UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Biorobotika
Course title:	Biorobotics

Študijski program in stopnja Study programme and level	Modul Module	Letnik Academic year	Semester Semester
Informacijske in komunikacijske tehnologije, 3. stopnja	Inteligentni sistemi in robotika	1	1
Information and Communication Technologies, 3rd cycle	Intelligent Systems and Robotics	1	1

Vrsta predmeta / Course type	Izbirni / Elective
Univerzitetna koda predmeta / University course code:	IKT3-627

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Druge oblike	Samost. delo Individ. work	ECTS
15	**15**			**15**	**105**	**5**

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transfered to individual work.*

Nosilec predmeta / Lecturer:	Prof. dr. Jan Babič

Jeziki / Languages:	**Predavanja / Lectures:**	slovenščina, angleščina / Slovenian, English
	Vaje / Tutorial:	

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Zaključena druga stopnja bolonjskega študija ali diploma univerzitetnega študijskega programa. Pri tem predmetu je potrebno predznanje matematike, fizike, znanje o sistemih vodenja in programiranja. Priporočeni predmeti: • inteligentni sistemi vodenja robotov • robotski vid	Completed Bologna second cycle study program or an equivalent pre-Bologna university study program. This course requires profound knowledge of mathematics, physics, theory of control systems and computer programming. Recommended courses: • Intelligent robot control • Robot vision

Vsebina:	**Content (Syllabus outline):**
• Uvod v mehaniko in motorično vodenje živali in ljudi • Mehanika mišično-skeletnega sistema in principi nevronskega sistema vodenja • Metode zajemanja gibanja in merjenje biomehanskih parametrov	• Introduction to mechanics and motor control of animals and humans • Mechanics of musculoskeletal system and principles of neural control • Motion capture methods and acquisition of biomechanical parameters

- Uporaba biomehanike pri razvoju humanoidnih mehanizmov
- Učenje robotov
  - s posnemanjem
  - spodbujevalno učenje
- Humanoidni roboti v človekovem okolju (sodelovanje človeka z robotom)
- Biološko motivirani robotski sistemi
- Lokomocija
- Senzorski sistemi za zaznavo okolja
- Uporaba servisnih robotov

- Application of biomechanics in the development of humanoid mechanisms
- Learning of humanoid and service robots
  - Imitation learning
  - Reinforcement learning
- Humanoid robots in human environments (human – robot cooperation)
- Biologically inspired robotic systems
- Locomotion
- Advanced sensory systems for environment detection and localisation
- Service robots applications.

Temeljna literatura in viri / Readings:

Izbrana poglavja iz naslednjih knjig: / Selected chapters from the following books:

- R.M. Enoka: Neuromechanics of Human Movement, 3rd edition, Human Kinetics Books, 2002. ISBN 0-736-00251-0
- D.A. Winter: Biomechanics and Motor Control of Human Movement, John Wiley & Sons, 2005. ISBN 0-471-50908-6
- J.M. Winters, P.E. Crago: Biomechanics and Neural Control of Posture and Movement, Springer, 2000. ISBN 0-387-94974-7
- B. Siciliano, O. Khatib (Eds.): Springer Handbook of Robotics, Springer-Verlag Berlin Heidelberg, 2008. ISBN 9893540239574
- J.H. Connell, S. Mahadevan: Robot Learning, Springer, 1993. ISBN 9780-7923-9365-8

Cilji in kompetence:

Cilj predmeta je razumeti osnovne biomehanske principe gibanja, osvojiti znanja iz osnov biorobotike, vodenja, učenja ter uporabe humanoidnih robotov. Poudarek je na sodobnih pristopih vključevanja robotskih mehanizmov v človekovo okolje.

Pridobljena znanja bodo omogočila študentom razumevanje principov gibanja in obvladovanje osnov sodobnih tehnologij s področja biorobotike ter prenos teh tehnologij v prakso.

Objectives and competences:

The objective of this course is to understand the basics biomechanical principles of motion, to obtain theoretical and practical knowledge of the basics of biorobotics, control, learning and applications of humanoid robots. The emphasis is on modern approaches of the integration of robot systems into human-like environments.

The obtained knowledge will allow the students to understand the basic principles of motion and handle modern technologies of biorobotics and to apply these technologies into real practice.

Predvideni študijski rezultati:

Študent z uspešno opravljenimi obveznostmi tega predmeta:

- izkazuje znanje in razumevanje s področja biomehanike in motoričnega vodenja živali in ljudi,
- zna analitsko opredeliti lastnosti biorobotov in utemeljiti njihov namen,
- zna uporabiti pridobljeno znanje za izvedbo, analizo in ovrednotenje aplikacije v sodobni robotiki,
- razume pomen in strukturo humanoidnega robota,
- pozna vrste biorobotov, njihove značilnosti in tipična področja uporabe tovrstnih robotov ter vzroke za uporabo humanoidnih robotov.

Intended learning outcomes:

Student successfully completing this course will:

- demonstrates the knowledge and understanding of biomechanics and motor control of animals and humans,
- is able to analytically determine properties of biorobots and justify their purpose,
- is able to apply the knowledge to implement, analyse and evaluate applications in contemporary robotics,
- understands the structure and sense of a humanoid robot,
- knows the various types of biorobots and their characteristics and knows the most common areas of applications for such robots and reasons for application of humanoid robots.

Metode poučevanja in učenja:

Predavanja, konzultacije, seminarji, laboratorijsko delo

Learning and teaching methods:

Lectures, consultancy, seminar work, laboratory work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Ustni izpit, Seminarska naloga Zagovor	50% 25% 25%	Oral exam, Seminar work Oral defense

Reference nosilca / Lecturer's references:

- **Babic, J.**, Hale, J. G., & Oztop, E. (2011). Human sensorimotor learning for humanoid robot skill synthesis. Adaptive Behavior, 19(4), 250–263.
- **Babič, J.**, Petrič, T., Peternel, L., & Sarabon, N. (2014). Effects of supportive hand contact on reactive postural control during support perturbations. Gait & Posture, 40, 441–446.
- Gams, A., Petric, T., Debevec, T., & **Babic, J.** (2013). Effects of robotic knee exoskeleton on human energy expenditure. IEEE Transactions on Bio-Medical Engineering, 60(6), 1636–44.
- Peternel, L., Petric, T., Oztop, E., & **Babic, J.** (2014). Teaching robots to cooperate with humans in dynamic manipulation tasks based on multi-modal human-in-the-loop approach. Autonomous Robots, 36(1-2), 123–136.
- Peternel, L., Tomoyuki, N., Petric, T., Ude, A., Morimoto, J., & **Babic, J.** (2015). Adaptive control of exoskeleton robots for periodic assistive behaviours based on EMG feedback minimisation. IEEE Transactions on Mechatronics.