

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: Modul C: Biomehanika
Course title: Module C: Biomechanics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Podiplomski magistrski študijski program druge stopnje Elektrotehnika	Vse smeri	1	2
2 nd cycle masters study programme in Electrical Engineering	All study fields	1	2

Vrsta predmeta / Course type

Izbirni-strokovni /elective professional

Univerzitetna koda predmeta / University course code:

64263

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
45		30			75	6

Nosilec predmeta / Lecturer:

Roman Kamnik

Jeziki / Languages
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Predavanja / Lectures: angleški / English
Vaje / Tutorial: angleški / English

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

Vpis v letnik predmeta.

Prerequisites:

Enrolment in the year of the course

Vsebina:

Uvod v biomehaniko (razvoj skozi zgodovino, aktualna področja, znanstveni pristop k biomehanskim študijam) in osnovni pojmi; Mišično-skeletni gibalni sistem pri človeku (model mišice kot aktuatorja, mehanika sklepov); Obravnava togih in deformabilnih teles v mirovanju (osnove statične analize, težišče, ravnotežje, notranje obremenitve,

Content (Syllabus outline):

Introduction to Biomechanics (development of biomechanics through history, areas of biomechanics, approach to the research) and fundamental terminology; Musculoskeletal motion system in human (human muscle as actuator, joint mechanics); Analysis of rigid and deformable bodies in static conditions (static analysis, center of mass,

deformacije); Obravnava biomehanskega sistema človeka v gibanju (opis kinematičnih in kinetičnih parametrov, mehanika sklepov, merjenje gibanja in določitev obremenitev v sklepih, energijske razmere, ocenjevanje funkcionalnih sposobnosti, zakonitosti gibanja pri dinamičnih manevrih hoje, teka, vstajanja in veslanja); *Gibalna vadba z inteligentnimi napravami s sprotno biomehansko analizo in posredovanjem povratne informacije.*

analysis of elastic materials, deformations, strength of materials); Analysis of human motion (kinematic and kinetic parameters, joint mechanics, motion assessment, joint loadings assessment, energy conditions, assessment of functional capabilities, motion laws in dynamic manoeuvres of walking, running, standing-up and rowing); Motion exercise by intelligent devices incorporating on-line biomechanical analysis and presentation of feedback information.

Temeljni literatura in viri / Readings:

1. J. D. Humphrey, S.L. Delange, An Introduction to Biomechanics, Solids and Fluids, Analysis and Design, Springer Verlag, New York, 2004.
2. Y.C. Fung, Biomechanics, Mechanical Properties of Living Tissues, Springer Verlag, New York, 2004.
3. D. A. Winter, Biomechanics and Motor Control of Human Movement, John Wiley & Sons, New Jersey, 2009.
4. D. Knudson, Fundamentals of Biomechanics, Springer, New York, 2007.
5. M. Nordin, V. H. Frankel, Basic Biomechanics of the Musculoskeletal System, Wolters Kluwer Health, 2012.
6. P. McGinnis, Biomechanics of Sport and Exercise, Human kinetics, Auckland, 2004.

Cilji in kompetence:

Cilj predmeta Biomehanika je študentu podati znanje tehniške mehanike, ki je uporabno pri študiju gibanja živih sistemov. Predmet vključuje področja, ki obravnavajo gibanje in mirovanje togih in deformabilnih teles. Študent spozna principe uporabe Newtonove mehanike in senzornih sistemov pri analizi gibanja človeka. Predmet daje teoretične osnove za interdisciplinarno delo na področju ocenjevanja ter rehabilitacijske ali športne vadbe gibalnega sistema človeka. Hkrati je z vidikov prenosa rešitev narave v tehniko pridobljeno znanje podlaga za razvoj robotskih sistemov, umetnih organov, biomaterialov, rehabilitacijskih pripomočkov, simulacijskih modelov in inteligentnih naprav za vadbo v rehabilitaciji in športu.

Objectives and competences:

The objective of the course on Biomechanics is to familiarize students with fundamental laws of mechanics and to present how these can be applied to understanding and analyzing of the living systems. The foundations of biomechanics that are developed in this course include the mechanics of materials and structures of rigid and deformable bodies. The course gives the basic knowledge for interdisciplinary work in the fields of human motion assessment and exercise in rehabilitation and sport. From the perspectives of solutions transfer from nature the knowledge is fundamental in development of robotic systems, artificial organs, biomaterials, rehabilitation products, simulation models, and intelligent devices for exercise in rehabilitation and sport.

Predvideni študijski rezultati:

Po uspešno opravljenem modulu naj bi bili študenti zmožni:

- razviti matematični model gibanja deformabilnih in nedeformabilnih materialnih teles,
- opisati biomehanske pogonske mehanizme,

Intended learning outcomes:

After successful completion of the course, students should be able to:

- develop a mathematical model for the movement of deformable and non-deformable material bodies,
- describe biomechanical propulsion mechanisms,

- uporabiti senzorne sisteme za merjenje parametrov gibanja in obremenitev človeškega telesa, ki so v uporabi v kliničnem ali športnem okolju,
- analizirati gibanje človeka in učinke na njegovo telo,
- izračunati obremenitve v sklepih večsegmentnega sistema med gibanjem,
- razložiti mehanizme večnožne lokomocije in vzdrževanja ravnotežja.

- use sensory systems for assessment of the movement parameters and human body loadings that are used in a clinical or sports environment,
- analyze the motion of a person and the effects on his body,
- calculate the loadings in the joints of the multi-segment system during movement,
- explain the mechanisms of multileg locomotion and maintaining the body balance.

Metode poučevanja in učenja:

Na predavanjih so predstavljene teoretične osnove obravnavanih poglavij skupaj s prikazom rešitev enostavnih praktičnih primerov. Študentom je na voljo študijski material s podrobno vsebino. Praktično delo poteka v okviru laboratorijskih vaj. Te so zasnovane projektno v več delih, v katerih se študentje postopoma seznanjajo s problemom in instrumentacijo. Projektno skupino sestavljata dva ali trije študentje, ki opravijo biomehansko analizo gibalnega manevra pri športni vadbi, npr. skoka, kolesarjenja, veslanja ali teka. Ob koncu semestra študentje poročajo o končnih rezultatih s primerjavo izsledkov iz literature.

Learning and teaching methods:

The lectures provide a theoretical background on particular subjects together with presentation of simple practical examples. A complete study material is available to the students. Practical work is being performed in the laboratory environment, and is accomplished in steps acquainting students with the problem and instrumentation. Project group is consisted of two or three students who accomplish the biomechanical analysis of motion maneuver, e.g. jumping, cycling, rowing or running. At the end of semester, students report on their results together with comparison to the results from the literature.

Načini ocenjevanja:

Delež (v %)
/
Weight (in %)

Assessment:

Način: laboratorijske vaje, pisni izpit, ustni izpit.
Ocena 5 je negativna ocena,

Type: laboratory exercises, written exam, oral exam.
Negative grades is 5, positive

ocene od vključno 6 do 10 so pozitivne. Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu. Prispevki k oceni: laboratorijske vaje pisni izpit ustni izpit	40% 35% 25%	grades: from 6 to 10. Positive evaluation of laboratory exercises is a prerequisite for the exam. Contributions to final grade: laboratory exercises written exam oral examination
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Reference nosilca / Lecturer's references:

1. AMBROŽIČ, Luka, GORŠIČ, Maja, GEEROMS, Joost, FLYNN, Louis, LOVA, Molino, KAMNIK, Roman, MUNIH, Marko, VITIELLO, Nicola. Cyberlegs : a user-oriented robotic transfemoral prosthesis with whole-body awareness control. *IEEE robotics & automation magazine*, Dec. 2014, vol. 21, no. 4, str. 82-93.
2. ŠLAJPAH, Sebastjan, KAMNIK, Roman, MUNIH, Marko. Kinematics based sensory fusion for wearable motion assessment in human walking. *Computer Methods and Programs in Biomedicine*, Sep. 2014, vol. 116, no. 2, str. 131-144.
3. GORŠIČ, Maja, KAMNIK, Roman, AMBROŽIČ, Luka, VITIELLO, Nicola, LEFEBER, Dirk, PASQUINI, Guido, MUNIH, Marko. Online Phase Detection Using Wearable Sensors for Walking with a Robotic Prosthesis, *Sensors*. 2014, vol. 14, pp. 2776-2794.
4. AMBROŽ, Miha, PREBIL, Ivan, KAMNIK, Roman, MUNIH, Marko. System for interactive scientific driving simulation with haptic information. *Advances in engineering software*, Mar. 2012, vol. 45, iss. 1, str. 239-251.
5. ČERNE, Tomaž, KAMNIK, Roman, MUNIH, Marko. The measurement setup for real-time biomechanical analysis of rowing on an ergometer. *Measurement*, Dec. 2011, vol. 44, no. 10, str. 1819-1827.