Noormohammadi, N.; Boroomand, B.
A fictitious domain method using equilibrated basis functions for harmonic and bi-harmonic problems in physics. (English) Zbl 1349.65653

Summary: In this paper we present a new meshless method to solve well-known problems in physics and engineering with either constant or variable material properties in 2D space. Harmonic and bi-harmonic problems are considered in this paper. The method constructs a set of basis functions, called Equilibrated Basis Functions (EqBFs), through a weighted residual integration over a fictitious domain embedding the main one. The bases can satisfy the governing partial differential equations approximately. Chebyshev polynomials of the first kind are employed to construct the EqBFs and exponential functions are used as the weights in the integrals. The parameters of the solution are arranged so that all the integrals can be decomposed into much simpler 1D ones over a normalized intervals. This reduces the computational efforts significantly. Either the EqBFs or the results of the integration process may be stored for further use. The validity of the results is examined through an extended patch test. A set of physical sample problems with variable/non-variable material properties; as the potential flow over a cylinder, steady-state heat conduction problems in an anisotropic inhomogeneous functionally graded material, potential and stokes flow through a channel of finite width obstructed by periodic cylinders, and the bending of thin elastic plates having constant or variable thickness are solved to demonstrate the capabilities of the method. As a preliminary study, we show that the method may effectively be used in a domain decomposition approach.

MSC:
65N35 Spectral, collocation and related methods for boundary value problems involving PDEs

Keywords:
meshless method; weighted residual; non-constant coefficient; high-order element; Chebyshev polynomials; fictitious domain method; domain decomposition

Full Text: DOI

References:


This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.