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RADIAL BASIS FUNCTION BASED MESHLESS PSEUDOSPECTRAL METHOD FOR HIGHER ORDER EQUATIONS

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In recent years one can notice a significant development of the meshless methods for solving differential equations from various disciplines of science. These numerical techniques can approximate the domain of the problem with the use of scattered nodes. Therefore they can handle well with irregular domains as well as with problems defined in more than one dimension. Many formulations of meshless methods have been developed so far [1, 2]. Among them there is a method that uses radial basis functions in the pseudospectral mode (RBF-PS) to approximate the solution [2]. This formulation with a slight difference is also known as the global radial basis function-based differential quadrature method (RBF-DQ) [3] and may be considered as a special kind of generalized finite difference methods [4-6]. The RBF-PS as well as the RBF-DQ apply collocation technique and weighting coefficients determined with the use of radial functions to reduce a differential equation to the set of algebraic equations. Since only one discrete equation can be written for each node, the problem arises for higher order equation that possesses more than one boundary condition at a boundary.

In the present paper the problem of the imposition of the multiple boundary conditions in the RBF-PS is considered. To overcome the mentioned inconvenience, Hermite type interpolation for the radial functions is applied in the framework of the method [7]. To this end, the differential operators corresponding to boundary conditions of considered problem are introduced at each boundary node as degrees of freedom. Under this assumption the extended interpolation formula for the sought function is written. With the use of this interpolant one can easily determine weighting coefficients for derivatives included in the differential equation and finally reduce the equation to the system of algebraic equations by the collocation technique. Due to the use of the extended interpolation function, the boundary conditions are conveniently involved into discretization process. Moreover, the approach presented facilitates the discretization process.

In order to show the usefulness of the approach, the static analysis as well as the free vibration analysis of quadrangular plates have been carried out in the present work. Irregular shaped plates with various boundary conditions have been taken under consideration. To discretize the domain irregular grid node distributions have been applied. The results obtained have been compared with those computed by other numerical techniques. It has been found that regardless of the node distribution the method provides satisfying results. Therefore the method has a potential to be an effective technique for analyzing constructions characterized by irregular shapes. Numerical experiments carried out in the work incline also to the conclusion that in the future work a special emphasis should be laid on a reasonable irregular node distribution – suitably diversified density of nodes in appropriate areas and soft transition between areas of high and low density.

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