## ABSTRACT

## PIEZOELECTRIC CERAMICS AND THEIR APPLICATIONS IN SMART AEROSPACE STRUCTURES

Çalışkan, Tarkan

Ph.D., Department of Aeronautical Engineering

Supervisor: Prof. Dr. Yavuz Yaman

Co-Supervisor: Dr. Volkan Nalbantoğlu

September 2002, 279 pages

This thesis investigates some applications of smart structures in aerospace engineering. The smart structures considered are finite and flat aluminum beam-like and plate-like structures with surface bonded PZT (Lead-Zirconate-Titanate) patches. The smart structures are studied in cantilevered configuration.

The thesis gives the theoretical and experimental studies conducted on the smart structures with particular attention given to the vibration control aspects.

In the determination of the structural models of the smart structures, the finite element package program ANSYS® (v.5.6) is used. During the analysis and the design of the vibration controllers both finite element approach and the experimental system identification techniques are utilized.

The thesis first determines the structural models of smart beam-like and plate-like structures. By using those models, the study extensively analyzes the static and dynamic behaviour of the smart structures by considering the effects of the smart elements like the size, placement and the actuation voltages of the PZT patches in detail. The study then proceeds to obtain the models of PID and $H_\infty$ vibration controllers, which are intended to be used in the suppression of the vibrations of the smart structures due to their first two flexural modes. The closed-loop control characteristics of the smart structures are studied. It was shown that the designed controllers ensure robust performance of the system in the presence of uncertainties.



Keywords: Smart structure, finite element modeling, system identification, vibration control, PID and $H_\infty$ controllers, robust performance