UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Numerično reševanje parcialnih diferencialnih enačb
Course title:	Numerical solving of partial 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
Univerzitetna koda predmeta / University course code:	M2411

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
30	**15**	**30**			**105**	**6**

Nosilec predmeta / Lecturer:	prof. Emil Žagar, prof. Marjetka Knez

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:**

Vsebina:	**Content (Syllabus outline):**
Parcialne diferencialne enačbe: Uvod v PDE in modelni problemi drugega reda. Enačbe eliptičnega tipa: Poissonova enačba.	Partial differential equations: Introduction to PDE and examples of partial differential equations of the second order. Elliptic equations: Poisson's equation. Finite

Diferenčna metoda. Diskretni maksimalni princip in ocena globalne napake. Iterativno reševanje diskretiziranih enačb. Jacobijeva, Gauss-Seidelova in SOR metoda. Simetrična SOR metoda s pospešitvijo Čebiševa. ADI metoda. Metode podprostorov Krilova. Večmrežne metode. Variacijske metode. Različni tipi metod končnih elementov. Enačbe paraboličnega tipa: Prevajanje toplote. Eksplicitne in implicitne numerične sheme. Crank-Nicolsonova metoda. Konsistenca, stabilnost in konvergenca. Enačbe hiperboličnega tipa: Valovna enačba. Karakteristike, karakteristične spremenljivke. Diferenčna metoda. Courantov pogoj. Konvergenca diferenčnih aproksimacij za modelni primer. Metoda karakteristik.		difference method. Discrete maximum principle and global error estimation. Iterative methods for discretized equations. Jacobi, Gauss-Seidel and SOR iterative methods. Symmetric SOR and Chebyshev acceleration. ADI method. Krilov subspace methods. Multigrid methods. Variational methods. Several tipes of finite element methods. Parabolic equations: Heat transfer equation. Explicit and implicit numerical schemes. Crank-Nicolson's method. Consistency, stability and convergence. Hyperbolic equations: Wave equation. Characteristics. Characteristical variables. Finite difference method. Courant's condition. Convergence of finite difference approximations for a model equation. Method of characteristics.

Temeljni literatura in viri / Readings:

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

W. F. Ames: Numerical Methods for Partial Differential Equations, 3rd edition, Academic Press, Boston, 1992.

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.

J. W. Demmel: Uporabna numerična linearna algebra, DMFA-založništvo, Ljubljana, 2000.

E. Isaacson, H. B. Keller: Analysis of Numerical Methods, John Wiley & Sons, New York-London-Sydney, 1966.

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

K. W. Morton, D. F. Mayers: Numerical Solution of Partial Differential Equations, 2nd edition, Cambridge Univ. Press, Cambridge, 2005.

G. D. Smith: Numerical Solution of Partial Differential Equations : Finite Differences Methods, 3rd edition, Clarendon Press, Oxford (New York), 2004.

Cilji in kompetence:	Objectives and competences:
Slušatelj spozna metode za numerično reševanje parcialnih enačb. Pridobljeno znanje praktično utrdi z reševanjem domačih nalog.	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 reševanje parcialnih diferencialnih enačb. Sposobnost numeričnega reševanja parcialnih diferencialnih enačb s pomočjo računalnika. Sposobnost izbire najprimernejšega algoritma glede na lastnosti problema. Uporaba: Numerično reševanje parcialnih diferencialnih enačb s pomočjo računalnika in ocenjevanje napak na podlagi teorije. V praksi (fizika, mehanika, kemija, ekonomija ...) se pogosto pojavljajo parcialne diferencialne enačbe, ki jih ni mogoče rešiti drugače kot numerično. Refleksija: Razumevanje teorije na podlagi uporabe. 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.	Knowledge and understanding: Understanding of numerical methods for solving partial differential equations. Ability of solving partial differential equations with the computer. Capability of choosing the most appropriate algorithm according to some features of the problem. Application: Numerical solution of partial differential 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...). 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, projekt.	Lectures, exercises, homeworks, consultations, project

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		homeworks or project
pisni izpit		written exam
ustni izpit		oral exam
	30% 40%	
Ocene: 5 (negativno), 6-10 (pozitivno) (po Statutu UL)	30%	Grading: 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]