# MASTER OF SCIENCE
# IN
# MECHANICAL ENGINEERING

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**SIMULATION AND MODELING OF A SOFT GROUNDING SYSTEM FOR AN AUTONOMOUS UNDERWATER VEHICLE (AUV)**
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**B.S., Turkish Naval Academy, 1993**
**Master of Science in Mechanical Engineering-June 1999**
**Advisor: Anthony J. Healey, Department of Mechanical Engineering**

Energy storage is very limited in AUVs. To assist with energy management, data gathering missions have been proposed where the vehicle should sit on the bottom and gather acoustic/video/chemical data over extended periods of time. In this grounding senario while thrusters may be used, they are less desirable because of their high energy consuption and restricted use close to the ocean floor. The purpose of this work is to study a low cost, simple soft grounding capability for a submersible vehicle using controllable ballast. The ballast system based on the NPS *Phoenix* AUV is designed to control weight addition into or out of two ballast tanks. The developed control law adjusts the pump flow rate keeping the pitch angle and depth rate within the limits. Results for a soft grounding operation have been obtained using simulation.

**DoD KEY TECHNOLOGY AREAS:** Surface /Under Surface Vehicles-Ships and Watercraft, Modeling and Simulation, Other (Robotics)

**KEYWORDS:** Sliding Mode Control, Linear Quadratic Regulator, Autonomous Underwater Vehicles, Flight and Ballast Control Systems, Bottom Stability

**A PRELIMINARY EXPERIMENTAL STUDY OF THE BEHAVIOR OF LIQUIDS UNDER TENSIONS**
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A set of experiments has been performed to study the extensional behavior of a thin layer of liquid (silicone oil), trapped between two smooth plexiglass disks that are pulled apart in a controlled manner. Different values of separation velocities, liquid viscosities, and liquid layer thicknesses were used to obtain a range of capillary numbers, all in the surface tension dominated regime. Force, displacement, and time information have been recorded for each experimental run. Qualitative visual data has also been gathered for the selected runs. From the quantitative data, force-displacement, and stress-strain plots have been generated to analyze the trends in extensional behavior of the thin liquid layers. Visual data were used to observe the competing regimes (viscous regime and surface tension regime) that are taking place in the process of liquid layer separation. This study could offer fundamental insight into the phenomenon of cavitation and its applications, help to better understand the role of thin liquid layers in material deformations.

**DoD KEY TECHNOLOGY AREAS:** Materials, Processes, and Structures, Other (Lubrication and Wear Cavitation)

**KEYWORDS:** Thin Liquid Layers, Capillary Number, Surface Tension, Viscous Fingering

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## INVESTIGATION INTO THE MECHANISM OF ACICULAR FERRITE IN STEEL WELD METAL

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Although steel with its high strength and toughness has been used extensively in all facets of construction, the joining of steels through welding has been problematic at best. The weld itself is the weakest part in any structure. This belief has been pervasive until recently when a microstructure called acicular ferrite was discovered. Acicular ferrite forms on non-metallic inclusions found within the weldment and when significant amounts are "grown," the weldment's toughness and strength approaches that of the steel-base plate. Unfortunately, the mechanism by which high levels of acicular ferrite are nucleated in steel weld metal is unknown. This thesis is ground-breaking work in understanding this process and factors that can influence acicular ferrite formation. The present work has found that titanium-rich inclusions are the strongest acicular ferrite formers available, and goes on to suggest a new, undocumented compound may form if the proper amounts of titanium and aluminum within the weld are produced. The applications of this work are far reaching as steel is used by all services for most all equipment. If welding practices can be adopted to obtain maximum amounts of acicular ferrite given the welding process, the equipment can be stronger, tougher and last much longer than today's standards.

**DoD KEY TECHNOLOGY AREA:** Materials, Processes, and Structures

**KEYWORDS:** Acicular Ferrite, Non-Metallic Inclusions, Microstructure, Scanning Electron Microscopy, Transmission Electron Microscopy