MECHATRONICS BOOK SERIES

SYSTEM DESIGN AND SIGNAL PROCESSING

VOLUME 2

Editors
Md. Raisuddin Khan
Md. Mozasser Rahman
Muhammad Mahbubur Rashid
Shahrul Na'im Sidek

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CHAPTER 31

FINITE ELEMENT FORMULATION OF PIEZOELECTRIC LAMINATED COMPOSITE PLATE

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31.1 Introduction

This chapter presents a finite element formulation for laminated composite plates integrated with piezoelectric materials. The higher-order shear displacement theory (HSDT) developed by [1] is used in order to accurately describe the kinematic behavior of the laminated composite plates and the piezoelectric layers. The elastic field and the electric field are coupled through the linear piezoelectric constitutive equations. In the finite element model, an eight-noded two-dimensional isoparametric element is used. Each node has seven mechanical degrees of freedom and one electrical degree of freedom.

31.2 Displacements and Strains

Following is the geometry of the laminated composite plate surface bonded with piezoelectric actuator layer on the top and piezoelectric sensor layer at the bottom. The plate of total thickness h, length a, width b has n number of layers as illustrated in Figure (31.1).

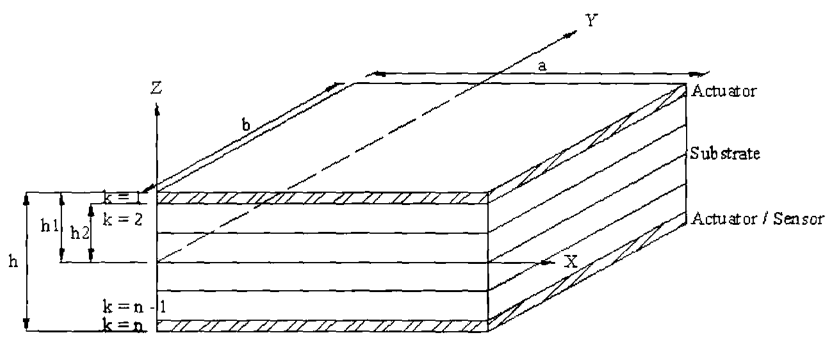

Figure (31.1): Geometry of a laminated plate.

The higher-order shear displacement fields considered in this research work are [1]:

$$u(x,y,z,t)=u_o(x,y,t)+z\theta_x+z^3\zeta_x \quad (31.1)$$

$$v(x,y,z,t)=v_o(x,y,t)+z\theta_y+z^3\zeta_y \quad (31.2)$$

$$w(x,y,z,t)=w_o(x,y,t) \quad (31.3)$$