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Recent Researches in Applied Mechanics

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Proceedings of the 3rd International Conference on Fluid Mechanics and Heat and Mass Transfer (FLUIDS-HEAT '12)

Vouliagmeni Beach, Athens, Greece, March 7-9, 2012

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Table of Contents

Plenary Lecture 1: Instability of Cracked and Porous Media by Statics and Small Vibrations 9
Boris P. Sibiryakov

Plenary Lecture 2: Gauge Theory of Flows of an Ideal Fluid 10
Tsutomu Kambe

Plenary Lecture 3: Different Mixtures of Diesel-Vegetable Oils as Fuel 11
Charalampos Arapatsakos

Vibration Analysis of a Heat Conducting Viscoelastic Cylindrical Panel 13
P. K. Sharma, V. Walia

Dynamic Design Verification (DDV) of Vertical Pump using, Combined Modal Analysis (MA), Finite Element Analysis (FEA) & Operation Deflection Shape (ODS) 18
Siamak Noroozi, Mihai Dupac, Abdul Ghaffar Abdul Rahman

Numerical Analysis of Earth Dams Structure 24
Hamidreza Ahmadaghaei

Analysis of Dimensionless Numbers for Convective Heat Transfer Models Used in the Study of Spark Ignition Engines 28
Adrian Irimescu

Optimal Dew Point in Paper Drying Process 34
Ioana Diaconescu, Cristian-Silviu Simionescu, Luiza Grigorescu

An Experimental Research Project on Sinusoidal Pulsatile Pipe Flows Part 1: Presentation of Software Programming Utilized for Measurements and Data Acquisition 39
Emrah Özahi, Melda Özdinç Çarpinlioğlu

An Experimental Research Project on Sinusoidal Pulsatile Pipe Flows Part 2: Influence of Oscillation Frequency and Amplitude on Onset of Transition to Turbulence 45
Melda Özdinç Çarpinlioğlu, Emrah Özahi

Modes of Flow in Pneumatic Conveying Systems 51
Alperen Tozlu, Emrah Özahi, Ahmet Ihsan Kutlar, Melda Özdinç Çarpinlioğlu

Measurement of the 3D Turbulent Flow Field of an Annular Jet and Proper Orthogonal Decomposition Analysis. 57
B. Patte-Rouland, A. Danlos, E. Rouland

Theoretical Study on the Evaporative Properties of Gasoline–Bioethanol Fuel Blends 63
Ciprian Sebastian Flueras, Adrian Irimescu

ISBN: 978-1-61804-078-7

Investigation of Fluidic Performance of Cooling Fan in the High Power Automatic Transmission for Commercial Vehicle 69
In Guk Jeong, Ji Hun Yun, Chung Seob Yi, Chul Ki Song, Jeong Se Suh, Kwon Hun Yoon, Kwang Hyun Kim

Groundborne Noise and Vibration Assesment from Metro Operation in the New Athens Metro Extension to Piraeus 75
Konstantinos Vogiatzis

Finite Element Based Fatigue Analysis of Bolted Joints in Multi-Megawatt Wind Turbines Main Frame 84
Masoud Asgari, Aidin Ghaznavi, Hamid Reza Lari

Modeling and Optimization of MEMS-Based Acoustic Sensor for Underwater Applications 88
S. Shevtsov, I. Parinov, I. Zhilyaev, S.-H. Chang, J. C.-Y. Lee, P. -C. Wu, C.-F. Lin, D. -S. Wuu

Gauge Theory of Flows of an Ideal Fluid 94
Tsutomu Kambe

Control Steam Turbine Combined Cycle Power Plant Based on Soft Computing 104
Ali Ghaffari, Ali Chaibakhsh, Ali Mostafavi Manesh

Modeling of Steam Turbine Combined Cycle Power Plant Based on Soft Computing 110
Ali Ghaffari, Ali Chaibakhsh, Ali Mostafavi Manesh

The Gas Emission Characteristics of Olive Seed Oil and Soy Oil 115
Charalampos Arapatsakos, Anastasios Karkanis, Dimitrios Christoforidis

Finite Element Simulation of Deep Rolling and Evaluate the Influence of Parameters on Residual Stress 121
Afshin Manouchehrifar, Kianoush Alasvand

Soil-Structure Interaction of Underground Composite Pipes 128
G. Lucaci, K. Zafiris, C. Sbiliris, S. Lykakos, D. Pavlou

An Algorithm in Element Deletion Process used in Moving Three Zones Unstructured Grid for Arbitrary Relative Motion of Two Objects 134
Pedram Pakseresht, Seyed Saied Bahrainian, Reza Bahoosh Kazerooni

Authors Index 139

ISBN: 978-1-61804-078-7

Plenary Lecture 1

Instability of Cracked and Porous Media by Statics and Small Vibrations

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Abstract: The book introduces strain problems for high-contrast microinhomogeneous media featuring a very high (many orders of magnitude) difference in physical-mechanical properties between the matrix and the closing. These are oil, gas or water reservoir, coals and other fractured rocks. The classical continuum hypothesis is unsuitable for these media, since the classical continuum implies that close points should have close values of all physical properties (stresses, strains, temperatures etc). Rejecting the continuum hypothesis means either setting the boundary conditions at the whole internal pore surface or constructing a new continuum with initially specified collective geometrical properties of pores and fractures. The integral geometry describes these collective properties. This geometry substantially affects the physics of elementary strain process so that the equilibrium and motion equations differ radically from the classic ones. These equations describe, besides the regular effects, very slow waves, catastrophe dynamics and the intermediate states between statics and dynamics.

Brief Biography of the Speaker:
I was born in 1939 in Leningrad (Sankt-Petersburg). In 1961 graduated Leningrad University in special engineer-geophysics. In 1971 I have got degree candidate of physics and mathematics in special “Theory of elasticity and plasticity”. In 1986 I have got degree as senior research worker. In 1987 I have got State Praise Winner of USSR for papers in the field of multi-wave seismic. In 1989 I have got a degree of doctor of physics and mathematics in special geophysics. In 1999 I have got degree as professor of Novosibirsk University. I am a participant of 11 International conferences in geophysics and meso mechanics. During 1998-2000 I was a visiting professor in Brazil (Petrobras Company, Unibersity of state Para). During 1996-1997 I was a member of expert Council of Fund of fundamental researches of Russia.

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Plenary Lecture 2

Gauge theory of flows of an ideal fluid

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Abstract: Fluid mechanics is a field theory in Newtonian mechanics, i.e. a field theory of mass flows of Galilean symmetry. In the gauge theory of theoretical physics, a guiding principle is that laws of physics should be expressed in a form that is independent of any particular coordinate system. Variational formulations of fluid flows are reviewed first from the point of view of gauge theory, and then a new variational formulation is proposed, which leads to a new representation of compressible rotational flows of an ideal fluid. This improves the classical solution of Clebsch (1859). There is a fundamental question how a rotational component of fluid flow can be formulated in the variational framework of an ideal compressible fluid. Present Lagrangian for the action principle consists of main terms of total kinetic energy and internal energy (with negative sign), together with three additional terms yielding the equations of continuity, entropy and the third term which provides rotational component of velocity field. The last term leads to an explicit expression of non-vanishing helicity. Thus, a new expression of velocity field ***v(x,t)*** is given in terms of vector potentials of frozen field, i.e. the potentials are convected by the fluid flow under effect of stretching, while the potentials of Clebsch solution are just convected without stretching effect. It is verified that the system of new expressions in fact satisfies the Euler's equation of motion. Associated with two symmetries (translation and space-rotation), there are two gauge fields ***E*** and ***H***, which do not exist in the system of discrete masses. One can show that those are analogous to the electric field and magnetic field in the electromagnetism, and fluid Maxwell equations can be formulated for ***E*** and ***H***. Sound wave within the fluid is analogous to the electromagnetic wave, in the sense that phase speeds of both waves are independent of wave lengths, i.e. non-dispersive.
[$\boldsymbol{E} \equiv (\boldsymbol{v}\cdot\nabla)\boldsymbol{v}$, $\boldsymbol{H} \equiv \nabla\times\boldsymbol{v}$]

Brief Biography of the Speaker:
Tsutomu Kambe graduated from the University of Tokyo (Physics Department) in 1962, and started his career of research from 1966 in fluid mechanics from physical point of view. He stayed in Cambridge (England) as a postdoc scholar of British Council and worked with Professor Sir James Lighthill and Professor George Batchelor on vortex motion, animal locomotion and aerodynamic sound. He studied sound generation by vortex motions both theoretically and experimentally at the Kyushu University (Japan). In 1983, this study succeeded in the first experimental detection of sound waves generated by collision of vortex rings, which were consistent with theoretical prediction. In 1984, he became Associate Professor at the Department of Physics, University of Tokyo, and Full Professor there in 1995. His research interests now focus on gauge theoretic formulation of fluid flows, which is the study of fluid mechanics on the basis of theoretical physics. This resulted in formulation of Fluid Maxwell Equations (2010) and a new variational formulation of fluid flows of an ideal fluid (2007, 2008). He is author of about 100 papers published in international journals and conference proceedings. He published two textbooks, Elementary Fluid Mechanics (2007) and Geometrical Theory of Dynamical Systems and Fluid Flows (2004, 2010), in addition to Japanese publications of four textbooks and about fifty papers. He is Former Professor of physics and retired from the University of Tokyo. He is Honorary Member of the Japan Society of Fluid Mechanics, Former member of IUTAM Bureau, and Visiting Professor at the Chern Institute of Mathematics (Tianjin, China).

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Plenary Lecture 3

Different mixtures of diesel-vegetable oils as fuel

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Abstract: Biofuels are the fuels that are being produced from biomass. Furthermore, biofuel is defined as solid, liquid or gas fuel derived from relatively recently dead biological material. They can replace conventional fuels, completely or partially, in the internal combustion engines. Some of the consequences of crude oil dependence are the increasing price of crude oil, the important changes in oil market, the finite of reserves as well as the environmental pollution. Therefore, there is a big need to produce appropriate fuels, which will have minimal environmental and social degradation. This led to the revaluation of the importance of the rural and forestall factor as a renewable resources supplier. This work examines the behavior of a four-stroke Diesel engine when mixtures of diesel-vegetables oils (sunflower oil, olive seed oil, cotton oil) are used as fuel. For those mixtures the gas emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen monoxide (NO) and smoke emissions are being examined.

Brief Biography of the Speaker:
Dr. Charalampos Arapatsakos is a Greek citizen, who has been born in Athens. He has studied Mechanical of Engineering. He is a Ph.D. Assoc. Professor in the University of Thrace in Greece. At the present he is a member of Technical Chamber of Greece, member of Electrical and Mechanical Engineering Association and member of Combustion Institute of Greece too. Dr C. Arapatsakos has participated in many research programs about biofuels, gas emissions and antipollution technology. His research domains are mainly on biofuels and their use in internal combustion engines, the power variation from the use of biofuels, the gas emissions and mechanical damages.

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Authors Index

Abdul Rahman, A. G.	18	Lucaci, G.	128
Ahmadaghaei, H.	24	Lykakos, S.	128
Alasvand, K.	121	Manesh, A. M.	104, 110
Arapatsakos, C.	115	Manouchehrifar, A.	121
Asgari, M.	84	Noroozi, S.	18
Bahrainian, S. S.	134	Özahi, E.	39, 45, 51
Çarpinlioğlu, M. O.	39, 45, 51	Pakseresht, P.	134
Chaibakhsh, A.	104, 110	Parinov, I.	88
Chang, S.-H.	88	Patte-Rouland, B.	57
Christoforidis, D.	115	Pavlou, D.	128
Danlos, A.	57	Rouland, E.	57
Diaconescu, I.	34	Sbiliris, C.	128
Dupac, M.	18	Sharma, P. K.	13
Flueras, C. S.	63	Shevtsov, S.	88
Ghaffari, A.	104, 110	Simionescu, C.-S.	34
Ghaznavi, A.	84	Song, C. K.	69
Grigorescu, L.	34	Suh, J. S.	69
Irimescu, A.	28, 63	Tozlu, A.	51
Jeong, I. G.	69	Vogiatzis, K.	75
Kambe, T.	94	Walia, V.	13
Karkanis, A.	115	Wu, P.-C.	88
Kazerooni, R. B.	134	Wuu, D.-S.	88
Kim, K. H.	69	Yi, C. S.	69
Kutlar, A. I.	51	Yoon, K. H.	69
Lari, H. R.	84	Yun, J. H.	69
Lee, J. C.-Y.	88	Zafiris, K.	128
Lin, C.-F.	88	Zhilyaev, I.	88

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