Project ON144002 -Theoretical and Applied Mechanics of the Rigid and Solid Bodies. Mechanics of Materials (2006-2010)
Support: ***Ministry of Sciences and Environmental Protection of Republic of Serbia***
Institution Coordinator: ***Mathematical Institute Serbian Academy of Sciences and Arts.***
Project Leader: ***Katica (Stevanović) Hedrih***
Researchers: 37**.**
Researcher months: ***approximately 160 months***.

Report – Research Results in 2006.

Short Abstract:

Today, it seems generally accepted that nonlinear dynamical problems should be cooperatively addressed through the combined use of analytical, computational, geometrical and experimental approach (see Refs. [1-16]).

Further, interaction between nonlinear dynamics and control, as well as energy transfer between subsystems, plays an important role in advanced engineering systems in order to obtain desired dynamics behavior and improved reliability during operation [11]. The nonlinear deterministic and stochastic dynamics [1] and control of processes in complex mechanical systems are subject of our project research results.

New mathematical and phenomenological knowledge is a advances to theoretical and applied mechanics of the rigid and solid bodies and complex hybrid structures [2-5] and [8] and dynamical [6-7] systems with applications in mechanical engineering. Mechanics of materials with coupled fields is also subject of project research [12].

Seminar for Nonlinear Dynamics – Milutin Milanković was spontaneously organized by the Project researchers as a forum for scientific research results evaluations and is working at Faculty of Mechanical Engineering in Nish suported by researchers from other Serbian Universities and by visiting professors from all the Wolrd.. There are two main tasks. First is to contribute to yang researchers in the Project field, and second

Partial and partial fractional differential equations of creeping and vibrations of double plate system [2, 3, 8] and axially moving double belt system [5] are derived. A fractional-differential operator with the creep material parameters are introduced. Plate material is elastic or creeping and constitutive relation of stress-strain state is expressed through fractional derivatives.

The finite number of coupled partial fractional order differential equations of transversal vibrations of a creeping connected multi plate homogeneous system and multi belt system [5[have been derived. The analytical solution of the system of coupled partial fractional order differential equations of corresponding dynamical free and forced processes are obtained. It is also obtained time series functions as a particular components of the solution.

The influence of rotatory inertia of beam cross section and transverse shear of beam cross section under the transverse force, and the corresponding members in the partial differential equation are taken into account and by use Ariaratnam's idea the expression for Lyapunov exponents are obtained and the stochastic stability of beam deformable forms and processes are investigated. The partial differential equations of transversal stochastic vibrations of a parametrically excited beam graded by pure elastic material or by hereditary material or by creep material, was derived. The influence of rotatory inertia of beam cross section and transverse shear of beam cross section under the transverse force, and the corresponding members in the partial differential equation are taken into account. The asymptotic averaged method is used for obtaining the first approximation of corresponding Itô stochastic differential equations. By using idea Ariratnam, for all three cases of beam material, the sets of Lyapunov exponents are obtained in the function of the Bessel functions [1]

Using Krilov – Bogolyubov - Mitropolskiy's asymptotic method, both the solutions in the first approximation and the system of nonlinear coupled differential equations for the corresponding number of excited amplitudes and phases, for multifrequency vibrations of a hybrid system are derived and the analysis of energy transfer between modes is also performed..

The measures of integrity of dynamical systems and dynamical system processes by which is possible made to conclude whether the system possesses integrity or whether that system loses integrity are investigated and defined [6] and [7]. Models, dynamics and stability of vibroimpact systems are investigated [9,10,16,17]. New contribution to the mechanics of materials with rheological properties, with crack or with coupled fields [12, 13, 14]. Contributions in the form of mathematical description of deterministic and stochastic dynamics of the sandwich multibelt, multibeam or multiplate systems with rheological or hereditary properties and stability of its deformable shape are present [2-8].

Project Leader give series of the Plenary or Invited lectures and was member of scientific Committees or Organizer of Minisymposia or invited participant as session chairman in area of Project research results at following European or international scientific meetings:

1* The 16th European Conference of Fracture – *Integrity of Dynamical Systems* Alexandroupolis Greece 2006;
2* IFNA – Elsevier Journal Nonlinear Analysis Symposia – *Hybrid Systems and Applications*, University of Luisiana, Lafayette, USA 2006;
3* The 9th International Conference on Tensor Society on *Differential Geometry, Functional and Complex Informatics and their Applications*, Sapporo, September 4-8, 2006. Hokkaido Tokai University Sapporo;
4* Conference *Aplied Mathematics and Mechanics* KPH, Kharkov 2006;
5* 2nd IFAC Workshop on *Fractional Differentiation and its Applications*, 19-21 July, 2006, Porto, Portugal,
as well as Contributed Lectures:
6* Eiromech - *European Solid Mechanics Conference* ESMC 2006 – Budapestm Hungary;
7* SEECCM 06 –First South-East European Conference on *Computational Mechanics*, Kagujavac 2006.

WEB of the Project: http://www.mi.sanu.ac.yu/projects/projects.htm
WEB of the Projet Seminar: http://www.masfak.ni.ac.yu/sitegenius/topic.php?id=863

Published References in 2006.

[1] Hedrih (Stevanović) K., (2006), *Transversal Vibration of a Parametrically Excited Beam: Influence of Rotatory Inertia and Transverse Shear on Stochastic Stability of Deformable Forms and Processes*, ©Freund Publishing House Ltd. ***International Journal of Nonlinear Sciences and Numerical Simulation***, 7(1), 117-124, 2006. **Impact Factor 2,345 .**

[2] Hedrih (Stevanović) K., (2006), *Transversal Vibrations of Double-Plate Systems*, ***Acta Mechanica Sinica, Springer***, (2006) 22, pp. 487-501 (hard cower and on line). **ISI List**

[3] Hedrih (Stevanović) K., (2006), *Modes of the Homogeneous Chain Dynamics*, ***Signal Processing***, ***Elsevier,*** 86(2006), 2678-2702.. ISSN: 0165-1684 www.sciencedirect.com/science/journal/01651684 **ISI List**

[4] Hedrih (Stevanović) K., (2006), Vukota Babović, Dragan Šarković, (2006), An auxi liary size distribution model for the ultrasonically produced water droplets, ***Experimental Thermal and Fluid Science - ETF, Elsevier***, Volume 30, Issue 6, June 2006, Pages 559-564. http://www.elsevier.com/locate/etfs **ISI List**

[5] Hedrih (Stevanović), K., (2006), *Transversal vibrations of the axially moving double belt system with creep layer*, *Preprints, 2nd* ***IFAC*** *Workshop on Fractional Differentiation and its Applications*, 19-21 July, 2006, Porto, Portugal, pp.230-235. +CD. IFAC WS 2006 0007 PT, ISBN 972-8688-42-3, 978-972-8688-42-4.ISBN . http;/www.iser.ipp.pl

[6] Hedrih (Stevanović), K., (2006), *Measurements of Dynamical System Integrity and Fracture Mechanics*, Invited Key Lecture in ***Fracture of Nano and Engineering Materials and Structures*** (p. 1416), Edited by E.E.Gdoutos, Proceedings of the 16th *European Conference of Fracture* (p. 1416), ***Springer 2006***, pp. 793-794, plus CD 1-15. ISBN 1-4020-4971-4, BARCOD 9 781402 049712. http://ecf16.civil.duth.gr

[7] Booklet of Abstracts - *Minisymposium - Integrity of Dynamical Systems- ECF16*, Edited by Katica (Stevanović) Hedrih, invited organizer of Minisymposia ***IDS-ECF - the 16th European Conference of Fracture***, Greece 2006, Centre for Nonlinear Dynamics and Active Structures, Faculty of Mechanical Engineering University of Niš and Democritus University of Thrace, Xanthi, Greece, 2006. p. 324. ISBN 86-80587-57-5. BarCod 9 788680 587578. COBIS. SR - ID 130756620. UDK 531:01 /048); 530:182(048); 530:42 (048); 53:005.745 (100)

[8] Hedrih (Stevanović) K. and Simonović, J., (2006), *Characteristic Eigen Numbers and Frequencies of the Transversal Vibrations of Sandwich System*, SEECCM 06 –First South-East European Conference on Computational Mechanics, Proceedings, Editors – M. Kojic and M Papadrakakis, Kragujevac, pp. 90-94. + CD. hppt://www.seeccn.kg.ac.yu. ISBN 86-81037-13-7, COBISS.SR-ID 131758092, udc 531/533(082)

[9] Ugrčić Marinko, (2006), *Clock Mechanism as Base of Artillery Safety and Arming Devices*, Invited Lectute in ***Fracture of Nano and Engineering Materials and Structures*** (p. 1416), Edited by E.E.Gdoutos, Proceedings of the 16th European Conference of Fracture (p. 1416), ***Springer 2006***, pp. 799-800, plus CD. ISBN 1-4020-4971-4, BARCOD 9 781402 049712. http://ecf16.civil.duth.gr

[10] Ugrčić, M., Dimitrijević, D. (2006), *Kill Probability of Armoured Targets by Firing the Airborne Antitank Warfare Systems*, 1st Conference NACORT, National Committee of Range Testing, Air Range Testing centre, Chandipur, INDIA, 2006.

[11] Nestorović T. *Controller Design for the Vibration Suppression of Smart Structures* ***(Ph.D. thesis),*** Fortschritt-Berichte VDI Reihe 8, Nr. 1071, Düsseldorf: ***VDI Verlag*** 2005, ISSN 0178-9546, ISBN 3-18-507108-5, http://www.vdi-nachrichten.com/onlineshops/buchshop/literaturshop/langanzeige.asp?vr_id=7095

[12] D. Marinkovic, H. Köppe, U. Gabbert: *Numerically efficient finite element formulation for modeling active composite laminates*, ***Mechanics of Advanced Materials and Structures***, Volume 13, Number 5, pp. 379 - 392, 2006.

[13] Atanasovska I. and Nikolić-Stanojević V., (2006), Influence of addendum modification Coefficient of the Gear's Load Capacity, Invited Contribution in ***Fracture of Nano and Engineering Materials and Structures*** (p. 1416), Edited by E.E.Gdoutos, Proceedings of the 16th European Conference of Fracture (p. 1416), ***Springer 2006***, pp. 787-788, plus CD. ISBN 1-4020-4971-4, BARCOD 9 781402 049712. http://ecf16.civil.duth.gr

[14] Maksimović K., Maksimović S., and and Nikolić-Stanojević V., (2006), Modeling of the Surface Cracks and Fatigue Life Estimation, Invited Contribution in ***Fracture of Nano and Engineering Materials and Structures*** (p. 1416), Edited by E.E.Gdoutos, Proceedings of the 16th European Conference of Fracture (p. 1416), ***Springer 2006***, pp. 795-796, plus CD. ISBN 1-4020-4971-4, BARCOD 9 781402 049712. http://ecf16.civil.duth.gr

[15] Nikolić R. and Veljković J.M, (2006), *Some Aspects Dynamics Interfacial Cracks Growth*, Invited Contribution in ***Fracture of Nano and Engineering Materials and Structures*** (p. 1416), Edited by E.E.Gdoutos, Proceedings of the 16th European Conference of Fracture (p. 1416), ***Springer 2006***, pp. 807-808, plus CD. ISBN 1-4020-4971-4, BARCOD 9 781402 049712. http://ecf16.civil.duth.gr

[16] Mitić S., (2006), *On stability of problems of periodic impact motions*, Invited Contribution in ***Fracture of Nano and Engineering Materials and Structures*** (p. 1416), Edited by E.E.Gdoutos, Proceedings of the 16th European Conference of Fracture (p. 1416), ***Springer 2006***, pp.809-810, plus CD. ISBN 1-4020-4971-4, BARCOD 9 781402 049712. http://ecf16.civil.duth.gr

[17] Mitić S., (2006), *Vibroimpact systems*, Fakultet zaštite na radu, Niš, p. 250. (in Serbian)

[18] Drašković Z., On the invariance in Mechanics, Posebna izdanja 22. Matematički institut SANU, 2005, p- 95., ISBN86-80593-38ć9.

[19] *R. Selmic, P. Cvetkovic, R. Mijailovic and G. Kastratovic*, Optimum Dimensions of Triangular Cross-Section in Lattice Structures, ***Meccanica*** (2006) 41:391-406.

[20] Vujičić A. Veljko, Modification of the characteristic gravitational constants, ***Astronomical and Astrophysical Transactions***, Vol. 25. N0.4, 2006. . **R51**

[21] Knezevic-Miljanovic Julka : Asymptotic property of differential equatons, ***Differential equations (Differentsial'nye Uravneniya)*** Vol 41, N 1, 2006, 139-140., ISSN 0012-2661 UDK 517,927.3.

[22] Radovanović M., Some Possibities for Determining Cutting Data when Using Laser Cutting, Strojniški vestnik, ***Journal of Mechanical Engineering***, Volume 52, Number 10, ISSN 0039-2480, Ljubljana, Slovenia, 2006, pp. 645-652 .

[23] Maksimović, S., Zeljković, V., Ugrčić, M., "*On Multilevel Optimization Method with Applications on Aircraft Landing Gears*", ***WSEAS-Transactions on applied and theoretical mechanics***, Volume Issue 2, Vol No1, 2006.

[24] D. Marinkovic, H. Köppe, U. Gabbert: "Numerically efficient finite element formulation for modeling active composite laminates", ***Mechanics of Advanced Materials and Structures***, Volume 13, Number 5, pp. 379 - 392, 2006.

[25] Hedrih (Stevanović), K., (2006), THE FREQUENCY EQUATION THEOREMS OF SMALL OSCILLATIONS OF A HYBRID SYSTEM CONTAINING COUPLED DISCRETE AND CONTINUOUS SUBSYSTEMS, FACTA UNIVERSITATIS Series: Mechanics, Automatic Control and Robotics, Vol.5, No 1, 2006 pp. 25 - 41 UDC 534.1:534.012:534.013:

[26] Veljko A. Vujičić, THE ACTION OF FORCE AND COUNTERACTION PRINCIPLE, FACTA UNIVERSITATIS Series: Mechanics, Automatic Control and Robotics, Vol.5, No 1, 2006, pp. 59 – 70. UDC 531.011:531.31 **R61**

[27] Milutin Marjanov, MOTION OF THE BODY IN AN INHOMOGENEOUS GRAVITATIONAL FIELD, FACTA UNIVERSITATIS Series: Mechanics, Automatic Control and Robotics, Vol.5, No 1, 2006, pp. 79 – 89, UDC 51:550.312:629.

[28] Tamara Nestorović Trajkov, Falko Seeger, Heinz Köppe, Ulrich Gabbert, OPTIMAL LQ CONTROLLER WITH ADDITIONAL DYNAMICS FOR THE ACTIVE VIBRATION SUPPRESSION OF A CAR ROOF, FACTA UNIVERSITATIS Series: Mechanics, Automatic Control and Robotics, Vol.5, No 1, 2006, pp. 117 – 129. UDC 62-52

[29] Marinko Ugrčić, Stevan Maksimović, Zijah Burzić, From *Scientific Technical Review*- The 16th European Conference on Fracture, FACTA UNIVERSITATIS Series: Mechanics, Automatic Control and Robotics, Vol.5, No 1, 2006., *UDC: 531:061.3(047)=20 COSATI: 20-04, 05-02*

[30] D. Mikičić, B.Radičević, Ž. Đurišić, *"Wind Energy potential in the World and Serbia and Montenegro",* FACTA UNIVERSITATIS-Series: Electronics and Energetics, Vol. 19, N°1, April 2006., ISSN: 0353-3670, pp.(47-61).

The Publications are listed under 2005. but was published in beginning of 2006.

[1] Hedrih (Stevanović) K., (2005), Partial Fractional Order Differential Equations of Transversal Vibrations of Creep-connected Double Plate Systems, in Monograph - Fractional Differentiation and its Applications, Edited by Alain Le Mahaute, J. A. Tenreiro Machado, Jean Claude Trigeassou and Jocelyn Sabatier, **U-Book**, pp. 289-302.

[2] Hedrih (Stevanović) K., (2005), *Nonlinear Dynamics of a Heavy Material Particle Along Circle which Rotates and Optimal Control***, Chaotic Dynamics and Control of Systems and Processes in Mechanics** (Eds: G. Rega, and F. Vestroni), p. 37-45. IUTAM Book, **in Series *Solid Mechanics and Its Applications*, *Editerd by G.M.L. Gladwell, Springer***,. 2005, XXVI, 504 p., Hardcover ISBN: 1-4020-3267-6.

[3] Hedrih (Stevanović) K., (2005), *Homoclinic Orbits Layering in the Coupled Rotor Nonlinear Dynamics and Chaotic Clock Models*, SM17 – Multibody Dynamics (M. Geraldin and F. Pfeiffer), p. Lxiii – CD - SM10624, Mechanics of the 21st Century (21st **ICTAM,** Warsaw 2004) - CD ROM INCLUDED, edited by Witold Gutkowski and Tomasz A. Kowalewski, IUTAM, **Springer 2005**, ISBN 1-4020-3456-3, Hardcover., p. 421+CD. ISBN-13 978-1-4020-3456-5 (HB), ISBN-10 1-4020-3559-4(e-book), ISBN-13-978-1-4020-3559-3

Subject: Citrate

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* Hedrih (Stevanović) K., Filipovski A., (2002), *Longitudinal Vibration of a Fractional Derivative Order Rheological Rod with Variable Cross Section*, Facta Universitatis, Series Mechanics, Automatic Control and Robotics, Vol. 3 No. 12, 2002. pp.327-350. YU ISSN 0534-2009.
http://facta.junis.ni.ac.yu/facta/macar/macar2002/macar2002-02.html

* ***Cited (quoted) in:***

Jakšić N., Boltežar M., (2005), Viscously damped transverse vibrations of a moving string, Journal of Mechanical Engineering – Strojniški vestnik, 560-569. **ISI List**

**

19. Hedrih (Stevanovic′) K.: Interpretation of the transfer of energy from high-frequency to low-frequency modes by averaging asymptotic method Krilov-Bogolybov-Mitropolsky. In.: Proc. of the Second International Conference “Asymptotics in Mechanics”, pp. 97-104. Saint-Petersberg State Marine Technological University, Saint-Petersberg (1997)

20. Hedrih (Stevanovic′) K.: Multifrequency forced vibrations of thin elastic shells. In: CD Proc. of the Fifth EUROMECH Nonlinear Dynamics Conference, pp. 2417-2426. Eindhoven University of Technology (2005)

* ***Cited (quoted) in***:

Kozmin A., Mikhlin Yu. and C. Pierre, Transient in a two DOF nonlinear Systems, Nonlinear Dynamics, 2006; **ISI List/**