

UČNI NAČRT PREDMETA / COURSE SYLLABUS						
<b>Predmet:</b>		Uvod v funkcionalno analizo				
<b>Course title:</b>		Introduction to functional analysis				
<b>Študijski program in stopnja</b> Study programme and level		<b>Študijska smer</b> Study field		<b>Letnik</b> Academic year	<b>Semester</b> Semester	
Magistrski študijski program Matematika		ni smeri		1 ali 2	prvi ali drugi	
Master's study programme Mathematics		none		1 or 2	first or second	
<b>Vrsta predmeta / Course type</b>				temeljni		
<b>Univerzitetna koda predmeta / University course code:</b>				M2111		
<b>Predavanja</b> Lectures	<b>Seminar</b> Seminar	<b>Vaje</b> Tutorial	<b>Klinične vaje</b> work	<b>Druge oblike študija</b>	<b>Samost. delo</b> Individ. work	<b>ECTS</b>
45		30			105	6
<b>Nosilec predmeta / Lecturer:</b>		prof. Bojan Peter Magajna, prof. Peter Šemrl, prof. Roman Drnovšek				
<b>Jeziki / Languages:</b>		<b>Predavanja / Lectures:</b> slovenski/Slovene, angleški/English				
		<b>Vaje / Tutorial:</b> slovenski/Slovene, angleški/English				
<b>Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:</b>				<b>Prerequisites:</b>		
<b>Vsebina:</b>				<b>Content (Syllabus outline):</b>		
Hilbertovi prostori. Ortonormirani sistemi. Besslova neenakost. Komplettnost. Fouriereve vrste. Parsevalova enakost.				Hilbert spaces. Orthonormal systems. Bessel's inequality. Completeness. Fourier series. Parseval's identity.		

<p>Linearni operatorji in funkcionali na Hilbertovih prostorih.</p> <p>Reprezentacija zveznega linearnega funkcionala.</p> <p>Adjungirani operator. Sebiadjungirani in normalni operatorji.</p> <p>Projektorji in idempotenti. Invariantni podprostori.</p> <p>Kompaktni operatorji. Spekter kompaktnega operatorja.</p> <p>Diagonalizacija kompaktnega sebiadjungiranega operatorja.</p> <p>Uporaba: Sturm-Liouillovi sistemi.</p> <p>Banachovi prostori. Primeri.</p> <p>Linearni operatorji in funkcionali na Banachovih prostorih.</p> <p>Končnorazsežni normirani prostori. Kvocienti in produkti normiranih prostorov.</p> <p>Hahn-Banachov izrek in posledice. Separacija konveksnih množic.</p>	<p>Linear operators and functionals on Hilbert spaces. The representation of a continuous linear functional. Adjoint operator. Selfadjoint and normal operators. Projectors and idempotents. Invariant subspaces. Compact operators. The spectrum of a compact operator. Diagonalization of a selfadjoint compact operator. An application: Sturm-Liouville systems. Banach spaces. Examples. Linear operators and functionals on Banach spaces. Finite dimensional normed spaces. Quotients and products of normed spaces. The Hahn-Banach theorem and consequences. Separation of convex sets.</p>
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### Temeljni literatura in viri / Readings:

B. Bollobás: Linear Analysis : An Introductory Course, 2nd edition, Cambridge Univ. Press, Cambridge, 1999.

J. B. Conway: A Course in Functional Analysis, 2nd edition, Springer, New York, 1990.

Y. Eidelman, V. Milman, A. Tzolomitis: Functional Analysis : An Introduction, AMS, Providence, 2004.

D. H. Griffel: Applied Functional Analysis, Dover Publications, Mineola, 2002.

M. Hladnik: Naloge in primeri iz funkcionalne analize in teorije mere, DMFA-založništvo, Ljubljana, 1985.

E. Zeidler: Applied Functional Analysis : Main Principles and Their Applications, Springer, New York, 1995.

**Cilji in kompetence:**

Študent spozna osnovne pojme teorije Hilbertovih prostorov in linearnih operatorjev med njimi. Z njeno uporabo se seznanj pri reševanju Sturm-Liouville problema. Nekoliko spozna tudi teorijo Banachovih prostorov, ki so posplošitev Hilbertovih prostorov.

**Objectives and competences:**

Students acquire basic knowledge of the theory of Hilbert spaces and linear operators between them. The theory is applied for solving simple Sturm-Liouville problems. Students also learn some basic concepts from the theory of Banach spaces, which are a generalization of Hilbert spaces.

**Predvideni študijski rezultati:**

Znanje in razumevanje: Razumevanje teorije Hilbertovih prostorov s teoretičnega in uporabnega vidika.  
Uporaba: Uporaba funkcionalne analize sega tudi v naravoslovje in druga področja znanosti kot na primer ekonomijo.  
  
Refleksija: Razumevanje teorije na podlagi uporabe.  
  
Prenosljive spretnosti – niso vezane le na en predmet: Sposobnost abstraktnega razmišljanja. Spretnost uporabe domače in tuje literature.

**Intended learning outcomes:**

Knowledge and understanding: Understanding of the theory of Hilbert spaces.  
Application: Functional analysis is used in natural sciences and other areas of science such as economics.  
  
Reflection: Understanding of the theory on the basis of examples.  
  
Transferable skills: Ability to use abstract methods to solve problems. Ability to use a wide range of references and critical thinking.

**Metode poučevanja in učenja:**

predavanja, vaje, domače naloge, konzultacije

**Learning and teaching methods:**

Lectures, exercises, homeworks, consultations

**Načini ocenjevanja:**

Delež (v %) /

Weight (in %)

**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt): domače naloge		Type (examination, oral, coursework, project): homeworks
izpit iz vaj		written exam
ustni izpit	10%	oral exam
Ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)	50%	Grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)
	40%	

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

Roman Drnovšek:

- DRNOVŠEK, Roman. An irreducible semigroup of idempotents. *Studia Mathematica*, ISSN 0039-3223, 1997, let. 125, št. 1, str. 97-99 [COBISS.SI-ID 7436633]
- DRNOVŠEK, Roman. Common invariant subspaces for collections of operators. *Integral equations and operator theory*, ISSN 0378-620X, 2001, vol. 39, no. 3, str. 253-266 [COBISS.SI-ID 10597721]
- DRNOVŠEK, Roman. Invariant subspaces for operator semigroups with commutators of rank at most one. *Journal of functional analysis*, ISSN 0022-1236, 2009, vol. 256, iss. 12, str. 4187-4196 [COBISS.SI-ID 15167321]

Bojan Peter Magajna:

- MAGAJNA, Bojan. On completely bounded bimodule maps over  $W^*$ -algebras. *Studia Mathematica*, ISSN 0039-3223, 2003, t. 154, fasc. 2, str. 137-164 [COBISS.SI-ID 12278105]
- MAGAJNA, Bojan. Duality and normal parts of operator modules. *Journal of functional analysis*, ISSN 0022-1236, 2005, vol. 219, no. 2, str. 306-339 [COBISS.SI-ID 13366105]
- MAGAJNA, Bojan. On tensor products of operator modules. *Journal of operator theory*, ISSN 0379-4024, 2005, vol. 54, no. 2, str. 317-337 [COBISS.SI-ID 13920089]

Peter Šemrl:

- ŠEMRL, Peter, VÄISÄLÄ, Jussi. Nonsurjective nearisometries of Banach spaces. *Journal of functional analysis*, ISSN 0022-1236, 2003, vol. 198, no. 1, str. 268-278 [COBISS.SI-ID 12371545]
- ŠEMRL, Peter. Generalized symmetry transformations on quaternionic indefinite inner product spaces: an extension of quaternionic version of Wigner's theorem. *Communications in Mathematical Physics*, ISSN 0010-3616, 2003, vol. 242, no. 3, str. 579-584 [COBISS.SI-ID 12770649]

- ŠEMRL, Peter. Applying projective geometry to transformations on rank one idempotents.  
Journal of functional analysis, ISSN 0022-1236, 2004, vol. 210, no. , str. 248-257 [COBISS.SI-ID  
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