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# Mathematical Institute SANU, Belgrade, Department for Mechanics

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# Program of Mechanics Colloquium – JANUARY 2012

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.

**Sreda (Wednesday), 11 januar (January 11) 2012 u 18 sati (18h)** **Lecture No. 1177**

Teaching and Research Assistant Đorđe Čantrak, Hydraulic Machinery and Energy Systems Department, Faculty of Mechanical Engineering, University of Belgrade

**Investigation of the turbulent swirl flows by use of stereo PIV, LDA and classical techniques**

Investigation of turbulent swirl flows, thanks to its presence in nature and science, as well as to its complexity of the three-dimensional velocity field, has fundamental and practical significance.
Experimental investigations have been performed behind the axial fan impeller in a straight pipe in three measuring sections x/D=2.96, x/D=21.1 and x/D=25.92, where x denotes distance from the test rig inlet and D is average test rig inner diameter. Measurements by use of optical techniques stereo PIV (Particle Image Velocimetry) and LDA (Laser Doppler Anemometry) have been performed in the first and the last measuring section. Measurements with classical probes have been conducted in the second section. These experiments have been conducted for three angle positions of the axial fan and five regimes defined by the rotation number of the axial fan.
Application of the stereo PIV offers good spatial, up to 160mm x 120mm dimension, and acceptable, up to 7Hz, time resolution of the turbulent swirl flow in pipe. “Three-dimensional” picture of the velocity field is obtained in defined sections.
Excellent time resolution of the LDA measurements, over 30 kHz, offers good basis for Reynolds statistics application. However, only one-dimensional system was employed. Thee components were successively measured, without time correlation. Combining stereo PIV and LDA for investigation of unsteady swirl flows, what is here case in the core region allows a more detailed interpretation of velocity fluctuations than that from LDA alone. This is of the significance for turbulence models and numerical simulations which try to resolve fluid flow unsteadiness.
Measurements with classical probes for two-dimensional flows in this work, as well in [1] confirmed difficulties in determination of the pressure and velocity field in the core region. HWA measurements in [2] confirmed the same conclusion with velocity field. On the other side, good results were obtained in the outer regions. The most recent investigations show existence of the velocity radial component in the core region, i.e. three-dimensional character of the turbulent swirl flow [3].
Investigation of the vortex dynamics in large-scale turbulence is possible with visualization and quantification of smaller vortices and understanding of their contribution to the fluid flow [4, 5]. Reynolds equations are of the great significance for statistical analysis [6]. Visualization and quantification of the vortex structure by use of PIV offers additional possibilities for results interpretation, especially by use of optical systems of great time resolution Time-Resolved PIV (TR PIV).
In this lecture will also been shown part of the newest results obtained by stereo TR PIV behind the axial fan impeller. In these experiments were employed high repetition rate laser with maximum frequency of 10 kHz and two speed cameras with 20.000 frames per second each. This technique and obtained results offer excellent basis for application of the different velocity field decompositions which is of importance in the process of resolving turbulence.

**Keywords:** turbulence, swirl flow, PIV, LDA, TR PIV.

**Acknowledgement**

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**References**

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2. Lečić M. (2003) Theoretical and Experimental Investigations of the Turbulent Swirling Flows, Ph.D. thesis, Faculty of Mechanical Engineering, University of Belgrade, Belgrade, Serbia.
3. Protić Z.D., Nedeljković M.S., Čantrak Đ.S., Janković N.Z. (2010): Novel Methods for Axial Fan Impeller Geometry Analysis and Experimental Investigations of the Generated Swirl Turbulent Flow, Thermal Science, Vol. 14, pp. S125-S139.
4. Adrian R.J., Christensen K.T., Liu Z.-C. (2000): Analysis and interpretation of instantaneous turbulent velocity fields, Experiments in Fluids, No. 29, pp. 275-290.

5. Derksen J.J. (2005): Simulations of confined turbulent vortex flow, Computer & Fluids, No. 34, pp. 301-318.
6. Čantrak S. (1981) Experimental Investigation of the Statistical Properties of Swirling Flows in Pipes and Diffusers, Dr.-Ing. thesis, Faculty of Mechanical Engineering, Technical University Karlsruhe, Karlsruhe, Germany.

**Sreda (Wednesday), 18 januar (January 16) 2012 u 18 sati (18h)** **Lecture No. 1178**

Mr Zvonko Rakarić, teaching assistant of Faculty of Technical Sciences University of Novi Sad.

**The Free and Forced Oscillations of Nonconservative Systems with Fractional Order Restoring Force**

In this work free and forced oscillations of the systems with a non-negative real power restoring force are studied. In order to analyze free oscillations, a novel perturbative method is developed with a Jacobi elliptic function as a generative solution. The parameters of the Jacobi elliptic function are determined by using the energy conservation law and Hamilton's variational principle. The method is further developed for forced oscillations. Applications of both methods to the systems with different damping mechanisms are given. In addition, the corresponding phenomena are also investigated.

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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

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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