UČNI NAČRT PREDMETA / COURSE SYLLABUS (leto / year 2017/18)	
Predmet:	Numerična integracija in navadne diferencialne enačbe
Course title:	Numerical integration and ordinary differential equations

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **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

Vrsta predmeta / Course type	izbirni / elective
Univerzitetna koda predmeta / University course code:	M2408

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

Nosilec predmeta / Lecturer:	prof. dr. Marjeta Krajnc, prof. dr. Emil Žagar

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski / Slovene, angleški / English
	Vaje / Tutorial:	slovenski / Slovene, angleški / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Vpis v letnik študija.	Enrolment in the programme.

Vsebina:	**Content (Syllabus outline):**

Numerično odvajanje: Stabilno računanje odvodov. Diferenčne aproksimacije za odvode. Numerična integracija: Stopnja in konvergenca. Newton–Cotesove formule. Gaussove kvadraturne formule. Sestavljena pravila. Ocene napak. Konvergenca. Euler-McLaurinovo sumacijsko pravilo in Rombergova ekstrapolacija. Singularni integrali. Večkratni integrali. Metode tipa Monte Carlo. Reševanje navadnih diferencialnih enačb: Začetni problem. Enačbe prvega reda. Enačbe višjih redov. Sistemi diferencialnih enačb. Lokalna in globalna napaka. Eksplicitne in implicitne metode. Enočlenske metode: Eulerjeva metoda. Uporaba Taylorjeve vrste. Metode tipa Runge-Kutta. Eksplicitna RK metoda četrtega reda, trapezno pravilo, Mersonova metoda, Runge-Kutta Fehlbergova metoda. Stabilnost, konsistentnost in konvergenca enočlenskih metod. A-stabilnost. Veččlenske metode: Metode, ki temeljijo na numerični integraciji. Adamsove metode. Splošne linearne veččlenske metode. Rodovna polinoma in lokalna napaka. Prediktor–korektor metode. Milnova metoda. Ničelna stabilnost. Ocena reda ničelno stabilne veččlenske metode. Metode, ki temeljijo na diferenčnih aproksimacijah odvoda. Implicitne BDF metode. Ničelna stabilnost, konsistentnost in konvergenca veččlenskih metod. Robni problemi: Linearne enačbe. Prevedba na začetne probleme in strelska metoda. Diferenčna metoda.		Numerical differentiation: Stable computing of derivatives. Differential approximations for derivatives. Numerical integration: Degree of a rule and convergence. Newton-Cotes integration rules. Gauss quadratures. Composite rules. Error estimates. Convergence. Euler-Maclaurin formula and Romberg extrapolation. Singular integrals. Multiple integrals. Monte Carlo methods. Ordinary differential equations: Initial value problems. First order ODE equations. Higher order ODE equations. Systems of ODE equations. Local and global error. Explicit and implicit methods. One-step methods: Euler method. Methods based on Taylor's series. Runge-Kutta methods. Explicit RK method of order four, trapezoidal rule, Merson method, Runge-Kutta Fehlberg method. Stability, consistency and convergence of one-step methods. A-stability. Multistep methods: Methods based on numerical integration. Adams methods. Linear multistep methods. Characteristic polynomials and a local error. Predictor-Corrector methods. Milne's method. Zero stability. Order estimation of a zero stable method. Methods based on derivative approximations. Implicit BDF methods. Stability, consistency and convergence of multistep methods. Boundary value problems: Linear equations. Initial value and shooting methods. Finite difference methods.

Temeljni literatura in viri / Readings:

J. Kozak: Numerična analiza, DMFA-založništvo, Ljubljana, 2008.

R. L. Burden, J. D. Faires: Numerical Analysis, 8th edition, Brooks/Cole, Pacific Grove, 2005.

E. K. Blum: Numerical Analysis and Computation : Theory and Practice, Addison-Wesley, Reading, 1998.

Z. Bohte: Numerične metode, DMFA-založništvo, Ljubljana, 1991.

S. D. Conte, C. de Boor: Elementary Numerical Analysis : An Algorithmic Approach, 3rd edition, McGraw-Hill, Auckland, 1986.

E. Isaacson, H. B. Keller: Analysis of Numerical Methods, John Wiley & Sons, New York-London-Sydney, 1994.

D. R. Kincaid, E. W. Cheney: Numerical Analysis : Mathematics of Scientific Computing, 3rd edition, Brooks/Cole, Pacific Grove, 2002.

Cilji in kompetence:	Objectives and competences:
Slušatelj dopolni poznavanje metod za numerično odvajanje, integracijo in numerično reševanje navadnih diferencialnih enačb. Ob domačih nalogah pridobljeno znanje praktično utrdi.	Student supplements knowledge of numerical differentiation, integration and numerical solving of ODE equations. By solving homeworks the obtained theoretical knowledge is consolidated.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: Razumevanje delovanja metod za numerično integriranje in reševanje navadnih diferencialnih enačb. Sposobnost numeričnega reševanja navadnih diferencialnih enačb in robnih problemov s pomočjo računalnika. Sposobnost izbire najprimernejšega algoritma glede na lastnosti problema. Uporaba: Numerično računanje integralov in numerično reševanje navadnih diferencialnih enačb s pomočjo računalnika in ocenjevanje napak na podlagi teorije. V praksi (fizika, mehanika, kemija, ekonomija ...) se pogosto pojavljajo integrali in diferencialne enačbe, ki jih ni možno rešiti drugače kot numerično. Refleksija: Razumevanje teorije na podlagi uporabe.	Knowledge and understanding: Understanding methods for numerical integration and ordinary differential equations. Ability of numerical solving of initial and boundary value problems with the help of computers. Capability of choosing the most appropriate algorithm according to some features of the problem. Application: Numerical computing of integrals ans numerical solving of ODE equations using a computer and error estimation based on theory. Problems that can not be solved any other way that numerically occurs very often in practise (physics, mechanics, chemistry, economy...).

Prenosljive spretnosti – niso vezane le na en predmet: Spretnost uporabe računalnika pri reševanju matematičnih problemov. Razumevanje razlik med eksaktnim in numeričnim računanjem. Predmet konstruktivno nadgrajuje zahtevnejša znanja analize in drugih področij matematike.	Reflection: Understanding of theory through applications. Transferable skills: Skill of using computer for solving numerical problems. Understanding differences between exact and numerical computing. Knowledge of analysis and other fields of mathematics is constructively upgraded.

Metode poučevanja in učenja:	Learning and teaching methods:
Predavanja, vaje, domače naloge, konzultacije.	Lectures, exercises, homeworks, consultations.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Način (domače naloge, pisni izpit, ustno izpraševanje, naloge, projekt):		Type (homeworks, examination, oral, coursework, project):
domače naloge ali projekt	20%	homeworks or project
pisni izpit	40%	written exam
ustni izpit	40%	oral exam
Ocene: 1-5 (negativno), 6-10 (pozitivno) (po Statutu UL)		Grading: 1-5 (fail), 6-10 (pass) (according to the Statute of UL)

Reference nosilca / Lecturer's references:

Marjetka Krajnc:

JAKLIČ, Gašper, KOZAK, Jernej, KRAJNC, Marjetka, VITRIH, Vito, ŽAGAR, Emil. High order parametric polynomial approximation of conic sections. Constructive approximation, ISSN 0176-4276, 2013, vol. 38, iss. 1, str. 1-18. [COBISS.SI-ID 16716121]

KRAJNC, Marjetka. Interpolation scheme for planar cubic G [sup] 2 spline curves. Acta applicandae

mathematicae, ISSN 0167-8019, 2011, vol. 113, no. 2, str. 129-143. [COBISS.SI-ID 16215385]

KRAJNC, Marjetka. Geometric Hermite interpolation by cubic G[sup]1 splines. Nonlinear Analysis, Theory, Methods and Applications, ISSN 0362-546X. [Print ed.], 2009, vol. 70, iss. 7, str. 2614-2626. [COBISS.SI-ID 15508569]

Emil Žagar:

JAKLIČ, Gašper, KOZAK, Jernej, VITRIH, Vito, ŽAGAR, Emil. Lagrange geometric interpolation by rational spatial cubic Bézier curves. Computer Aided Geometric Design, ISSN 0167-8396, 2012, vol. 29, iss. 3-4, str. 175-188. [COBISS.SI-ID 16207449]

KOZAK, Jernej, ŽAGAR, Emil. On geometric interpolation by polynomial curves. SIAM journal on numerical analysis, ISSN 0036-1429, 2004, vol. 42, no. 3, str. 953-967. [COBISS.SI-ID 13398617]

ŽAGAR, Emil. On G [sup] 2 continuous spline interpolation of curves in R [sup] d. BIT, ISSN 0006-3835, 2002, vol. 42, no. 3, str. 670-688. [COBISS.SI-ID 12027993]