive Myology</td>
<td>Period 5</td>
<td>3.0</td>
<td>B_MECHADMYO</td>
</tr>
<tr>
<td>Perception for Action</td>
<td>Period 4</td>
<td>3.0</td>
<td>B_PERCACTION</td>
</tr>
<tr>
<td>Psychological Factors in Sport</td>
<td>Period 2</td>
<td>3.0</td>
<td>B_PSYFACSPRT</td>
</tr>
<tr>
<td>Sport Biomechanics</td>
<td>Period 5+6</td>
<td>3.0</td>
<td>B_SPORTBIO</td>
</tr>
<tr>
<td>Studentbegeleiding</td>
<td>Ac. Jaar (september)</td>
<td>6.0</td>
<td>B_STDBEG</td>
</tr>
<tr>
<td>Time Series Analysis</td>
<td>Period 5</td>
<td>3.0</td>
<td>B_TIMESERANA</td>
</tr>
</tbody>
</table>

### RM1 Obligatory Courses

#### Vakken:

<table>
<thead>
<tr>
<th>Naam</th>
<th>Periode</th>
<th>Credits</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Methodology</td>
<td>Period 5</td>
<td>3.0</td>
<td>B_ADVANMETH</td>
</tr>
<tr>
<td>Exercise Immunology</td>
<td>Period 1</td>
<td>6.0</td>
<td>B_EXERIMMUONO</td>
</tr>
<tr>
<td>History and Theory of Movement Sciences</td>
<td>Period 1</td>
<td>3.0</td>
<td>B_HTOMS</td>
</tr>
<tr>
<td>Molecular Biology</td>
<td>Period 1</td>
<td>3.0</td>
<td>B_MOLECULBIO</td>
</tr>
<tr>
<td>Neurosciences</td>
<td>Period 2</td>
<td>6.0</td>
<td>B_NEUROSC</td>
</tr>
<tr>
<td>Statistics for Experimental Research</td>
<td>Period 4</td>
<td>3.0</td>
<td>B_STATEXPRES</td>
</tr>
<tr>
<td>Tissue Engineering and Mechanobiology</td>
<td>Period 4</td>
<td>3.0</td>
<td>B_TISSUEEENG</td>
</tr>
<tr>
<td>Treating Locomotor Disease</td>
<td>Period 2+3</td>
<td>6.0</td>
<td>B_LOCOMOTOR</td>
</tr>
</tbody>
</table>
RM2 Obligatory programme

Vakken:

<table>
<thead>
<tr>
<th>Naam</th>
<th>Periode</th>
<th>Credits</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Internship</td>
<td>Ac. Year (September)</td>
<td>60.0</td>
<td>B_RIRM</td>
</tr>
<tr>
<td>Research Master</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3D-Kinematics

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_3DKIN (900632)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 4</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>prof. dr. J. Harlaar</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>prof. dr. H.E.J. Veeger</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Computer lab</td>
</tr>
</tbody>
</table>

**Course objective**

The student is capable to:

- Define and calculate local joint coordinate systems;
- Use and understand different calibration methods and their limitations;
- Translate technical motion descriptions into clinically relevant units;
- Apply the above to experimental data;
- Interpret and comment on methods as described in the literature.

**Course content**

In this course students are introduced to the fundamentals of three-dimensional kinematics, as well as the (more or less) standard application methods.

The course will comprise three separate blocks focusing on:

1. The definition and use of local coordinate systems in the calculation of osteokinematics;
2. The use of technical marker sets as well as the practical implications of data processing, especially correcting for missing markers and;
3. The calculation procedures for obtaining helical axes, needed for the definition of functional axes-based coordinate systems.

The course consists of classes, computer practicals and work group, in which 3D kinematics theory and application will be taught and consequences for research will be discussed.

**Form of tuition**

Lectures, computer practicals and tutorials

The three computer practicals are linked to in-term assessments. Each practical will contribute for 15% to the final score.
Type of assessment
The assessment consists of:
- three in-term practical assignments, each contributing for 15% of the final score;
- computer test consisting of a matlab based assignment and a literature review (55%)

Course reading
Relevant papers will be listed in Blackboard.

Entry requirements
This course requires proficiency in Matlab and matrix calculation. If there is a deficiency related to Matlab skills, students are strongly advised to take the TUE web-based matlab course that can be found at http://www.imc.tue.nl/
The BSc course “Mechanische Analyse …” is advised.

Remarks
The maximum number of participants in this course is limited to 40.

Advanced Methodology

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_ADVANMETH (900808)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 5</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Seminar</td>
</tr>
</tbody>
</table>

Course objective
At the end of course the student will be capable to understand statistical models for regression, and use them to analyze data with the help of a statistical package

Course content
Regression models try to explain or predict a dependent variable using measured "independent variables" (or "fixed effects"). Statistical methods are needed if there is random variation in the dependent variables and/or if the measured variables are a sample from a population. Dependencies in the variables (for instance by repeatedly measuring the same unit) require introduction of unmeasured "random effects". In this course the concept of a statistical model, as given by equations involving random variables, will be central. The model reflects a design by which data is collected, allows formulating the assumptions underlying the statistical analysis, and is basic for interpreting the results of the analysis. The analysis itself is carried out by a computer package, for which we need to know code but no formulas.

Brief introduction to basic statistical concepts. Statistical model, likelihood function, maximum likelihood estimation, confidence region,
likelihood ratio test, p-value.
Introduction to R. Basics of the open source computer package R, and its application to fixed and mixed effects regression.
Fixed effects regression. Multiple linear regression: estimation, testing, variable selection and diagnostics. Extension to generalized linear models.
Mixed effects regression. Linear random effects models, repeated measures, longitudinal data. Extension to nonlinear models.

Form of tuition
lecture
4 x 2 hours
tutorial
5 x 2 hour
Lectures, practical exercises, discussion of the exercises.

Type of assessment
Based on the written reports of the assignments.

Course reading
- slides of the lectures;
- r manual;
- assignments;
- background reading to be announced.

Entry requirements
Previous experience with statistics. Some knowledge of ANOVA.

Remarks
Course website http://www.math.vu.nl/~aad/ARM/

Biophysics of Locomotion

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_BIOPHLOCO (900812)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 5</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>dr. M.F. Bobbert</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. M.F. Bobbert</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Computer lab, Practical</td>
</tr>
</tbody>
</table>

Course objective
Upon completion of the course, the student:
• has knowledge of and insight into current research questions regarding human locomotion;
• is able to perform complex analyses of kinetic, kinematic and physiological data on human locomotion;
• has knowledge of advanced research techniques and methods used in the study of human locomotion;
• is able to integrate knowledge from biomechanics and, (neuro) physiology, nonlinear dynamics;
• is able to critically evaluate methods used and results obtained in the study of human locomotion;
• is able to correctly and convincingly present results and
interpretations thereof given in the literature to a specialist audience.

Course content
This course clarifies how mathematical modeling of the neuromusculoskeletal system is used in the study of mechanics and energetics and control of locomotion. Key questions are: why is walking metabolically expensive while very little external mechanical work is done? To what extent do humans exploit the passive dynamics of their skeletal linkage? In the search for answers to these questions, mathematical models of the neuromusculoskeletal system play a key role. In this course the results of various studies in which such models have been applied, will be discussed.

Form of tuition
Total amount of contact hours: 32 hrs
Lectures/Tutorials: 10*2 hrs
Practicals (computer labs): 3*3 hrs
Assessment: 2 hrs
The lectures/tutorials are devoted to critical evaluation of publications in which modeling and simulation have been used to provide answers to the key questions mentioned above. The lecturers will briefly outline the theoretical and methodological background of the work in each publication; students will take turns in giving a short presentation on publications and in posing critical questions. The practicals (computer labs) are intended to give the students hands-on experience with mathematical methods.

Type of assessment
The mark for the course is determined by the mark for the written examination (essay-questions) on the course material, provided that the student has fulfilled the obligation to give a presentation and to complete assignments related to the practicals, and has been present during no less than 7 of the 9 lectures/seminars.

Course reading
The course is taught with the aid of scientific papers.

Entry requirements
The student has knowledge and understanding of basic concepts in linear algebra, calculus, ordinary differential equations, Newtonian mechanics and exercise physiology. The student is able to use Matlab or similar programs.

Remarks
Students are welcome to contact the lecturers for further information. Students who lack working knowledge of mechanics and computational skills are discouraged from enrolling. Students who wonder whether their background is adequate for participation in the course are advised to contact the lecturers at an early stage.

Clinical Exercise Physiology
Course objective
To provide the student with the fundamental knowledge of clinical exercise physiology as a variant of normal exercise physiology, which will enable the student to apply this knowledge in preventive and rehabilitative exercise programs.

Course content
Basic didactic information and laboratory experiences of the effect of pathophysiologic conditions on human energy metabolism and health. The focus will be on organ systems and their linkage to ATP generating pathways and on how this influences skeletal muscle performance. The application is to the use of exercise both diagnostically and as a therapeutic tool. After this course the student will have the fundamental knowledge and skills to use exercise in patients with cardiopulmonary/metabolic disease and to work cooperatively with other health care providers.

Form of tuition
Lecture
Practical laboratory exercises
Directed reading

Type of assessment
Written examination.

Course reading
A selection of articles and practical guide on Blackboard.

Entry requirements
Toegepaste Inspanningsfysiologie.

Coordination Dynamics: principles and clinical applications

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_CLINCORDYN (900666)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 2</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>dr. M. Roerdink</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. M. Roerdink</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Computer lab, Practical</td>
</tr>
</tbody>
</table>

Course objective
The student is acquainted with the principles, concepts and methods of coordination dynamics, as used in the study of basic and pathological movements. The student can explain these aspects of coordination dynamics in a qualitative manner and is able to indicate how they may contribute to clinical diagnosis and intervention.
**Course content**
The coordination dynamics approach is pursued to study how patterns of coordinated movement come about, persist and change as a function task constraints, learning, expertise and pathology. Coordination dynamics is governed on the one hand by principles of self-organization, and on the other hand by intentionality, perceptual information and explicit knowledge.

Coordination patterns exist at multiple levels:
1. dynamics within or between body segments of a moving person;
2. dynamics between moving segments of multiple persons and
3. dynamics between person and external events, as well as between persons.

The first part of the course provides an overview of the principles, concepts and methods of coordination dynamics.

The second part of the course focuses on the application of coordination dynamics in a clinical (rehabilitation) setting, with specific emphasis on pathological gait and interventions based on environmental coupling. Specifically, coordination dynamics provides a framework to study the nature of healthy and pathological movements by assessing stability and loss of stability of coordination patterns, thereby assisting the diagnosis and evaluation of rehabilitation-induced changes in coordination. Furthermore, coordination dynamics may promote therapeutic interventions based on environmental coupling, aimed at facilitating desired coordination patterns and/or stabilizing existing unstable coordination patterns.

**Form of tuition**
Amount of contact hours, divided in:
- Lectures: 8 * 1.75 hrs
- Laboratories: 2 * 2.00 hrs
- Computer Practicals: 5 * 2.00 hrs
- Exam: 2.75 hrs

Part 1: Principles of coordination dynamics
- Lecture 1: How nature handles complexity: self-organization of behavior
- Lecture 2: Coordination dynamics at multiple levels
- Lecture 3: Tools and methods of coordination dynamics
- Laboratory 1: Relative phase and phase transitions in action
- Practical 1: Analyses of rhythmic interlimb coordination
- Practical 2: Analyses of rhythmic sensorimotor coordination

Part 2: Clinical applications of coordination dynamics
- Lecture 4: Introduction to clinical coordination dynamics
- Lecture 5: Interventions based on environmental coupling
- Laboratory 2: Clinical coordination dynamics in action
- Practical 3: Functional changes in interlimb interactions following stroke
- Practical 4: Pathological gait modulation with visual and acoustic cues
- Lecture 6: Coordination dynamics and pathological gait
- Lecture 7: Coordination dynamics in the future
- Practical 5: Optional class for questions and feedback
- Lecture 8: Feedback on Laboratories and Practical plus discussion on example exam questions

The practical exercises aim to apply the principles of coordination dynamics to concrete experimental and clinical settings. The
Laboratories entail hands-on experience with examining rhythmic interlimb and sensorimotor coordination as well as assessments and interventions involving environmental couplings in rehabilitation practice. The computer practicals are included to become acquainted with the handling and interpretation of the gathered data using methods of coordination dynamics (Matlab scripts and functions are provided; no programming skills required). Note that Laboratory 2 will be held at the Duyvensz-Nagel Research Laboratory of Reade Center for Rehabilitation and Rheumatology (DNO, Reade, Overtoom 283).

**Type of assessment**
Written exam, consisting of open questions and true/false statements.

**Course reading**
A selection of relevant book chapters and articles.

**Electromyography**

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_ELECTROMYO (900815)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 4</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>prof. dr. ir. D.F. Stegeman</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>prof. dr. J.H. van Dieen, prof. dr. ir. D.F. Stegeman</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Practical, Computer lab</td>
</tr>
</tbody>
</table>

**Course objective**
- The student has a basic knowledge of electrophysiology and the background of electromyographical; signals;
- the student has a basic knowledge of the different ways; of collecting electromyograpical data in various application fields;
- the student can collect and analyze EMG data for kinesiological use;
- the student can choose the appropriate method for collecting EMG data in kinesiological study;
- the student knows the possibilities and limitations of EMG data;
- the student can interpret EMG data in relation to motor control, force and fatigue;
- the student can identify contamination in EMG data and can apply methods to reduce its effects;
- the student knows the standards for reporting EMG data.

**Course content**
In this course, the students are introduced to the electrophysical background of electromyograph (EMG). Subsequently, the course focuses on methodological aspects of EMG acquisition and analysis, focusing on the potential of this method as well as its pitfalls.

**Form of tuition**
lecture
lecture 5 x 2 hours
practical
practical 3 x 2 hours
The lectures introduce the following topics:
- electrophysiology;
- motor control (motor unit recruitment and firing);
- instrumentation and electrodes;
- HD- EMG and spatio- temporal information;
- onset determination;
- amplitude estimation;
- force estimation;
- cocontraction and cross- talk;
- motor unit firing and decomposition;
- frequency content, conduction velocity and fatigue.

Practical: measuring EMG, analyzing EMG data.

Type of assessment
tentamen
Written test with open-ended questions.

Course reading
Research articles and lecture handouts to be made available before the course.

Entry requirements
The student should have a basic knowledge and understanding of the human musculoskeletal anatomy and biomechanics (statics).

Energy Flow Models

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_ENERFLOW (900675)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 2</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>dr. J.J. de Koning</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. J.J. de Koning</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Computer lab</td>
</tr>
</tbody>
</table>

Course objective
To provide the student with knowledge about energy flow models, and so to enable the student to apply this knowledge in the modelling of human endurance performance.

Course content
Research in which exercise physiology and biomechanics are combined as a 'toolbox' is apparently unique and successful. This course familiarizes the student with one branch of this approach. Energy flow models, based on power equations, will be used to study performance determining factors in endurance sports. This course explains the technique of modelling, how parameter values are obtained from experiments and how simulations with the model can be done. The student will construct a model of an endurance athlete to study the effect of parameter values on performance in cycling, speed skating and running. The models will be made in MATLAB. Knowledge of MATLAB is necessary to be successful in this course.

Form of tuition
Lectures and guided practical;
34 hours (28 practical, 6 lecture).
Type of assessment
Written examination and practical report (30%/70%).

Course reading
A selection of articles and practical guide on Blackboard.

Entry requirements
900104: Biomechanica (Students are expected to have sufficient knowledge of this subject);

900215: Mechanische analyse van het menselijk bewegen (Students are expected to have sufficient knowledge of this subject)

Exercise Immunology

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_EXERIMMUNO (900807)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 1</td>
</tr>
<tr>
<td>Credits</td>
<td>6.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>prof. dr. G. Kraal</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>prof. dr. G. Kraal</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Seminar, Practical, Meeting</td>
</tr>
</tbody>
</table>

Course objective
The student:
- is capable to understand the principles of the functioning of the immune system and understand its importance for the homeostasis of the body;
- has a good knowledge of the various cell types and organs that cooperate in the body’s defense is acquired;
- will learn in addition to an in depth knowledge of the function of the immune system, how the immune system can attack our own body and how immunological diseases can affect joint functions and neural innervation in normal situations.

Course content
In a series of lectures the immune system will be explained. In two practicals the structure of the lymphoid organs and immunological techniques are taught. In two tutorials several aspects of the immune system will be discussed in depth. In addition students present literature to study the role of exercise clinical immunology. The assessment consists of a written examination.

Form of tuition
lecture
practical
tutorial

- Lectures based on the textbook “The Immune System” by P. Parham, the lectures will follow the various chapters. Emphasizing the highlights and by giving additional examples the functioning of the immune system are explained;
- Tutorials: in the tutorial the role of antibodies in disease and
vaccination will be discussed. Attention will be given to the therapeutic use of antibodies in various diseases;
- Practical I: Microscopy of the lymphoid organs;
- Practical II: Immunological techniques;
- Assessment: written examination.

**Type of assessment**
tentamen
Written test (80%), presentation (20%)

**Course reading**
Peter Parham, The immune system, 3rd edition, Garland Science

**Entry requirements**
A general knowledge of cell biology is required.

**Fatigue, Aging and Disuse**

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_FATIGUE (900648)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 5</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>prof. dr. A. de Haan</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>prof. dr. A. de Haan, dr. R.T. Jaspers</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Seminar, Lecture</td>
</tr>
</tbody>
</table>

**Course objective**
At the end of this course the student has knowledge of the short term changes in the physiology of the neuromuscular system, as induced by fatigue and long term adaptations as a result of disuse and aging, and the underlying (molecular) mechanisms. The student can apply this knowledge to questions regarding human movement in various situations (e.g. sports, aging, illness, injury, disorders).

**Course content**
During the course, a critical overview is given of the current knowledge of short and long term adaptations of the neuromuscular system. The manifestation and (metabolic) mechanisms of neuromuscular fatigue during high intensity exercise is addressed using own research examples. Neuromuscular performance is impaired during aging and with a chronic decrease in usage, such as during bed rest, diseases, injuries, neuromuscular disorders and (most extreme) after a spinal cord injury. Underlying (molecular) processes leading to decreased performance of the neuromuscular system are discussed, mostly based on ones recent own research.

**Form of tuition**
The course will consist of a series of lectures during which relevant questions are addressed and discussed. In additional meetings relevant items are addressed in group discussions based on prepared questions/statements.

**Type of assessment**
Assessment
Written test with open-ended questions.

Course reading
Book chapters, research articles and review papers to be made available before the course.

Entry requirements
The student should have a basic knowledge and understanding of molecular, biology, exercise and muscle physiology.

History and Theory of Movement Sciences

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_HTOMS (900661)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 1</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>dr. O.G. Meijer</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. O.G. Meijer</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Seminar</td>
</tr>
</tbody>
</table>

Course objective
Students will be confronted with the overall development of movement science, and thereby better understand its central problems. A systems theory analysis is used to highlight the problem of relationships between different levels. Students are trained in critical reading of published papers.

Course content
Lectures: Introduction into the history of movement sciences, the relevance of systems theory, and the problem of the relationship between levels. Discussion in small groups: learning to discuss and analyze movement science papers.

Form of tuition
Lectures, discussion groups. Students who attend all discussions in small groups on movement science papers, and who have prepared these discussions appropriately, are exempted from the corresponding part of the written examination.

Type of assessment
Written examination.

Course reading
Lecture notes.

Intermuscular load Sharing

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_INMUSCLOAD (900809)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 6</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
</tbody>
</table>
Course objective
The student knows the most common methods for inverse mechanical analysis of muscle-joint systems and is able to apply these. The student is aware of the possibilities and limitations of these methods. The student is able to assess validity and sensitivity of such methods and can interpret and report results in a scientific format.

Course content
In this course, the students are introduced to the methods to estimate the mechanical load on structures in a muscle-joint system through inverse mechanical analysis. Since muscle-joint systems are mechanically indeterminate, estimating the distribution of the net moment over moment-producing structures (mainly muscles) is the main challenge. The course consists of three parts. In the first part, after a general introduction on EMG driven and optimization models for estimating the distribution of the net moment over muscles will be dealt with and data on load sharing as measured in animal experiments will be discussed in the context of such models. During a computer lab students will modify and use a simple model of a muscle-joint system driven by optimization. In the second part, the effects of myofascial transmission of force between muscles will be introduced in a lecture. In the subsequent computer lab, the model will be adapted to study the effects of intermuscular force transmission. In the third part of the course, a formal analysis of joint stability will be introduced and the effects of stability requirements on load sharing between muscles will be discussed. In the following computer lab, students will apply stability constraints in the model to further study these effects. Based on sensitivity analyses for specified inputs, parameters, or model assumptions with the model students will prepare a written report with respect to one of three questions related to the three parts of the course.

Form of tuition
16 contact hours, divided in:
Lectures 5 * 2 hours
Practicals 3 * 2 hours

Type of assessment
- Written report.

Course reading
A series of papers will be made available at the start of the course.

Entry requirements
The student should have a basic knowledge and understanding of The student should have a basic knowledge and understanding of the human musculoskeletal anatomy (e.g. the BSc course “Inleiding Functionele Anatomie”) and biomechanics (e.g. the BSc course “Mechanische Analyse van het Menselijk Bewegen” or Chapters 1-5 in Zatsiorsky, V. Kinetics of Human Motion. 1st ed. Human Kinetics, 2002). The student should have basic Matlab programming skills (e.g. as taught in the BSc course “Analyse van digitale signalen”).
Introduction into the Clinic

Course code  B. INTROCLIN (900803)
Period       Period 3, Period 6
Credits      6.0
Language of tuition  English
Faculty      Faculteit der Bewegingswetenschappen
Coordinator  dr. O.G. Meijer
Teaching staff dr. O.G. Meijer
Teaching method(s) Lecture

Course objective
To understand the impact of locomotor pathology on the lives of patients, to know how clinical decision making for such patients unfolds itself, to understand what kind(s) of research we can do to understand locomotor pathology and to help the patients in question, to communicate with others about these topics.

Course content
Pairs of students will attend consultations of two medical specialists (about 8 hours each), then select, together with the specialist, a patient to evaluate, provided this patient agrees with the procedures. Students will then interview the patient, introduce the patient to the course coordinator, and follow the patient's road through the medical system (for about 2 months). Students produce a paper a) presenting the impact of the pathology on the patient's life, b) capturing the kind(s) of research students of Fundamental and Clinical Human Movement Sciences can do (see: aim). These papers are presented, in such a way that each student presents at least once, and that the whole group comes to know about each patient. In principle, the coordinator and the specialist in question will attend this presentation.

Learning activities:
1. Attending consultation. Students select a medical specialization from, e.g., Internal Medicine, the Outpatient Clinic for Pain, Orthopaedic Surgery, Rheumatology, Neurology, Rehabilitation, etc. This choice is made in consultation with the course coordinator.
2. Following patients. It is important that students present the patient as soon as possible to the course coordinator, and that relatively frequent interaction between the students, the patient and the coordinator is maintained until the paper is produced.
3. The relevant literature. The paper will summarize relevant literature on: Current understanding of the pathology, current treatment options, the evidence for those options, and current priorities for research. Students are advised to consult the coordinator to locate relevant papers. For the main content of the paper, see Content.
4. Presentation. The course coordinator and the medical specialist receive the first draft of the paper, and give recommendations to improve it. As soon as the improved version is ready, a meeting is scheduled, in which the paper is presented and discussed. The student's mark is determined by the coordinator and the medical specialist, on the basis of the quality of the written product, the presentation, and, if any, feedback from the host(s) as well as the patient.
Form of tuition
active participation

Type of assessment
presentation
see content.

Course reading
Students are required to select their own literature.

Maximal Neuromuscular Performance

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_MAXNEUR (900678)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 2</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>dr. C.J. de Ruiter</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. C.J. de Ruiter</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture</td>
</tr>
</tbody>
</table>

Course objective
The student has knowledge of the role of muscle activation and (changing) muscle properties on maximal human neuromuscular performance during high intensity exercise and the student has knowledge of the relevant research methods. The student can apply this knowledge to questions regarding testing and improving of maximal neuromuscular performance in sports (and rehabilitation).

The student is able to evaluate the validity and relevance of basic scientific literature for neuromuscular performance in a sport (rehabilitation) related context. The student will be able to communicate ('translate') the implications of basic scientific knowledge of neuromuscular performance to practical issues raised by coaches and therapists in the field of sports (and rehabilitation). The students will learn to critically read scientific papers on neuromuscular performance published in international journals.

Course content
During the course, a critical overview will be given of the current knowledge of maximal neuromuscular performance during relatively high intensity exercise of short duration (40 ms up to 5 min). Most examples will be provided from own research. The emphasis will be on the coupling between basic knowledge of muscle activation and (changing) muscle properties during human movement and their consequences for testing and training.

The following subjects will be addressed:
• Voluntary activation;
• Explosive force/power;
• Influence of temperature (incl. warm-up);
• Potentiation;
• Low frequency fatigue;
• Shortening deficit and lengthening force enhancement;
Recruitment of motor units.
Muscle oxygenation

Form of tuition
7 Lectures (‘hoorcolleges’): 14 hours
Assessment: 2.75-hour exam with open-ended questions.

The course will consist of a series of (four) lectures on basic neuromuscular properties, during which relevant practical questions will be postulated. These questions are addressed by the students in (four) tutorials, which alternate with the lectures.

Type of assessment
2.75-hour exam with open-ended questions.

Entry requirements
Sufficient knowledge of the basics of Muscle Physiology is absolutely necessary. In order to successfully participate, the students have to be familiar with the following concepts: twitch, tetanus, length-force, force- and power-velocity, and stimulation frequency-force relations, the size principle of motor unit recruitment, EMG, electrical stimulation, fibre type related differences in contractile properties, cross-bridge kinetics, excitation contraction coupling.

Mechanical and Adaptive Myology

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_MECHADMYO (900813)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 5</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>dr. R.T. Jaspers</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. R.T. Jaspers</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Seminar, Practical</td>
</tr>
</tbody>
</table>

Course objective
At the end of this course, the student has detailed knowledge and understanding of the principles of functional morphology and physiology of the muscular system embedded within a connective tissue context as well as of the mechanical load induced adaptations thereof. The student is able to apply and discuss this knowledge with respect to problems and questions related to locomotion, movement, training induced muscle adaptation and orthopeadic interventions.

Course content
During the course, a critical evaluation is made of the current knowledge of how muscle structure and function are related and how these properties adapt in response to mechanical loading. This involves the subjects indicated below:
- force exertion by sarcomeres, muscle fibers, muscle and muscle tendon- complexes;
- elasticity;
- functional morphology and determinants of the muscle length- force-velocity characteristics;
- heterogeneity in mechanical properties and functional consequences;
- force transmission between muscle fiber, tendon and fascia;
- adaptation of muscle due to growth, immobilization, training and surgical interventions;
- mechanotransduction and cellular signaling in the regulation of adaptation of muscle size.

**Form of tuition**

lecture  
practical  
tutorial  

The course consists of a series of lectures and tutorials. In this combination, the relevant topics will be addressed, explored and discussed. One practical is included in which the analysis of gene expression in muscle in response to mechanical loading will be introduced.

**Type of assessment**

exam  

The assessment consists of:  
- written examination (essay questions including calculations) - 90%;  
- practical report - 10%.

**Course reading**

Lecture notes, book chapters, research articles and review papers which will be made available before the course.

**Entry requirements**

The student should have basic knowledge and understanding of the muscle anatomy and physiology as well as molecular biology.

**Molecular Biology**

<table>
<thead>
<tr>
<th>Course code</th>
<th>B MOLECULBIO (900801)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Period</strong></td>
<td>Period 1</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Language of tuition</strong></td>
<td>English</td>
</tr>
<tr>
<td><strong>Faculty</strong></td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td><strong>Coordinator</strong></td>
<td>prof. dr. V. Everts</td>
</tr>
<tr>
<td><strong>Teaching staff</strong></td>
<td>prof. dr. V. Everts, dr. ir. T.J. de Vries</td>
</tr>
<tr>
<td><strong>Teaching method(s)</strong></td>
<td>Lecture, Practical</td>
</tr>
</tbody>
</table>

**Course objective**

Learning activities:
1. General overview of molecular biology and its relevance for movement  
   Faculty: Prof.dr. V. Everts*  
   Format: lecture  
2. "Omics" and molecular biology  
   Faculty: Prof.dr. W. Crielaard  
   Format: lecture  
3. Technical approaches in molecular biology  
   Faculty: Dr.ir. T.J. de Vries* and A.M. Schoenmaker  
   Format: lecture, working groups, practical course

**Course content**
This course provides an overview and insight into (1) general aspects of molecular biology, (2) molecular biology in relation to movement (muscles, nerves, bone, tendon), and (3) use of modern molecular biological techniques.

A general overview of molecular biology will be presented. Topics will be discussed like structure and function of DNA, RNA, siRNA, transcription and translation. In addition interference with gene expression will be discussed (e.g., gene transfection, deletion).

Molecular aspects of movement will be discussed with an emphasis on the functioning of muscles, nerves, bones and tendon, as well as other collagen tissue in relation to movement and non-movement. A central issue will be the question how movement or the lack of movement affects the activity and protein expression of the cells associated with these tissues.

Finally an in depth insight in modern biological strategies for the analyses of (defects in) the above mentioned molecular aspects of movement and the tissues involved will be presented.

The following techniques and their applications in cell biology will be highlighted:
1) mutation detection, important for understanding effects of genomic mutations on cellular functioning,
2) RT-PCR, a breakthrough technique developed in the 1980’s, which enables the study of gene expression and its relevance for physiological or pathological processes in minute biological samples,
3) DNA-sequencing, DNA-microarrays and proteomics, elegant and valuable tools for studying gene-variations and gene-expression of a large number of genes in one biological sample,
4) RNA interference, a technique of the last decade with which you can inhibit the expression of specific RNA’s, used to study the function of different genes.
5) Bioinformatics, the development, validation and application of computational techniques to the management, analyses and understanding of biological information.

Ultimate learning objective is to know more about molecular biology and its role in answering movement related research projects.

Form of tuition
The course will include:

Tutorials/lectures for 4 hours on general aspects of Molecular Biology and transfection and deletion (V. Everts).
Tutorials/lectures for 4 hours on bioinformatics, microarrays, genomics and proteomics. (W. Crielaard)
Practicals for 2 days on qPCR and RNA interference (T.J. de Vries and A.M. Schoenmaker).

Type of assessment
Written test with open-ended questions and a written reports on the practicals.
interim examination.

Entry requirements
No entry requirements.
Neurosciences

Course objective
- The student understands the basic structure and function of the neuromuscular system as a model for neuronal communication and interaction;
- The student understands the relation between the electric activity at nerve and muscle cell level and macroscopic electrophysiological non invasive EEG, MEG and EMG measurements;
- The student understands the interpretation of the brain as a dynamic network and can use basic computer simulation techniques to interpret mechanisms;
- The student knows how to collect encephalographic (EEG) data; and interpret such data also in relation with external events
- The student knows the important mechanisms behind central nervous diseases and how these are reflected theoretically in abnormal brain activity;
- The student knows principles and applications of the most often used techniques for (functional) brain imaging (EEG, MEG, (f)MRI, PET).

Course content
This course will approach the function of the human nervous system from different angles. The students will be familiarized with basic approaches to neural communication and interaction. We then will deal with the functional background of mass activity in the central and the peripheral nervous system. The student will become familiar with the general principles of electrophysiology and other neurophysiological imaging techniques. The possible roles of oscillatory neuronal dynamics will be explained. The use of relevant methods in the diagnostic process of peripheral and central nervous disorders and in the recent developments around brain-computer interfaces will be considered.

Form of tuition
Lecturers: 14 ’ 2 hours
Computer lab: 3 ’ 4 hours
Practical: 1 ’ 4 hours
The different themes are globally built up as a set of lectures and – in parts - include laboratory practicals and computer lab practicals.

Type of assessment
An open-book written test with open questions, including some mathematical problems.

Course reading
Obligatory: Research articles and lecture hand-outs will be provided before the course in a course manual.

Entry requirements
- The student should have a basic understanding of the laws of electricity and electrostatics;
- The student should have some active programming experience, preferably with Matlab.

Perception for Action

Course code | B_PERCACTION (900810)
---|---
Period | Period 4
Credits | 3.0
Language of tuition | English
Faculty | Faculteit der Bewegingswetenschappen
Coordinator | prof. dr. J.B.J. Smeets
Teaching staff | prof. dr. J.B.J. Smeets
Teaching method(s) | Lecture, Computer lab

Course objective
The student is able to:
- describe the functioning of the sensory systems relevant for motor control;
- interpret scientific literature in the area of perception and apply it to the field of motor control.

Course content
The topic of this course is the question: how is sensory information processed to guide ones action? More specific: how do we know where a target and (a part of) our body is? The answers to these questions require knowledge about the sensory organs, their signals, and how these signals are processed and combined to be used to control our actions. The main focus will be on the various aspects of visual information (localisation, motion perception, binocular vision, eye movements), but proprioception, haptics, and vestibular information are also treated. The discussion will be about both the phenomenology and the mechanisms. For the latter, some mathematical models describing the coupling will be discussed.

Form of tuition
Amount of contact hours:
Lectures (‘hoorcolleges’) 7
Tutorials (‘werkcolleges’) 7
Assignments & self study 68
Practicals 2

Each meeting will be a combination of tutorial consisting of a discussion of the previous assignment (1 hour), and a lecture introducing to the topic of the next assignment (1 hour)

In the practical, the students will compare two psychophysical techniques and discuss their effectiveness in answering the question what perceptual information is available.
Type of assessment
After each lecture, students receive an assignment. Six of them have to be handed in before the next meeting. These assignments are graded, and count for 10% of the final grade. The assignment after the final lecture will contribute 35%: the remaining 5% on completion of the practical.

Course reading
Literature needed for the course will be distributed during the course.

Entry requirements
No entry requirements. Basic knowledge of the nervous system is expected (e.g. function of various brain areas).

Remarks
- The maximum number of participants in this course is limited to 40

Psychological Factors in Sport

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_PSYFACSPRT (900676)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 2</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>dr. R.R.D. Oudejans</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. R.R.D. Oudejans</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Seminar, Meeting</td>
</tr>
</tbody>
</table>

Course objective
The student is able to:
- give an overview of several psychological factors that play a role in sport, the assumed working mechanisms as well as ways of influencing these factors with mental training;
- critically assess (recent) literature about psychological factors in sport and sport psychology on its thesis, content, empirical rigor and applicability;
- critically discuss (recent) literature about psychological factors in sport and sport psychology in a written report, culminating in the evaluation of the literature and a discussion of implications for sport (psychology) practice;
- critically assess and discuss papers of fellow students on contents, structure, writing and originality.

Course content
In this course several psychological factors that determine performance in sports will be discussed with special focus on the role of attention, anxiety and anticipation and decision-making. Because these topics are crucial in sports practice and because they have a prominent place in research at the Faculty of Human Movement Sciences. Other than that the content is for a large part determined individually as each student writes a paper in a key topic in sport psychology.

Form of tuition
lecture 5 times 2 hours
discussion tutorial 1 meeting 4 hours
There are several lectures on topics in sport psychology. Other than that students will produce an individual paper on a topic in sport psychology and reviews of the papers of their fellow students.

Type of assessment
Students produce a paper (80%) and reviews about papers of other students (20% of the final grade). The paper and reviews must at least be of sufficient quality to pass the course.

Course reading
- Course manual (available on Blackboard);
- Recent articles and book chapters on psychological factors in sport and sport psychology.

Background literature:

Entry requirements
Students should have basic knowledge and understanding of sport psychology as is available in textbooks such as Cox, R.H., Sport Psychology: Concepts and Applications, 6th edition. Boston: McGraw-Hill, 2007.

Research Internship Research Master

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_RIRM (900800)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Ac. Year (September)</td>
</tr>
<tr>
<td>Credits</td>
<td>60.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
</tbody>
</table>

Course objective
During the research internship, students conduct scientific research in a 'master - pupil relationship'.
The research project must be:
- aimed at a suitably challenging research question;
- conducted in a methodologically correct way;
- related to and based on the theory.

The aim the internship is to learn to perform under supervision the components of the research process (formulating a research question, creating a hypothesis, planning and conducting experiments, processing the data, interpretation of the results and reporting) and to gain insight in the connection between these components.

Form of tuition
The student conducts the research internship within one of the research programs of MOVE, under the supervision of one of more MOVE members within the programme. The subject of the internship is chosen in consultation with the coordinator. Students are advised to participate in the meetings of at least one of the MOVE research programs (www.move.vu.nl) during the first year of the MSc program, to prepare the choice of a research topic. Once the subject and the internship supervisor(s) have been established, the student writes a proposal,
comprising research question, hypothesis(es), methods statistics and planning. In addition to a time schedule, the latter should include choices for equipment and indications for organization of the work. After the proposal has been approved by the supervisor(s), it is presented during a meeting of the research group. The time available for supervision is in the order of 80 hrs.

The student can opt to divide the internship in two parts, a major internship (36 EC) to which the above applies and a second internship in another research institute, preferably abroad (24 EC). For these minor internships a MOVE member will be appointed as supervisor (by the coordinator). The main responsibilities for supervision will be delegated to the external supervisor.

**Type of assessment**
The evaluation of the research internship is performed using a standardized form (available on the course blackboard site) and is based on the following elements:
- the research proposal (originality, relevance and methodological quality);
- actual performance of the study, quality of data collection and processing;
- the report (this should contain a description of the work preferably in the format of a journal paper and a detailed description data acquisition, data analysis and data storage);
- The oral presentation of the report during the work group meeting.

The proposal and overall performance of the student during the internship are judged by the internship supervisor(s). The report and the oral presentation are judged by both the internship supervisor(s) and a second assessor from the same research program but not directly involved in the project. The quality of the proposal and the performance of the study make up 40 % of the mark, the report makes up 50 % and the oral presentation makes up the final 10 %.

For minor internships performed outside MOVE, the role of the internal supervisor can be limited to that of assessor of the report. In all cases, the external supervisor advises the MOVE supervisor with respect to the mark on all elements mentioned above, but the MOVE supervisor decides on the final mark.

**Sport Biomechanics**

<table>
<thead>
<tr>
<th><strong>Vakcode</strong></th>
<th>BSPORTBIO (900673)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Periode</strong></td>
<td>Periode 5+6</td>
</tr>
<tr>
<td><strong>Credits</strong></td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Voertaal</strong></td>
<td>Engels</td>
</tr>
<tr>
<td><strong>Faculteit</strong></td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td><strong>Coördinator</strong></td>
<td>dr. ir. J.W. van der Eb</td>
</tr>
<tr>
<td><strong>Lesmethode(n)</strong></td>
<td>Hoorcollege, Practicum, Computerpracticum</td>
</tr>
</tbody>
</table>

**Doel vak**
To apply biomechanical knowledge to sports related problems and understand the difficulties of performing research for the daily support of Athletes.
Inhoud vak
The course will focus on the biomechanical analysis of movements in technical sports. This year the course will focus on areal movements in the flight phase. A mathematical description of the flights phase and the relation between the different rotations about the body axes will be analyzed in detail. In the first part of the practical work the rotational modes of a free body will be analyzed.

In the second part of the practical work a problem from daily sports practice will be analyzed and a proposal will be made as to how the problem can be dealt with and what the implications are for the coach and athlete.

Knowledge of biomechanics, inverse and forward dynamics will be used to tackle current biomechanical problems from gymnastics. Basic and advanced analysis techniques will be discussed and there usability for sports practice.

Onderwijsvorm
Lecture
Practical work

Toetsvorm
Practical report and Oral presentation

Literatuur
Will appear on blackboard.

Aanbevolen voorkennis
A good understanding of biomechanics, inverse and forward dynamics is required:
900104: Biomechanica (Students are expected to have sufficient knowledge of this subject)
9 inverse dynamica (Students are expected to have sufficient knowledge of this subject)
900215: Mechanische analyse van het menselijk bewegen (Students are expected to have sufficient knowledge of this subject)
The course will be using Matlab.

Statistics for Experimental Research

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_STATEXPRES (900683)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 4</td>
</tr>
<tr>
<td>Credits</td>
<td>3.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>dr. M.J.M. Hoozemans</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. M.J.M. Hoozemans</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture, Seminar, Computer lab</td>
</tr>
</tbody>
</table>

Course objective
On the basis of case descriptions and raw data the student is capable to:
• determine the research designs and choose, justify and perform the
appropriate statistical analyses (t-tests or ANOVAs or their non-parametric counterparts) using SPSS.
• report the analyses and the results in the same way as is commonly done in methods and results sections of scientific journal articles.

Course content
Students will learn ins and outs of applying and interpreting statistical techniques that are common or are becoming common in experimental research. The topics covered in this course are:
• Research design
• Basic statistical principles (e.g. data exploration)
• Estimating a population mean from a sample
• Independent and paired t-tests and their associated confidence intervals
• Non-parametric difference tests
• One-way ANOVA (between subjects and repeated measures)
• Factorial ANOVA (two-way between subjects, two-way repeated measures, two-way mixed design)
• Effect size
• Data transformations
• Power and sample size estimation
There will be lectures and SPSS practical sessions for all the topics covered in the course.

Form of tuition
The four days of teaching are taken up with lectures, tutorials and SPSS practical sessions with session assignments in which students perform statistical tests.

Type of assessment
The students have to take an interim examination. It will focus on t-tests, non-parametric difference tests, one-way ANOVA and factorial ANOVA.

Course reading

Studentbegeleiding

<table>
<thead>
<tr>
<th>Vakcode</th>
<th>B_STDBEG ()</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periode</td>
<td>Ac. Jaar (september)</td>
</tr>
<tr>
<td>Credits</td>
<td>6.0</td>
</tr>
<tr>
<td>Voertaal</td>
<td>Nederlands</td>
</tr>
<tr>
<td>Faculteit</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coördinator</td>
<td>drs. M.G.J. Buijtenweg</td>
</tr>
</tbody>
</table>

Time Series Analysis
Course objective
Students will learn various techniques for the analysis of time series. A brief sketch of the mathematical background will enable students to select and apply proper methods for the study of signals typically found in the movement sciences. As examples range from kinematic and (neuro-) physiological signals students will get well-equipped to analyze and interpret their own experimental recordings.

Course content
Recent advances in recording techniques and increasing data storage capacity render time series analysis a challenge. In this course various uni-, bi-, and multivariate methods for the study of experimental data will be outlined and critically discussed. Statistical time-domain approaches go hand in hand with Fourier analysis, Hilbert and Gabor transforms, wavelet decomposition, et cetera. For the multivariate extension primary focus will be on principal and independent component analysis and on investigating recordings of whole-body kinematics and electromyographic signals. All techniques will be discussed based on current research articles and implemented by means of numerical exercises (Matlab).

Form of tuition
21 contact hours (4 seminars, 7 practicals, 10 lectures); 59 hours self-study

A mixture of lectures, seminars, and computer practicals. At the computer students will analyze typical examples of movement-related, temporal data like kinematic or electromyographic signals. During the seminars, research articles on the analysis of movement dynamics will be discussed on the basis of brief summaries written by the students (writing assignment).

Type of assessment
60% of the grade is determined by the written exam (essay questions). 20% is determined by the quality of the written summaries and 20% by the quality of solution of the computer practicals.

Course reading
• Several research articles that will be provided

Entry requirements
Basic knowledge of Matlab is mandatory.

Recommended background knowledge
Tissue Engineering and Mechanobiology

Basic knowledge of Matlab is mandatory

Course objective
The student is capable of:
- describing and understanding the importance of regenerative medicine, and provide arguments;
- understanding tissue engineering, stem cell- based tissue engineering for clinical application, and mechanobiology;
- giving argumentation of scientific conclusions using journal publications on tissue engineering, stem cell- based tissue engineering for clinical application and mechanobiology;
- summarizing and explain the key issues of a scientific text on tissue engineering, stem cell- based tissue engineering for clinical application and mechanobiology;
- applying gained knowledge and understanding of tissue engineering, stem cell- based tissue engineering for clinical application and mechanobiology, and placing this in a clinical context.

Form of tuition
lecture
tutorial

Lectures
- Introduction to tissue engineering;
- Stem cell- based tissue engineering for clinical applications;
- Introduction to mechanobiology.

Tutorials
The tutorials are given in working groups, which are introduced with a lecture. There is study material available in order to support both lecture and working groups. The subjects are:
- tissue engineering;
- stem cell- based tissue engineering for clinical applications;
- mechanobiology.

Following the lecture, the working group is briefly introduced by the teacher, after which the students are divided into small groups. Each group studies the scientific publications. This is done using instructions and questions which will be provided. At the end, the publications are discussed with each other, so that all group members understand the publication.

Type of assessment
Written exam (multiple choice + open questions)
Course reading
Introduction to tissue engineering

Stem cell-based tissue engineering for clinical applications

Introduction to mechanobiology

Treating Locomotor Disease

<table>
<thead>
<tr>
<th>Course code</th>
<th>B_LOCOMOTOR (900818)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Period 2+3</td>
</tr>
<tr>
<td>Credits</td>
<td>6.0</td>
</tr>
<tr>
<td>Language of tuition</td>
<td>English</td>
</tr>
<tr>
<td>Faculty</td>
<td>Faculteit der Bewegingswetenschappen</td>
</tr>
<tr>
<td>Coordinator</td>
<td>prof. dr. J. Harlaar</td>
</tr>
<tr>
<td>Teaching staff</td>
<td>dr. E.E.H. van Wegen</td>
</tr>
<tr>
<td>Teaching method(s)</td>
<td>Lecture</td>
</tr>
</tbody>
</table>

Course objective
1. Knowledge and Understanding:
   - A general knowledge of and insight into the main clinical issues (epidemiology, pathophysiology, consequences and treatment modalities) with regard to diseases that affect the locomotor system.
   - Knowledge of current research questions and translational research projects at VUmc/MOVE
2. Applying knowledge and Understanding:
- The ability to integrate knowledge from human movement sciences and medicine
- The ability to frame tentative research questions relevant to a specific locomotor disease, by applying knowledge from human movement science.

3. Making Judgments:
- The ability to reflect on ethical and practical issues that constrain the feasibility to perform applied studies in the area of locomotor diseases.
- The ability to formulate relevant hypotheses regarding research questions on translational research in locomotor diseases.
- The ability to reflect on the scientific relevance and societal value of achievements in translational research on locomotor diseases.

4. Communication:
- The ability to communicate with fellow researchers as well as clinicians, and finding ways to bridge gaps between different conceptual frameworks that are current in human movement science and medicine.

5. Learning skills:
- The ability to write a research proposal that could serve as starting point for a research master thesis (i.e. a scientific report in the form of a scientific (peer-reviewed) paper).

Course content
This course provides an overview of leading innovative research and medical treatments in the field locomotor disease, rehabilitation and movement science. Each topic of this module is designed around a clinical theme, i.e. a specific disease. A general introduction will include a discussion on the main clinical problems, related to the design of possible new treatments. This discussion will be focused on how methods and techniques from the several medical disciplines as well as the movement sciences are being applied to study and treat locomotor disease. Both neurological diseases (progressive as well as non progressive) as degenerative diseases of the skeletal system will be discussed. Also general principles of clinical movement analysis and outcome measurements are part of this module.

Form of tuition
Topics:
Joint Replacement
Hand Surgery
Parkinson’s Disease
Cerebral Palsy
Cerebro Vascular Accident
Clinical Movement Analysis
Rheumatoid Arthritis
Osteoarthritis
Endocrinology/Osteoporosis
Clinimetrics in Neurorehabilitation
Multiple Sclerosis
Ankylosing Spondilitis
Obstetric Plexus Brachialis Lesion
Amputation/ prosthetics
Spinal Cord Injury

Type of assessment
paper: research proposal 100%
Course reading
- literature to be studied: will be provided through blackboard
- additional literature: will be provided through blackboard

Entry requirements
Not applicable