

**UČNI NAČRT PREDMETA / COURSE SYLLABUS**

**Predmet:** Raziskovalne metode in modeliranje v biomehaniki športnih gibanj  
**Course title:** Research methods and Modelling in Sport movement Biomechanics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Doktorski študij		1	1 ali 2
Doctoral study program		1	1 or 2

**Vrsta predmeta / Course type**

izbirni

**Univerzitetna koda predmeta / University course code:**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	15	15		65		5

**Nosilec predmeta / Lecturer:**

izr. prof. dr. Matej Supej

**Jeziki /**

**Predavanja / Lectures:** Slovenski/Slovene

**Languages:**

**Vaje / Tutorial:** Slovenski/Slovene

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Izpolnjevanje pogojev za vpis na doktorski študij Kineziologija

**Prerequisites:**

General conditions for enrolment into the Doctoral Programme of Kinesiology

**Vsebina:**

- Teorija raziskovalnih metod na področju biomehanike športa:
  - direktne metode merjenja,
  - indirektne metode merjenja,
  - modeliranja in simulacije.
- Uporaba merilne tehnologije vezano na različne športne zvrsti kot so:
  - alpsko smučanje,
  - nordijsko smučanje,
  - igre z loparji,
  - igre z žogo,
  - gimnastika,
  - atletika,
  - konjenišтво,
  - vodni športi,
  - druge.
- Problematika napak merjenja:
  - natančnost merilnega sistema,
  - sistematične napake,
  - naključne napake.
- Obdelava izmerjenih podatkov:

**Content (Syllabus outline):**

- Theory of research methods in sport biomechanics:
  - direct measurement methods,
  - indirect measurement methods,
  - modelling and simulations.
- Use of measurement technology in relation to different sports such as:
  - Alpine skiing,
  - Nordic skiing,
  - racquet games,
  - ball games,
  - gymnastics,
  - athletics,
  - equestrian sports,
  - water sports,
  - other.
- Problems associated with measurement errors:
  - accuracy of the measurement system,
  - systemic errors,

- numerične metode,
- matematično in fizikalno modeliranje,
- osnove filtriranja podatkov.
- Osnove obdelave podatkov v okolju Matlab
  - seznanitev z okoljem
  - skalar, vektor, matrika
  - uporaba funkcij in računanje s podatki
  - izrisovanje grafov
  - »avtomatska« obdelava in osnove programiranja
- Analiza in interpretacija rezultatov.

- random errors.
- Processing of measurement data:
  - numerical methods,
  - mathematical and physical modelling,
  - basics of data filtration.
- Data processing basics in the Matlab environment:
  - learning about the environment,
  - scalar, vector, matrix,
  - use of functions and calculation with data,
  - drawing graphs,
  - 'automated' processing and programming basics.
- Analysis and interpretation of results.

### Temeljni literatura in viri / Readings:

Winter D. A.: Biomechanics and motor control of human movement (2nd ed.). – New York: J. Willey, 1990.

Zastiorsky V.M.: Kinetics of human motion, Human Kinetics, 2002

Zastiorsky V.M.: Kinematics of human motion, Human Kinetics, 1998

Enoka, R.M. (1994) Neuromechanical basis of kinesiology. Human Kinetics, Champaigne.

De Mestre, N., The mathematics of projectiles in sport, Cambridge University press, 1990

Omladič, V., Uporaba linearne algebre v statistiki. Ljubljana, Fakulteta za družbene vede, 1997

Bohte, Z., Numerične metode. Ljubljana: Društvo matematikov, fizikov in astronomov Slovenije, 1991

### Cilji in kompetence:

#### Cilji

- Spoznati se z raziskovalnimi metodami v biomehaniki športa.
- Spoznati se z modeliranjem športnih gibanj v povezavi z izmerjenimi podatki.
- Spoznati se z aktualno merilno opremo iz področja biomehanike športa.
- Osvojiti znanja iz obdelave izmerjenih podatkov v biomehaniki športnih gibanj.
- Spoznati se z načini interpretacije različnih biomehanskih parametrov

### Objectives and competences:

#### Objectives

- Learn about research methods in biomechanics of sport
- Learn about sport movement modelling in relation to measured data
- Learn about the contemporary measurement equipment in biomechanics of sport
- Gain knowledge of processing of measured data in biomechanics of sport movements

### *Splošne kompetence*

- Sposobnost iskanja novih dejstev, njihove interpretacije in integracije v kontekst študija
- Sposobnost prepoznavati in preučevati posledice interakcije okolja in človeka in preventivno delovanje s ciljem trajnostnega razvoja
- Sposobnost znanstveno-raziskovalnega dela, na nacionalni in mednarodni ravni, na področju kineziologije in presečnih ved
- Sposobnost kritičnega preverjanja informacij in predvidevanja rešitev in posledic

### *Predmetnospecifične kompetence*

- Poglobljeno poznavanje različnih raziskovalnih pristopov v biomehaniki športnih gibanj
- Poglobljeno poznavanje biomehanskih merilnih metod
- Sposobnost abstrahiranja, analize in sinteze izmerjenih in modeliranih podatkov človeškega telesa pri različnih gibalnih nalogah
- Sposobnost interdisciplinarnega povezovanja znanj ved, ki se prepletajo z biomehaniko človeškega gibanja

- Learn about the methods of interpretation of different biomechanical parameters

### *General competences*

- Ability to find new facts, interpret them and integrate them in the study context
- Ability to identify and investigate the consequences of the environment-man interaction and preventive action to achieve sustainable development
- Ability to perform scientific-research work at the national and international levels in the field of kinesiology and related sciences
- Ability to critically assess information and foresee the solutions and consequences

### *Subject-specific competences:*

- In-depth knowledge of different research methods in sport movement biomechanics
- In-depth knowledge of measurement methods in biomechanics
- Ability to abstract, analyse and synthesise the measured and modelled data on human body in different motor tasks

Ability to make inter-disciplinary connections in knowledge gained from sciences that are interrelated with the biomechanics of human movement.

### **Predvideni študijski rezultati:**

#### *Znanje in razumevanje:*

Poznavanje in razumevanje temeljnih raziskovalnih metod v biomehaniki športnih gibanj v povezavi s koncepti delovanja gibalnega aparata, njegovih obremenitev in zdravstvenih posledic pri nekaterih vsakodnevni in športnih obremenitvah.

Uporabno znanje rokovanja z različno aktualno merilno opremo na področju biomehanike športnih gibanj.

Poznavanje omejitev in prednosti različne merilne opreme omogoča njeno optimalno izbiro v različnih pogojih merjenja.

Spozna se z obdelavo in interpretacijo podatkov ter osnovami avtomatizacije obdelave podatkov.

#### *Uporaba*

Pridobljena znanja iz raziskovalnih metod in biomehanskih modeliranj športnih gibanj predstavljajo platformo za delo na raziskovalnem področjih varnega, racionalnega, učinkovitega in uspešnega gibanja, na področju ergonomije in drugih presečnih ved, kjer je potrebno znanje iz

### **Intended learning outcomes:**

#### *Knowledge and understanding:*

Knowledge and understanding of the basic research methods in biomechanics of sport movements related to the concepts of locomotor movement, loading and health consequences in some everyday and sport loadings.

Practical knowledge of operating different modern measurement equipment in the field of biomechanics of sport movements.

Knowledge of the limitations and advantages of different measurement equipment enables optimal selection in different measurement conditions.

Knowledge of data processing and interpretation as well as the basics of data processing automation.

#### *Application*

The acquired knowledge of research methods and biomechanical modelling of sports movements represent a platform for work in research areas of safe, rational, effective and efficient movement, in the area of ergonomics and other related sciences requiring knowledge of human movement in

razumevanja človeškega gibanja v interakciji z okolico, drugimi ljudmi in športnimi ali drugimi rekviziti.

**Prenosljive spretnosti:**

Študent pridobi tudi nekatera znanja za diagnostično in industrijsko raziskovalno-razvojno delo.

interaction with the environment, other people and sport and other devices.

**Transferrable skills:**

Students also gain some knowledge of diagnostic and industrial research-development work.

**Metode poučevanja in učenja:**

Teoretična predavanja, laboratorijsko in seminarsko delo.

**Learning and teaching methods:**

Theoretical lectures, laboratory and seminar work.

<b>Načini ocenjevanja:</b>	Delež (v %) / Weight (in %)	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt)  Projekt s seminarjem in ustni izpit.	<b>100 %</b>	Type (examination, oral, coursework, project):  The project seminar and oral examination.

**Reference nosilca / Lecturer's references:**

SUPEJ, Matej, SÆTRAN, L., OGGIANO, Lucca, ETTEMA, Gertjan, ŠARABON, Nejc, NEMEC, Bojan, HOLMBERG, Hans-Christer. Aerodynamic drag is not the major determinant of performance during giant slalom skiing at the elite level. *Scandinavian journal of medicine & science in sports*, 2013, vol. 23, no. 1, str. e38-e47

SUPEJ, Matej, HOLMBERG, Hans-Christer. A new time measurement method using a high-end global navigation satellite system to analyze alpine skiing. *Res. q. exerc. sport*, 2011, vol. 82, no. 3, str. 400-411

SUPEJ, Matej, KIPP, R., HOLMBERG, Hans-Christer. Mechanical parameters as predictors of performance in alpine world cup slalom racing. *Scandinavian journal of medicine & science in sports*, 2011, vol. 21, no. 6, str. 72-81

SUPEJ, Matej, HOLMBERG, Hans-Christer. How gate setup and turn radii influence energy dissipation in slalom ski racing. *J. appl. biomech.*, 2010, vol. 26, no. 4, str. 454-464

SUPEJ, Matej. 3D measurements of alpine skiing with an inertial sensor motion capture suit and GNSS RTK system. *J. sports sci.* [Print ed.], 2010, vol. 28, no. 7, str. 759-769

SUPEJ, Matej. Differential specific mechanical energy as a quality parameter in racing alpine skiing. *J. appl. biomech.*, 2008, vol. 24, no. 2, str. 121-129