MATEMATIČKI INSTITUT SANU , ODELJENJE ZA MEHANIKU

Mathematical Institute SANU, Belgrade, Department for Mechanics

http://www.mi.sanu.ac.rs/colloquiums/mechcoll.htm

http://www.mi.sanu.ac.rs/colloquiums/collsems.htm

Program of Mechanics Colloquium –SEPTEMBER 2011

Sreda (Wednesday), 14 septembar (September 14) 2011 u 18 sati (18h) **Lecture No. 1161**

Prof. dr Livija Cveticanin, Full Professor of Faculty of Technical Sciences University of Novi Sad, (Project ON174000)

Dynamics of the non-ideal mechanical systems: A review

A review on the literature dealing with the main properties of non-ideal vibrating systems would be presented. The analytical and numerical methods applied for analyzing such systems would be shown. The practical examples of non-ideal systems would be considered. The most common phenomenon for the systems would be discussed. The specific properties for various models would be also discussed. Special attention would be given to the 'Sommerfeld effect' and steady-state deterministic chaos in this system. Methods for controlling chaos and its elimination would be presented, too. The direction of the future investigation would be given.

Sreda (Wednesday), 21 septembar (September 21) 2011 u 18 sati (18h) **Lecture No. 1163**

Trifce Sandev, Radiation Safety Directorate, Skopje, Republic of Macedonia

Generalized stochastic and kinetic equations approach to anomalous diffusion

We consider generalized stochastic and kinetic equations to model anomalous diffusion processes. The generalized Langevin equation with frictional memory kernels of the Mittag-Leffler type for a free particle and a harmonic oscillator is investigated through velocity and displacement correlation functions. The Laplace transform method and the properties and asymptotic behavior of the Mittag-Leffler type functions are applied to find the relaxation functions, which are in close connection with the correlation functions. The asymptotic behavior of the particle in the short and long time limit is obtained from the analytical results and by using the Tauberian theorems. It is shown that for various values of the parameters of the frictional memory kernels anomalous diffusion occurs. We distinguish cases of subdiffusion and superdiffusion. The proposed models may be used to model anomalous diffusive processes in complex media. From the other side, we investigate generalized fractional diffusion and fractional Fokker-Planck equations. These equations with Caputo or Riemann-Liouville time fractional derivatives are introduced in the context of the continuous time random walk theory. Instead of ordinary time derivative, we use composite or so-called Hilfer time fractional derivative, which was originally introduced by Hilfer, based on fractional time evolutions. This composite derivative arises in context of relaxation models, and it is shown to provide an excellent description of experimental data over more than ten orders of magnitude, with less parameters than traditional fit functions such as Havriliak-Negami. The solutions are obtained in terms of the Mittag-Leffler type functions and Fox's H-function by application of the Fourier-Laplace transform methods. The asymptotic behaviors of the solutions are derived and the moments of fundamental solutions obtained. The obtained results may be helpful for the evaluation of data from complex systems, in particular, in the context of relaxation dynamics in glassy systems or aquifer problems.

References:

[1] R. Hilfer, *Application of Fractional Calculus in Physics* (Singapore: World Scientific Publishing Company, 2000).

[2] R. Metzler and J. Klafter, *Phys. Rep.* **339** (2000) 1; R. Metzler and J. Klafter, *J. Phys. A: Math. Gen.* **37** (2004) R161.

[3] T. Sandev and Z. Tomovski, *Phys. Scr.* **82** (2010) 065001.

[4] T. Sandev, Z. Tomovski and J.L.A. Dubbeldam, *Physica A* **390** (2011) 3627.

[5] T. Sandev, R. Metzler and Z. Tomovski, *J. Phys. A: Math. Theor.* **44** (2011) 255203.

[6] T. Sandev and Z. Tomovski, *The General Time Fractional Fokker-Planck Equation with a Constant External Force* (to be presented: Symposium on Fractional Signals and Systems, Coimbra, Portugal, 4 – 5 November 2011).

[7] H.M. Srivastava and Z. Tomovski, *Appl. Math. Comput.* **211** (2009) 198.

[8] Z. Tomovski, R. Hilfer and H.M. Srivastava, *Integral Transform. Spec. Func.* **21** (2010) 797.

Sreda (Wednesday), 28 septembar (September 28)2011 u 18 sati (18h) **Lecture No. 1163**

Prof. Marinko UGRČIĆ, PhD (Eng), Economical institute, Belgrade, (Project OI174001)

NUMERICAL SIMULATION OF PROCESSES IN PHYSICS OF EXPLOSION

Abstract: Physics of explosion deals with different and complex processes, followed by the shock wave in the materials and extremely high parameter of state (density, pressure, temperature, stress and strain rate, etc.), so that they belong naturally to the class of mechanics' problem of nonlinear continuum. The examples of explosive propulsive systems used in military and civil purposes are very large and all of them consist of two basic components: explosive charge as a source of energy and inert layer (with or without confinement) as an executive part that after acceleration and eventual deformation must produce expected effect.

The requirements for qualitative description and evaluation of the processes of explosive propulsion, provided entirely by experiments, were exceeded a long time ago. The modern design requests more complex analyses of quantitative type that shortens significantly time and reduce costs of development of new systems of explosive propulsion. Further, numerical simulation of processes of explosive propulsion represents powerful and effective method in the analysis of singular and summary influence of the significant factors on the course of process and in solving of optimization assignments of explosive propulsive systems, as well.

Numerical simulation of the above mentioned systems functioning may be realized by the use: empirical (quasi-analytical), analytical, numerical and coupled methods of the mathematical modeling of processes.

Each of given methods, besides the determined systems of equation, require some number of enter data to be known, related to the physical and chemical characteristics of explosive charge and inert materials (layer, confinement) for considered system. For the inert component of system the values of material density, dynamic pressure resistance, hardiness, and tensile strength and so on are involved in calculation. For a finer and more complex analysis that takes into account the shock wave on the process of explosive propulsion we need to know the equation of state of materials (i.e. shock adiabate) and sound velocity in the material. On the other hand, the input data related to the explosive charge lake the density of explosive, thermodynamic and kinematic parameters of detonation, isentropic exponent of gaseous product of detonation; and for more detailed analysis the dynamic shock adiabate of explosive and equation of state of products of detonation, must be entered in the calculation.

Today, the numerical simulation of processes in the physics of explosion, that considers appropriate mathematical modeling and analysis based on the finite elements method, is preferable. The illustration of possibilities of the AUTODYN solver based on this method is shown by some examples of simulation of functioning of the explosive propulsive systems such as the shaped charge, high explosive projectile, explosive reactive armour, concrete penetrating warhead, etc.

References:

1. WALTERS, W. P., ZUKAS, J. A.: *Foundamentals of shaped charges*, A Wiley-Interscience Publication, John Wiley and sons, New York, 1989.
2. ОРЛЕНКО Л. П. (реадактор): *Физика взрыва*, издание третье, дополненное и переработанное, под редакцией издательство «Наука», Главная редакция физико-математической литературы, Москва, 2004.
3. UGRČIĆ, M.: *Numerical simulation and optimisation of the shaped charge function*, Scientific Technical Review, Vol. XLVIII, Num. 4, pp. 30-41, 1998.
4. www.century-dynamics.com and www.ansys.com *Theory manual*, Century Dynamics, Solutions through Software, Huston, USA.
5. EMAM, R., MIRANVILLE, A.: *Mathematical modeling in continuum mechanics*, Second edition, Cambridge University Press The Edinburgh Building, Cambridge UK, Published in the United States of America by Cambridge University Press, New York, 2005.
6. UGRČIĆ, M.: *Warheads and rocket engines of aircraft missiles*, COFIS Export-Import Co. Ltd., Malta, 2010.
7. UGRČIĆ, M.: *Shaped charge based projectiles and warheads*, VIZ, Belgrade, 2010.
8. UGRČIĆ, M.: *Modeling and Simulation of Interaction Process of Shaped Charge Jet and Explosive Reactive Armour*, International Conference EXPLOMET'95, El Paso - USA, pp. 511-518, 1995.
9. Ugrčić, M, Ugrčić, D.: *FEM Techniques in Shaped Charge Simulation*, Scientific Technical Review, Vol. LVIX, No.1, pp. 26-34, 2009.

Next month

Sreda (Wednesday), 5 oktobar (October 5) 2011 u 18 sati (18h) **Lecture No. 1164**

Assistant Professor dr Natača Trišović, Faculty of Mechanical Engineering University of Belgrade, (Project OI174001

Modification of the Dynamics Characteristics in the Structural Dynamic Reanalysis

Structural dynamic modification (SDM) techniques can be defined as the methods by which dynamic behavior of a structure is improved by predicting the modified behaviour brought about by adding modifications like those of lumped masses, rigid links, dampers, beams etc. or by variations in the configuration parameters of the structure itself. Such methods, especially those with their roots in finite element models, have often been described as REANALYSIS. Most of the techniques imply a dynamic test at some stage of SDM and currently prefer implementation on a personal computer.

The need for SDM arises because of the demands on higher performance capabilities of complex mechanical and structural systems, like machine tools, automobiles, rail vehicles aerospace systems and high speed rotating systems, which require sound dynamic design, i.e. desired dynamic characteristics like vibration levels/response, resonances/eigenvalues, dynamic stability and mode shapes.

Key words: Structural dynamic modification, reanalysis, eigenvalues, design variables

Sreda (Wednesday), 12 oktobar (October 12) 2011 u 18 sati (18h) **Lecture No. 1164**

Prof. dr Milutin Marjanov, Mathematical Institute SANU , (Project OI174001)

THREE-BODY SYSTEM: STABLE AND CHAOTIC ORBITS

Abstract. Three bodies moving in the closed orbits, exposed to the gravitational interactions only, enter gradually, as a rule, into the gravitational resonances: periods of their rotations become related as the rational fractions. Because of that, motions of the bodies, for the most part, become harmonized, but some period ratios are causes of the chaotic motions, also.

In this work, investigation of that phenomenon was based on the, so cold, Newton's three-body system consisting of one massive and two considerably smaller bodies ($m_0 >> m_1, m_2$) turning around it. The same procedure may be used for examination of the correspondent restricted three-body problem ($m_0 >> m_1, m_2 \approx 0$).

It was revealed that the chaotic motions zones are situated around the $T_1:T_2 \sim 1:3$ and 3:1 resonances and that their extensions mostly depend on the small masses and the large mass ratios.

The adopted model may be applied to the Sun, together with any pair of the (not necessarily mutualy closest) heavenly bodies, provided that they do not form the binary system.

Thus, it was possible to determine some of the Solar System regions in which the orbits may become chaotic. Existence of such zones are probably the causes of the fact that numerous meterodes, comets and asteroides leave their regular orbits and begin to move through the interplanetary space along the paths crossing the planets' orbits.

Concerning the planets, it seems that Mars' and Uranus' orbits lie in the zones of the unstable orbits. This fact, eventually, may produce approach of these bodies towards the Sun.

Key words: resonance, stable, unstable orbits, chaotic motions

****
****

Предавања ће се одржавати средом са почетком у 18.00 часова, у сали 301 F на трећем спрату зграде Математичког института САНУ, Кнез Михаилова 36/III, (зграда преко пута главне зграде САНУ).

Позив научницима и истраживачима да пријаве сцоја предавања

Пријава потенцијалног предавача треба да садржи апстракт предавања до једне странице на српском језику ћирилицом и превод на енглески јесик, као и CV обима до две странице. Пријаву послати на адресу управника Одељења за механику у виду Word DOC на адресу: khedrih@eunet.rs

****

Announcement and Invitation

Start of each lecture is at each Wednesday at 18,00 h in room 301 F at Mathematical Institute SANU, street Knez Mihailova 36/III.

All scientists and researchers in area of Mechanics are invited to contribute to the Program of Mechanics Colloquium of Mathematical Institute of Serbian Academy of Sciences and Arts. One page Abstract of proposed Lecture with short CV is necessary to submit in world doc to Head of Department of Mechanics (address: khedrih@eunet.rs), one month before first day in the next moth.

Катица (Стевановић) Хедрих

Katica R. (Stevanovic) Hedrih
Head of Department of Mechanics