

AN ABSTRACT OF A THESIS

**GEOMETRICALLY NONLINEAR ANALYSIS
OF RECTANGULAR ORTHOTROPIC PLATES
USING GROEBNER BASES**

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The objective in this thesis is to explore new applications of Groebner bases in applied mechanics by applying it to the geometrically nonlinear analysis of orthotropic plates. Structures made of modern materials, like composite and nanocomposite materials, can now behave in the linear elastic range and still have large deformation. So when the displacement of a plate is large when compared to the thickness, the linear assumptions in the analysis of the plate are no longer accurate and geometrically nonlinear provisions must be made. Typically these difficult problems are handled numerically; and although numerical methods are very powerful, analytical solutions are still desired whenever possible. Groebner bases are used in the proposed method outlined in this thesis to solve systems of nonlinear algebraic equations purely symbolically.

In the current study, first the total strain energy was used to derive a governing integro-(partial)differential equation. Second, approximate solutions to the governing equation were assumed based on the Ritz method for three boundary conditions: fully fixed, fully pinned with immovable edges, and a combination of the two. Finally, the displacement variational principle was applied to generate systems of multivariate polynomials with unknown coefficients. Maple 11 was used to compute the Groebner basis for this system of polynomials, and solve for the coefficients symbolically; and with these expressions stresses, curvatures, and moments at any point in the plate can easily be determined. Results for two composite material properties were compared to a nonlinear analysis in the commercial finite element code, ANSYS, and were in fair agreement. Although the procedure outlined in this thesis is limited by computer power, the current study demonstrates the potential of Groebner bases methods in computational mechanics.