| UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2016/17) | | | |
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| **Predmet:** | Dinamično modeliranje | | |
| **Course title:** | Dynamical modelling | | |
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| **Študijski program in stopnja<br>Study programme and level** | **Študijska smer<br>Study field** | **Letnik<br>Academic year** | **Semester<br>Semester** |
| Visokošolski strokovni študijski program Praktična matematika | ni smeri | 3 | prvi ali drugi |
| First cycle professional study programme Practical Mathematics | none | 3 | first or second |

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| **Vrsta predmeta / Course type** | izbirni / elective |
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| **Univerzitetna koda predmeta / University course code:** | M0442 |

| **Predavanja<br>Lectures** | **Seminar<br>Seminar** | **Vaje<br>Tutorial** | **Klinične vaje<br>work** | **Druge oblike študija** | **Samost. delo<br>Individ. work** | **ECTS** |
|---|---|---|---|---|---|---|
| **30** | | **30** | | | **90** | **5** |

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| **Nosilec predmeta / Lecturer:** | prof. dr. Igor Dobovšek |

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| **Jeziki / Languages:** | **Predavanja / Lectures:** | slovenski / Slovene |
| | **Vaje / Tutorial:** | slovenski / Slovene |

| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | **Prerequisites:** |
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| Vpis v letnik študija. | Enrolment in the programme. |
| **Vsebina:** | **Content (Syllabus outline):** |

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| Gravitacija in centralne sile.<br><br>Gibanje v polju centralne sile. Gibanje v polju gravitacijske sile. Keplerjevi zakoni. Integrabilnost gibanja v polju centralne sile.<br><br>Seminar: Diferencialna enačba orbite in energijska enačba gibanja. Efektivni potencial in limite radialnega gibanja.<br><br>Neinercialni sistemi.<br><br>Pospešeni koordinatni sistemi in inercialne sile. Vpliv vrtenja Zemlje. Foucaltevo nihalo.<br><br>Seminar: Gibanje izstrelka z upoštevanjem zračnega upora in vrtenja Zemlje. Numerično integriranje in grafični prikaz trajektorije gibanja.<br><br>Nihanja.<br><br>Sistemi z več prostostnimi stopnjami. Lastna nihanja. Linearizacija gibanja v okolici ravnotežne lege. Majhna nihanja okrog ravnovesne lege.<br><br>Seminar:<br><br>Dvojno matematično nihalo. Določitev lastnih frekvenc, lastnih vektorjev in nihajnih oblik gibanja.<br><br>Linearna nihanja triatomske molekule.<br><br>Prostorska nihanja sferičnega nihala. Numerična integracija cnačb gibanja. Fazni diagram gibanja za znatne odklone od ravnovesne lege.<br><br>Kinematika in dinamika togega telesa.<br><br>Relativni in absolutni koordinatni sistem. Vektor kotne hitrosti. Togo gibanje, razcep togega gibanja na translatorno in rotacijsko gibanje. Koordinatne transformacije in Eulerjevi koti. | Gravitation and central forces.<br>Motion in gravitational and central force fields. Kepler's laws. Integrability of motion in central force field.<br><br>Seminar: Differential equation of the orbit and energy equation of motion. Effective potential and limits of radial motion.<br><br>Non-inertial systems.<br><br>Accelerated coordinate systems and inertial forces. Influence of Earth rotation. Foucault's pendulum.<br><br>Seminar: Projectile motion including air resistance and Earth rotation. Numerical integration and graphical representation of trajectory of motion.<br><br>Oscillations.<br><br>Systems with many degrees of freedom.<br><br>Eigenfrequencies and eigenmodes. Linearization of motion in the vicinity of equilibrium state. Small oscillations in the vicinity of equlibrium state.<br><br>Seminar:<br><br>Double pendulum. Eigenmodes and eigenfrequencies. Normal modes of harmonic motion.<br><br>Linear motion of a three-atomic molecule<br><br>Spatial oscillations of spherical pendulum. Numerical integration of equations of motion. Phase portrait for moderate perurbations from equilibrium state.<br><br>Rigid body kinematics and dynamics.<br><br>Relative and absolute coordinate systems. Vector of angular velocity. |

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| Eulerjeve dinamične enačbe. Prosta vrtavka. Gibanje okrog stalne osi.<br><br>Seminar: Gibanje osnosimetrične proste vrtavke. Precesija vektorja kotne hitrosti. Enakomerna rotacija in stabilnost gibanja.<br><br>Sistemi s spremenljivo maso.<br><br>Splošne enačbe gibanja sistemov s spremenljivo maso. Gibanje enostopenjske rakete.<br><br>Seminar: Optimizacija gibanja večstopenjskih raket. Optimizacija porabe goriva in trajektorije letenja rakete. | Translational and rotational decomposition of motion of rigid body.<br><br>Coordinate transformations and Euler's angles.<br><br>Euler's dynamical equations. Free gyro or top. Motion around fixed axis.<br><br>Seminar: General motion of a symmetric gyro or top. Steady precession of a vector of angular velocity. Uniform rotation and stability of motion.<br><br>Systems with variable mass.<br><br>General equations of motion for systems with variable mass. Motion of one-stage<br><br>space rocket.<br><br>Seminar: Motion optimization for multistage rockets. Optimization of fuel consumption and trajectory of flight. |

**Temeljni literatura in viri / Readings:**

G. R.Fowles in G. L. Cassiday: Analytical mechanics, Fort Worth [etc.] : Saunders College: Harcourt Brace College, 1999.

W. Greiner: Classical Mechanics: Point Particles and Relativity, Springer, 2004.

W. T. Thomson: Introduction to Space Dynamics, Dover, Publ. Inc., 1986.

| **Cilji in kompetence:** | **Objectives and competences:** |
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| Študentje se bodo seznanili z zahtevnejšimi pojmi in vsebinami klasične in analitične mehanike s poudarkom na korektni matematični formulaciji in povezovanju že osvojenih matematičnih znanj s področja matematičnega modeliranja. | Students will acquire knowledge about more comprehensive facts and ingredients of rational mechanics with emphasis on strict mathematical formulation based on previously mastered mathematical knowledge. |
| **Predvideni študijski rezultati:** | **Intended learning outcomes:** |

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| Znanje in razumevanje: Poznavanje in razumevanje zahtevnejših pojmov in principov s področja klasične analitične mehanike.<br><br>Uporaba: Temelj za nadgraditev osvojenega znanja s specifičnimi znanji iz prakse s področja mehanike in podobnih naravoslovno tehničnih področij.<br><br>Refleksija: Povezovanje osvojenega matematičnega znanja v okviru enega predmeta in njegova uporaba na področju mehanike.<br><br>Prenosljive spretnosti – niso vezane le na en predmet: Celovit pogled na matematične metode modeliranja v okviru mehanike. Reševanje nalog in problemov iz sorodnih področij uporabne matematike, naravoslovja in tehnike. | Knowledge and understanding: To establish knowledge and understanding of fundamental principles of rational mechanics at more advanced level.<br><br>Application: Mastered coursework represents a foundation for specialized research in the field of mechanics.<br><br>Reflection: Connecting acquired mathematical knowledge within the course with implementation of that knowledge in a general field of mechanics.<br><br>Transferable skills: A global overview of mathematical methods of modelling within the framework of rational mechanics. Solving problems from related areas of applied mathematics, natural sciences and engineering. |

| **Metode poučevanja in učenja:** | **Learning and teaching methods:** |
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| Predavanja in seminar. Študent v okviru predmeta spozna možnosti uporabe višjih simbolnih programskih jezikov (npr. Mathematice ali podobnih) pri reševanju konkretnih problemov. Seznani se s projektnim pristopom reševanja problemov, ki je sestavljen iz faze načrtovanja, matematične zasnove, izbora metode reševanja in uporabe razpoložljivih računalniških orodij. | Theoretical lectures and seminar work. During the course student gets acquainted with application of symbolic languages (like Mathematica etc.) in real-problem solving. Student becomes familiar with a project problem solving approach which consist of different phases: the phase of planning, the phase of mathematical conceptualization, the choice of appropriate method of solution together with implementation of available computational tools. |

| **Načini ocenjevanja:** | Delež (v %) / Weight (in %) | **Assessment:** |
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| Pogoj za pristop h končnemu izpitu je sodelovanje na predavanjih in izdelava predlaganih seminarskih nalog ali projektov po izboru. | 50%<br><br>50% | Active participation at the theoretical part of lectures is required. Completion of seminar assignments or projects by |

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| izdelava in zagovor izbrane teme seminarske naloge<br><br>zagovor teoretičnega dela predavanj<br><br>Ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL) | | individual choice.<br><br>Oral defense of seminar assignments.<br><br>Written defense of theoretical part<br><br>Grade is combination of the above.<br><br>Grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL) |

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

DOBOVŠEK, Igor. The influence of dislocation distribution density on curvature and interface stress in epitaxial thin films on a flexible substrate. V: Advances in Modeling and Evaluation of Materials in Honor of Professor Tomita : a symposium to mark the occasion of Prof. Tomita's retirement from Kobe University, (International journal of mechanical sciences, ISSN 0020-7403, Vol. 52, iss. 2, 2010). Oxford [etc.]: Pergamon Press, 2010, issue 2, vol. 52, str. 212-218. [COBISS.SI-ID 15261529]

DOBOVŠEK, Igor. A theoretical model of the interaction between plastic distortion and configurational stress on the phase transformation front. V: Proceedings of the 7th European Symposium on Martensitic Transformations, ESOMAT 2006, (Materials science & engineering. A, ISSN 0921-5093, Vol. 481-482). Amsterdam: Elsevier, 2008, str. 956-361. [COBISS.SI-ID 14629209]

DOBOVŠEK, Igor. Problem of a point defect, spatial regularization and intrinsic length scale in second gradient elasticity. V: ZENG, Kai (ur.). Mechanical Behaviour of Micro- and Nano-scale Systems, (Materials Science and Engineering, ISSN 0921-5093, Vol. 423, Issue 1-2). Amsterdam: Elsevier, 2006, str. 92-96. [COBISS.SI-ID 13962841]

DOBOVŠEK, Igor. Micromechanical modeling of nanostructured materials by polyclustering techniques. International journal of nanoscience, 2005, vol. 4, no. 4, str. 623-629. [COBISS.SI-ID 13904473]