

UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2016/17)						
<b>Predmet:</b>		Modeliranje s slučajnimi procesi				
<b>Course title:</b>		Modelling with stochastic processes				
<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>				izbirni / elective		
<b>Univerzitetna koda predmeta / University course code:</b>				M2528		
<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>
30	15	30			105	6
<b>Nosilec predmeta / Lecturer:</b>		prof. dr. Janez Bernik				
<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>		
Vpis v letnik študija.				Enrolment in the programme.		
<b>Vsebina:</b>				<b>Content (Syllabus outline):</b>		

<p>Aktuarski del:</p> <p>Lundbergov proces, verjetnosti bankrota, martingalske metode, verjetnosti bankrota v končnem času, posplošitve Lundbergovega modela.</p> <p>Modeliranje z markovskimi verigami, enačbe Kolmogorova, Thielejeve diferencialne enačbe, izračun matematičnih rezervacij, zvarovalni produkti z izplačili odvisnimi od matematičnih rezervacij, vpeljava slučajnih obrestnih mer z markovskimi verigami.</p> <p>Finančni del:</p> <p>Optimalna kontrola: formulacija problema, Hamilton-Jacobi-Bellmanove enačbe, linearni regulator, primeri uporabe.</p> <p>Optimalno ustavljanje: formulacija problema, primeri, ameriške opcije.</p> <p>Osnovni izrek vrednotenja opcij: formulacija, dokaz, enačbe za varovanje, povezava s parcialnimi diferencialnimi enačbami, primeri nekompletnih trgov.</p> <p>Nekompletni trgi: Lévyjevi modeli, super-varovanje, vrednotenje, optimizacija.</p>	<p>Actuarial part:</p> <p>Lundberg process, the probability of ruin, martingale methods, the probability of ruin in finite time, generalized Lundberg model.</p> <p>Markov chain models, Kolmogorov equations,</p> <p>Thiele differential equation, mathematical reserves calculation, reserves dependent payoffs, stochastic interest rates via Markov chains.</p> <p>Financial part:</p> <p>Optimal control: formulation of the problem, Hamilton-Jacobi-Bellman equations, linear regulator, applications.</p> <p>Optimal stopping: formulation of the problem, examples, American options.</p> <p>Fundamental theorem of asset pricing: formulation, proof, hedging equations, connections to partial differential equations, examples of incomplete markets.</p> <p>Incomplete markets: Lévy models, superhedging, pricing, optimization.</p>
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#### **Temeljni literatura in viri / Readings:**

M. Denuit, J. Dhaene, M. Goovaerts, R. Kaas: *Dependent Risks, Measures, Orders and Models*, Wiley, New York, 2005.

J. Grandell: *Aspects of Risk Theory*, Springer, New York, 1991.

M. Koller: *Stochastische Modelle in der Lebensversicherung*, Springer, Berlin, 2000.

H. Bühlmann: *Mathematical Methods in Risk Theory*, Springer, New York, 2005.

T. Björk: *Arbitrage Theory in Continuous Time*, Oxford University Press, Oxford, 1998.

B. Øksendal: *Stochastic Differential Equations, An Introduction with Applications*, Springer, New

York, 2003.

D. Wong: Generalised Optima Stopping Problems and Financial Markets, Longman, 1996.

M.H.A. Davis: Stochastic Modelling and Control, Chapman & Hall, 1995.

Karatzas, S. E. Shreeve: Methods of Mathematical Finance, Springer, New York, 1998.

W. Schoutens: Lévy Processes in Finance: Pricing Financial Derivatives, Wiley, New York, 2003.

### **Cilji in kompetence:**

Slučajni procesi so osnova za številne modele, ki se uporabljajo v finančnem in aktuarskem svetu. Tečaj se navezuje na teoretična tečaja iz slučajnih procesov in po eni strani odpira pot do uporabe, po drugi pa na drugačen način osvetli teoretične osnove.

Zaradi nepostredne uporabnosti vsebin bodo pri predmetu sodelovali tudi strokovnjaki iz prakse.

### **Objectives and competences:**

Stochastic processes form a basis for numerous models in finance and insurance. The course links theoretical parts learned in other courses on stochastic processes by showing their applications on one side and elucidates the theoretical background on the other.

Since the content is of great practical importance we expect that also specialists from financial practice will present their work experience during the course.

### **Predvideni študijski rezultati:**

Znanje in razumevanje: Razumevanje modeliranja s slučajnimi procesi v financah in aktuarstvu in razumevanja matematičnih orodij in predpostavk.

Uporaba: Uporaba je neposredna, saj so obravnavani modeli izhodišče za vrednotenje mnogih finančnih in zavarovalnih produktov.

Refleksija: Uporaba slučajnih procesov utrdi znanje iz verjetnosti in slučajnih procesov po eni strani, po drugi pa odpira pot do praktične uporabe teorije slučajnih procesov.

Prenosljive spretnosti – niso vezane le na en predmet: Spretnosti so prenosljive na druga področja matematičnega modeliranja, še

### **Intended learning outcomes:**

Knowledge and understanding: Understanding of stochastic modelling in finance and insurance and understanding of mathematical framework.

Application: Application is immediate as the models under consideration form a basis for

Pricing many financial and insurance products.

Reflection: The application of stochastic processes deepens the knowledge of probability calculus and stochastic processes and paves the way for their application.

Transferable skills: The skills obtained are transferable to other areas of mathematical modelling, but the gist of the course is its

najbolj pa je predmet pomemben zaradi svoje neposredne uporabnosti.

immediate applicability.

**Metode poučevanja in učenja:**

predavanja, vaje, domače naloge, konzultacije, seminarsek naloge

**Learning and teaching methods:**

Lectures, exercises, homeworks, consultations, seminars

**Načini ocenjevanja:**

Delež (v %) /

Weight (in %)

**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt):

samostojna seminarska naloga

ustni izpit

Ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)

50%

50%

Type (examination, oral, coursework, project):

seminar work

oral exam

Grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

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

Janez Bernik:

BERNIK, Janez, MASTNAK, Mitja, RADJAVI, Heydar. Realizing irreducible semigroups and real algebras of compact operators. Journal of mathematical analysis and applications, ISSN 0022-247X. [Print ed.], 2008, vol. 348, no. 2, str. 692-707. [COBISS.SI-ID 14899289]

BERNIK, Janez, MASTNAK, Mitja, RADJAVI, Heydar. Positivity and matrix semigroups. Linear Algebra and its Applications, ISSN 0024-3795. [Print ed.], 2011, vol. 434, iss. 3, str. 801-812. [COBISS.SI-ID 15745625]

BERNIK, Janez, MARCOUX, Laurent W., RADJAVI, Heydar. Spectral conditions and band reducibility of operators. Journal of the London Mathematical Society, ISSN 0024-6107, 2012, vol. 86, no. 1, str. 214-234. [COBISS.SI-ID 16357721]

