Special Session 5: Boundary Value Problems and Control Theory

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Boundary-value problem of a class of nonlinear dispersive equations

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For a class of nonlinear dispersive evolution equations derived from fluid mechanics, we study their well-posedness when posed on a quarter-plane.

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Supercritical surface gravity waves generated by a negative forcing

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Forced surface waves on an incompressible, inviscid fluid in a two-dimensinal channel with a small bump on a horizontal rigid flat bottom are studied. A time dependent forced Korteweg-de Vries equation (FKdV) can be derived to model the wave motion on the free surface when the nondimensional wave speed F far upstream, called a Froude number, is near critical value 1. Here, the supercritical case is considered. The both steady and time indepedent FKdV equation is studied both theoritically and numerically when the forcing term is negative.

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Stochastic fluctuations in the Gross-Pitaevskii equation

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We study from a mathematical point of view a model equation for Bose Einstein condensation, in the case where the trapping potential varies randomly in time. We will present the results on local and global existence of solution, blow up occurrence, and random modulation of the deterministic standing waves, introducing a control problem related to the topics.

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Well-posedness for a nonlinear fluid-structure interaction model

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A nonlinear fluid-structure interaction model coupling the Navier-Stokes system with a linear system of elasticity will be considered. The coupling takes place on the common boundary/interface via the continuity of the velocities and the normal components of the stress tensor. A well-posedness theory in the case of small but rapid oscillations of the interface will be presented.

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The bifurcation of doubly-diffusive convection

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Convective motions occur in a fluid when there are density variations present. Doubly-diffusive convection is the name given to such convective motions when the density variations are caused by two different components which have different rates of diffusion. In this talk, we present a bifurcation and stability analysis on the double-diffusive convection. This study includes a complete bifurcation analysis when the system parameter crosses some critical values and the asymptotic stability of bifurcated solutions.

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Shallow water approximations for water waves

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In this talk we are concerned with the initial value problem for two types of water waves and their shallow water approximations. The first type of the water wave is the standard one, that is, the fluid is bounded from above by a free surface and from below by a rigid boundary, and is subject to a uniform gravity in the vertical direction as an external force. The second one corresponds to the ocean around the earth, that is, we take an effect of the curvature into account on the surface of the earth. Therefore, the free surface and the bottom are nearly spheres and the fluid is subject to the gravitation due to the earth. We will give a mathemathcally rigorous justification of the shallow water approximation for water waves in Sobolev space by showing that the solution of the full water wave problem converges the solution of the shallow water equations when a shallowness parameter δ goes to zero. One of the main parts of the analysis is to show the existance of solutions that satisfy uniform estimates with respect to the shallowness parameter δ.

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Thermal effect on vibration of clamped visco-elastic rectangular plate with exponentially thickness variation in both directions

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Many materials are visco-elastic by nature and visco-elastic plates are quiet often approximated for analytical purpose and the vibration of such plates are of great momentous. The study of vibrations of visco-elastic plates is required due to its practical importance in the field of engineering like its application in designing the structural parts of materials which exhibit visco-elasticity.Machines very often operate under diverse temperature conditions. In space shuttles, internal combustion engines, rocket systems and in satellites, the conditions are particular temperature sensitive. In majority of cases the impact of temperature are ignored yet they need to be taken in to consideration. This paper is the study of thermal effect on free transverse vibrations of clamped (having clamped boundary condition on all the four edges) rectangular plate. The plate is considered to be varying in thickness as exponentially in both directions. Rayleigh-Ritz technique is chosen to give a good approximation for the frequency corresponding to the first two modes of vibration. A two terms deflection function has been used as a solution. The effect of linear temperature variation has been considered. Deflection and time period corresponding to the first two modes of vibrations of clamped plate have been computed for various values of aspect ratio, thermal constants, and taper constants.

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Nonlinear wave equations with localized dissipations in exterior domains

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Nonlinear wave equations with quadratic nonlinearities in three spatial dimensions are considered in exterior domains. Under the assumption of the existence of the localized dissipations, the long time existence of the solutions is considered. The method is based on the commuting vector fields and the Keel-Smith-Sogge type estimates for wave equations. The obstacle which has some boundaries causing trapping rays can be considered if the localized dissipations are assumed in those neighborhoods.

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Asymptotic behavior for a class of solutions of the critical modified Zakharov-Kuznetsov equation.

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We consider the initial value problem (IVP) associated to the modified Zakharov-Kuznetsov (mZK) equation

$$u_t + 6u^2u_x + u_{xxx} + u_{xyy} = 0, \quad (x, y) \in \mathbb{R}^2,\ t \in \mathbb{R},$$

which is known to have global solution for given data in $u(x, y, 0) = u_0(x, y) \in H^1(\mathbb{R}^2)$ satisfying $\|u_0\|_{L^2} < \|\phi\|_{L2}$, where ϕ is a solitary wave solution. In this work, the issue of the asymptotic behavior of the blowing up solutions of the mZK equation is addressed. The principal tool to obtain the main result is the use of appropriate scaling argument.

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Comparison of solutions of model evolution equations

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The solutions of the pure initial-value problems for some model evolution equations are compared to that of their regularized counterparts. It is shown that the solutions are the same, within the order of accuracy attributable to either model.

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A new solution representation for the BBM equation in a quarter plane and the eventual periodicity

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The initial- and boundary-value problem for the Benjamin-Bona-Mahony (BBM) equation is studied in this paper. The goal is to understand the periodic behavior (termed as eventual periodicity) of its solutions corresponding to periodic boundary condition or periodic forcing. To this aim, we derive a new formula representing solutions of this initial- and boundary-value problem by inverting the operator $\partial_t + \alpha\partial_x - \gamma\partial_{xxt}$ defined in the space-time quarter plane. The eventual periodicity of the linearized BBM equation with periodic boundary data and forcing term is established by combining this new representation formula and the method of stationary phase.

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