



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

### UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	<b>Mikrofluidika kompleksnih tekočin</b>
<b>Course title:</b>	<b>Microfluidics of complex fluids</b>

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA, 3. stopnja		1. ali 2.	1., 2. ali 4.
PHYSICS, 3 <sup>rd</sup> cycle		1. or 2.	1., 2. or 4.

Vrsta predmeta / Course type

Izbirni za vse module

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
10		5			165	6

Nosilec predmeta / Lecturer:

Uroš Tkalec

Jeziki /

Languages:

Predavanja /

Lectures:

Slovenski/Slovenian

Vaje / Tutorial:

Slovenski/Slovenian

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

Ni pogojev. Priporočeno je predznanje iz klasične in moderne fizike, mehke snovi in eksperimentalnih metod.

**Prerequisites:**

None. Preknowledge of classical and modern physics, soft matter and experimental methods is recommended.

**Vsebina:**

Načrtovanje mikrofluidičnih vezij in osnove mehke litografije, fizika na mikrometrski skali, hidrodinamika v mikrofluidičnih sistemih, kapilarni pojavi, difuzija in transportni procesi, kapljična mikrofluidika, mikrofluidika tekočih kristalov.

**Content (Syllabus outline):**

Drawing microfluidic channels, basic soft lithography, physics at the micrometric scale, hydrodynamics of microfluidic systems, capillary action, diffusion and transport phenomena, droplet microfluidics, liquid crystal microfluidics.

Priprava vzorcev v laboratoriju, analiza in obdelava eksperimentalno zajetih podatkov.

Preparation of sample in the laboratory, analysis and processing of experimental data.

### Temeljni literatura in viri / Readings:

P. Tabeling, Introduction to Microfluidics, Oxford University Press, UK (2010).  
B. J. Kirby, Micro- and Nanoscale Fluid Mechanics, Cambridge University Press, UK (2010).  
H. Bruus, Theoretical Microfluidics, Oxford University Press, UK (2008).  
A. Fernandez-Nieves, A. M. Puertas, Fluids, Colloids, and Soft Materials, Wiley, USA (2016).  
S. E. Spagnolie, Complex Fluids in Biological Systems, Springer, USA (2015).  
R. G. Larson, Structure and Rheology of Complex Fluids, Oxford University Press, UK (1999).  
T. M. Squires & S. R. Quake, *Rev. Mod. Phys.* **77**, 977 (2005).  
G. M. Whitesides, *Nature* **442**, 368 (2006).

### Cilji in kompetence:

Študenti pridobijo poglobljeno znanje s področja mikrofluidike kompleksnih tekočin in se seznanijo z aktualnimi raziskavami na tem področju.

### Objectives and competences:

Students acquire advanced knowledge on microfluidics with complex fluids and become familiar with recent research in the field.

### Predvideni študijski rezultati:

Znanje in razumevanje:  
Razumevanje osnovnih eksperimentalnih metod in pojavov v mikrofluidiki, poznavanje teoretičnih osnov hidrodinamike tekočin na mikroskopskem nivoju.

Prenosljive ključne spretnosti in drugi atributi:  
Sposobnost oblikovanja in implementacije izvirnih znanstvenih pristopov v danih (bio)fizikalnih izzivih v mikrofluidičnem okolju.

Sposobnost predstavitve pridobljenih znanstvenih izsledkov in rezultatov s področja mikrofluidike na nivoju mednarodnih srečanj in publikacij.

### Intended learning outcomes:

Knowledge and understanding:  
The ability to perform and understand basic microfluidic phenomena, and to gain theoretical knowledge on hydrodynamics of fluids at the microscopic level.

Transferable/key skills and other attributes:  
To achieve an ability of defining and implementing original scientific approaches within perspective (bio)physical problems in microfluidic environment.

Ability of presenting the acquired results and scientific findings on microfluidics related topics on the level of international conferences and publications.

### Metode poučevanja in učenja:

- predavanja in diskusije,
- individualno raziskovalno delo.

### Learning and teaching methods:

- lectures and discussion,
- individual research work.

Delež (v %) /

Načini ocenjevanja:

Weight (in %) **Assessment:**

<p>Način (pisni izpit, ustno izpraševanje, naloge, projekt)</p> <ul style="list-style-type: none"> <li>• ustni izpit,</li> <li>• laboratorijsko delo.</li> </ul> <p>Vsaka izmed naštetih obveznosti mora biti opravljena s pozitivno oceno.</p>	<p><b>40</b></p> <p><b>60</b></p>	<ul style="list-style-type: none"> <li>• oral exam,</li> <li>• laboratory work.</li> </ul> <p>Each of the mentioned commitments has to be assessed with a passing grade.</p>
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### Reference nosilca / Lecturer's references:

EMERŠIČ, Tadej, ZHANG, Rui, KOS, Žiga, ČOPAR, Simon, OSTERMAN, Natan, PABLO, Juan J. de, TKALEC, Uroš. Sculpting stable structures in pure liquids. *Science advances*, ISSN 2375-2548, Feb. 2019, vol. 5, art. no. eaav4283, 8 str., ilustr., doi: [10.1126/sciadv.aav4283](https://doi.org/10.1126/sciadv.aav4283). [COBISS.SI-ID [3291748](#)]

KIM, Dae Seok, ČOPAR, Simon, TKALEC, Uroš, YOON, Dong Ki. Mosaics of topological defects in micro-patterned liquid crystal textures. *Science advances*, ISSN 2375-2548, Nov. 2018, vol. 4, art. no. eaau8064, 8 str., ilustr., doi: [10.1126/sciadv.aau8064](https://doi.org/10.1126/sciadv.aau8064). [COBISS.SI-ID [3267684](#)]

ČOPAR, Simon, TKALEC, Uroš, MUŠEVIČ, Igor, ŽUMER, Slobodan. Knot theory realizations in nematic colloids. *Proceedings of the National Academy of Sciences of the United States of America*, ISSN 0027-8424, 2015, vol. 112, no. 6, str. 1675-1680, ilustr. <http://www.pnas.org/content/112/6/1675.full.pdf+html>. [COBISS.SI-ID [2787940](#)]

SENGUPTA, Anupam, TKALEC, Uroš, RAVNIK, Miha, YEOMANS, Julia M., BAHR, Christian, HERMINGHAUS, Stephan. Liquid crystal microfluidics for tunable flow shaping. *Physical review letters*, ISSN 0031-9007. [Print ed.], 2013, vol. 110, iss. 4, str. 048303-1-048303-5. <http://prl.aps.org/abstract/PRL/v110/i4/e048303>. [COBISS.SI-ID [2528868](#)]

TKALEC, Uroš, MUŠEVIČ, Igor. Topology of nematic liquid crystal colloids confined to two dimensions. *Soft matter*, ISSN 1744-683X, 2013, vol. 9, issue 34, str. 8140-8150, doi: [10.1039/C3SM50713K](https://doi.org/10.1039/C3SM50713K). [COBISS.SI-ID [26755367](#)]