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Editorial

Editorial

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Abstract. In recent years, thanks to the great progresses in numerical approaches, computational procedures are increasingly applied to different braches of science, and more specifically to engineering and related physical sciences. Fluid and solid mechanics are known as two separate fields of mechanical science and technology including several applications from solids and structures analyses to fluid flow and heat transfer problems. The mentioned topics are of much interest to physicists, mathematicians and in particular, mechanical engineers. The objective of this special issue is to establish a unique collection in the subject of computational solid and structural mechanics, fluid dynamics, nanolfluids heat and mass transfer and of course multiphysics problems emphasizing the applications of advanced computational approaches. Modeling, simulation and solution of engineering problems are of great interest and mostly welcome in this special collection.

Special Issue Title: New Trends in Applied and Computational Solid and Fluid Mechanics.

1. Introduction

Computational mechanics has had a remarkable influence on science and technology over the past decades. It has numerically transformed much of the classical theory models into practical tools for predicting and understanding the complex engineering systems. Structural mechanics, on the other hand, could be traced back to ancient times when some breathtaking structures were built, but which manage to raise eyebrows even today. Already at that time, it was extremely important to predict and assess all external influences onto the structures and to take them somehow into account in the final design. This process progressed from sketches in the sand, via classical manual computations and graphical solutions, to reach the modern high level of structural analysis and design performed on computers by means of versatile software packages. Such a combination of powerful hardware and software opens up a whole new virtual world to the engineers who can use it as a 'playground' to challenge the frontiers of both their imagination and abilities of modern materials.

Computational fluid mechanics analyzes different systems including fluid flow, heat transfer and associated phenomena such as chemical reactions by means of computer-based simulations. This technique is very powerful and spans a wide range of industrial and non-industrial application areas. In recent decades, pioneering heat transfer research has led to the development of a new innovative fluids called "nanofluids" through the addition of nanoparticles (usually less than 100nm) to low thermal conductivity conventional fluids. It has been reported that the suspended metallic or non-metallic nanoparticles change the transport properties and heat transfer characteristics of the base fluid by a significant amount. Metallic nanofluids often refer to those containing metallic nanoparticles (such as Cu, Al, Zn, Ni, Si, Fe, Ti, Au and Ag), while nanofluids containing non-metallic nanoparticles such as aluminium oxide (Al2O3), copper oxide (CuO) and silicon carbide (SiC) are often considered as non-metallic nanofluids. Nanofluids exhibit superior heat transfer properties compared to conventional heat transfer fluids. Investigators have recently reported on the use of hybrid nanofluids for further heat transfer enhancement in which they two dissimilar types of nanoparticles. Heat transfer enhancement in heat-exchange devices is one of the key factors affecting energy savings and compact designs in wide variety of engineering applications. Heat transfer enhancement refers to the application of different methods to improve the rate of heating or cooling of a surface. There are many different methods of improving heat exchange in thermal systems. These include both passive and active techniques such as the application of magnetic fields, usage of oscillators and baffles, etc. In most situations, the working fluids in energy systems suffer from having a low thermal conductivity which limits the amount of required heat transfer and this dictates the need to go to big systems' designs. However, with the use of nanofluids as the working fluids, the required heat transfer can be achieved with much smaller designs.

In this special issue, we have gathered some novel contributions in this field of work to offer hopefully a rather interesting, challenging and inspiring set of articles to a vast audience. This special issue was initiated to focus on the recent advances in computational approaches in simulating and solving different problems in solid, structural and fluid mechanics. A relatively large number of papers were submitted, but only 36 articles were finally accepted for publication.

2. Authors and Abstracts

1. Akil J. Harfash, Ghazi A. Meften

Poiseuille Flow with Couple Stresses Effect and No-slip Boundary Conditions

In this paper, the problem of Poiseuille flow with couple stresses effect in a fluid layer using the linear instability and nonlinear stability theories is analyzed. Also, the nonlinear stability eigenvalue problems for *x,z* and *y,z* disturbances are derived. The Chebyshev collocation method is adopted to arrive at the eigenvalue equation, which is then solved numerically, where the equivalent of the Orr-Sommerfeld eigenvalue problem is solved using the Chebyshev collocation method. The difficulties which arise in computing the spectrum of the Orr-Sommerfeld equation are discussed. The critical Reynolds number R_c, the critical wave number a_c, and the critical wave speed c_c are computed for wide ranges of the couple stresses coefficient M. It is found that the couple stresses coefficient M has great stabilizing effects on the fluid flow where the fluid flow becomes more unstable as M increases.

2. Ali Aborehab, Mohammed Kassem, Ahmed Farid Nemnem, Mohamed Kamel

Miscellaneous Modeling Approaches and Testing of a Satellite Honeycomb Sandwich Plate

The honeycomb sandwich structures are commonly and efficiently adopted in the development of light mass satellite structures as a result of their inherent high stiffness and strength properties. Through a comprehensive study, the equivalent finite element modeling of honeycomb sandwich structures utilizing miscellaneous modeling approaches is introduced. For the sake of validating results, both theoretical analysis and experimental modal testing are implemented upon a honeycomb sandwich plate utilizing free-free boundary conditions. Based on the results, the sandwich theory and its related shell-volume-shell approach introduce a good match with the experimental results. The aforementioned approach is utilized extensively during the process of satellite structural design and modeling. In addition, a parametric study is executed so as to relate the geometric and material variations to the resonant modal frequencies. The study results indicate a crucial influence of both honeycomb core and facing sheets thicknesses on the modal frequency values.

3. Fadi Ali

Numerical Study on Subsurface Stress in Hertzian Contacts under Pure Sliding Conditions

In this study, the two-dimensional numerical simulation on the subsurface stress field in Hertzian contact under the pure sliding condition for different speeds and coefficients of friction is presented. The Hertzian contacts are represented by a dry contact between a rigid flat surface and an elastic cylinder with radius R=12.5 mm. Simulation is carried out through two steps, the first one is for applying normal load and the second one is for applying angular speed for the cylinder. The results of subsurface stress filed for pure sliding are compared to non-moving Hertzian contact. The results show that pure sliding speed has a major effect on the value of maximum von Mises stress in the subsurface of contact. The effect of sliding speed is attributed to tangential forces and elastic deformation in the contact. On the other hand, the coefficient of friction has a primary effect on the position of maximum stress and the shift of the contact region. Indeed, when pure sliding motion is introduced with a low value of friction coefficient, the shift of the contact region is negligible compared to non-moving Hertzian contact. The study is extended to investigate the effect of contact geometry on subsurface stress for Hertzian contact in the cam-follower interface. The shape of the follower has a significant effect on the value and distribution of Hertzian stress, thus, the fatigue life of rubbing surfaces of the cam-follower interface.

4. Helder K. Miyagawa, Ingrid V. Curcino, Fabio A. Pontes, Emanuel N. Macêdo, Péricles C. Pontes, João N. N. Quaresma

Hybrid Solution for the Analysis of MHD Micropolar Fluid Flow in a Vertical Porous Parallel-Plates Duct

In this paper, we analyze the transient magnetohydrodynamic (MHD) flow of an incompressible micropolar fluid between a porous parallel-plates channel. The fluid is electrically-conducting subjected to radiation described by the Cogley-Vincent-Gilles formulation and with convective thermal boundary conditions at the plates. The solution methodology employed is the hybrid numerical-analytical approach known as the Generalized Integral Transform Technique (GITT). The consistency of the integral transform method in handling such a class of problem is illustrated through convergence analyses, and the influence of physical parameters such as radiation, and micropolar parameters, and Hartman number. The wall shear stress, the coupled stress coefficient, and heat flux at the walls were also calculated, demonstrating that increasing the gyroviscosity decreases the wall stresses magnitudes. Furthermore, the results show that increasing the radiation heat transfer decreases the fluid temperature distribution. Additionally, the velocity is damped, and the angular velocity is increased by the Lorentz force in the presence of a magnetic field.

5. Aamir Ali, Sana Mumraiz, Sara Nawaz, Muhammad Awais, Saleem Asghar

Third-grade Fluid Flow of Stretching Cylinder with Heat Source/Sink

In this research, the impact of heat transfer on mixed convection steady third-grade fluid flow over an impermeable stretching cylinder with heat source is scrutinized. The investigation of mixed convection with non-Newtonian fluid is significant in geophysical and engineering fields. Appropriate transformations are alleged to obtain ordinary differential equations, which are later computed by using an analytical approach called the homotopy analysis methodology (HAM), and the interval of convergence is computed. Local Nusselt number and coefficient of skin friction values are computed numerically for novel parameters.

6. Madaliev Murodil Erkinjon son

Numerical Calculation of an Air Centrifugal Separator Based on the SARC Turbulence Model

The numerical results of mathematical modeling of a two-phase swirling turbulent flow in the separation zone of a centrifugal apparatus are presented. The motion of the carrier gas flow was modeled using the averaged Navier-Stokes equations, for the closure of which the well-known turbulence model by Schur and Spalart was used, the amendment to the Spalart-Allmaras SARC model. Based on the obtained field of averaged velocities of the carrier medium, taking into account turbulent diffusion. The article compares the results taking into account the influence of the solid phase on the dynamics of the air environment and without taking it into account with experimental data.

7. Oluwole Daniel Makinde, Adetayo Samuel Eegunjobi

Entropy Analysis of a Radiating Magnetic Liquid Film along a Slippery Inclined Heated Surface with Convective Cooling

The hydromagnetic flow of a Newtonian incompressible and electrically conducting variable-viscosity liquid film along an inclined isothermal or isoflux hydrophobic surface is investigated numerically. It is assumed that the fluid is subjected to a convective cooling at the free surface in the presence of a transversely imposed magnetic field. We incorporated in the energy equation, the viscous dissipation, Joule heating due to the magnetic field and the local radiative heat flux term for optically thick gray fluid reported by Roseland approximation. The governing non-linear differential equations are obtained and solved numerically using the shooting method coupled with a fourth-order Runge-Kutta method. The effects of some parameters on velocity and temperature profiles, skin friction, Nusselt number entropy generation rate, and the Bejan number profiles are analyzed graphically and discussed.

8. Worathep Sae-Long, Suchart Limkatanyu, Chayanon Hansapinyo, Thanongsak Imjai, Minho Kwon

Forced-based Shear-flexure-interaction Frame Element for Nonlinear Analysis of Non-ductile Reinforced Concrete Columns

An efficient frame model with inclusion of shear-flexure interaction is proposed here for nonlinear analyses of columns commonly present in reinforced concrete (RC) frame buildings constructed prior to the introduction of modern seismic codes in the Seventies. These columns are usually characterized as flexure-shear critical RC columns with light and non-seismically detailed transverse reinforcement. The proposed frame model is developed within the framework of force-based finite element formulation and follows the Timoshenko beam kinematics hypothesis. In this type of finite element formulation, the internal force fields are related to the element force degrees of freedom through equilibrated force shape functions and there is no need for displacement shape functions, thus eliminating the problem of displacement-field inconsistency and resulting in the locking-free Timoshenko frame element. The fiber-section model is employed to describe axial and flexural responses of the RC section. The modified Mergos-Kappos interaction procedure and the UCSD shear-strength model form the core of the shear-flexure interaction procedure adopted in the present work. Capability, accuracy, and efficiency of the proposed frame element are validated and assessed through correlation studies between experimental and numerical responses of two flexure-shear critical columns under cyclic loadings. Distinct response characteristics inherent to the flexure-shear critical column can be captured well by the proposed frame model. The computational efficiency of the force-based formulation is demonstrated by comparing local and global responses simulated by the proposed force-based frame model with those simulated by the displacement-based frame model.

9. Zarqa Bano, Abdul Majeed Siddiqui, Kaleemullah Bhatti

Unsteady Stokes Flow through a Porous Pipe with Periodic Suction and Injection with Slip Conditions

The problem of unsteady Stokes flow of certain Newtonian fluids in a circular pipe of uniform cross section is discussed. The pipe is uniformly porous. The unsteady Navier-Stokes equations for the system in cylindrical polar coordinates have been solved analytically to obtain a complete description of the flow. The solution of the flow equations subject to the slip boundary conditions leads to the detailed expressions for axial and radial components of velocity and the pressure distribution depending on position coordinates and time. As a special case we have presented the situation when no-slip boundary conditions are implemented. The velocity profile is analyzed for different values of the flow parameters like Womersley number, slip length and time.

10. Xiao-Qun Cao, Ya-Nan Guo, Cheng-Zhuo Zhang, Shi-Cheng Hou, Ke-Cheng Peng

Different Groups of Variational Principles for Whitham-Broer-Kaup Equations in Shallow Water

Because the variational theory is the theoretical basis for many kinds of analytical or numerical methods, it is an essential but difficult task to seek explicit functional formulations whose extrema are sought by the nonlinear and complex models. By the semi-inverse method and designing trial-Lagrange functional skillfully, two different groups of variational principles are constructed for the Whitham-Broer-Kaup equations, which can model a lot of nonlinear shallow-water waves. Furthermore, by a combination of different variational formulations, new families of variational principles are established. The obtained variational principles provide conservation laws in an energy form and are proved correct by minimizing the functionals with the calculus of variations. All variational principles are firstly discovered, which can help to study the symmetries and find conserved quantities, and might find lots of applications in numerical simulation. The procedure reveals that the semi-inverse method is highly efficient and powerful, and can be extended to more other nonlinear equations.

11. Ji-Huan He

A Simple Approach to Volterra-Fredholm Integral Equations

This paper suggests a simple analytical method for Volterra-Fredholm integral equations, the solution process is similar to that by variational-based analytical method, e.g., Ritz method, however, the method requires no establishment of the variational principle for the discussed problem, making the method much attractive for practical applications. The examples show the method is straightforward and effective, and the method can also be extended to other nonlinear problems.

12. Muhammad Nawaz Khan, Imtiaz Ahmad, Hijaz Ahmad

A Radial Basis Function Collocation Method for Space-dependent Inverse Heat Problems

In this study, a radial basis function collocation method (RBFCM) is proposed for the numerical treatment of inverse space-wise dependent heat source problems. Multiquadric radial basis function is applied for spatial discretization whereas for temporal discretization Runge-Kutta method of order four is employed. Numerical experiments for one, two and three-dimensional cases are included to test the efficiency and accuracy of the suggested method. Both non-rectangular and rectangular geometries with uniform and non-uniform points are taken into consideration and the obtained results are compared with the exact as well as with the techniques presented in recent literature.

13. Hameed K. Hamzah, Farooq H. Ali, M. Hatami, D. Jing

Effect of Two Baffles on MHD Natural Convection in U-Shape Superposed by Solid Nanoparticle having Different Shapes

In this paper, numerical Galerkin Finite Element Method (GFEM) applies for natural convection heat transfer of U-shaped cavity filled by Fe3O4-water nanofluid under the magnetic field and including two baffles. The above boundaries of the cavity are at low temperatures and bottom boundary is in a variable function temperature. It is assumed that two baffles in the cavity make vortexes to enhance heat transfers. The dimensionless governing equations including velocity, pressure, and temperature formulation are solved by the Galerkin finite element method. The results are discussed based on the governing parameters such as a nanoparticle volume fraction, Hartmann and Rayleigh numbers, magnetic field angle and nanoparticles shapes. As a main result, increasing both Aspect Ratio (AR) and Ra numbers enhanced heat transfer process and improved the average Nusselt numbers, while increasing the Hartmann number decreased the Nusselt number. Furthermore, it concluded that AR=0.4 had the maximum ψ and Nusselt numbers among the other examined aspect rations. Also, platelet, cylindrical, brick and spherical shapes had the maximum Nusselt numbers in sequence.

14. Adam Abikan, Zhiyin Yang, Yiling Lu

Computational Analysis of Turbulent Flow over a Bluff Body with Drag Reduction Devices

Reducing aerodynamic drag of heavy trucks is crucially important for the reduction of fuel consumption and hence results in less air pollution. One way to reduce the aerodynamic drag is the deployment of drag reduction devices at the rear of trucks and this paper describes a numerical study of flow over a bluff body with rear drag devices using the Reynolds-Averaged-Navier-Stokes (RANS) approach to investigate the drag reduction mechanisms and also to assess accuracy of the RANS approach for this kind of flow. Four cases, a baseline case without any drag reduction devices and three cases with different drag reduction devices, have been studied and the predicted mean and turbulent quantities agree well with the experimental data. Drag reduction varies hugely from a few percent in one case to more than 40% in another case and detailed analysis of flow fields has been carried out to understand such a difference and to elucidate the drag reduction mechanism, which ultimately can lead to better design of future drag reduction devices.

15. Hijaz Ahmad, Tufail A. Khan, Predrag S. Stanimirovic, Imtiaz Ahmad

Modified Variational Iteration Technique for the Numerical Solution of Fifth Order KdV-type Equations

In this article, a simple and new algorithm is proposed, namely the modified variational iteration algorithm-I (mVIA-I), for obtaining numerical solutions to different types of fifth-order Korteweg de-Vries (KdV) equations. In order to verify the precision, accuracy and stability of the mVIA-I method, generated numerical results are compared with the Laplace decomposition method, Adomian decomposition method, Homotopy perturbation transform method and the modified Adomian decomposition method. Comparison with the mentioned methods reveals that the mVIA-I is computationally attractive, exceptionally productive and achieves better accuracy than the others.

16. William Orozco Murillo, José Alfredo Palacio-Fernandez, Iván David Patiño Arcila, Johan Steven Zapata Monsalve, John Alexander Hincapié Isaza

Analysis of a Jet Pump Performance under Different Primary Nozzle Positions and Inlet Pressures using two Approaches: One Dimensional Analytical Model and Three Dimensional CFD Simulations

A jet pump operates under the Venturi effect, where a fluid enters through a primary nozzle and, when passing through a convergent-divergent nozzle, it reaches supersonic conditions, originating a vacuum pressure in a secondary fluid. Fluid-dynamics simulations of jet pumps are performed here using standard k-ε turbulence model. Numerical results are compared to those obtained with an analytical model previously developed, concluding that both approaches predict a similar behavior of Match number, fluid pressure and fluid velocity. A parametric study is done to determine the influence of inlet pressure and primary nozzle position in jet pump performance, Mach number field and total pressure profile. Both parameters have an important influence in those variables, but this is not monotonic in all cases.

17. Ahmed A. Daikh, Ashraf M. Zenkour

Bending of Functionally Graded Sandwich Nanoplates Resting on Pasternak Foundation under Different Boundary Conditions

This article proposes a refined higher order nonlocal strain gradient theory for stresses and deflections of new model of functionally graded (FG) sandwich nanoplates resting on Pasternak elastic foundation. Material properties of the FG layers are supposed to vary continuously through-the-thickness according to a power function or a sigmoid function in terms of the volume fractions of the constituents. The face layers are made of FG material while the core layer is homogeneous and made of ceramic. In this study, an analytical approach is proposed using the higher-order shear deformation plate theory and nonlocal strain gradient theory with combination of various boundary conditions. Numerical outcomes are reported to display the impact of the material distribution, boundary conditions, elastic foundation parameters and the sandwich nanoplate geometry on the deflections and stresses of FG sandwich nanoplates. The exactness of this theory is determined by comparing it to other published outcomes.

18. Kashif Ali Abro, Muzaffar Hussain Laghari, J.F. Gómez-Aguilar

Application of Atangana-Baleanu Fractional Derivative to Carbon Nanotubes Based Non-Newtonian Nanofluid: Applications in Nanotechnology

Single and multi-walled carbon nanotubes (SWCNTs & MWCNTs) comprise a large group of nanometer-thin hollow fibrous nanomaterials having physico-chemical characteristics like atomic configuration, length to diameter ratios, defects, impurities and functionalization. This manuscript is devoted for the analysis of carbon nanotubes based non-Newtonian nanofluid suspended in ethylene glycol taken as base fluid. The problem is modeled through modern method of fractional calculus namely Atangana-Baleanu fractional derivative and then solved analytically by invoking Laplace transform. The analytic solutions are established for the temperature and velocity distribution and expressed in terms of special function. The graphical results are depicted through computational software Mathcad and discussed for carbon nanotubes with various embedded parameters. An interesting comparison is explored graphically between single and multi-walled carbon nanotubes subject to the single and multi-walled carbon nanotubes are suspended in ethylene glycol. The several similarities and differences suggested that carbon nanotubes are accelerated and decelerated, while for unit time t = 1s, carbon nanotubes have identical velocities with and without fractional approach.

19. Evangelia D. Farsirotou, Alexander D. Panagiotopoulos, Johannes V. Soulis

Explicit and Implicit Finite -Volume Methods for Depth Averaged Free-Surface Flows

In recent years, much progress has been made in solving free-surface flow variation problems in order to prevent flood environmental problems in natural rivers. Computational results and convergence acceleration of two different (explicit and implicit numerical techniques) finite-volume based numerical algorithms, for depth-averaged subcritical and/or supercritical, free-surface, steady flows in channels, are presented. The implicit computational model is a bi-diagonal, finite-volume numerical scheme, based on MacCormack's predictor-corrector technique and uses the semi-linearization matrices for the governing Navier-Stokes equations which are expressed in terms of diagonalization. This implicit numerical scheme puts primary emphasis to solution convergence using non-orthogonal local coordinate system. The explicit formulation uses volume integrals to solve the governing flow equations. Computational results and convergence performance between the implicit and the explicit finite-volume numerical schemes, for incompressible, viscous, depth-averaged free-surface, steady flows are presented. Implicit and explicit computational results are satisfactorily compared with available measurements. The implicit bi-diagonal technique yields fast convergence compared to the explicit one at the expense of programming effort. Iterations require to achieve convergence solution error of less than 10^{-5}, can be reduced down to 90.0 % in comparison to analogous flows with using explicit numerical technique.

20. Nadezhda S. Bondareva, Mikhail A. Sheremet, Fu-Yun Zhao
The Brick Thermal Performance Improvement using Phase Change Materials
The problems of heat and mass transfer in phase change materials are of great engineering interest. The absorption and storage of energy in the form of latent heat makes it possible to use them in the construction industry to smooth out the effects of temperature transitions in the environment. This work is devoted to the study of heat transfer in a building block with paraffin inserts under unsteady external conditions. The influence of the geometric dimensions of the block and the volume fraction of the phase change material on the effect of restraining external temperature fluctuations was studied. The unsteady conjugate melting problem was solved in a closed rectangular region with two cavities filled with PCM. The temperature of the environment on the left boundary changes in harmonic law. Thermal distributions were obtained at various points in time.

21. Nasser S. Elgazery
A Periodic Solution of the Newell-Whitehead-Segel (NWS) Wave Equation via Fractional Calculus
The Newell-Whitehead-Segel (NWS) equation is one of the most significant amplitude equations with a wider practical applications in engineering and applied physics. It describes several line patterns; for instance, see lines from seashells and ripples in the sand. In addition, it has several applications in mathematical, chemical, and mechanical physics, as well as bio-engineering and fluid mechanics. Therefore, the current research is concerned with obtaining an approximate periodic solution of a nonlinear dynamical NWS wave model at three different powers. The fractional calculus via the Riemann-Liouville is adopted to calculate an analytical periodic approximate solution. The analysis aims to transform the original partial differential equation into a nonlinear damping Duffing oscillator. Then, the latter equation has been solved by utilizing a modified Homotopy perturbation method (HPM). The obtained results revealed that the present technique is a powerful, promising, and effective one to analyze a class of damping nonlinear equations that appears in physical and engineering situations.

22. Ephesus Olusoji Fatunmbi, Sulyman Olakunle Salawu
Analysis of Entropy Generation in Hydromagnetic Micropolar Fluid Flow over an Inclined Nonlinear Permeable Stretching Sheet with Variable Viscosity
A numerical analysis is performed on entropy generation in a radiative and dissipative hydromagnetic micropolar fluid prompted by a nonlinearly stretching sheet with the impact of non-uniform heat source/sink, variable magnetic field, electrical conductivity, and dynamic viscosity. The main equations are computationally solved via shooting techniques in the company with Runge-Kutta algorithms. The impact of the prominent controlling parameters is graphically checked on the velocity, temperature, microrotation, entropy generation, and Bejan number. An excellent relationship exists between the results obtained with related studies previously reported in the literature in the limiting conditions. More so, it is revealed by the findings that the irreversibility due to heat transfer is dominant over viscous dissipation irreversibility as the radiation parameter advances while the trend changes with the Brikman number parameter.

23. Hoang Lan Ton-That
A Novel Quadrilateral Element for Dynamic Response of Plate Structures Subjected to Blast Loading
We study the dynamic response of plate structures subjected to blast loading. This load is introduced in dynamically excited form over time. Two assumptions are given to ensure the physical properties of dynamic problems. The plate structures are studied its response under explosion. The governing equation with respect to the motion is solved by using a novel quadrilateral element SQ4T related to the twice interpolation strategy (TIS) and the average acceleration method of Newmark's family. Our solutions are compared with reference solutions to confirm the accuracy of the proposed element.

24. Abdul Rauf, Memoona Naz
Simultaneous Flow of Three Immiscible Fractional Maxwell Fluids with the Clear and Hoamogeneous Porous Cylindrical Domain
One-dimensional transient flows of three layers immiscible fractional Maxwell fluids in a cylindrical domain have been investigated in the presence of a porous medium. In the flow, the domain is considered the concentric regions namely one clear region and other two annular regions are filled with a homogeneous porous medium saturated by a generalized Maxwell fluid. The studied problem is based on a mathematical model focused on the fluids with memory described by a constitutive equation with time-fractional Caputo derivative. Analytical solutions to the problem with initial-boundary conditions and interface fluid-fluid conditions are determined by employing the integral transform method (the Laplace transform, the finite Hankel transform and the finite Weber transform). The memory effects and the influence of the porosity coefficient on the fluid motion have been studied. Numerical results and graphical illustrations, obtained with the Mathcad software, have been used to analyze the fluid behavior. The influence of the memory on the fluid motion is significant at the beginning of motion and it is attenuated in time.

25. Thanh Chau-Dinh, Nhat Le-Tran
An 8-Node Solid-Shell Finite Element based on Assumed Bending Strains and Cell-Based Smoothed Membrane Strains for Static Analysis of Plates and Shells
In this paper, a new 8-node solid-shell finite element is proposed. The transverse shear strains and transverse normal strains of the element are separately interpolated and related to the C^0-displacement approximation at tying points to overcome the shear- and trapezoidal-locking phenomena. From the bending strain approximation suggested for degenerated shell elements, the assumed bending strains for the solid-shell element are firstly established. The membrane strains of the element are smoothed on domains defined by dividing the middle surface's element into 1, 2, 3 or 4 sub-cells in accordance with the cell-based strain smoothing (CS) technique. The formulations of the membrane stiffness matrices are explicitly integrated on the boundary lines of the smoothing sub-cells. The proposed CSn-Q8 element, in which n is the number of smoothing sub-cells, is verified through static analysis of several benchmark plate and shell problems. Numerical results show the improved performance of the CSn-Q8 element in comparison with other references.

26. Marco A. Noguez, Salvador Botello, Rafael Herrera, Humberto Esqueda
Discretization of the 2D Convection–Diffusion Equation Using Discrete Exterior Calculus
While the Discrete Exterior Calculus (DEC) discretization of the diffusive term of the Transport Equation is well understood, the DEC discretization of the convective term, as well as its stabilization, is an ongoing area of research. In this paper, we propose a local discretization for this term based on DEC and geometric arguments, considering the particle velocity field prescribed at the vertices of the primal mesh. This formulation is similar to that of the Finite Element Method with linear interpolation functions (FEML) and can be stabilized using known stabilization techniques, such as Artificial Diffusion. Using this feature, numerical tests are carried out on simple stationary and transient problems with domains discretized with coarse and fine simplicial meshes to show numerical convergence.

27. Chonlada Luangarpa, Hideo Koguchi

Singular Stresses at a Vertex and Along a Singular Line in Three-dimensional Piezoelectric Bonded Joints

Singular stress fields in three-dimensional piezoelectric bonded joints are investigated at a vertex and along a free edge (the singular line) of an interface. Two perfectly bonded joints, which are different in the side surface shapes, are considered. The joints consist of multi-terms of singularity. Two-major terms of singularity are investigated in details. The orders of singularity at the vertex and along the singular line are calculated using three-dimensional finite element eigen-analysis. The intensities of singularity are calculated using the conservative integral. The intensities of singularity at several points located on the singular line are examined. The relationships between the intensities of singularity and the distances from the vertex are plotted to determine how the vertex singularity affects the singularity along the singular line. Finally, the relationships between singular stress fields at the vertex and along the singular line are considered.

28. Sara Ahmed El-Bahloul

Pre-drilling Effect on Thermal Friction Drilling of Cast Aluminum Alloy Using Thermo-mechanical Finite Element Analysis

Thermal friction drilling is a non-conventional hole making process, which uses a rotating tool to penetrate the workpiece and create a bushing. Friction drilling of brittle cast alloys is likely to result in severe petal forming and radial fracturing. This research investigates the effect of pre-drilling diameter and depth on the produced bushing cracks and petal formations while drilling cast aluminum alloy (A380). A three-dimensional finite element model of high-temperature deformation and large plastic strain is performed by using ABAQUS software. Modeling by using dynamic, temperature-displacement, explicit, as well as the adaptive meshing, element deletion, interior contact, and mass scaling techniques, is necessary to enable the convergence of the solution. The finite element analysis results predict that the pre-drilling has a significant effect on the produced bushing shape. The effect of initial deformation decreases with pre-drilling, leading to fewer cracks and petal formations. Hence, the obtained bushing length increases, so providing a more load-bearing surface that leads to a stiffer joint. Additionally, the effect of pre-drilling on the produced temperature is studied, and the results reveal that by increasing the pre-drilling diameter or depth the temperature decreases. Therefore, less workpiece material melting occurs, which leads to less adhering on the tool surface, so fewer cracks and petal formations.

29. Flavia-Corina Mitroi-Symeonidis, Ion Anghel, Octavian Lalu, Constantin Popa

The Permutation Entropy and its Applications on Fire Tests Data

Based on the data gained from a full-scale experiment, the order/disorder characteristics of the compartment fire temperatures are analyzed. Among the known permutation/encoding type entropies used to analyze time series, we look for those that fit better in the fire phenomena. The literature in its major part does not focus on time series with data collected during full-scale fire experiments, therefore we do not only perform our analysis and report the results, but also discuss methods, algorithms, the novelty of our entropic approach and details behind the scene. The embedding dimension selection in the complexity evaluation is also discussed. Finally, more research directions are proposed.

30. Yusry O. El-Dib, Galal M. Moatimid, Nasser S. Elgazery

Stability Analysis of a Damped Nonlinear Wave Equation

The current manuscript is concerned with extracting an analytical approximate periodic solution of a damped cubic nonlinear Klein-Gordon equation. The Riemann-Liouville fractional calculus is utilized to obtain an analytic approximate solution. The Homotopy technique is absorbed in the multiple time-spatial scales. The approved scheme yields a generalization of the Homotopy equation; whereas, two different small parameters are adapted. The first parameter concerns with the temporal perturbation, simultaneously, the second one is accompanied by the spatial one. Therefore, the analytic approximate solution needs the two perturbation expansions. This approach conducts more advantages in handling the classical multiple scales method. Furthermore, the initial conditions are included throughout the multiple scale method to achieve a special solution of the governing equation of motion. The analysis ends up deriving two first-order equations within the extended variables and their actual solution is achieved. The procedure adopted here is very promising and powerful in managing similar numerous nonlinear problems arising in physics and engineering. Furthermore, the linearized stability of the corresponding ordinary Duffing differential equation is analyzed. Additionally, some phase portraits are shown.

31. Ahmed Hassan Ahmed Hassan, Naci Kurgan, Nihat Can

The Relations between the Various Critical Temperatures of Thin FGM Plates

This work investigates the relations between the critical temperature of the thin FGM plates under various temperature distributions through the thickness resting on the Pasternak elastic foundation. Both rectangular and skew plates are investigated. The uniform, linear, and nonlinear temperature distributions through the plate's thickness are considered. Formulations are derived based on the classical plate theory (CPT) considering the von Karman geometrical nonlinearity taking the physical neutral plane as the reference plane. The partial differential formulation is separated into two sets of ordinary differential equations using the extended Kantorovich method (EKM). The stability equations and boundary conditions terms are derived according to Trefftz criteria using the variational calculus expressed in an oblique coordinate system. Novel multi-scale plots are presented to show the linear relations between the critical temperatures under various temperature distributions. The critical temperature of plates with different materials are also found linearly related. Resulting relations should be a huge time saver in the analysis process, as by knowing one critical temperature of the one FGM plate under one temperature distribution many other critical temperatures of many other FGM plates under any temperature distributions can be obtained instantly.

32. Naveed Anjum, Ji-Huan He

Two Modifications of the Homotopy Perturbation Method for Nonlinear Oscillators

Nonlinear vibration arises in engineering and physics, and the periodic motion of these nonlinear oscillatory systems have rich dynamics. An estimation of amplitude-frequency relationship of a nonlinear oscillator is much needed, therefore, well-known homotopy perturbation method is employed for this purpose. In this paper, two last modifications of the homotopy perturbation method are briefly reviewed, which couples with either the parameter-expansion technology or the enhanced perturbation method. Both modifications are extremely effective for nonlinear oscillators, and the cubic-quintic-septic Duffing oscillator is used as an example to elucidate the solution processes.

33. Fikret A. Aliev, N.A. Aliev, N.I. Velieva, N.A. Safarova

Larin Parameterization to Solve the Problem of Analytical Construction of the Optimal Regulator of Oscillatory Systems with Liquid Dampers

The problem of the analytical construction of the optimal regulator of oscillatory systems with liquid dampers on the complex plane is considered. Since the fractional derivative is included in the differential equation describing the oscillatory systems with liquid dampers movement, the corresponding input-output transfer function also contains fractional rational orders, the general Larin parameterization scheme is modifying for this case. The results are illustrated by numerical examples and it is shown that they coincide with Letov's A.M. analytical construction of the optimal regulator.

34. Andrzej Borawski, Dariusz Szpica, Grzegorz Mieczkowski, Eliza Borawska, Mohamed M. Awad, Rizk M. Shalaby, Mohammed Sallah

Theoretical Analysis of the Motorcycle Front Brake Heating Process during High Initial Speed Emergency Braking

Motorcycles are a common mode of transport. They are used both for a conventional purpose - as a way to cover the distance from A to B, but more and more often they are a way of recreation. The choice of bikes is huge on the market: from scooters, threw small city bikes, to high-speed performance or racing machines. High speeds is closely related to high kinetic energy of movement. In case of emergency stopping, the brakes may overheat and cause fading. In this study, it was decided to check how the initial speed affects the motorcycle brake heating process. FEM was used for this purpose.

35. Vinícius Torres Pinto, Luiz Alberto Oliveira Rocha, Cristiano Fragassa, Elizaldo Domingues dos Santos, Liércio André Isoldi

Multiobjective Geometric Analysis of Stiffened Plates under Bending through Constructal Design Method

Constructal Design, Finite Element Method and Exhaustive Search were applied to analyze different arrangements of steel plates with rectangular or trapezoidal stiffeners. As performance parameters, the maximum deflection and maximum von Mises stress were considered. A non-stiffened plate adopted as reference was studied together with 25 plates with rectangular stiffeners and 25 plates with trapezoidal stiffeners. The results showed that trapezoidal stiffeners are more effective in minimizing the maximum deflection in comparison with rectangular stiffeners. However, regarding the minimization of stress, the rectangular stiffeners normally presented better performance. When both performance parameters were concomitantly considered, a slight advantage of 4.70% for rectangular geometry was identified.

36. Hancheol Cho

On Adaptive PD Control of Robot Manipulators in the Presence of Uncertainties

In this study an adaptive proportional-derivative (PD) control scheme is proposed for trajectory tracking of multi-degree-of-freedom robot manipulators in the presence of model uncertainties and external disturbances whose upper bounds are unknown but bounded. The developed controller takes the advantages of linear control in the sense of simplicity and easy design but simultaneously possesses high robustness against model uncertainties and disturbances while avoiding the necessity of precise knowledge of the system dynamics. Due to the linear feature of the proposed method, both the transient and steady-state responses are easily controlled to meet desired specifications. Also, an adaptive law for control gains using only position and velocity measurements is introduced so that parameter uncertainties and disturbances are successfully compensated, where the prior knowledge about their upper bounds is not required. The stability analysis is conducted using the Lyapunov's direct method and brief guidelines of how to select control parameters are also provided. Simulation results corroborate that the adaptive PD control law proposed in this paper can achieve fast convergence rate, small tracking errors, low control effort, and small computational cost and its performance is compared with that of an existing nonlinear sliding mode control method.

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