# Optimal Vibration Control of Thin Plates with Oblique Piezoelectric Patches

**I. Sadek**[1], **I. Kucuk**[2,3], **and S. Adali**[4]

**Abstract:** The use of smart materials to control the position, noise and vibration of flexible structures has successfully been investigated. Although various active materials are available, piezoelectric materials are preferred for control applications. In many applications, the patches are usually placed with their edges parallel to those of the plate. Unfortunately, the parallel pathes cannot generate enough influence on controlling plates.

The objective of the present work is to develop a model of thin plates with oblique piezoelectric patches. Furthermore, the paper provides a theoretical foundation and a solution technique for the application of active oblique piezoelectric patches in controlling the dynamic response of a thin rectangular plate. The optimization problem consists of finding the control voltage applied to distributed piezoelectric patch actuators which suppress the transient displacements and velocities of plates with the least control effort. The theory presented here concerns the determination of the optimal control for an initial-boundary value problem governed by a linear, two-dimensional distributed parameter hyperbolic equation over a bounded region in which the index of performance is convex. A Hamiltonian functional is introduced and it is shown that the admissible control function that maximizes this Hamiltonian is, due to uniqueness, indeed the optimal control. The connection between the maximum of the Hamiltonian and the minimum of the cost functional leads to the derivation of the maximum principle. The Hamiltonian is expressed in terms of an adjoint variable as well as admissible control functions. The state and adjoint variables are linked by terminal conditions leading to a boundary-initial-terminal value problem. A method of solution for this optimization problem is suggested by using the method of the eigenfunctions and the maximum principle. The numerical results are provided to demonstrate the influence of the shapes of actuators on the performance of the control system.

[1,2] Department of Mathematics and Statistics
American University of Sharjah
Sharjah, UAE
*sadek@aus.edu, ikucuk@aus.edu*

[3] Visiting Professor
Mathematical Engineering Department
Yildiz Technical University
Davutpasa Campus, 34210, Istanbul, Turkey

[4] School of Mechanical Engineering
University of KwaZulu-Natal
Durban, South Africa
*adali@ukzn.ac.za*