2025/2026

Univerza v Mariboru
Medicinska fakulteta

UČNI NAČRT PREDMETA / SUBJECT SPECIFICATION	
Predmet:	Laserji v medicini
Subject Title:	Lasers in medicine

Študijski program Study programme	Študijska smer Study field	Letnik Year	Semester Semester
Dentalna medicina Dental medicine	Dentalna medicina Dental medicine	4	**4**

Vrsta predmeta / Course type	Izbirni/Elective
Univerzitetna koda predmeta / University subject code:	

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Labor. work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
15	15		15		45	**3**

Nosilec predmeta / Lecturer:	Red. prof. dr. Miljenko Križmarić, red. prof. dr. Marko Marhl

Jeziki / Languages:	**Predavanja / Lecture:**	slovenski/Slovene
	Vaje / Tutorial:	Slovenski/Slovene

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

POGOJI ZA PRISTOP K USTNEMU IZPITU:
- opravljene laboratorijske/klinične/terenske vaje,
- opravljena seminarska naloga,
- pozitiven pisni izpit (v primeru opravljenih kolokvijev, le-ti nadomestijo pisni izpit).

Prerequisits:

REQUIREMENTS FOR ACCESS TO ORAL EXAM:
- Lab/Clinical/Field practice completed,
- seminar paper completed,
- positive written exam (written exam can be recognized on the basis of partial written examinations).

Vsebina:

Osnove laserjev: fizikalni principi laserjev - spektri laserske svetlobe in sevanje, optika laserjev in modeli sevanja.

Varnost pri delu z laserji: varnostna pravila za medicinsko osebje in paciente, nacionalni in mednarodni varnostni standardi, etika, varnostna oprema, obvladovanje neželenih učinkov.

Vpliv laserskega sevanja na tkiva: odboj, sipanje, prenos in absorpcija v tkivih, fototermični, fotokemični in fotodegradacijski učinki, terapevtsko okno – doza sevanja, temperaturno območje, območje moči laserja.

Tipi in lastnosti laserjev: CO_2 laser, Diodni laser, Erbijevi laserji (fizikalne in tehnične lastnosti Er:YAG in Er,Cr:YSGG laserjev), Nd:YAG laserji, HeNe laser.

Klinična uporaba laserjev:
- pregled aplikacij laserjev v diagnostiki, preventivi,

Content (Syllabus outline):

Fundamentals of lasers: physical principles of lasers - laser light spectrum and radiation, laser optics, and emission models.

Laser safety: the laser safety rules for medical staff and patients, national and international safety standards, ethics, safety equipment, adverse effects managing.

Laser radiation effect on tissues: reflection, scattering, transmission, and absorption in tissues, photothermal, photochemical, and photodegradation effects, therapeutic window – radiation dose, temperature range, laser power range.

Laser types and characteristics: CO_2 laser, diode laser, Erbium lasers (physical and technical properties of Er:YAG and Er,Cr:YSGG lasers), Nd:YAG lasers, HeNe laser.

Clinical application of lasers:
- review of laser applications in diagnostics,

estetiki, kirurgiji, nekirurških posegih, fotodinamične terapije celjenja, regeneracije in apllikacije citotoksinov;
- uporaba laserjev v parodontologiji in implantologiji, lasersko podprto konzervativno, endodontsko in ortodontsko zobozdravstvo, laserji v otroškem zobozdravstvu, intraoralna kirurgija mehkih in trdih tkiv, celjenje ran in obvladovanje bolečine;
- aplikacije laserjev v dermatologiji, angioplastiki, očesni kirurgiji, plastični kirurgiji, celjenju ran, zdravljenju raka.

Kratek pregled vsebin laboratorijskih/kliničnih/terenskih vaj (ekskurzija/praktikum v podjetju laserjev):

- varno delo z laserji v praksi
- uporaba in rokovanje z laserskimi sistemi
- implementacija laserjev v klinični praksi, npr.:
  - diagnostika: detekcija kariesa
  - klinična aplikacija v parodontologiji in implantologiji: ne-kirurška terapija
  - klinična aplikacija v endodontiji: dezinfekcija koreninskih kanalov
  - mehko- in trdo-tkivna kirurgija na živalskih tkivih
- izmenjava izkušenj s strokovnimi sodelavci iz prakse (podjetniško okolje)
- spoznavanje najsodobnejših laserskih sistemov na trgu

prevention, aesthetics, surgery, non-surgical interventions, photodynamic healing therapy, regeneration and application of cytotoxins;
- use of lasers in periodontology and implantology, laser-assisted conservative dentistry, endodontics and orthodontics, lasers in pediatric dentistry, intraoral soft and hard tissue surgery, wound healing, and pain management;
- applications of lasers in dermatology, angioplasty, eye surgery, plastic surgery, wound healing, cancer treatment.

A brief overview of the contents of lab/clinical/field exercises (excursion/practicum at laser manufacturer):

- Laser safety work in practice
- Laser instrument set-up and management
- Implementation of lasers in clinical practice, e.g.:
  - Diagnostics: caries detection
  - Clinical application in periodontology and implantology: non-surgical therapy
  - Clinical application in endodontics: root canal disinfection
  - Soft and hard tissue surgery on animal tissues
- exchange of experience with professional colleagues from practice (business environment)
- acquainting the current modern laser systems on the market

Temeljni literatura in viri / Textbooks:

1. R. A. Convissar, Principles and Practice of Laser Dentistry, Mosby, 2016.
2. G. E. Romanos, Laser Light Therapy in Dentistry: Efficacy, Uses and Limitations, Nova, 2021.

Dopolnilno gradivo:

3. J. Blayden, A. Mott, Soft-Tissue Lasers in Dental Hygiene, Wiley-Blackwell, 2013.

Cilji:

Pridobiti znanje o osnovnih fizikalnih principih laserjev za razumevanje njihovih učinkov na mehka in trda tkiva. Seznaniti se z različnimi vrstami laserjev in razumeti dentalne principe, povezane s klinično uporabo laserskih sistemov v medicini in dentalni medicini.

Objectives:

To attain knowledge of fundamental physical principles of lasers for understanding their effects on soft and hard tissues. To get acquainted with different types of lasers and understanding dental principles associated with the clinical application of laser systems in medicine and dental medicine.

Predvideni študijski rezultati:

Znanje in razumevanje:
Študenti spoznajo temeljne lastnosti laserjev, pomembne za razumevanje njihovega vpliva na človeško telo. Spoznajo klinično uporabo različnih vrst laserskih sistemov v medicini in dentalni medicini.

Intended learning outcomes:

Knowledge and understanding:
Students get knowledge of fundamental properties of lasers, important for understanding their impact on human body. They learn about the applications of different types of laser systems in medicine and dental medicine clinical practice.

Prenesljive/ključne spretnosti in drugi atributi: Študenti so sposobni varno obvladati osnovne laserske sisteme v predkliničnih in kliničnih pogojih. Seznanijo se z uporabo laserja pri diagnosticiranju in zdravljenju ter pri napovedovanju izidov zdravljenja v kliničnem okolju.	Transferable/Key skills and other attributes: Students are able to safely manage with basic laser systems in pre-clinical and clinical conditions. They become familiar with the use of lasers in diagnosing and treating, and in predicting healing outcomes in clinical set-up.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja. Seminar. Laboratorijske/klinične/terenske vaje (ekskurzija/praktikum v podjetju Fotona).	Lectures. Course work. Lab/Clinical/field practice.

Načini ocenjevanja:	Delež (v %) / weight (in %)	**Assessment:**
Pisni izpit	40%	Written exam
Seminarska naloga	20%	Seminar paper
Ustni izpit	40%	Oral exam
OPOMBE ŠTUDIJSKE OBVEZNOSTI ŠTUDENTOV 1. Opravljene laboratorijske/klinične/terenske vaje (obvezna prisotnost na vajah, opravljene vse laboratorijske/klinične/terenske vaje in izdelana poročila o vseh vajah po programu). 2. Opravljena seminarska naloga (obvezna prisotnost na seminarju, aktivna udeležba, izdelana in učitelju oddana seminarska naloga ter predstavljena pred skupini v seminarju). 3. Opravljen ustni izpit s pozitivno oceno.		NOTES ACADEMIC OBLIGATIONS OF STUDENTS: 1. Lab/Clinical/Field practice completed (obligatory participation, measurements and reports completed, final test on lab/clinical/field practice or written exam). 2. Seminar paper done (obligatory and active participation, oral presentation to the colleagues in the seminar group, and prepared for the lecturer in a written form). 3. Oral examination done.

Reference nosilca / Lecturer's references: Red. prof. ddr.Miljenko Križmarić

MLINARIČ, Marko, **KRIŽMARIĆ, Miljenko**, TAKAČ, Iztok, REPŠE-FOKTER, Alenka. Identification of women with high grade histopathology results after conisation by artificial neural networks. *Radiology and oncology*. [Online ed.]. 2022, vol. 56, issue 3, str. 355-364, ilustr. ISSN 1581-3207. https://sciendo.com/article/10.2478/raon-2022-0023, DOI: 10.2478/raon-2022-0023. [COBISS.SI-ID 115112451], [JCR, SNIP, WoS, Scopus]

KRIŽMARIĆ, Miljenko, MAVER, Uroš, ZDRAVKOVIĆ, Marko, MEKIŠ, Dušan. Effects of the reservoir bag disconnection on inspired gases during general anesthesia : a simulator-based study. *BMC anesthesiology*. 2021, vol. 21, str. 1-9, ilustr. ISSN 1471-2253. https://bmcanesthesiol.biomedcentral.com/track/pdf/10.1186/s12871-021-01256-2.pdf, DOI: 10.1186/s12871-021-01256-2. [COBISS.SI-ID 50343171], [JCR, SNIP, WoS do 26. 10. 2022: št. citatov (TC): 1, čistih citatov (CI): 0, čistih citatov na avtorja (CIAu): 0,00, Scopus do 27. 7. 2022: št. citatov (TC): 1, čistih citatov na avtorja (CIAu): 0,00]

FRANIĆ, Damir, FISTONIĆ, Ivan, FRANIC IVANISEVIC, Maja, PERDIJA, Željko, **KRIŽMARIĆ, Miljenko**. Pixel CO2 laser for the treatment of stress urinary incontinence : a prospective observational multicenter study. *Lasers in surgery and medicine*. 2021, vol. 53, issue 4, str. 514-520. ISSN 1096-9101. https://onlinelibrary.wiley.com/doi/10.1002/lsm.23319, DOI: 10.1002/lsm.23319. [COBISS.SI-ID 28354307], [JCR, SNIP, WoS do 5. 11. 2022: št. citatov (TC): 3, čistih citatov (CI): 3, čistih citatov na avtorja (CIAu): 0,60, Scopus do 11. 7. 2022: št. citatov (TC): 3, čistih citatov (CI): 3, čistih citatov na avtorja (CIAu): 0,60]

Reference nosilca / Lecturer's references: red. prof. dr. Marko Marhl

DOBOVIŠEK, Andrej, VITAS, Marko, BLAŽEVIČ, Tina, MARKOVIČ, Rene, **MARHL, Marko**, FAJMUT, Aleš. Self-organization of enzyme-catalyzed reactions studied by the maximum entropy production principle. *International journal of molecular sciences*. 2023, vol. 24, iss. 10, 21 str. ISSN 1422-0067. DOI: 10.3390/ijms24108734. [COBISS.SI-ID 152729603]

ZMAZEK, Jan, SKELIN, Maša, MARKOVIČ, Rene, DOLENŠEK, Jurij, MARHL, Marko, STOŽER, Andraž, GOSAK, Marko. Assessing different temporal scales of calcium dynamics in networks of beta cell populations. *Frontiers in physiology*. Mar. 2021, vol. 12, 16 str., ilustr. ISSN 1664-042X. DOI: 10.3389/fphys.2021.612233. [COBISS.SI-ID 56986115]

ŠTERK, Marko, MARKOVIČ, Rene, **MARHL, Marko**, FAJMUT, Aleš, DOBOVIŠEK, Andrej. Flexibility of enzymatic transitions as a hallmark of optimized enzyme steady-state kinetics and thermodynamics. *Computational biology and chemistry*. [Print ed.]. Apr. 2021, vol. 91, str. 1-10. ISSN 1476-9271. DOI: 10.1016/j.compbiolchem.2021.107449. [COBISS.SI-ID 52543491]