

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Operacijski sistemi
Course title:	Operating systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Informatika v sodobni družbi, visokošolski strokovni študijski program prve stopnje	-	Drugi	Četrta
Informatics in Contemporary Society, first cycle Professional Study Programme	-	Second	Fourth

Vrsta predmeta / Course type

Obvezni / Obligatory

Univerzitetna koda predmeta / University course code:

1-ISD-VS-OS-2025-12-04

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	45	-	-	105	6

Nosilec predmeta / Lecturer:

prof. dr. Biljana Mileva Boshkoska, doc. dr. Panče Panov

Jeziki / Languages:

Predavanja / Lectures: Slovenski / Slovenian, Angleški / English

Vaje / Tutorial: Slovenski / Slovenian, Angleški / English

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

Pogoj za pristop k izpitu so opravljene vse obveznosti na vajah.

Prerequisites:

Student must complete all requirements given at the tutorials.

Vsebina:

- Uvod v operacijske sisteme (OS): Naloge OS. Pregled organizacije računalniškega sistema. Pregled različnih arhitektur računalniškega sistema. Upravljanje z računalniškimi viri. Varnost in zaščita OS.
- Struktura OS: Storitve OS; Uporabniški in sistemski vmesnik; Sistemski klici; Sistemske storitve; Povezovalniki in nalagalniki; Različne izvedbe OS.
- *Upravljanje s procesi in nitmi:* Koncept procesa v OS; Operacije nad procesi; Med-procesna komunikacija (deljen

Content (Syllabus outline):

- Introduction to operating systems (OS): OS tasks. Overview of computer system organization; Overview of different computer system architectures. Computer resource management. OS security and protection.
- OS structure: OS services. User and system interface. System calls. System services. Linkers and loaders. Various OS implementations.
- Management of processes and threads: Concept of a process in the OS; Operations on processes; Inter-process

<p>pomnilnik, komunikacija z izmenjavo sporočil). Koncept niti v OS. Večjedrno programiranje. Modeli nitkanja. Programske knjižnice.</p> <ul style="list-style-type: none"> • <i>Razvrščanje</i>: Osnovni pojmi; Razvrščanje procesov; Kriteriji za razvrščanje; Algoritmi za razvrščanje; Razvrščanje na večprocesorskih sistemih in razvrščanje v realnem času. • <i>Sinhronizacija</i>: Uvodni pojmi. Problem kritičnega odseka. Petersonova rešitev problema kritičnega odseka. Mutex ključi. Semaforji. Monitorji. Pregled klasičnih problemov sinhronizacije (problem omejenega vmesnika, problem bralcev in zapisovalcev, problem filozofske večerje). • <i>Zastoj</i>: Model zastoja v OS. Opisovanje zastojev. Metode za upravljanje z zastoji. Preprečevanje, izogibanje, in detekcija zastojev. Obnova od zastoja. • <i>Upravljanje s pomnilnikom</i>: Uvodni pojmi. Nalaganje procesa v pomnilnik. Tehnike za upravljanje s pomnilnikom. Odstranjevanje. Struktura tabele strani. Segmentacija. Navidezni pomnilnik. Nalaganje na zahtevo. Algoritmi za zamenjavo strani in alokacijo okvirjev. • <i>Upravljanje z vhodnimi in izhodnimi napravami</i>: Upravljanje z diski, Upravljanje z perifernimi napravami. • <i>Upravljanje z datotečnimi sistemi</i>: Kocept datoteke in struktura imenikov. Strukture datotečnih sistemov. Operacije nad datotečnimi sistemi. Implementacija datotečnih sistemov. Primeri različnih datotečnih sistemov. • <i>Uvod v skriptno programiranje v operacijskem sistemu Linux</i>: Pregled osnovnih Linux ukazov. Osnovne strukture Bash skript. Reševanje praktičnih problemov. • <i>Uvod v sistemsko programiranje s programskim jezikom C</i>: Pregled osnovnih podatkovnih tipov in programskih struktur jezika C. Ilustracije upravljanja s procesi in upravljanja s pomnilnikom v programskem jeziku C. 	<p>communication (shared memory, message-passing). Concept of threads in OS. Multicore programming. Multi-threading models. Software libraries.</p> <ul style="list-style-type: none"> • <i>Scheduling</i>: Basic concepts. Scheduling of processes. Scheduling criteria. Scheduling algorithms. Scheduling on multiprocessor systems and real-time systems. • <i>Synchronization</i>: Introductory concepts. The critical section problem. Peterson's solution to the critical section problem. Mutex keys. Semafor. Monitors. Review of classic synchronization problems (bounded buffer problem, reader-writer problem, philosopher's dinner problem). • <i>Deadlocks</i>: The deadlock model in the OS. Describing deadlocks. Methods for dealing with deadlocks. Congestion prevention, avoidance, and detection of deadlocks. Recovery from deadlock. • <i>Memory management</i>: Introductory concepts. Loading process into memory. Memory management techniques. Paging. Page table structure. Segmentation. Virtual memory. Loading on demand. Algorithms for page replacement and frame allocation. • <i>Management of input and output devices</i>: Management of disks. Management of peripheral devices. • <i>File system management</i>: File concept and directory structure. Structures of file systems. Operations on file systems. Implementation of file systems. Examples of different file systems. • <i>Introduction to scripting in the Linux operating system</i>: Overview of basic Linux commands. Basic Bash script structures. Solving practical problems. • <i>Introduction to System Programming with the C Programming Language</i>: Overview of the basic data types and programming structures of the C language. Illustrations of process management and memory management in the C programming language.
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Temeljni literatura in viri / Readings:

- Silberschatz, A., Galvin, P. B. & Gagne, G. (2019). *Operating System Concepts* (Global ed.). John Wiley & Sons.
- Tanenbaum, A. S. (2015). *Modern Operating Systems* (4th ed.). Prentice Hall.
- Zazula, D. (2005). *Operacijski sistemi*. Maribor: Založniška tiskarska dejavnost tehniških fakultet.
- Blum, R. (2015). *Linux Command Line and Shell Scripting Bible* (3rd ed.). Wiley Publishing, Inc.
- Hover, A. (2010). *System Programming with C and Unix*. Pearson Education.
- Prosojnice s predavanj in vaj (dostopne prek <https://moodle.fis.unm.si/>).

Cilji in kompetence:

Učna enota prispeva k razvoju naslednjih splošnih in predmetno-specifičnih kompetenc:

Splošne kompetence:

- poznavanje osnovnih principov modernih operacijskih sistemov
- sposobnost praktične uporabe najbolj razširjenih operacijskih sistemov
- sposobnost fleksibilne uporabe znanja v praksi
- osnovna znanja potrebna za razvoj aplikacij na različnih operacijskih sistemih

Predmetno-specifične kompetence:

- poznavanje temeljnih algoritmov v operacijskih sistemih
- kodiranje algoritmov za medprocesno komunikacijo v primernem računalniškem okolju

Objectives and competences:

The instructional unit contributes to the development of the following general and subject-specific competences:

General competences:

- familiarity with the basics of principles used in modern operating systems
- familiarity with practical usage of most frequently used operating systems
- ability to use the acquired knowledge in practice in a flexible manner.
- basic knowledge relevant for application development on various operating systems

Subject-specific competences:

- familiarity with the fundamental algorithms used in operating systems
- ability to code the algorithms for inter-process communications within appropriate software framework

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent/študentka:

- se seznani z osnovnimi zakonitostmi, funkcionalnostmi in koncepti najpogostejših računalniških operacijskih sistemov
- razume kompleksnost MPK in se seznani s problemi, ki jih mora reševati sodoben operacijski sistem
- razume razliko med procesi in nitmi in se seznani z različnimi algoritmi za upravljanje z njimi
- razume potrebo po razvrščanju in se seznani z algoritmi, ki se uporabljajo za razvrščanje v različnih operacijskih sistemih
- razume problematiko in algoritme za upravljanje s pomnilnikom

Intended learning outcomes:

Knowledge and understanding:

The student:

- becomes familiar with the basic structure, functionality and concepts of the most frequently used computer operating systems
- understands the complexity of ICP and get familiar with problems that are managed by modern operating system
- understands the difference between processes and threads, and gets familiar with different algorithms for their management
- understands the need of scheduling and gets familiar with the algorithms used for scheduling in different operating systems
- understands the problems and algorithms for memory management

- razume strukturo datotečnih sistemov
- razume načela V/I strojne in programske opreme

- understands the structure of the file systems
- understands the principles of I/O hardware and software

Metode poučevanja in učenja:

- predavanja z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov)
- vaje, kjer bodo študentje na konkretnih problemih ponovili, utrdili in dodatno osvetlili pojme in metode, spoznane na predavanjih

Learning and teaching methods:

- lectures with active student participation (explanation, discussion, questions, examples, problem solving)
- tutorials where students will rehearse, revise and lit up concepts, and methods encountered at lectures

Delež (v %) /

Weight (in %)

Načini ocenjevanja:

Assessment:

<p>Način (pisni izpit, ustno izpraševanje, naloge, projekt):</p> <ul style="list-style-type: none"> • pisni izpit 	<p>100</p>	<p>Type (examination, oral, coursework, project):</p> <ul style="list-style-type: none"> • written exam
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Reference nosilca / Lecturer's references:

- Stepišnik, T., Simidjievski, N., Nikola, Petković, M., Panov, P., Džeroski, S., Kocev, D., et al. (2022) Machine learning for effective spacecraft operation: Operating INTEGRAL through dynamic radiation environments. *Advances in space research*. 2022, vol. 69, iss.. 11, str. 3909-3920
- Ring, N., Stepišnik, T., Panov, P., Kocev, D., Fortuna, S., Džeroski, S., et al. (2022) Wet-dry-wet drug screen leads to the synthesis of TS1, a novel compound reversing lung fibrosis through inhibition of myofibroblast differentiation. *Cell death & disease*. 2022, vol. 13, str. 2-1-2-12, DOI: 10.1038/s41419-021-04439-4.
- Vitali, F., Zinno, P., Schifano, E., Gori, A., Costa, Ana, De Filippo, C., Koroušič Seljak, B., Panov, P., Devirgilis, C., Cavalieri, D. (2022) Semantics of dairy fermented foods: A microbiologist's perspective. *Foods*. 2022, vol. 11, no. 13, str. 1939-1-1939-18, ilustr. ISSN 2304-8158. DOI: 10.3390/foods11131939.
- Petković, M., Levatić, J., Breskvar, M., Stepišnik, T., Kostovska, A., Panov, P., Osojnik, A., Džeroski, S., Simidjievski, N., Ženko, B., Kocev, D., et al. (2022) Machine-learning ready data on the thermal power consumption of the mars express spacecraft. *Scientific data*. 2022, vol. 9, str. 229-1-229-8. DOI: 10.1038/s41597-022-01336-z.
- Kostovska, A., Bogatinovski, J., Džeroski, S., Kocev, D., Panov, P. (2022) A catalogue with semantic annotations makes multilabel datasets FAIR. *Scientific reports*. 2022, vol. 12, str. 7267-1-7267-11, DOI: 10.1038/s41598-022-11316-3.
- Kostovska, A., Vermetten, D., Doerr, C., Džeroski, S., Panov, P., Eftimov, (2021) T., OPTION: optimization algorithm benchmarking ontology. In: *GECCO '21, Proceedings of the Genetic and Evolutionary Computation Conference Companion*, 10 July - 14 July, 2021, Lille, France, Francisco Chicano (ur.), New York: ACM = Association for Computing Machinery, 2021, str. 239-240, DOI: 10.1145/3449726.3459579.
- Osojnik, A., Panov, P., Džeroski, S. (2020) Incremental predictive clustering trees for online semi-supervised multi-target regression. *Machine learning* vol. 109, no. 11, str. 2121-2139.

- STROJNIK, Lidija, STOPAR, Matej, ZLATIĆ, Emil, KOKALJ, Doris, NAGLIČ, Mateja, ŽENKO, Bernard, ŽNIDARŠIČ, Martin, BOHANEK, Marko, MILEVA BOSHKOSKA, Biljana, LUŠTREK, Mitja, GRADIŠEK, Anton, POTOČNIK, Doris, OGRINC, Nives. Authentication of key aroma compounds in apple using stable isotope approach. *Food chemistry*, ISSN 0308-8146. [Print ed.], 2019, vol. 277, str. 766-773, doi: 10.1016/j.foodchem.2018.10.140.
- BOŠKOSKI, Pavle, DEBENJAK, Andrej, MILEVA BOSHKOSKA, Biljana. Rayleigh copula for describing impedance data - with application to condition monitoring of proton exchange membrane fuel cells. *European journal of operational research*, ISSN 0377-2217. [Print ed.], 2018, vol. 266, no. 1, str. 269-277, doi: 10.1016/j.ejor.2017.08.058.
- GRAŠIČ, Valerij, KOS, Andrej, MILEVA BOSHKOSKA, Biljana. Classification of incoming calls for the capital city of Slovenia smart city 112 public safety system using open Internet of Things data. *International journal of distributed sensor networks*, ISSN 1550-1477. [Online ed.], 2018, vol. 14, no. 9, str. 1-12, ilustr.
<https://journals.sagepub.com/doi/pdf/10.1177/1550147718801703>, doi: 10.1177/1550147718801703.
- MILJKOVIĆ, Dragana, LAVRAČ, Nada, BOHANEK, Marko, MILEVA BOSHKOSKA, Biljana. Discovering dependencies between domains of redox potential and plant defence through triplet extraction and copulas. *International journal of intelligent engineering informatics*, ISSN 1758-8723, 2018, vol. 6, no. 1/2, str. 61-77.
<http://www.inderscience.com/info/ingeneral/forthcoming.php?jcode=ijiei>, doi: 10.1504/IJIEI.2018.10012065.
- MILEVA BOSHKOSKA, Biljana, LIU, Shaofeng, CHEN, Huilan. Towards a knowledge management framework for crossing knowledge boundaries in agricultural value chain. *Journal of decision systems*, ISSN 1246-0125, [in press] 2018, 15 str., doi: 10.1080/12460125.2018.1468173.
- MILEVA BOSHKOSKA, Biljana, RONČEVIĆ, Borut, DŽAJIĆ URŠIČ, Erika. Modeling and evaluation of the possibilities of forming a regional industrial symbiosis networks. *Social sciences*, ISSN 2076-0760, 2018, vol. 7, iss. 1. <http://www.mdpi.com/2076-0760/7/1/13/pdf>, doi: 10.3390/socsci7010013.
- BOHANEK, Marko, MILEVA BOSHKOSKA, Biljana, PRINS, Theo W., KOK, Esther. SIGMO: a decision support System for Identification of genetically modified food or feed products. *Food control*, ISSN 0956-7135. [Print ed.], 2016, vol. 71, str. 168-177, doi: 10.1016/j.foodcont.2016.06.032.
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