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THESES AND RESEARCH PAPERS

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1968 - 1969

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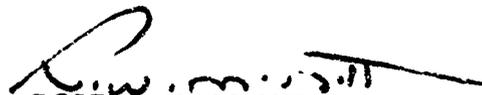
NAVAL POSTGRADUATE SCHOOL
Monterey, California

December 1970

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LARGE ANGLE SCATTERING OF LITHIUM IONS BY HELIUM ATOMS

Thomas Oliver Bush
Lieutenant, United States Navy

(AD #44451)

An experiment using the focusing properties of a nonuniform axially symmetric magnetic field to study large angle ($\theta > 32^\circ$) scattering of ions from atoms and molecules is described. The scattering cell is placed on the magnetic field axis and all ions in the momentum interval $|\Delta p|$ at $|p|$ scattered into a conical shell $\Delta\theta$ at θ are counted by a detector placed further down the axis. The solid angle is increased by a factor of several hundred over conventional scattering techniques of comparable angular resolution. The magnetic vector potential and the trajectory equation for a charged particle in the field are derived. The computer program which solves the trajectory equation is given along with a detailed description of the apparatus. Our measurements of the absolute differential scattering cross sections for Li^+ on He from 36° to 41.7° at 200 eV and 300 eV and for He^+ on He from 40° to 54° at 300 eV and 400 eV demonstrate the feasibility of the technique. Using the measured cross sections for Li^+ on He and the computational method of Firsov we have calculated the interatomic potential function for nuclear separations of 0.15\AA to 1.1\AA .

Doctor of Philosophy
September 1968

Advisor: Otto Heinz
Department of Physics

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023)

**AN INVESTIGATION OF THE NONLINEAR DYNAMIC RESPONSE
OF CYLINDRICAL SHELLS UNDER TRANSIENT PRESSURE**

**Charles Clinton Cromer
Lieutenant Commander, United States Navy**

(AD #711292)

A numerical algorithm was developed for computing the nonlinear dynamic response of a ring-stiffened, nearly circular cylindrical shell of finite length under transient, axisymmetric radial loads of arbitrary axial distribution. Nonlinear Donnell-type equations were solved using Fourier series expansions of the dependent variables in the circumferential coordinate, modified finite difference approximations of the axial derivatives, and Newmark's beta-method, combined with Gauss elimination, for the time integration.

The response of a simply supported shell under an exponentially decaying, uniform pressure was computed for peak pressures and total impulses between the static buckling limit and the dynamic buckling limit, the exponential growth of the static buckling parametrically excited Mathieu modes became increasingly important. The significance of damping, the initial imperfections, and nonlinear coupling was also investigated.

Doctor of Philosophy
April 1969

Advisor: Robert E. Ball
Department of Aeronautics

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**LAMINAR BOUNDARY LAYER SEPARATION
IN OSCILLATING FLOW**

**Ronald Arthur Despard
Lieutenant Commander, United States Navy**

(AD #694907)

Laminar boundary layer separation phenomena in oscillating flow was experimentally investigated. Multiple hot-wire anemometers were used to obtain instantaneous boundary layer velocity profiles on a model in an oscillating freestream. Certain instantaneous profile behavior was found to be uniquely related to wake formation, while non-wake-inducing transient flow reversals were found to occur throughout the adverse pressure gradient regime. Based on these observations, a practical definition of boundary layer separation in oscillating flows was formulated. Separation then obtained revealed that the imposition of oscillations caused the separation point to move upstream of its steady flow location. From the data acquired, a parametric correlation of separation point location was developed.

Doctor of Philosophy
June 1969

Advisor: James A. Miller
Department of Aeronautics

This document has been approved for public release and sale; its distribution is unlimited.

**SPECTROSCOPIC AND PHOTOCHEMICAL
INVESTIGATIONS OF s-TETRAZINE**

**Charles Donald Kimble
Lieutenant Commander, United States Navy**

(AD #700248)

Raman scattering, fluorescence, visible absorption, ultraviolet absorption, and infrared absorption spectra of s-tetrazine-d₀ and s-tetrazine-d₂ were observed. Previously unreported fundamental vibrational bands were found. Vapor phase fluorescence was observed for the first time. Absorption band structure was found in the 300-400 nm region of solutions and a corresponding vapor phase absorption was observed. The high resolution visible absorption spectrum of s-tetrazine-d₂ is reported for the first time. The chemistry of the thermal and photochemical decomposition of tetrazine vapor was investigated including studies of thermochemical parameters, quantum yield, and decomposition products. A quantitative evaluation was made on the temperature dependence of selected lines in the visible absorption spectrum. Absorption coefficients, solubilities in various solvents, vapor pressure, mass spectra, and far infrared spectra were among the other properties investigated. The Raman spectrum of N,N-dimethylformamide is reported.

Doctor of Philosophy
December 1968

Advisor: J. W. Schultz
Department of Material Science
and Chemistry

This document has been approved for public release and sale; its distribution is unlimited.

**THE EFFECT OF STAGNATION TEMPERATURE AND MOLECULAR WEIGHT
VARIATION ON GASEOUS INJECTION INTO A SUPERSONIC STREAM**

**Larry "J" Chrans
Lieutenant, United States Navy**

(AD #851864)

The purpose of this study was to investigate the effect of injectant stagnation temperature and molecular weight variation on the flow field generated from secondary injection of a gas normal to a supersonic stream. Experiments were conducted at a primary stream Mach number of 2.80 in the Naval Postgraduate School supersonic wind tunnel. Experimental data have been correlated with various theories, showing both agreement and disagreement. Data presented include penetration of secondary jet into primary flow and shock shape as correlated with the second order blast wave theory.

**Aeronautical Engineer
September 1968**

**Advisor: Daniel J. Collins
Department of Aeronautics**

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**NONSIMILAR SOLUTION OF THE LAMINAR BOUNDARY LAYER
IN AN OSCILLATORY FLOW BY AN INTEGRAL MATRIX METHOD**

**Barry Allen Gastrock
Lieutenant, United States Navy**

(AD #692444)

The development of a numerical procedure for the treatment of non-similar, unsteady, laminar boundary layers is presented. The solution is obtained from the laminar, isothermal, incompressible boundary layer equations employing a modification of the integral matrix procedure of Bartlett and Kendall. Solutions of example problems are presented for steady Blasius and Howarth flows, and for oscillating Blasius flow. Agreement with the known classical results is satisfactory and establishes the general feasibility of the method. Core storage requirements of 130,000 bytes allow consideration of as many as 25 nodal points across the boundary layer, 50 time increments per oscillation cycle and 50 streamwise stations. Solution of oscillating Blasius flow considering 8 nodal points and 16 time increments requires 13.49 seconds for one streamwise station utilizing IBM 360/67 time sharing capabilities.

**Aeronautical Engineer
June 1969**

**Advisor: James A. Miller
Department of Aeronautics**

This document has been approved for public release and sale; its distribution is unlimited.

A TECHNIQUE FOR MEASURING UNSTEADY PRESSURES

**Ronald Bruce Johnson
Lieutenant, United States Navy**

(AD #851892)

A system for measuring unsteady pressures in flow fields employing a remote transducer and thin plastic pressure transmitting lines has been designed and built.

The static and dynamic characteristics of the system were determined experimentally, and the results were found to agree well with a theoretical model.

A measuring system was subsequently integrated into a two-dimensional wind tunnel model consisting of a symmetrical airfoil with a plain oscillating flap. The flap was harmonically oscillated, and the measuring system was used to determine both the steady and unsteady pressures at a point near the flap hinge line. The static and dynamic results were then compared to those obtained using thin airfoil theory and found to agree well when corrected for thickness effects.

**Aeronautical Engineer
September 1968**

**Advisor: Louis V. Schmidt
Department of Aeronautics**

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023)

**AN INVESTIGATION OF THE EFFECT OF A TANGENTIAL
GAS VELOCITY ON COMBUSTION INSTABILITY**

**Joseph Alan Kiel
Lieutenant, United States Navy**

(AD #708386)

A small, uncooled research rocket motor was built to study the effects of a vortex flow on combustion instability. Normal heptane and air were used as propellants with the air being divided into two flows; a primary flow at the center of the combustion chamber and a secondary flow at the periphery of the chamber. The secondary air provided the swirl which could be directed clockwise or counter-clockwise at various angles or a straight mode of operation. Runs were made at various flow rates with the direction of swirl changed during the run.

The first tangential high frequency mode of combustion instability was developed and a significant change in stability conditions was found when a vortex flow was generated within the combustion chamber. It was found that a swirl in one direction tended to decrease the instability while a flow in the opposite direction increased it.

Aeronautical Engineer
June 1969

Advisor: David W. Netzer
Department of Aeronautics

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**AN EXPERIMENTAL INVESTIGATION OF
THE SENSITIZATION OF ALIPHATIC HYDROCARBON FUELS**

**Dennis Raymond Laack
Lieutenant, United States Navy**

(AD #704509)

Jet aircraft fuels are relatively stable and safe to handle. Therefore they are not readily adaptable to weapons applications.

A study of the sensitization of the jet fuel with solid additives was carried out. Comparisons between the mixtures with the different solid additives were made to determine the best ones. An investigation of different ignition methods was also made to find a practical means of igniting the mixtures.

The results indicated that the jet fuel could be sensitized using a strong oxidizer in conjunction with either magnesium or red phosphorous. The fuel can also be ignited with a combination of chemicals which produce a spontaneous reaction.

Aeronautical Engineer
June 1969

Advisor: James E. Sinclair
Department of Material Science
and Chemistry

This document has been approved for public release and sale; its distribution is unlimited.

**COMPUTER OPTIMIZATION OF WATER-AUGMENTED TURBOFAN
CONCEPT AND DEVELOPMENT OF A TEST FACILITY FOR
TWO-PHASE FLOW**

**Randolph Grant Watson
Lieutenant, United States Navy**

(AD #708044)

A turbofan engine propulsion system in which large amounts of water are injected into the fan discharge duct is investigated with the goal of increasing both the thrust and propulsive efficiency while retaining the light-weight qualities of a standard turbofan engine. A parametric computer analysis is used to examine the effect of several variables, including water-to-gas generator air ratio, water injection velocity, fan duct pressure loss, and fan duct thermal and dynamic nonequilibrium, upon thrust and propulsive efficiency. In addition, the design parameters of fan pressure ratio and fan bypass ratio are examined for their optimum values, and optimum operating combinations of water-to-gas ratio and water injection velocity are determined.

A test apparatus is developed for the direct measurement of wall friction force in two-phase flows. A computer program is presented to reduce experimental data and compare with pressure drop predicted by two empirical correlations.

**Aeronautical Engineer
June 1969**

**Advisor: Robert D. Zucker
Department of Aeronautics**

This document has been approved for public release and sale; its distribution is unlimited.

**AN INVESTIGATION OF THE LONGITUDINAL HANDLING QUALITIES
OF A VARIABLE STABILITY FLIGHT SIMULATOR**

**Leo Joseph Willetts, Jr.
Lieutenant, United States Navy**

(AD #703225)

An investigation of the longitudinal handling qualities of the variable stability flight simulator, converted from a C-11B Instrument Flight Trainer, found the qualities to be an unrealistic representation of aircraft motion. Non-linearities found in the dc servo drive circuits were caused by the dc servo drive motor's starting voltage, stiction, misalignment of the motor and reduction gear axes, potentiometer resolution, and gearing backlash. The equations of motion for the T-33 aircraft were simulated with the analog portion of a hybrid computer.

**Aeronautical Engineer
June 1969**

**Advisor: Donald M. Layton
Department of Aeronautics**

**This document has been approved for public release and sale; its
distribution is unlimited.**

**TRANSMITTER DESIGN IN A COMMERCIAL
MARINE, SINGLE-SIDEBAND TRANSCEIVER**

**Kenneth Bygler
Lieutenant, United States Navy
B.E.E., Rensselaer Polytechnic Institute 1961**

(AD #860356)

Design of the transmitter portion of a solid state, state-of-the art, single-sideband 2-17 MHz transceiver is presented. A short discussion of the theory of single sideband and a comparison of single sideband systems with amplitude modulated systems are also presented. The unique requirements of commercial, marine communications are considered and the method of their fulfillment in this transceiver is discussed. Circuitry common to both the receiver and the transmitter is presented in detail.

Electrical Engineer
December 1968

Advisor: Gerald D. Ewing
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**A PROCEDURE FOR THE SYNTHESIS OF A
FUNDAMENTAL LOOP OR CUT SET MATRIX**

**Hans Jürgen Lohse
Lieutenant Commander, Federal German Navy**

(AD #686656)

Existing realization procedures for a fundamental loop or cut set matrix are reviewed, compared, and classified broadly on the basis of their underlying approach. A new combinatorial synthesis technique is presented utilizing the concepts of trunk branches, main branches, limbs, and unique connections which are introduced. This procedure is direct, easy to apply and learn, general, and yields an expression for the number of physically different or alternate realizations which are possible. A general computer program for realization of the graphs is presented and illustrated with some examples.

Electrical Engineer
December 1968

Advisor: Sydney R. Parker
Department of Electrical
Engineering

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**ANALYSIS AND SYNTHESIS OF A TIME LIMITED
COMPLEX WAVE FORM**

**Jerry Lee Post
Lieutenant, United States Navy**

(AD #692440)

The problem of analyzing time limited complex wave forms having time variant frequency domain characteristics is discussed. A bell tone is selected as a wave form to analyze and it is then synthesized to produce an approximation to the original sound. An electronic device is constructed to simulate all required fog signals for a sailboat, including a rapidly ringing bell.

**Electrical Engineer
December 1968**

**Advisor: D. B. Hoisington
Department of Electrical
Engineering**

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AN EXPERIMENTAL BICONVEX LIQUID-FILLED ACOUSTIC LENS

Jackie Lee Roudebush
Lieutenant Commander, United States Navy

(AD #705070)

An experimental study has been made of the properties of a biconvex liquid-filled acoustic lens formed by pressurizing a refracting fluid between two deformable diaphragms. Trichlorotrifluoroethane was used as a refracting liquid and stainless steel sheets 76 cm in diameter and 0.3 mm (0.012 inch) thick were used as the diaphragm material. Distortion of the spherical surfaces due to the weight of the liquid was negligible because of the tension developed by the internal hydrostatic pressure (1.4 atmospheres for focal length 1.2 meters). Acoustic diffraction patterns measured at $f/4.0$ in water at frequencies from 200 KHz to 500 KHz compare favorably with patterns computed numerically. Multiple focal points were found and can be associated with multiple internal reflections.

Electrical Engineer
June 1969

Advisor: George L. Sackman
Department of Electrical
Engineering

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**A STUDY OF DIGITAL FILTER-OBSERVER SYSTEMS
USING THE SECOND METHOD OF LYAPUNOV**

**Edward Clair Rozelle
Lieutenant, United States Navy**

(AD #701668)

The basic filter-observer equations of Kalman for optimal and suboptimal filters are studied using the concepts of Lyapunov functions and stability theory. The Second Method of Lyapunov is used to form a basis for comparison of the convergence rates of such filters. Lyapunov functions are also used to derive constraining relations for the elements of the filter gain matrix leading to design criteria for suboptimal filters. A derivation of the optimal filter gain based upon the Lyapunov function of a random variable is given. A design of a suboptimal filter for one class of signal models is given based solely upon stability constraints.

**Electrical Engineer
June 1969**

**Advisor: Sydney R. Parker
Department of Electrical
Engineering**

This document has been approved for public release and sale; its distribution is unlimited.

A SOLID STATE PULSE MODULATED RADIOSONDE

Ara Sagerian
Lieutenant, United States Navy

(AD #700699)

This thesis is concerned with the design and construction of a radiosonde utilizing solid state devices and state-of-the-art techniques. The radiosonde is designed with the idea of obtaining data at a ground station in digital form and transmitting this data direct to Weather Central via high speed data links. Pulse modulation is utilized to transmit the data from the radiosonde. The multiplexer (time multiplexing is utilized) is designed using MOS micro technology and a breadboarded simulation is accomplished using discrete MOS integrated circuits. A computer simulation of the actual multiplexer design is performed. The modulator and transmitter are of complete solid state design. Extensive testing of the overall system indicated satisfactory results and show a substantial improvement over the present radiosonde. Modification of ground receiving systems to facilitate proper reception of information from the radiosonde is also discussed.

Electrical Engineer
June 1969

Advisor: Harold Titus
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**DEVELOPMENT AND EVALUATION BY HYBRID SIMULATION
OF AN ADAPTIVE FIRING DOCTRINE FOR THE DGFCs Mk 86 (U)**

**Wayne John Smith
Lieutenant, United States Navy**

(AD #508890)

THIS THESIS IS CLASSIFIED CONFIDENTIAL

**Electrical Engineer
December 1968**

**Advisor: James S Demetry
Department of Electrical
Engineering**

In addition to security requirements which must be met, this document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

**ON NUMERICAL METHODS FOR THE TREATMENT
OF HYDRODYNAMIC SHOCKS**

**William Randall Davis
Lieutenant (junior grade), United States Navy**

(AD #704782)

Several numerical methods used in the calculation of hydrodynamic shocks were investigated. Particular attention was given to the artificial viscosity approach of Von Neumann and Richtmyer and its application to the "PUFF" numerical scheme. The particle model approach of Ludford, Polachek and Seeger, and the method of Lax were also considered.

**Master of Science
June 1969**

**Advisor: George W. Morris
Department of Mathematics**

This document has been approved for public release and sale; its distribution is unlimited.

A STUDY OF THE EFFICIENCIES
IN THE MOBILE PROGRAMMING SYSTEM

Ernest Henry Henninger
Lieutenant (junior grade), United States Navy

(AD #712464)

The Mobile Programming System was developed to provide the capability of moving programs from one computing machine to another with a minimum of difficulty. This paper is an initial study of the efficiencies involved in the development of a processor for a programming language via the system. To this end, a language processor was implemented through the system on a particular machine (IBM 360 Mod 67), and comparisons made with the same language processor implemented directly on the same machine. Although the results of this paper are taken from this specific case, they give an indication of the relative efficiencies that could be expected from other processors implemented in a similar way. A significant side benefit of the study is a simplified implementation process for the SNOBOL4 programming language.

Master of Science
June 1969

Advisor: G. A. Kildall
Department of Mathematics

This document has been approved for public release and sale; its distribution is unlimited.

BOUNDARY VALUE APPLICATION OF A
ONE-DIMENSIONAL MAXIMUM PRINCIPLE

James Dale Jones
Lieutenant, United States Marine Corps

(AD #701676)

The problem considered is the application of a one-dimensional maximum principle to second order, linear differential equations of the form

$$u'' + g(x)u' + h(x)u = f(x) \text{ for } a < x < b$$

with associated general boundary conditions to obtain functions $z_1(x)$ and $z_2(x)$ such that

$$z_2(x) \leq u(x) \leq z_1(x)$$

on $[a, b]$. The functions f , g and h are assumed to be bounded. We wish to determine the behavior of the solution $u(x)$ on $[a, b]$ and also to obtain reliable numerical estimates of u .

The basic concepts in the theoretical background are expanded versions of a presentation in Protter and Weinberger [Ref. 4].

Master of Science
June 1969

Advisor: Robert W. Hunt
Department of Mathematics

This document has been approved for public release and sale; its distribution is unlimited.

ON THE UNRECOGNIZABILITY OF SETS

Ronald Barry Knode
Lieutenant (junior grade), United States Navy

(AD #703654)

Let $M = \langle Q, q_0, \delta, F \rangle$ be a finite automaton over the alphabet $\Sigma = \{1, \dots, k\}$. A state $q \in Q$ is a dead state if $q \notin F$ and $\delta(q, \alpha) = q \forall \alpha \in \Sigma^*$. Let $\bar{\cdot}$ be a mapping from Σ^* onto the non-negative integers defined by $\bar{\Lambda} = 0$ (Λ is the empty string) $\overline{\alpha x} = k\bar{\alpha} + \bar{x}$, $x \in \Sigma$, $\alpha \in \Sigma^*$. Define $\pi_A(n) = \# \{ \alpha \in A : 0 \leq \bar{\alpha} \leq n \}$ and $\lambda_A(n) = \# \{ \alpha \in A : \bar{\alpha} = n \}$. If A is regular let M_A be the minimal automaton recognizing A . Each automaton M induces a Markov process obtained by considering the inputs to be generated by independent rolls of a k -sided fair die. Let $p(M)$ represent the probability of being in a final state. Let $p(A) = p(M_A)$. The following are proved: 1) $\frac{\pi_A(n)}{n} \rightarrow \theta$
 $\Rightarrow \frac{\lambda_A(n)}{2n} \rightarrow \theta$; 2) $\frac{\pi_A(n)}{n} \rightarrow \theta$, A regular $\Rightarrow p(A) = \theta$; 3) $p(A) = 0 \Rightarrow M_A$ has the dead state as the only absorbing state; 4) $\forall \epsilon > 0 \exists$ a regular set $A \ni M_A$ has a dead state and $\frac{\lambda_A(n+1)}{\lambda_A(n)} \rightarrow \theta$ where $k - \epsilon < \theta < k$; 5) If $p(A) = 0$, then $\frac{\lambda_A(n+1)}{\lambda_A(n)}$ cannot converge to k . With $k = 2$, these results prove that there is no regular set A such that

$$\lambda_A(2n+1) = \frac{1}{n+1} \binom{2n}{n} \text{ and } \lambda_A(2n) = 0. \text{ Hence there is no 1-1}$$

mapping from the set of all trees representing expressions involving a binary $+$ and a variable x into $\{+, x\}^*$ which preserves the number of $+$'s and x 's and such that the set of tree images is a regular set.

Master of Science
June 1969

Advisor: W. S. Brainerd
Department of Mathematics

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ON STABILITY IN ORDINARY DIFFERENTIAL EQUATIONS

**Ronald Albert Rinaldi
Lieutenant (junior grade), United States Navy**

(AD #705691)

Stability in the sense of Lyapunov is investigated for systems of ordinary differential equations. Various established results are discussed and a new set of sufficient conditions for a stability comparison theorem is obtained. The treatment is principally concerned with linear systems, though some results for non-linear systems are considered briefly.

**Master of Science
June 1969**

**Advisor: Robert W. Hunt
Department of Mathematics**

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NUMERICAL PROPERTIES OF THE FULL TRANSFORMATION
SEMIGROUP ON A FINITE DOMAIN

Orval Lester Sweeney
Lieutenant (junior grade), United States Navy

(AD #703252)

In this paper certain properties that are common to all finite transformation semigroups are discussed. For example special properties of ideals in transformation semigroups are established. It is also proved that every element of a finite transformation semigroup must be one-to-one from some maximal subset of its domain onto that same set. This maximal subset is decomposed into cycles, and results are obtained connecting the orders of the cycles of an element and the order of the monogenic semigroup generated by that element. Numerical results concerning arbitrary subsemigroups in the transformation semigroup on three elements are listed at the end of the paper.

Master of Science
June 1969

Advisor: Carroll O. Wilde
Department of Mathematics

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PRESSURE DISTRIBUTION ON AN AIRFOIL
IN OSCILLATING FLOW

Terry Jon Allen
Lieutenant (junior grade), United States Navy

(AD #694911)

The effect of oscillating flow on the pressure distribution of a symmetrical airfoil was investigated experimentally employing a remote pressure transducer.

An open circuit wind tunnel utilizing rotating shutter blades downstream of the test section was used to create oscillating flow. Tests were run at two frequencies, as well as at steady flow, and three angles of attack.

The mean and unsteady pressure characteristics were recorded from which mean values of the normal force were determined. The results indicate that an airfoil at high angle of attack will produce more lift in oscillating flow than in steady flow.

Master of Science
Aeronautical Engineering
June 1969

Advisor: James A. Miller
Department of Aeronautics

This document has been approved for public release and sale; its distribution is unlimited.

**THE EFFECT OF STRAND SIZE ON EXPERIMENTAL MEASUREMENT
OF SOLID PROPELLANT BURNING RATE AUGMENTATION**

**William Bringham, Jr.
Lieutenant, United States Navy**

(AD #848872)

The burning rates of metallized solid propellant strands ranging in cross-section from $1/4 \times 1/4$ inch to 1×1 inch and in length from $1/2$ inch to 2 inches were tested at five acceleration levels and three pressure levels to determine the effect of the presence of a rigid inhibitor case on measured burning rate. The investigation showed that sample size did influence the average burning rate but that this effect could be minimized by increasing the cross-sectional area of the propellant strand.

The burning rates obtained were compared with data from other test facilities, each set of data utilizing a different technique to investigate the influence of acceleration and pressure on propellant burning rate. By proper selection of strand size, a good correlation of results was possible.

Master of Science
Aeronautical Engineering
December 1968

Advisor: David W. Netzer
Department of Aeronautics

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**THE EFFECT OF ACCELERATION ON THE BURNING RATE
OF DOUBLE BASE ROCKET PROPELLANTS**

**Melvin John Bulman
Lieutenant (junior grade), United States Navy**

(AD #865736)

Double base rocket propellants with and without aluminum were burned in a centrifuge at two pressures and nine accelerations. The burning rates were measured to isolate the effect of the aluminum.

The burning rate of the non-aluminized propellant was found to vary with acceleration and a model was advanced. The addition of aluminum causes an increase in burning rate at higher accelerations and a possible mechanism is discussed.

**Master of Science
Aeronautical Engineering
June 1969**

**Advisor: David W. Netzer
Department of Aeronautics**

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DEVELOPMENT OF A SIMULATOR FOR THE EVALUATION
OF RIGID AND MOVABLE AIRCRAFT CONTROLS

David White Caswell
Commander, United States Navy

(AD #703638)

A simulator was constructed with two sets of aircraft controls; one set was movable and one set was rigid. The control output signals were integrated into an analog computer circuit to provide the desired aerodynamic characteristics. A repeatable, random input voltage to an oscilloscope was used as a basis for a tracking exercise in which the test subject, by manipulation of the control stick, attempted to cancel the random signal. A scoring method was devised which utilized an electronic counter and signal comparator to evaluate pilot performance with each of the four control sticks.

Master of Science
Aeronautical Engineering
June 1969

Advisor: Donald M. Layton
Department of Aeronautics

This document has been approved for public release and sale; its distribution is unlimited.

THE INSTRUMENTATION OF THE S-2 AIRCRAFT
FOR STABILITY AND CONTROL FLIGHT TESTING

Thomas John Duncan
Lieutenant, United States Navy

(AD #691194)

A Navy US-2A aircraft was instrumented for use in stability and control flight testing. Various methods of recording and sensing the aerodynamic parameters necessary to evaluate stability and control flight testing were investigated. An Ampex Series 800 Magnetic Tape Recorder, obtained on a loan basis, was calibrated and installed to provide a means of recording airborne data. Using available equipment, sensing devices were installed in the aircraft and calibrated to measure control forces, control surface position and normal acceleration. The completed installation provides the means for sensing and recording those aerodynamic parameters most difficult to measure without electronic aids. It also allows for the incorporation of additional sensing and recording devices should they become available.

Master of Science
Aeronautical Engineering
April 1969

Advisor: Donald M. Layton
Department of Aeronautics

This document has been approved for public release and sale; its distribution is unlimited.

**SHOCK TUBE INVESTIGATION OF THERMAL
CONDUCTIVITY IN NOBLE GASES**

**Federico Alberto Penaranda Garces
Lieutenant Commander, Chilean Navy
(AD #703655)**

The Aeronautics Department shock tube has been developed and instrumented. The shock tube has been used in an experiment in which the thermal conductivity of argon has been determined in the temperature range of 1500 - 5000^oK and at relatively high pressures, 10 to 30 atmospheres.

Master of Science
Aeronautical Engineering
April 1969

Advisor: Daniel J. Collins
Department of Aeronautics

This document has been approved for public release and sale; its distribution is unlimited.

**ION INJECTORS FOR SINGLE- AND TWO-PHASE
ELECTROGASDYNAMIC GENERATORS**

**William Taylor Ober II
Lieutenant (junior grade), United States Navy**

(AD #694906)

Systems suitable for the injection of ions into electrogasdynamic (EGD) generator devices were built and tested. The mechanism of injection was based on a corona discharge, whereby ions moving through an electric field can be intercepted by a gaseous flow. The intercepted ions are of one polarity, insuring selective ion injection. Two types of injector units were investigated. One was a molecular ion device which produced ions directly from the carrier gas, and the other created larger sized ions, resulting in an aerosol flow. The latter consisted of passing saturated steam through a corona discharge and injecting it into an air stream. In order to aid the injection process, the wake of a cylinder in the air stream was utilized in both cases. Most of the work done here was devoted to the design and testing of the aerosol flow device. The degree of success was moderate.

Master of Science
Aeronautical Engineering
June 1969

Advisor: Oscar Biblarz
Department of Aeronautics

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**THE APPLICATION OF GAS CHROMATOGRAPHY
TO THE ANALYSIS OF THE COMBUSTION
PRODUCTS OF A HYBRID ROCKET (U)**

**Fred Merridith Sallee
Lieutenant (junior grade), United States Navy**

(AD # 510305)

THIS THESIS IS CLASSIFIED CONFIDENTIAL

**Master of Science
Aeronautical Engineering
June 1969**

**Advisor: David C. Wooten
Department of Aeronautics**

In addition to security requirements which must be met, this document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023)

AN EXPERIMENTAL INVESTIGATION OF THE MASS
DISTRIBUTION FROM THE EXHAUST OF A
COAXIAL PLASMA ACCELERATOR

Robert Dale Strouse
Second Lieutenant, United States Marine Corps

(AD #706028)

Investigations were conducted on the mass distribution of the exhaust of a coaxial plasma accelerator in order to gain insight into the manner by which the fuel (gold) is ionized and accelerated.

Tests were conducted using both annular sections of gold foil and single strands of gold wire. Both types of runs showed a non-uniform angular distribution with one or more well defined peaks. The similarity between the distributions leads to the probable conclusion that the foil, rather than undergoing uniform ionization around the annulus, is actually ionizing at discreet "spokes" about its periphery.

Experiments conducted with gold foil involved varying the distance from the accelerator to the collector. A fairly uniform dispersion of gold plasma was observed as collector distance increased.

Master of Science
Aeronautical Engineering
June 1969

Advisor: David C. Wooten
Department of Aeronautics

This document has been approved for public release and sale; its distribution is unlimited.

**CONVERSION OF A C-11B INSTRUMENT FLIGHT TRAINER
INTO A VARIABLE STABILITY FLIGHT SIMULATOR**

**Charles John Sweeney, Jr.
Lieutenant Commander, United States Navy**

(AD #851897)

A C-11B Instrument Flight Trainer was converted into a variable stability flight simulator. The original frame, cockpit, controls, pneumatic system and instruments were utilized as well as certain other necessary components. The original aerodynamic and engine computers were removed, a new instrument drive system was designed and a hybrid computer was programmed to solve the equations of motion. The cockpit controls supplied the inputs to the computer which in turn supplied the outputs to the various instruments through their respective drive systems. The computer program may be quickly changed to simulate the aerodynamic characteristics of almost any single engine jet aircraft, or the parameters of a specific aircraft may be varied to investigate their effects on flying qualities.

Master of Science
Aeronautical Engineering
September 1968

Advisor: Donald M. Layton
Department of Aeronautics

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MOLECULAR-ION ELECTROGASDYNAMIC FLOW CHANNEL

**David William Wallace
Lieutenant (junior grade), United States Navy**

(AD #694915)

This investigation evaluates the operating characteristics of an EGD (electrogasdynamic) generator system which utilizes air both as the carrier fluid and as the source of injected ions. The design and construction of a flow channel and a corona ion injector are discussed, the performance of the ion injector is examined, and the results of attempts to obtain work by EGD energy conversion are presented. The experimental results presented and discussed are in reasonable agreement with expectations. The high mobility of molecular ions inhibits the conversion process and only 0.5% of the ions were removed from the corona by the air flow. Suggestions for improvements on the present system and the design of an advanced system are made.

Master of Science
Aeronautical Engineering
June 1969

Advisor: Oscar Biblarz
Department of Aeronautics

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DETERMINATION OF PERFORMANCE PARAMETERS OF A
DUAL DISCHARGE RADIAL TURBINE

David Dante Williams
Lieutenant, United States Navy

(AD #690871)

This study was conducted to establish the performance parameters of a radial inflow, dual discharge turbine and to determine the effect of variations in axial clearance on these parameters. The representative stream surface is taken at the outer discharge radius instead of at a computed mass-average discharge radius, as was done previously. This technique results in considerably simplified computations and in better correlation of the rotor loss parameters.

Tests were conducted at axial clearances from 0.015 to 0.081 inches and at total-to-static pressure ratios from 1.2 to 1.7 for each clearance. The test installation is located at the Turbo-Propulsion Laboratory of the Naval Postgraduate School, Monterey, California.

Master of Science
Aeronautical Engineering
December 1968

Advisor: Robert D. Zucker
Department of Aeronautics

This document has been approved for public release and sale; its distribution is unlimited.

AN INVESTIGATION OF OSCILLATIONS IN AN ADAPTIVE
AIRCRAFT CONTROL SYSTEM UNDER LARGE INPUT COMMANDS

Larry Smith Wisler
Lieutenant (junior grade), United States Navy

(AD #705074)

The adaptive control scheme for aircraft was studied to find the cause of limit cycles which occurred under large input commands and to find a method for eliminating the oscillations. The complexity of the system equations dictated that all analytical studies be performed on simplified versions of the adaptive control scheme. After exhaustive analysis of the cause of limit cycles in the simplified systems and an investigation of possible fixes for this problem, it was decided that the oscillations were an inherent feature of the control scheme resulting from the servo and actuator lags.

A second adaptive control scheme was thus developed which obtained more feedback information downstream of the aircraft actuator and series servo. A comparison of the two adaptive systems was made under similar flight conditions for the F-4 aircraft and the modified adaptive controller was shown to be practical and free of limit cycle oscillations by analog simulation.

Master of Science
Aeronautical Engineering
June 1969

Advisor: Edward R. Rang
Department of Aeronautics

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SEARCH FOR SHORT-LIVED ISOTOPES IN
VOLATILE REACTOR FUEL PRODUCTS

Ward Duane Fagan
Major, Chemical Corps, United States Army

(AD #704085)

The volatile radioactive nuclides produced by thermal neutron fissioning of uranium oxide-polyethylene fuel of the AGN-201 Reactor were collected in an evacuated aluminum cylinder. The following constituent isotopes, identified by gamma ray spectrometry, present in 20 minute old gas are; Te^{131} , $\text{Xe}^{131\text{m}}$, Xe^{133} , $\text{Xe}^{135\text{m}}$, Xe^{137} , Xe^{138} , Xe^{139} , Se^{81} , Se^{83} , $\text{Kr}^{85\text{m}}$, Kr^{85} , Kr^{87} , Kr^{88} , and Kr^{89} . Radioactive daughter products identified are Cs^{137} , Cs^{138} , Cs^{139} , Rb^{88} , Rb^{89} , and I^{131} . Other isotopes of iodine, tellurium, and bromine may be present. Spectra were taken with a NaI (Th) scintillation crystal.

Master of Science
Chemistry
June 1969

Advisor: William W. Hawes
Department of Material Science
and Chemistry

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**INFRARED SPECTRUM ANALYSIS OF THE
HYDROCHLORIC ACID-WATER-CARBON TETRACHLORIDE SYSTEM**

**George Masaru Fukumoto
Lieutenant Colonel, United States Army**

(AD #705073)

The infrared vibrational-rotational spectra of hydrochloric acid and water dissolved together in carbon tetrachloride were obtained and compared with the spectra of hydrochloric acid in carbon tetrachloride and of water in carbon tetrachloride separately. Spectra of extremely dilute solutions of the two solutes in the non-polar solvent were analyzed for nature and extent of solvent-solute interaction. Dilution behavior was investigated by the use of the Beer-Lambert Law. Possible resulting species were also investigated.

Master of Science
Chemistry
June 1969

Advisor: John W. Schultz
Department of Material Science
and Chemistry

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ELECTRON PARAMAGNETIC RESONANCE STUDY OF COPPER
HALIDE TETRAZOLE COMPLEXES AND THE FREE RADICALS
IN IRRADIATED STRONTIUM ACETATE HEMIHYDRATE

Robert Gary Gisch
Lieutenant (junior grade), United States Navy

(AD #704508)

An EPR study of copper halide tetrazole complexes and x-irradiated strontium acetate hemihydrate has been made. The powder spectra of some of the tetrazole complexes exhibited temperature dependent narrowing and broadening. The one-electron population of the copper d orbital involved in bonding to 2-methyl-5-amino tetrazole has been found to be 0.56 and 0.47, respectively for the chloride and bromide complexes. The g values for these two complexes are consistent with the proposed planar polymeric structure for 2-substituted tetrazole-copper complexes. The species present in single crystals of strontium acetate hemihydrate irradiated and observed at liquid nitrogen temperature to -100°C has a spectrum of four lines of 1:3:3:1 intensity ratio and a $\text{CH}_3 = 11.0$ gauss. Temperature dependent exchange behavior of the spectrum for this species is observed and attributed to a rotating methyl group which was found to have $\Delta H^{\ddagger} = 3.0 \pm 0.3 \frac{\text{kcal}}{\text{mole}}$ and $\Delta S^{\ddagger} = 6.0 \pm 0.3 \text{ cal/mole deg.}$ for internal rotation. The species present at room temperature has an eight line spectrum consisting of two 1:3:3:1 intensity ratio patterns with a $\text{CH}_3 = 25.2$ and a $\text{H} = 21.3$ gauss. Molecular orbital calculations using the CNDO approximation were performed and possible fragments responsible for these spectra are suggested.

Master of Science
Chemistry
June 1969

Advisor: W. M. Tolles
Department of Material Science
and Chemistry

This document has been approved for public release and sale; its distribution is unlimited.

TEMPERATURE DEPENDENCE OF THE ELECTRON SPIN RESONANCE
SPECTRUM OF THE CH_2CO_2^- RADICAL FORMED IN
X-IRRADIATED ZINC ACETATE DIHYDRATE

John Woodrow Hunt
Major, United States Army

(AD #692445)

A decrease of one to six gauss (depending on magnetic field orientation) in the coupling constants of the CH_2CO_2^- radical formed in X-irradiated zinc acetate dihydrate has been observed over a temperature range of about -60°C to $+30^\circ\text{C}$. Calculations of dipolar and Fermi contact interaction based on a model of internal rotation of the methylene group about the C-C bond have shown a small coupling constant decrease on the order of 0.19 gauss over a temperature range of -150°C to $+90^\circ\text{C}$. The major effect has been shown to be due to a spin relaxation mechanism. The effect was calculated using Monte Carlo techniques, the results of which were confirmed by experimental data.

Master of Science
Chemistry
June 1969

Advisor: William M. Tolles
Department of Material Science
and Chemistry

This document has been approved for public release and sale; its distribution is unlimited.

THE KINETICS AND MECHANISM FOR THE
SUBSTITUTION OF BIPHENYLOXIDE FOR CHLORIDE ON
HEXAPHENYLDICHLOROTETRAPHOSPHONITRILE

John Hay McCorry
Lieutenant Commander, United States Navy

(AD #692443)

In this research, a study of the kinetics and mechanism of the biphenyloxide substitution for chloride on the hexaphenyldichloro-tetraphosphonitrile molecule was conducted. The reaction was studied in sealed, evacuated ampoules at 210°C and in an evacuated gas pressure measuring system at temperatures of 185°C and 195°C .

Two isomers of the expected disubstituted produce were isolated by fractional recrystallization from acetonitrile. The isomers had melting points of 204°C and 174°C .

The gas pressure studies provided extent of reaction versus time curves. An analog computer was used to simulate the reaction and the rates obtained were used to determine the Entropy of activation as $-42.5 \pm 10.0 \text{ cal mole}^{-1} \text{ degree K}^{-1}$ and Enthalpy of activation as $13.6 \pm 10.0 \text{ K cal mole}^{-1}$ for the first substitution.

A mechanism consistent with these values is proposed and discussed.

Master of Science
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June 1969

Advisor: Charles F. Rowell
Department of Material Science
and Chemistry

This document has been approved for public release and sale; its distribution is unlimited.

THE PHOTO-INDUCED REACTION OF
BROMINE WITH PHENYLCYCLOPROPANE

William Charles Nierman
Lieutenant (junior grade), United States Navy

(AD #705099)

Prior studies on the mechanism of the cleavage of cyclopropane and substituted cyclopropane compounds are reviewed and discussed. The rate law for the photolytic reaction of bromine with phenylcyclopropane in concentrations of about 0.2 molar in carbon tetrachloride was determined to be first order in phenylcyclopropane, and half order in bromine and in light intensity. The photoinduced reaction of bromine with a fifteen molar solution of phenylcyclopropane gave 1, 1, 2, 3-tetrabromo-1-phenylpropane as the major product. When this reaction was run using a 1.5 molar solution of bromine and phenylcyclopropane in carbon tetrachloride the product was a mixture of 1,3-dibromo-1-phenylpropane and 1,2-dibromo-1-phenylpropane with the 1,2 isomer predominating. The mechanism of this reaction is discussed.

Master of Science
Chemistry
June 1969

Advisor: Charles F. Rowell
Department of Material Science

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A. PROPOSED PROGRAMMING SYSTEM FOR
KNUTH'S MIX COMPUTER

Max Neil Akers
Lieutenant Commander, United States Navy

(AD #705101)

A programming system using a hypothetical computer is proposed for use in teaching machine and assembly language programming courses. Major components such as monitor, assembler, interpreter, grader and diagnostics are described. The interpreter is programmed and documented for use on an IBM 360/67. The interpreter can be used for teaching machine language programming and can be incorporated into the proposed programming system

Master of Science
Computer Science
June 1969

Advisor: G. L. Barksdale, Jr.
Department of Mathematics

This document has been approved for public release and sale; its distribution is unlimited.

THE PREPARATION OF A BUILDING AND SPACES
DATA BANK AT THE NAVAL POSTGRADUATE SCHOOL

Robert Judd Arnold
Lieutenant, United States Navy

(AD #691198)

This document describes the design and development of a Building and Spaces Information System at the Naval Postgraduate School. The system was designed to be used by the Naval Postgraduate School facility resource managers as a decision making aid.

System analysis techniques were applied to the present facility resource decision system to determine its structure and information needs. Additional problem analysis was conducted to determine which of the needs could be incorporated into an information system. The intersection of the foregoing needs and the subsequent problem analysis determined the structure of the new system. The objective of the new system was to supply the managers with a centralized source of information with regard to existing facilities. A complete software package was designed, tested, and documented, but not implemented. An extensive users manual is provided to expedite implementation when it occurs.

Master of Science
Computer Science
June 1969

Advisor: Richard K. Lockridge
Department of Business Adminis-
tration and Economics

This document has been approved for public release and sale; its distribution is unlimited.

AN INVESTIGATION OF AN AUTOMATIC MACHINE ;
GRADING SYSTEM FOR ASSEMBLY LANGUAGE INSTRUCTION

Roger Francis Bacon
Lieutenant Commander, United States Navy

(AD #691195)

Machine grading techniques are becoming of greater importance because of the increased number of students in programming classes. Characteristics and limitations of automatic machine grading systems are proposed. A grader for introductory assembly language programming courses was developed. The properties of this grader are discussed and an example of a graded program is given.

Master of Science
Computer Science
June 1969

Advisor: G. L. Barksdale, Jr.
Department of Mathematics

This document has been approved for public release and sale; its distribution is unlimited.

A SIMULATION STUDY OF THE TIME-SHARING
COMPUTER SYSTEM AT THE NAVAL POSTGRADUATE SCHOOL

Ronald Maxwell Goodman
Lieutenant, United States Navy

Leo Michael Pivonka
Lieutenant, United States Naval Reserve

(AD #692447)

A GPSS model of the CP/CMS time-sharing computer system at the Naval Postgraduate School was constructed, and was used in three experiments to investigate the performance of the system under a variety of conditions. In each of the experiments the model generated auto-correlated sequences of observations which were analyzed using techniques adapted from spectral analysis.

An experiment to determine the effect of an increased number of terminals on average response time revealed that the system adequately could support a 25% increase in the number of terminals, and that the number of terminals was limited by the magnetic disk I/O capability. In a second experiment it was found that increasing the number of disks from four to eight would enable the system to support up to 20 terminals. A final experiment involving the examination of a new scheduling algorithm showed no significant changes in average response times.

Master of Science
Computer Science
June 1969

Advisor: G. Heidern
Department of Operations
Analysis

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A UNIVERSAL SYNTAX CHECKER

John Francis Leahy III
Lieutenant, United States Navy

(AD #704087)

A universal syntax checker was constructed to be utilized with a text editor in a time-sharing environment. This syntax checker is a top-down left-right slow-back parser that will provide, when supplied the syntax of any language in the Backus-normal form, a syntax check for any string written in a language described. The procedure is capable of handling left, right, and self-embedded recursive definitions.

Master of Science
Computer Science
June 1969

Advisor: Gary A. Kildall
Department of Mathematics

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**A PROPOSED STUDENT OFFICER INFORMATION
RETRIEVAL SYSTEM FOR THE NAVAL POSTGRADUATE SCHOOL**

**Robert Lee Henry and Lawrence Lee Massa
Lieutenant Commanders, United States Navy**

(AD #696069)

Pertinent information on past and present Naval Postgraduate School students is now maintained, stored and processed in bulk files by Curriculum Officers. Information desired for management studies or analysis requires manual sorting of an ever increasing number of individual student records. This is an inadequate and inefficient system.

The foregoing problem could be resolved by the implementation of the Student Officer Information Retrieval System (SOIRS), which is a narrow scope retrieval system specifically designed to be responsive to the Curriculum Officer's needs with respect to student information. SOIRS evolved through a series of logical system design steps, identified as follows: (1) Problem Analysis; (2) Design of Records, Files and Reports; (3) Software Design; (4) Test of Entire System.

SOIRS is a complete system establishing required files, updating files, and retrieving stored information.

Master of Science
Computer Science
June 1969

Advisor: Richard K. Lockridge
Department of Business
Administration

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BUILT-IN SELF-TEST FOR AN AIRBORNE DIGITAL COMPUTER

**Edward Oliver Bierman
Major, United States Marine Corps**

(AD #698496)

This thesis describes the design of a built-in self-test capability for a military airborne digital computer. The supportive investigation of program constraints and their effects on the example test design is intended to give broad perspective to the general self-test design problem. Alternative procedures for achieving the goal of airborne detection and isolation of a certain class of failures to the modular level are surveyed. A specific test design is evolved illustrating the unique mix of program-oriented, periodic techniques, and added hardware, continuous techniques best suited to the example development program. The test design is evaluated and further work is suggested.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: Mitchell Cotton
Department of Electrical
Engineering**

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**INVESTIGATION OF DISTORTION OF DIVERS' SPEECH
USING POWER SPECTRAL ESTIMATES BASED ON THE
FAST FOURIER TRANSFORM**

**William Howard Bond
Major, United States Marine Corps**

**James Michael Myatt
Captain, United States Marine Corps**

(AD #707729)

The problem of distortion in underwater communications peculiar to free divers and techniques for analysis of speech wave forms are discussed. The Fast Fourier Transform algorithm, selected to analyze shifts in format frequencies due to restricted oral cavities, high ambient pressures, and forced speech is discussed. The Fast Fourier Transform is used to analyze a vowel sound and show that the expected shifts do occur. Recommendations are made for extending the techniques to all non-noise like sounds and breathing mixtures other than compressed air.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: Harold Titus
Department of Electrical
Engineering**

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distribution is unlimited.**

**EXPERIMENTAL DESIGN FOR CONTROL OF THE
HYDRAZINE-OXYGEN FUEL CELL**

**Robert Jackson Brenton
Lieutenant, United States Navy**

(AD #844364)

The control of output voltage of an experimental hydrazine-oxygen fuel cell is investigated. A mixture of nitrogen and oxygen is introduced into the cathode cavity, and the percentage of oxygen is varied to control the output voltage. After dynamic testing, a typical response is defined, and a feedback control system designed to improve transient response. The control scheme is evaluated using a digital computer to simulate the simplified plant model and the controller.

**Master of Science
Electrical Engineering
September 1968**

**Advisor: James S. Demetry
Department of Electrical
Engineering**

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AN INVESTIGATION OF THE AMPLIFICATION
OF FREQUENCY MODULATED MICROWAVE SIGNALS BY
INJECTION LOCKED GUNN-EFFECT OSCILLATORS

Arthur Eugene Burns III
Captain, United States Marine Corps

(AD #693034)

Although it has been known for many years that under the proper conditions an oscillator can lock to and follow an external signal of much smaller amplitude, this phenomena has not had widespread usage. The development of negative resistance solid state oscillator diodes, such as the Gunn diode, has brought about renewed interest in the locked oscillator, however.

The locking characteristics of an X-Band Gunn-effect oscillator have been investigated. The theory of injection locking is discussed and the experimental work performed is described. Amplifier performance of 20 db gain with 40 MHz bandwidth and 30 db gain with 13 MHz bandwidth is reported.

The advantages of the locked Gunn-effect oscillator as an amplifier for frequency modulated signals are its minimal power supply requirements, small size, low weight, and simplicity.

Master of Science
Electrical Engineering
April 1969

Advisor: George L. Sackman
Department of Electrical
Engineering

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DYNAMIC SYSTEMS WITH THREE VARIABLE PARAMETERS

**Jorge Enrique Cadena
Lieutenant, Colombian Navy**

(AD #841114)

A study of Dynamic Systems with three variable parameters is made by an initial scanning of the basic geometric properties on the three dimensional space generated by these parameters. From these geometric properties, a root-locus technique that simplifies greatly the amount of work in analysis and design is developed. This technique is extended to systems with k variable parameters. Finally singular lines in the parameter plane are treated as a special case of the parameter space, and formulae are derived for a fourth order system leaving the field open for systems of higher order.

**Master of Science
Electrical Engineering
September 1968**

**Advisor: George J. Thaler
Department of Electrical
Engineering**

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FIELD-EFFECT TRANSISTOR REACTANCE CIRCUITS

Gary Dale Clark
Captain, United States Marine Corps

(AD #851601)

Efforts to miniaturize the reactance circuits of vacuum-tube technology by using junction transistors have been only partially successful. Large equivalent inductances and capacitances are obtainable, but the effective Q is limited to low values by the low input impedance of these devices. Unipolar field-effect transistors offering high gain and high input impedance are investigated for this application. Analytical models, based on the equivalent circuits employing R-C feedback networks. A simple capacitive reactance circuit, utilizing a first-order feedback network and operating at a frequency of 250 KHz, yielded a low- Q effective capacitance but served to verify the model employed. Computer-aided design of a reactance circuit employing a second-order feedback network resulted in a stable effective capacitance offering Q multiplication. Sensitivity of the feedback voltage to component tolerances precludes packaging this circuit in integrated form, but the feasibility of designing an FET reactance circuit to meet rather precise specifications is demonstrated.

Master of Science
Electrical Engineering
September 1968

Advisor: W. Conley Smith
Department of Electrical
Engineering

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ECHO SPLITTING IN LINEAR FM DOPPLER RANGING SYSTEMS

Francis Paul Cleary
Lieutenant, United States Navy

(AD #844089)

Echo splitting is a phenomenon that produces difficulties in estimating target range and speed for radar and sonar systems. It occurs when more than one returned pulse is received from a single target for each transmitted pulse. This thesis investigates the effects of echo-splitting distortion of a linear frequency modulated (chirp) signal. An ambiguity function is proposed for both narrow-band and wideband analysis of multiple and overlapping target returns. The double-echo situation is examined in detail and equations are developed for both the narrow-band and wideband cases. Finally, using typical sonar parameters, sample computer-drawn plots of these ambiguity functions are presented.

Master of Science
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Advisor: C. F. Klamm, Jr.
Department of Electrical
Engineering

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A TOPOLOGICAL APPROACH TO FAULT ISOLATION

James Dewey Courville
Lieutenant (junior grade), United States Navy

(AD #692456)

A method is developed for determining by simple external measurements faulty components of passive networks without mutual inductances. A program has been written using topological relationships to calculate the necessary fault isolation reference data. Computation time and storage requirements have been maintained at a minimum.

Master of Science
Electrical Engineering
June 1968

Advisor: Shu-Gar Chan
Department of Electrical
Engineering

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SUB-OPTIMAL GAIN SCHEDULES FOR THE
DISCRETE KALMAN FILTER

Robert Allen Crotteau
Lieutenant (junior grade), United States Navy

(AD #703263)

The object of this study is to find an approximation to the discrete optimal Kalman filter gain schedule by closed-form analytic expressions. In doing so, required table storage and/or on-line computation time can be reduced at little expense in terms of filter performance degradation. The method of least squares was used to determine the closed-form solution which was the best fit to the discrete Kalman filter gain schedule. The criterion for performance degradation was the difference between the values of the diagonal elements of the estimation covariance matrix, $P_{k/k}$, obtained by using the Kalman gain schedule, and the corresponding values obtained by using the closed-form analytic expressions for the elements of the gain matrix. Examples are presented to show that near-optimal results were obtained utilizing this method. A comparison of the results of this study with another near-optimal estimation scheme is also included.

Master of Science
Electrical Engineering
June 1969

Advisor: James S. Demetry
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**FREQUENCY RESPONSE ANALYSIS AND DESIGN OF
SINGLE VALUED NONLINEAR SYSTEMS
USING THE PARAMETER PLANE**

**John Phillip Davis
Lieutenant (junior grade), United States Navy**

(AD #691384)

Frequency response techniques are a valuable tool in the analysis and synthesis of linear systems. Extension of these techniques is made to analyze and design systems with a single-valued nonlinear element. The relationship between the characteristics of a nonlinear element and the frequency of the system is developed by simple calculations and a digital computer program.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: George J. Thaler
Department of Electrical
Engineering**

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TIME SHARING TASK CONTROL FOR A HYBRID
COMPUTER SIMULATION LABORATORY

Andrew John Dietzler
Lieutenant, United States Navy

(AD #698499)

The study of time sharing system parameters and design is undertaken. On-line and hybrid simulation programmer's demands for iterative digital computing time are time inefficient for modern high speed computers, hence the motivation for time shared computing systems. The techniques for achieving time sharing are studied, then applied to the problems of a real time, on-line, hybrid simulation and batch processing system. Subroutines required for implementation of a task oriented time sharing capability are put forward with specific proposals for use. System improvements to accomplish the goal of a general time sharing system are introduced and discussed.

Master of Science
Electrical Engineering
April 1969

Advisor: M. L. Cotton
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

DIGITAL SPECTRAL ANALYSIS

Leonard Vincent Dorrian
Lieutenant, United States Coast Guard

(AD #861229)

A program has been developed for spectral analysis using a medium size digital computer for computation and a general purpose analog computer for signal processing and system control. This package is FORTRAN callable, providing the user with a variety of changeable system parameters in order to maximize the desired information required. The basic algorithm used is the Fast Fourier Transform. The effect of sampling rates, quantization and noise are investigated with system accuracy given. Application examples are shown and results discussed.

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Advisor: Mitchell Cotton
Department of Electrical
Engineering

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ON FAULT IDENTIFICATION OF LINEAR NETWORKS

James Richard Dyer
Lieutenant (junior grade), United States Navy

(AD #692445)

A study has been made on the possibility of identifying faulty components of a network by making tests only on external points of that network. The conclusion is made that this is possible, and that a practical method of doing this can be developed from the computer program presented as a result of this investigation.

The method used is to select the voltage transfer functions of a network as the quantities on which the tests will be made. The poles and zeros of these functions are used to select a set of test frequencies. From the measurements made at these frequencies, a set of signatures is available which allow the faulty components to be identified.

Master of Science
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June 1969

Advisor: Shu-Gar Chan
Department of Electrical
Engineering

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**IDENTIFICATION OF PLANT DYNAMICS
USING HO'S ALGORITHM**

**Ilker Eldem
Lieutenant, Turkish Navy**

(AD #703639)

Ho's Algorithm is reviewed and demonstrated with analytic examples. A digital computer program is developed to implement the algorithm for single-input, single-output systems and used to identify linear continuous and stationary systems which are driven with a unit step as the test input. Discrete realization of the continuous systems is obtained using the measured output-samples, to a step input, directly in the algorithm.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: George J. Thaler
Department of Electrical
Engineering**

**This document has been approved for public release and sale; its
distribution is unlimited.**

**A REAL-TIME SIMULATION OF A HUMAN-CONTROLLED,
COMMAND-GUIDED, AIR-TO-SURFACE MISSILE SYSTEM**

**Robert Stephen Erb
Lieutenant (junior grade), United States Navy**

(AD #706052)

This paper investigates the feasibility of an air-to-surface missile delivery system employing impact prediction to assist a human operator in controlling the system. The impact prediction information was used to drive a display which the operator used in controlling the flight of the weapon. It was desired to find whether impact prediction proved useful in weapons control.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: James S. Demetry
Department of Electrical
Engineering**

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**PREDICTION OF STATISTICAL SYSTEM PERFORMANCE
FROM PARAMETER DISTRIBUTIONS**

**Alvin LaVerne Franson
Lieutenant, United States Navy**

(AD #703258)

Techniques for extrapolating statistical data on the parameters of individual components to the statistical performance index for an overall system are considered. Two cases are evaluated. (1) The deterministic case in which the system's performance index is known functionally in terms of the system parameters. (2) The non-deterministic case in which only limited data on the performance index and its sensitivity with respect to system parameters is known. Computer programs are developed in both cases for combining given probability density distributions for the parameters into an overall probability density distribution for the system performance index. Theory and programs are developed and verified with a specific numerical example.

Master of Science
Electrical Engineering
June 1969

Advisor: Sydney R. Parker
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**DESIGN OF ACTIVE FILTER SYSTEMS
USING PARAMETER PLANE TECHNIQUES**

**Ronald Clement Funk
Lieutenant, United States Navy**

(AD #689727)

Since parameter planes were introduced, considerable investigation has been conducted in proving that the results obtained by this method are in agreement with those obtained from various other proven techniques. Research undertaken in this paper illustrates methods by which parameter planes are useful in the design of electrical networks. The investigations were conducted on an active parallel-T filter, in which the utilization of the constant bandwidth curves are beneficial, and the high Q double turned filter, where constant zeta curves aided in the design.

**Master of Science
Electrical Engineering
December 1968**

**Advisor: George J. Thaler
Department of Electrical
Engineering**

This document has been approved for public release and sale; its distribution is unlimited.

**PRELIMINARY INVESTIGATION OF A
PROPOSED SONOBUOY RANGING SYSTEM**

**Gary Maxwell Grant
Lieutenant (junior grade), United States Navy**

(AD #705497)

The ability to locate and determine the position of an ASW sonobuoy is an essential part of airborne anti-submarine operations. Present methods restrict the parent aircraft's operational capability and yield only marginal data. State-of-the-art frequency control makes it possible to range sonobuoys accurately with radio signals. Sonobuoy position can then be determined by combining this range data with other available information. A system is proposed to both free the parent aircraft from present restrictions and to increase the accuracy of the position information.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: Carl E. Menneken
Department of Electrical
Engineering**

**This document has been approved for public release and sale; its
distribution is unlimited.**

DATA COMPRESSION

Lawrence Alan Gray
Lieutenant (junior grade), United States Navy

(AD #708371)

A study of data compression techniques involving linear interpolation and linear prediction showed that redundancy is a problem that can be significantly reduced by various polynomial approximations. A more recent compressor, the continuous secant compressor which determines the optimum sampling interval prior to sampling, was found to be the most efficient compressor examined. The continuous secant compressor bases its reduction technique on a straight-line approximation. Data compression results when the system in question does not occupy its entire bandwidth. The addition of white noise over the entire bandwidth was found to reduce the efficiency of the continuous secant compressor by only a small amount. The probability distribution of the straight-line approximation in the presence of noise had a gaussian distribution and a relatively small standard deviation.

Master of Science
Electrical Engineering
June 1969

Advisor: George A. Rahe
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**AN INTEGRATED-CIRCUIT PIANO TUNER
FOR THE EQUAL-TEMPERED KEYBOARD EMPLOYING
TUNEABLE FIXED-COEFFICIENT DIGITAL FILTER**

**Michael William Hagee
Second Lieutenant, United States Marine Corps**

(AD #703640)

A study of the physics of the piano reveals that while the upper partials of the steel strings are the eigen-frequencies of the complex tone, they are not integer multiples of the respective fundamentals. To properly measure and tune these eigen-partial, a frequency spectrum had to be implanted. Such a filter, a tuneable fixed-coefficient digital filter, is discussed as well as a simple pole-zero design procedure for determining the required coefficients. Each module, including the Frequency Deviation Detector and Counter, the Time-Base Generator, the Digital Filter, the Reference Frequency Generator and the Display and Control Module, of the proposed tuner is illustrated and discussed.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: James S. Demetry
Department of Electrical
Engineering**

This document has been approved for public release and sale; its distribution is unlimited.

AN ACOUSTIC DIGITAL DATA LINK

Raymond Joseph Hopkins
Lieutenant (junior grade), United States Navy

(AD #703227)

A design study of various possible methods of developing an underwater data link to monitor a deep ocean capsule was undertaken. The capsule is designed to remain on the ocean floor for a year, and the data link is required to periodically sample the data being recorded and send it to a surface buoy for relay to a shore station. A comparative engineering evaluation of the possible systems was made and a final design proposed.

Master of Science
Electrical Engineering
June 1969

Advisor: Harold Titus
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**HIGH-FREQUENCY, HIGH-POWER TRANSISTOR
LINEAR POWER AMPLIFIER DESIGN**

**Ray Everett Huebner
Captain, United States Marine Corps**

(AD #844365)

This thesis discusses in detail the physical and electrical characteristics of high-frequency, high-power transistors, and why class B amplifiers are necessary for linear power amplification of signals containing more than one frequency.

Linear power amplifier design is contingent upon having a suitable design technique. "Suitable" often means being able to determine parameter values called for by that technique. Conjugate impedance matching is a suitable technique and three of the four parameters values can be accurately determined. In some cases manufacturers provide data for this technique, titled "Large-signal parameters".

**Master of Science
Electrical Engineering
September 1968**

**Advisor: William M. Bauer
Department of Electrical
Engineering**

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INVESTIGATION OF SUBHARMONIC RIPPLE
IN A FORCED LIMIT-CYCLING REGULATOR

Wilton Hubert Hyde, Jr.
Major, United States Marine Corps

(AD #691385)

Some Nonlinear Feedback Control Systems under high gain conditions exhibit the phenomenon of subharmonic instability, or contain subharmonics of the fundamental output frequency. A general discussion of subharmonics in nonlinear systems is followed by an investigation of ripple instability in a forced limit-cycling voltage regulator containing a thyristor or SCR bridge utilizing an ON-OFF switching scheme.

A digital computer program is used to simulate the dynamic response of the system under different loading conditions and for different reference voltage levels.

Master of Science
Electrical Engineering
December 1968

Advisor: George J. Thaler
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

A VIBRATING-REED MASS-FLOW-METER

**Clifford Larry Jamerson
Lieutenant, United States Navy**

(AD #693100)

For many fluid-mass-rate-of-flow metering situations, a measure of the fluid's density-velocity product is required. The density-velocity (pv) product is multiplied by an effective conduit cross-sectional area to yield the mass-rate-of-flow. The area multiplication is accomplished by simply changing the scale of the pv-product indicator.

The purpose of this paper is to show how a magnetically-driven vibrating reed can be used to measure either the pv product of a fluid or its mass-rate-of-flow through a conduit. The proposed meter differs from the rotating-vane mass-rate-of flow meters in that it operates on a transverse rather than angular momentum exchange.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: John B. Turner
Department of Electrical
Engineering**

This document has been approved for public release and sale; its distribution is unlimited.

PARAMETER PLANE SINGULAR LINE SYSTEMS

Paul Roper Jeffers
Lieutenant, United States Navy

(AD #691387)

Derivation and methods for the proof of existence of singular lines on the parameter plane is presented. A method is derived for producing singular line systems. Several systems are designed and evaluated using this technique.

Master of Science
Electrical Engineering
December 1968

Advisor: George J. Thaler
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

FOUR HOLE ORTHOGONALLY WOUND MAGNETIC AMPLIFIER

Thomas Buford Johnson
Lieutenant, United States Navy

The object of this paper is to investigate the magnetic properties of specially fabricated four hole orthogonally wound magnetic amplifiers. Experimental data has been obtained to determine a typical B-H Curve, input and output voltage wave forms, and relative gain at different degrees of saturation and at different frequencies utilizing a.c. and d.c. control. A qualitative explanation of operational theory is included and an attempt was made to explain some of the more important results mathematically.

Master of Science
Electrical Engineering
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Advisor: Orestes M. Baycura
Department of Electrical
Engineering

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**DES-1: AN INTER-ACTIVE CONTINUOUS
SYSTEM SIMULATION LANGUAGE**

**Michael Alex Kalashian
Second Lieutenant, United States Marine Corps**

(AD #701677)

There are strong tutorial advantages to Digital Computer Simulation of Control System's problems. This is particularly true where such simulations do not require sophisticated programming techniques and where the user may directly interact with his problem. The purpose of this study was to develop such a capability for the Naval Postgraduate School's direct-access Computer System.

The installation was to be accomplished using the DES-1 Simulation Language and an SDS 9300 Digital Computer. The DES-1 software requires a special DES-1 Console for optimum performance. Due to the lack of this Console, a reformulation of the language was necessary. This process involved simulating the Console and revising the language to operate with existing hardware.

The language was re-written and the revised system has been installed as an operating system. Complete documentation is available in the DES-1 Programming Manual, which was prepared as part of this study.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: George A. Rahe
Department of Electrical
Engineering**

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**A PROPOSED ADDRESS RECOGNITION SYSTEM
FOR DESTROYER MESSAGE COMMUNICATIONS**

**Frederick Gilbert Kleyn, III
Lieutenant, United States Navy**

(AD #705100)

An address recognition system is proposed for use on destroyers and other small ships. This proposed system is designed to be completely compatible with current fleet broadcast teletype communications methods and uses components, subsystems, and devices readily available off-the-shelf. The address recognition system is designed to search the fleet broadcast for messages addressed to own ship or unit. Only those messages addressed to own ship or embarked commands are printed out in the ship's communications center. A complete broadcast record is available if needed.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: Paul E. Cooper
Department of Electrical
Engineering**

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ANALYSIS OF A FORCED LIMIT-CYCLING REGULATOR

**Vincent John Leszcynski
Lieutenant Commander, United States Navy**

(AD #844361)

The recent introduction of high current-capacity thyristors has advanced the status of solid-state power supplies. ON-OFF switching of an entire rectifier bridge, rather than individual thyristors, provides a simple and economical method of control and regulation. This control philosophy causes the system to limit-cycle.

A describing function is developed to model the power-supply input transformer and rectifier bridge. The describing function is then used to predict the frequency and amplitude of the limit cycle.

A digital computer program is used to construct the describing function curves, and to simulate the dynamic response of the system. Limit cycle predictions are compared with the simulated response to verify the describing function validity.

**Master of Science
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September 1969**

**Advisor: G. J. Thaler
Department of Electrical
Engineering**

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**COMPARISONS BETWEEN RADIATION HARDENED AND STANDARD
INTEGRATED CIRCUIT AMPLIFIERS IN AN ELECTRON BEAM**

**Donald Frederick Lesemann
Lieutenant, United States Navy**

(AD #696566)

An investigation into the effect of radiation from a linear accelerator on two types of integrated circuit operational amplifiers was made. Dielectric isolation, thin film resistors and compensation diodes were used in one amplifier (μ A744). The other amplifier (μ A709) was fabricated using standard methods.

The μ A744 amplifier, in its current stage of development, was found to be more susceptible to the effects of accumulated dose from high energy electrons than the μ A709 amplifier.

Master of Science
Electrical Engineering
April 1969

Advisors: Shu-gar Chan
Department of Electrical Engineering
John Dyer
Department of Physics

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INVESTIGATION OF A MONOLITHIC INTEGRATED-CIRCUIT
DIFFERENTIAL AMPLIFIER AS A MIXING DEVICE

Robert Conrad McFarland
Lieutenant, U. S. Coast Guard

(AD #842885)

The balanced differential-amplifier configuration finds wide applicability in its monolithic integrated form. This paper investigates the use of the MIC differential amplifier as a mixer. The device chosen for this investigation permits signal injection both in the differentially driven pair and in the constant-current sink which biases the differential pair. Device characteristics pertinent to the mixing process are generated and discussed. On the basis of the experimentally derived characteristics several different frequency conversion methods are employed and compared on the basis of conversion gain and distortion and intermodulation effects.

Master of Science
Electrical Engineering
September 1968

Advisor: Wm. M. Bauer
Department of Electrical
Engineering

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**AUTOMATIC VOLUME COMPENSATION
FOR NOISY ENVIRONMENTS**

**Charles Randall McGough
Lieutenant (junior grade), United States Navy**

(AD #692441)

The importance of environmental noises which interfere with the audio output from the loudspeaker of an intercom or radio communications receiver has led to the study of sound masking and noise interference. The results are applied in the development of an automatic control system which compensates for environmental noises by maintaining the speaker output as a prescribed listening level above such interference. Such a system could be used to maintain the readability of communications in spite of a noisy environment such as on the bridge or in the engine room of a ship.

Master of Science
Electrical Engineering
June 1969

Advisor: David B. Hoisington
Department of Electrical
Engineering

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ACTIVE FILTERS WITH VOLTAGE-VARIABLE PASSBAND
FOR APPLICATION TO RANGE-GATED MTI SYSTEMS

Larry George Mitchell
Captain, United States Marine Corps

(AD #842886)

Range-gated moving target indicator (MTI) systems have some intrinsic advantages over delay-line canceler MTI systems. A further improvement in performance would result if the doppler cut-off frequency was adjustable by the radar operator. Because of the large number of filters involved in one system this would require a voltage-variable filter element.

A theory of variable filter response developed by Thiele was used as the basis for design using integrated-circuit operational amplifiers as the active elements. Three different types of active filter circuits are discussed. Implementation of voltage-variable filters and experimental frequency-response curves using field-effect transistors, Raysistors, and discrete switched resistors are described and illustrated.

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Advisor: David B. Hoisington
Department of Electrical
Engineering

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THE EFFECTS OF PREDICTIVE SOLUTIONS
ON TRAINING TIME AND POST-TRAINING PERFORMANCES
FOR CONTROL SYSTEMS WITH HUMAN OPERATORS

David Lee Myers
Lieutenant (junior grade), United States Navy

(AD #706026)

The effect of predictive solutions on human operator training time and post-training performance in a complex manual control system has been investigated. A control system with a slow and complex response to the input signals was formulated. Fifty operators, 25 with the aid of predictive solutions and 25 without the predictive solutions, were tested and the mean performance of each group was compared to that of the other.

There was a significant improvement in the training time when the predictive solutions were provided. The improvement was directly proportional to the complexity of the system. The greater the initial challenge of the system, the greater was the worth of the predictive solutions. The post-training performance was better by a factor of two when the predictive solutions were available to the operator. The performance of the operators without the aid of predictive solutions remained inconsistent even after a steady-state performance had been reached.

Master of Science
Electrical Engineering
June 1969

Advisor: J. S. Demetry
Department of Electrical
Engineering

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A PROCEDURE FOR TESTING FOR REALIZABILITY
AND THE REALIZATION OF A CIRCUIT MATRIX

James Franklin Nale
Lieutenant, United States Navy

(AD #693048)

Several procedures for the realization of a given realizable circuit matrix are reviewed and the techniques discussed. A new method for the realization of a given circuit matrix is introduced. The procedure also introduces a positive test to determine if the given matrix is realizable as a circuit matrix.

Master of Science
Electrical Engineering
April 1969

Advisor: Shu-Gar Chan
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

SENSORS FOR RADIOSONDE USE

**William Lee Newcomb
Lieutenant, United States Navy**

(AD #709113)

Current Navy expendable radiosonde sensors do not meet the required accuracies. A study was conducted to find improved sensors for temperature, pressure and humidity. Recent developments were investigated and recommendations made. An evaluation was conducted on a new humidity sensor and a new pressure sensor. The results obtained indicate improvements but further development is required.

Master of Science
Electrical Engineering
June 1969

Advisor: Rudolf Panholzer
Department of Electrical
Engineering

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MARGINAL OSCILLATOR FOR A MODIFIED FREE
PRECESSION MAGNETOMETER

Jerome William Offenberg
Lieutenant, United States Navy

(AD #705083)

The primary interest of the Naval Postgraduate School concerns the use of a magnetometer for mine detection, anti-submarine warfare, salvaging and other related naval operations.

The original concept of a modified free precession magnetometer utilizing the Overhauser Effect was formulated by A. Abragam. Independent research on this magnetometer was conducted at the Naval Postgraduate School by P. E. Burcher and R. G. Landrum fulfilling requirements for their master's thesis in 1965. The objective of this thesis was to develop an improved marginal oscillator for the magnetometer.

Master of Science
Electrical Engineering
June 1969

Advisor: Carl Menneken
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**THE SYNTHESIS OF AN MTI CANCELLATION FILTER USING
CAPACITIVE STORAGE ELEMENTS IN THE DELAY LINE**

**Robert Lee Peterson
Lieutenant (junior grade), United States Navy**

(AD #706734)

By using a series of diode sampling gates and capacitive storage elements to achieve the necessary time delay, a cancellation filter is designed that will give a maximally flat passband and that will give subclutter rejection at zero frequency and at harmonics of the pulse repetition frequency. Such a filter is necessary in each range channel of moving target indication (MTI) radar systems. Theoretical results obtained from digital simulation are compared with actual results obtained upon completion of the filter synthesis, and a brief evaluation of the entire range channel is presented.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: David B. Hoisington
Department of Electrical
Engineering**

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distribution is unlimited.**

**IDENTIFICATION OF THE INPUT DISTRIBUTION
MATRIX FOR LINEAR DYNAMIC SYSTEMS
OPERATING IN A STOCHASTIC ENVIRONMENT**

**Michael Raymond Polk
Lieutenant (junior grade), United States Navy**

(AD #705072)

An algorithm for the identification of the input distribution matrix of a linear, stationary system operating in a stochastic environment is derived. The identification is accomplished by defining a set of autocorrelation functions for a noise element composed of a linear combination of the input distribution matrix elements and the random excitations of the system. Another possible identification method employing a Kalman filter is discussed and the problems associated with its derivation are presented. Results of computer simulations for both methods are included.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: James S. Demetry
Department of Electrical
Engineering**

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**A NANOSECOND MICROWAVE BURST GENERATOR
USING RESONANT BUILDUP FOR
OUTPUT PEAK POWER ENHANCEMENT**

**Roy Lafayette Ray, Jr.
Lieutenant, United States Navy**

(AD #701675)

A system has been developed for generating nanosecond-order pulses of microwave energy with the output pulse amplitude considerably higher than the input CW source level. The system uses a PIN diode switched waveguide cavity for a pulse forming device. The output pulse width is shown to be directly proportional to the actual cavity length. Minimum pulse width and degree of enhancement of the output amplitude are shown to be a function of the switching time and loss characteristics of the switch. Pulse widths as narrow as 4.3 nsec and enhancements as high as 4.8 dB were obtained using pulse repetition rates from zero to 500 KHz.

The output level enhancement feature of this system is its chief advantage over other nanosecond RF pulse width and repetition rate, and its adaptability for rugged construction.

Master of Science
Electrical Engineering
June 1969

Advisor: George L. Sackman
Department of Electrical
Engineering

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**DUPLEX CONTROL FOR AN ELECTRONIC
TELEPHONE SWITCHING CENTRAL**

**Eugene Southard Rislér, III
Captain, United States Marine Corps**

System availability is of major concern to a field commander. This thesis involves an investigation into the implementation and results of one form of redundancy which promotes increased availability of a tactical telephone electronic switching central. A method is developed for detecting failures within the processor with an on-line exercise program. Transfer logic, both hardware and software, which can react to detected failures is also developed. A final development is a mathematical model which can be used to calculate the availability of complex systems.

Most of the work concerning the implementation of the redundant operation was performed at Sylvania Electronic Systems, Needham Heights, Massachusetts. Although the operation discussed in this paper is directed toward its use in the AN/TTC-31, the general concept is applicable to any system which relies on a digital computer for the control of its operation.

Master of Science
Electrical Engineering
September 1968

Advisor: George Marmont
Department of Electrical
Engineering

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**ANTENNA AND STABILIZATION CONSOLE
FOR A VLF RELATIVE NAVIGATIONAL SYSTEM**

**Bernard Franklin Roeder, Jr.
Lieutenant, United States Navy**

(AD #693098)

A VLF relative navigational system makes use of the fact that, at any given point on the earth, phase delay of a received VLF signal is highly stable and predictable. As the receiver is physically moved, phase delay changes linearly with distance from the transmitting station, so that by keeping track of the phase delay of the received signal from several VLF stations, an accurate plot of geographical position is maintained.

This paper outlines the development of a relatively simple antenna system, composed of two crossed loops and a whip sense antenna to produce a cardioid shaped radiation pattern, which effectively discriminates against the long-way-around-the-world contamination on the short path signal. A means is also devised for electronically rotating the fixed antenna by means of a goniometer which may be stabilized in azimuth by an input from a ship's gyro-compass.

Master of Science
Electrical Engineering
April 1969

Advisor: C. E. Menneken
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

FREQUENCY RESPONSE STUDY OF NONLINEAR NETWORKS
BY PARAMETER PLANE TECHNIQUES

Fernando Manuel Palma Ruivo
Lieutenant, Portuguese Navy

(AD #845178)

The use of parameter plane curves of output voltage magnitude versus one of the parameters as a means of obtaining the frequency response of nonlinear networks was investigated for networks containing one nonlinear element, which was a function of the magnitude of the voltage across it. The results obtained were checked by digital simulation and it may be concluded that the method is reliable. The method was also presented as a way of obtaining information for the reshaping of network frequency response, by introduction of the proper nonlinear elements.

Master of Science
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September 1968

Advisor: G J. Thaler
Department of Electrical
Engineering

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**WAVEGUIDE TESTING WITH NANOSECOND
R-F VOLTAGE PULSES**

**William Carl Schmidt
Lieutenant, United States Navy**

(AD #704526)

The testing of waveguide systems was demonstrated using nanosecond r-f voltage pulses. Pulse generation was effected by d-c coupled pulse grid modulation of a traveling-wave tube. This d-c modulation pulse was produced through the use of a fast thyatron circuit. Resultant r-f voltage pulses were used to drive a waveguide system and reflections from waveguide obstructions were viewed on a high-speed sampling oscilloscope. The location and reflection coefficients of obstructions were then obtained from measurements taken on the oscilloscope face.

**Master of Science
Electrical Engineering
June 1969**

**Advisor: D. B. Hoisington
Department of Electrical
Engineering**

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SINGULAR LINE COMPENSATION IN THE PARAMETER PLANE

Bruce Lawrence Shapiro
Major, United States Marine Corps

(AD #692448)

Previous work on parameter plane, three dimensional parameter space, and singular lines in the parameter plane are reviewed.

A general concept of n-dimensional parameter space is hypothesized whereby the parameter plane becomes a special case of the general hypothesis. By the same argument the singular line is shown to be a special case of the singular hyperplane.

Existence criteria for singular lines are established, and compensation methods for creating singular lines in non-singular systems are derived and used.

Master of Science
Electrical Engineering
April 1969

Advisor: George J. Thaler
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

NANOSECOND R-F PULSES FOR WAVEGUIDE FAULT-FINDING

William Bruce Shoemaker, Jr.
Lieutenant, United States Navy

(AD #844199)

A system has been developed for the location of waveguide discontinuities using nanosecond radio-frequency pulses with time-domain reflectometry techniques. The r-f pulses generation method used is discussed as well as the alternative methods investigated. Measurement-system design and procedures are outlined. Resolution on the order of 4 feet for reflections over 45-db return loss and accuracy of 2 per cent as compared to conventional methods are reported and various measurement examples are presented.

Significant advantages of this system appear in locating imperfections in waveguides and other bandpass transmission systems, as compared to conventional c-w-standing-wave or trial-and-error methods.

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Advisor: David B. Hoisington
Department of Electrical
Engineering

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INSTALLATION AND EVALUATION OF LORAC
PRECISE NAVIGATION SYSTEM

Richard Eugene Shrum
Lieutenant, United States Coast Guard

(AD #683047)

A navigation system has been established on Monterey Bay using the LORAC principle of phase-comparison. It is intended primarily for use in ocean sciences research within a 25 mile radius of Moss Landing, California. The system offers the capability of repeating a previously held position within a few feet, and may be used as a general navigation aid in the area with accuracy on the order of 100 yards. The theory of operation and error-causing factors are discussed in detail. Transmitter and receiver installations are described. Chapter IV is intended to serve as a self-contained user's guide, with instructions on the operation of the receiver, suggested techniques for use, and a description of the performance to be expected. A computer program is included to provide grid charts with hyperbolic position lines plotted for any desired area or scale. Brief initial testing indicated a high degree of stability and repeatability, however further evaluation over a longer period is necessary.

Master of Science
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December 1968

Advisor: Carl E. Menneken
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

THE TRANS-DERMA-PHONE - A RESEARCH DEVICE FOR THE
INVESTIGATION OF RADIO-FREQUENCY SOUND STIMULATION

Garland Frederick Skinner
Lieutenant, United States Navy

(AD #851608)

Electroponic hearing, stimulated by the passing of an audio-frequency current through various electrodes attached to the body, has previously been studied. More recently, transdermal stimulation, a means of electromagnetic excitation utilizing an amplitude-modulated radio-frequency stimulus applied through insulated electrodes, has received attention. Claims of sound transmission directly to the brain via this method have prompted several research efforts. Although most of the results tend to disprove the claims, they have not been conclusive. Further investigation of the transdermal mechanism is warranted. The purpose of this work is to design and construct a device especially for research of transdermal hearing. The TRANS-DERMA-PHONE, an amplitude-modulated, 100 kHz transmitter, is the end product of this endeavor. A complete description of this apparatus is presented in this paper, as well as an introduction to the phenomenon known as transdermal stimulation.

Master of Science
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Advisor: Gerald D. Ewing
Department of Electrical
Engineering

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FREQUENCY RESPONSE ANALYSIS OF
NONLINEAR DYNAMIC SYSTEMS

Robert Dean Staples
Captain, United States Marine Corps

(AD #842900)

A graphical technique to predict the frequency response of nonlinear transmission functions is presented. The technique is applied to nonlinear transmission functions with accurate results. The technique utilizes the magnitude ratio curve as a function of the system parameters developed in the algebraic methods.

Master of Science
Electrical Engineering
September 1968

Advisor: George J. Thaler
Department of Electrical
Engineering

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APPLICATION OF ASSOCIATED POLYNOMIALS
TO CIRCUITS AND SYSTEMS

Thomas Edward Stone
Lieutenant, United States Navy

(AD #847622)

In this thesis, the theory of associated polynomials is applied to linear circuits and systems. Associated polynomials are defined and used in the presentation of a computer algorithm suitable for accomplishing a partial fraction expansion including repeated roots. Variations of the coefficients of a polynomial are related to the variation of its roots (and vice-versa) by associated polynomials. These results are used in a root solving process and to express sensitivity coefficients in a new analytical form. Lastly, a theory of compensating parameter adjustments is developed with applications to self-adaptive systems. It is shown that by compensating adjustment of any two parameters in the system which are linearly related to the coefficients of the characteristic equation, adaptive compensation is possible for a real root of the closed loop transfer function only and that for complex roots, the real and imaginary parts may be kept invariant but not both.

Master of Science
Electrical Engineering
September 1968

Advisor: Sydney R. Parker
Department of Electrical
Engineering

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

SYNTHESIS OF A BASIC RANGE CHANNEL FOR IMPLEMENTATION
OF A COMPLETE MTI BY RANGE-GATED FILTERING

Eric Lee Washam
Lieutenant (junior grade), United States Navy

(AD #700710)

A range-gated channel was constructed for use with various doppler filters in building the basic element of a radar Moving-Target-Indicator (MTI) by Range-Gated Filtering (RGF). Improvement over existing systems was accomplished by circuit simplification and solid-state design incorporating MOS devices in sampling circuits and d-c coupled amplifiers. Performance of the channel, using an R-C high-pass filter as the simplest doppler filter, was compared to that of the delay-line canceler MTI of the AN/UPS-1 air-search radar.

Master of Science
Electrical Engineering
June 1969

Advisor: David B. Hoisington
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

INVESTIGATION AND ANALYSIS OF THREE-PHASE INDUCTION
MOTOR PERFORMANCE WITH NON-SINUSOIDAL VOLTAGE SUPPLY

Richard Paul Wells
Lieutenant, United States Navy

(AD #845180)

The development of vehicles powered by direct-current sources together with the development of the silicon-controlled rectifier has led to the use of squirrel-cage induction motors operating on non-sinusoidal, variable-frequency voltage supplies. A digital computer simulation of the transient and steady-state performance of a three-phase motor is derived and its use in predicting motor operation is illustrated.

Master of Science
Electrical Engineering
September 1968

Advisor: M. L. Wilcox
Department of Electrical
Engineering

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DETERMINATION OF DIRECT TREES BY T-TRIANGLE METHOD

Carl Edward Willman
Lieutenant, United States Navy

(AD #691761)

A method for determining all of the direct trees of an oriented graph is presented. This method, the T-triangle method, is suitable for either hand calculation or computer implementation. The method is simple, contains a minimal amount of steps, and generates all of the direct trees without any duplication.

Master of Science
Electrical Engineering
April 1969

Advisor: S. G. Chan
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

DERIVATION OF THE OPTIMAL CONTROL
FOR AN ALL-WEATHER AIRPLANE LANDING SYSTEM

Carl Hugo Dubac
Major, United States Marine Corps

(AD #695422)

Optimal control theory is used to derive a controller for the final phases of an all-weather landing in the McDonald Douglas F-4J airplane. The landing is formulated as a linear tracking problem by developing a mathematical model for the airplane which is linearized about an equilibrium flight condition, and by defining a desired state trajectory. Examples are presented which illustrate the performance of the system.

Master of Science
Engineering Electronics
June 1969

Advisor: Donald E. Kirk
Department of Electrical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

RECEIVER DESIGN IN A COMMERCIAL,
MARINE, SINGLE-SIDEBAND TRANSCEIVER

Richard Warren Hamon
Lieutenant, United States Navy

(AD #849746)

Design of the receiver portion of a solid-state, state-of-the-art, single-sideband, 2-17 MHz transceiver is presented. A short comparison of amplitude-modulated and single-sideband systems is offered. The unique requirements of commercial, marine communications are considered and the method of their fulfillment in this transceiver is discussed. Circuitry common to both receiver and transmitter is presented in detail. Receiver testing and specific results are included.

Master of Science
Engineering Electronics
September 1968

Advisor: Gerald D. Ewing
Department of Electrical
Engineering

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COMPUTERIZED SURVIVOR SEARCH PLANNING

Joseph Henry Discenza
Lieutenant, United States Coast Guard

(AD #704781)

A computer program is presented which solves the search planning problem for survivors at sea. The program is designed to utilize weather data as compiled by the United States Navy at its Fleet Numerical Weather Central, Monterey, California.

An investigation is also made into the search criteria used by the United States Coast Guard in its planning procedures. Guidelines are given for the use of the square search and the Sector search.

Master of Science
Management
June 1969

Advisor: Stephen M. Pollack
Department of Operations
Analysis

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OXIDATION PROTECTION OF MOLYBDENUM
BY DIVALENT METAL MOLYBDATES

Mohammed Akhtar Yehya
Commander, Pakistan Navy

(AD #691386)

Ni and Mg molybdates were prepared by an aqueous process and identified by x-ray analysis. Differential Thermal Analysis (DTA) of molybdates and their solid solutions mixed at various proportions were carried out. The spalling of NiMoO_4 on cooling was observed. This large exothermic phase transformation was modified. Flexural strength of MgMoO_4 bars were determined. Furnace designed to carry out this test at elevated temperature Vacuum Stability of bars made of MgMoO_4 at high temperatures was observed. Slurry process of coating Molybdenum was carried out with some success and the same sintered at 950°C in high vacuum. An attempt was made to study the coated material at high temperatures under vacuum and desired controlled atmosphere by a metallograph.

Master of Science
Material Science
December 1968

Advisor: Richard C. Cariston
Department of Material Science
and Chemistry

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CHARACTERIZATION OF MAXIMAL IDEALS

John Donald Carpenter
Lieutenant, United States Navy

(AD #847660)

The characterization of maximal ideals has been accomplished for the class of principal ideal rings and for the class of continuous functions on a compact topological space. In the latter case the characterization is somewhat more extensive than it appears since a non-compact space can often be compactified. Closely related to maximal ideals are the prime ideals and the coincidence of these two types of ideals is noted where occurring. When the prime and maximal ideals are not the same in a ring, illustrative examples are given.

Master of Science
Mathematics
December 1968

Advisor: Eric S. Langford
Department of Mathematics

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AN ALGORITHM FOR COMPUTING
NON-ISOMORPHIC SEMIGROUPS OF FINITE ORDER

James Stephen Cullen
Lieutenant (junior grade), United States Navy

(AD #704511)

In this paper an algorithm for computing semigroups of finite order is discussed. A computation procedure is developed to generate, for any specified order, all semigroups which are distinct up to isomorphism. Additional restrictions are also placed in the generating procedure to produce all groups of the given finite order. The algorithm was placed on the computer and the numerical results for orders one through four obtained.

Master of Science
Mathematics
June 1969

Advisor: Carroll O. Wilde
Department of Mathematics

This document has been approved for public release and sale; its distribution is unlimited.

OPTIMUM SHIP ROUTING
BY THE METHOD OF STEEPEST ASCENT

Richard Allen Gregor
Lieutenant, United States Navy

(AD #842884)

With the advent of the high speed digital computer, many problems heretofore considered unsolvable for all practical purposes are now well within the reach of the applied mathematician. One such problem is the routing of a ship through a time dependent ocean wave field, from one point on the earth's surface to another, so as to minimize a cost function of the form $g(x, y, t, u)$.

This paper considers a numerical solution to the above problem. The technique to be employed is known as the method of steepest ascent and is attributed to Arthur E. Bryson and Walter F. Denham [1]. Although the computer program as given in the Appendix is written specifically for a VC2AP3 class vessel operating in a described area of the North Pacific Ocean, it can be readily modified to accommodate any type vessel operating in the Northern Hemisphere.

Master of Science
Mathematics
September 1968

Advisor: W. E. Bleick
Department of Mathematics

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EXPERIMENTAL TECHNIQUES FOR ANALYSIS
OF TRANSVERSE IMPACT ON BEAMS

Thomas Herbert Berns
Lieutenant (junior grade), United States Navy

(AD #704483)

Procedures are developed to facilitate laboratory investigation of the effects of short-duration transverse impact loading on simply supported beams. The particular beam investigated was aluminum, with constant rectangular cross-section. Six loading conditions were examined, consisting of a central impact from three heights for each of two spherical masses. Theoretical analysis was made of the frequency and deflection characteristics for ten equally spaced locations on the beam, under the assumption of Euler's beam theory. Experimental data were compared with theoretical values to give an indication of the effectiveness of the theoretical system in representing the physical system. It was concluded that the theory gives a good representation of the physical system, especially with respect to the frequency characteristics.

The experimental work was performed from January, 1969, through May, 1969, at the Naval Postgraduate School, Monterey, California.

Master of Science
Mechanical Engineering
June 1969

Advisor: E. F. Lynch
Department of Mechanical
Engineering

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EXPERIMENTAL TECHNIQUES TO DETERMINE
 N_{tu} OF COMPACT HEAT EXCHANGER SURFACES

Marco Joseph Bruno
Lieutenant, United States Navy

(AD #851607)

Two new transient testing techniques were evaluated; the centroid method developed by Kohlmayr and the time zero intercept technique. The zero intercept method was found to be the most promising of the two but is limited to values of $N_{tu} < 2.5$. The centroid technique can be used effectively when the value of N_{tu} is less than 5.0.

A heater system made of .001 inch diameter nichrome wire was designed and tested to determine its effect on the transient testing of matrix type heat exchangers. Because the design showed no improvement in the test results and was unreliable its use was discontinued.

Master of Science
Mechanical Engineering
September 1968

Advisor: Paul F. Pucci
Department of Mechanical
Engineering

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THE EFFECT OF RECUPERATOR GEOMETRY
ON A REGENERATED BRAYTON CYCLE

Barry Vaile Burrow
Lieutenant (junior grade), United States Navy

(AD #690451)

A computer simulation of the Brayton cycle is used to develop a design procedure with respect to minimizing volume and weight for the counterflow plate-fin recuperator. Based on the Orenda OT-4 600 horsepower gas turbine, recuperator performance and dimensional characteristics are presented for an idealized equilateral plate-fin recuperator core matrix. The effects of plate spacings varying between 0.1 inches and 0.5 inches on recuperator performance characteristics are presented over a wide range of core frontal areas. Specific trends toward minimum volume and minimum weight plate-fin recuperator cores are discussed in detail.

Master of Science
Mechanical Engineering
June 1969

Advisor: P. F. Pucci
Department of Mechanical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

A COMPUTER PROGRAM FOR THE ANALYSIS OF
TWO-DIMENSIONAL HEAT CONDUCTION USING
THE FINITE ELEMENT TECHNIQUE

Allan Bischof Chaloupka
Lieutenant (junior grade), United States Navy
(AD #690450)

The computer program for the solution of unsteady heat conduction problems involving plane or axisymmetric geometry, devised by Robert E. Nickell, has been modified to include temperature dependent properties and time dependent boundary conditions. The original IBM 7094 computer dependent program has been converted for use on the IBM/OS 360 Model 67 computer. In both programs FORTRAN IV language was used. A "User's Manual" has been constructed for the modified program.

Master of Science
Mechanical Engineering
June 1969

Advisor: Paul . . Pucci
Department of Mechanical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

AN EXPERIMENTAL INVESTIGATION OF THE
VORTEX-SINK ANGULAR RATE SENSOR

Carlito Yllano Cunanan
Lieutenant, Philippine Navy

(AD #844357)

The purpose of this investigation was to experimentally determine the performance characteristics of certain probe geometries and their respective locations in the sink tube of a pneumatic angular rate sensor. Sensor response was determined for various flow rates and angular velocities for each test condition. It was found that the pickoff element placed inside the sink tube yields a longer linear-response range than the one placed outside the sink tube. Use of one of the special flow dividing plates, with the probe located outside the sink tube, improves the linear-response range of the sensor for all flow rates, but increases the magnitude of the response only for the lower flow rates. It was also observed that neither the shortening of the sink tube length downstream of the pickoff location nor the presence of a shallow circumferential groove at the midsection of the pickoff element alters the performance of the probe.

Master of Science
Mechanical Engineering
September 1968

Advisor: T. Sarpkaya
Department of Mechanical
Engineering

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

A PARAMETRIC ANALYSIS OF A DEEP SEA RADIOISOTOPIC
THERMOELECTRIC GENERATOR EMPLOYING A HEAT PIPE

Benjamin James Ewers, Jr.
Lieutenant (junior grade), United States Navy

(AD #704790)

A parametric design analysis was performed using a heat pipe in an existing deep sea Radioisotopic Thermoelectric Generator (SNAP-21). Heat is transferred from an annular fuel pellet to an annular thermoelectric generator through a connecting heat pipe. The fuel pellet is fully shielded so that the thermoelectric generator is easily removable. Overall efficiency and the weight of major components were determined for varying fuel radii of from 1.3 inches to 1.7 inches and for varying insulation thicknesses of from 1.0 inch to 2.0 inch.

The analysis indicates that there is a particular fuel radius (at constant insulation thickness) at which minimum weight is reached, while the maximum overall efficiency is obtained at a larger fuel radius. The median design has an overall efficiency (at the beginning of life) of 5.4% and a total weight of 570 lbs. These design results, when compared to the existing SNAP-21 design gives an increase in overall efficiency of at least 7%, and a reduction in total weight of 12%.

Master of Science
Mechanical Engineering
June 1969

Advisors: Paul F. Pucci
Paul J. Marto
Department of Mechanical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

A THEORETICAL AND EXPERIMENTAL STUDY
OF THE IMPINGEMENT OF TWO SUBSONIC JETS

Nihat Gungor
Lieutenant, Turkish Navy

(AD #705106)

A theoretical and experimental investigation has been performed on the determination of the characteristics of two impinging plane turbulent jets for the purpose of understanding the performance of proportional fluid amplifiers and momentum-exchange devices. The jet deflection angle was determined through the application of the free-streamline theory for two normally impinging jets with arbitrary throat widths and wall set-backs. The deflection angle and the velocity and turbulence distributions across and at various distances along the jet were determined through the use of a hot-wire anemometer system. The results are presented in terms of normalized parameters suitable for comparison with the theoretical predictions. The deflection angles predicted theoretically were found to be in good agreement with those obtained experimentally.

Master of Science
Mechanical Engineering
June 1969

Advisor T. Sarpkaya
Department of Mechanical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**EXPERIMENTAL INVESTIGATION OF TURBULENT
JET ATTACHMENT TO A CONVEX WALL**

**Larry Dean Johnson
Lieutenant, United States Navy**

(AD #847579)

The effects of geometry and Reynolds number on the attachment of an air jet to a circular convex wall and the mechanism of high pressure recovery in convex-walled amplifiers are investigated. The results are presented in terms of normalized parameters suitable for comparison with theoretical predictions. Extremely high pressure recoveries are possible in convex-walled amplifiers due to the particular velocity distribution and entrainment characteristics exhibited by flow attached to a convex wall. The wall setback and the condition of the control port have very little influence on the flow downstream of the initial attachment region.

**Master of Science
Mechanical Engineering
September 1968**

**Advisor: T. Sarpkaya
Department of Mechanical
Engineering**

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

DEVELOPMENT OF A TEST PROCEDURE FOR SPUTTERED GOLD
AS A SOLID FILM GEAR TOOTH LUBRICANT

Dennis Richard Jones
Lieutenant, United States Navy

(AD #690872)

Further work on a solid film lubricant testing apparatus designed and built by M. M. Sampsel was carried out. A power supply was constructed and a sputtered gold film applied to various portions of the apparatus. A torsion bridge was installed and calibrated to determine tooth contact forces. Calibration of strain gages installed to determine tooth radial forces was attempted but difficulties were encountered in determining a strain reading for the unstressed condition. Based on this work, recommendations for design changes were made.

Master of Science
Mechanical Engineering
April 1969

Advisor: R. W. Powell
Department of Mechanical
Engineering

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**THE EFFECT OF WICK GEOMETRY ON THE
OPERATION OF A LONGITUDINAL HEAT PIPE**

**Hugh Edward Kilmartin, Jr.
Lieutenant (junior grade), United States Navy**

(AD #692442)

Evaporative heat transfer limits were obtained and studied for an everted heat pipe with varying wick geometries. The wick geometries were a function of the wire mesh size and the total wick thickness.

A nickel heat pipe was built and operated using both water and ethyl alcohol as the working fluids. The different wick materials used were 50 mesh, 80 mesh, and 150 mesh, plain weave, nickel wire cloth. The scope of the investigation included operating the pipe at 25 inches mercury vacuum, 10 inches mercury vacuum, and 5 pounds per square inch gage.

The maximum heat transfer was found to increase as the mesh size was decreased, as the wick thickness was increased, or as the pressure was increased.

The equipment used to obtain experimental data is described and experimental results and sample calculations are presented.

**Master of Science
Mechanical Engineering
June 1969**

**Advisor: Paul F. Pucci
Department of Mechanical
Engineering**

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distribution is unlimited.**

AN EXPERIMENTAL STUDY OF A SELF-ACTING
FOIL BEARING AT LOW VALUES OF FOIL TENSION

John Michael Knight
Lieutenant, United States Navy

(AD #853486)

Theoretical solutions for the gap thickness in an infinitely wide foil bearing are reviewed. An experiment is described using a stainless steel foil wrapped about a high speed rotor. Details of instrumentation are included. Results are presented for the relation between gap thickness and foil stiffness for low values of foil tension.

Only a small amount of data was obtained due to failure of the rotor support mechanism. The results are therefore inconclusive. The results do, however, indicate a dependence of foil gap thickness on foil stiffness. The influence of fluid inertia on foil gap thickness is also indicated although this effect appears to be small compared to the effects of foil stiffness.

Master of Science
Mechanical Engineering
September 1968

Advisor: Paul F. Pucci
Department of Mechanical
Engineering

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HEAT TRANSFER CONSIDERATIONS IN A
PRESSURE VESSEL BEING CHARGED

John Thomas Lyons III
Lieutenant (junior grade), United States Navy

(AD #706713)

Experimental data for the charging of an air receiver is presented and interpreted in detail. The data indicates a substantial departure from the adiabatic behavior. The experimental results are used to evaluate existing closed form expressions for the thermodynamic state of a gas in a receiver. A method for experimentally determining the convective heat transfer coefficient is developed, evaluated and used in conjunction with these expressions.

The experimental work was performed from March 1969 through May 1969 at the Naval Postgraduate School, Monterey, California.

Master of Science
Mechanical Engineering
June 1969

Advisor: R. H. Nunn
Department of Mechanical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**A COMPUTER PROGRAM FOR THE ANALYSIS OF
LINEARLY ELASTIC PLANE-STRESS, PLANE-STRAIN PROBLEMS**

**John Patrick Malone
Lieutenant, United States Navy**

(AD #844095)

The computer program for the analysis of linearly elastic plane-stress or plane-strain problems devised by Felippa in his work on "Refined Finite Element Analysis of Linear and Nonlinear Two-dimensional Structures" has been modified to include the use of initial displacement boundary conditions. In addition the original IBM 7094 computer dependent program has been adapted for use on the IBM 360/65 computer. In both programs the FORTRAN IV language has been used.

Problems involving "Poor Fit" displacement boundary conditions and refined mesh analysis using coarse mesh analysis input displacements, which could not have been done with the original program, are now possible with the modified version presented herein.

**Master of Science
Mechanical Engineering
September 1968**

**Advisor: Gillis Cantin
Department of Mechanical
Engineering**

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THE EFFECT OF NUCLEATE BOILING ON HEAT PIPE OPERATION

William Leidy Mosteller
Lieutenant, United States Navy

(AD #691192)

An averted experimental stainless steel pipe was designed and operated to observe nucleate boiling in the wick and to determine the effects of such boiling on the overall operation of the pipe. Four layers of 100 mesh and both water and ethyl alcohol were used as working fluids. A pressure adjusting system was included so that observations could be made as a function of internal vapor pressure.

A type of boiling was observed which did not appear to affect the overall operation of the pipe and was detectable only by visual observation. The pipe operated in a regime dominated by high liquid flow resistance. Observations indicated effective values for the pipe length, wetted wick thickness, and contact angle. With these modifications, maximum heat transfer rates were in reasonably close agreement with theory.

The pressure adjuster provided a means of easily controlling the operating conditions of the heat pipe. Heat could be removed from a constant power source at any desired temperature within the limitations of the system.

Master of Science
Mechanical Engineering
April 1969

Advisor: P. J. Marto
Department of Mechanical
Engineering

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**AN INVESTIGATION OF FREEZING OF A LIQUID FLOWING
OVER A FLAT PLATE**

**Bruce Francis Nolan
Lieutenant Commander, United States Navy**

(AD #690453)

The rate at which the solid phase develops in a fluid, moving with Blasius flow over a chilled flat plate is analyzed. The time dependent, local, solid layer thickness is determined as function of the pertinent physical properties, the plate surface temperature and a one spatial dimension heat flux. Experimental equipment to measure the heat flux, transient ice growth and steady state ice profile is described. The spatial variation of the steady state ice profile is observed with respect to the streamwise coordinate.

**Master of Science
Mechanical Engineering
April 1969**

**Advisor: M. D. Kelleher
Department of Mechanical
Engineering**

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**SYNTHESIS OF DOUBLY SYMMETRIC
VIBRATING BEAMS INCLUDING SHEAR**

**Thomas Daniel Pestorius
Lieutenant (junior grade), United States Navy**

(AD #706730)

A fundamental, non-linear, ordinary differential equation is derived for the flexural vibrations of a non-uniform beam, including shear.

This equation is solved with the specializing assumptions of a constant shear coefficient and that the moment of inertia is directly proportional to the cross sectional area.

A perturbation method is used and the eigen frequencies and mode shapes obtained are functions of a perturbation parameter ϵ . These solutions are accurate up to the second order of ϵ .

**Master of Science
Mechanical Engineering
June 1969**

**Advisor: Eugene F. Lynch
Department of Mechanical
Engineering**

This document has been approved for public release and sale; its distribution is unlimited.

**FORCED AND PERIODIC VORTEX BREAKDOWN
IN A VORTEX VALVE**

**Sompong Phasook
Lieutenant Commander, Royal Thai Navy**

(AD #841120)

Forced or periodic vortex breakdown resulting from the instability of the impingement, in a vortex valve, of two equal and opposite jets is investigated. Experiments were conducted with a system consisting of a vortex chamber, two tangential jets, and two Helmholtz resonators. The results show that a periodic vortex breakdown is initiated when the velocities of the two opposing tangential jets acquire nearly identical values. The breakdown is accompanied by large pressure oscillations whose magnitude depends on the geometrical characteristics of the system and the magnitudes of the input flows. The major characteristics of the instability are theoretically predicted by a remarkably simple analysis by ignoring the viscous shear losses. The experimental results compare favorably well with those obtained theoretically.

**Master of Science
Mechanical Engineering
September 1968**

**Advisor: T. Sarpkaya
Department of Mechanical
Engineering**

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

A STUDY OF REACTIVITY CHANGES
IN THE AGN-201 REACTOR USING PERTURBATION THEORY

David Alan Sager
Lieutenant (junior grade), United States Navy

(AD #704791)

The effects of fuel burnup, fission product poisoning, and hydrogen moderator density variation on reactivity in the AGN-201 reactor are considered. A modified one-group perturbation theory is developed and applied to changes in parameters resulting from a change in hydrogen moderator density. An equation for the reactivity change is obtained for three models: a bare cylindrical core, a bare core using extrapolated dimensions, and a reflected core. These three equations are then used to predict values of the reactivity increase resulting from interchanging a new 3/4 inch thick fuel disk with comparable fuel disks presently in the core.

The results obtained by a digital computer solution of the reactivity equations reveal that the increase in reactivity varies from 0.4392 to 0.7707%, depending upon the core model and position of the old disk within the core. Because the license of the Naval Postgraduate School does not permit a value of excess reactivity above 0.40%, it is concluded that a simple interchange of disks in this manner would produce too large a value of excess reactivity.

Master of Science
Mechanical Engineering
June 1969

Advisor: Paul J. Marto
Department of Mechanical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

AN EXPERIMENTAL PROCEDURE TO TEST SPUTTERED
GOLD AS A SOLID FILM GEAR TOOTH LUBRICANT

Michael Martin Sampsel
Lieutenant, United States Navy

(AD #845190)

The design, construction, and instrumentation of a solid film lubricant tester are discussed. The testing phase and evaluation of test data are mentioned. The device was constructed to test sputtered gold as a gear tooth lubricant for low vacuum operation. The unit is small and self-sustained for operation entirely within the vacuum chamber with only external electrical leads. Methods of measuring gear tooth frictional forces are discussed. A computer program is used to check the results of classical gear tooth strength theory.

Master of Science
Mechanical Engineering
September 1968

Advisor: E. K. Gatcombe
Department of Mechanical
Engineering

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

**TRANSIENT THERMAL STRESS ANALYSIS
OF A PIPE JUNCTION**

**William John Sawyer
Ensign, United States Navy**

(AD #705108)

A method is devised for the transient-state thermal stress analysis of two pipes, joined butt to butt and subjected to rapid or sudden change of internal fluid temperature. Although it is assumed that there is symmetry about the common pipe axis, the properties of the materials as well as the thickness of each pipe may be different. Then, given a specified time-temperature relationship for the internal fluid, over a specified problem time, the maximum stress encountered may be obtained. A digital computer program is appended for the solution of such problems.

**Master of Science
Mechanical Engineering
June 1969**

**Advisor: John E. Brock
Department of Mechanical
Engineering**

This document has been approved for public release and sale; its distribution is unlimited.

ESTABLISHMENT OF BLASIUM FLOW IN AN OPEN CHANNEL

William Michael Slack
Lieutenant, United States Naval Reserve

(AD #701673)

The objective of this thesis was to simulate steady, uniform, laminar flow over a plane surface with zero pressure gradient. Design parameters and requirements for the flow field and construction of the free surface water channel are discussed. Data acquisition was accomplished by means of the Hydrogen Bubble Technique; and, once acquired was used to obtain a normalized velocity profile. An uncertainty analysis on the acquisition method and a comparison of the experimental results with the solution obtained by Blasius are presented.

Master of Science
Mechanical Engineering
April 1969

Advisor: M. D. Kelleher
Department of Mechanical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

**EXPERIMENTAL DETERMINATION OF THE AVERAGE HEAT TRANSFER
COEFFICIENT FOR YAW CYLINDERS**

**Marco Antonio Viteri
Lieutenant, Ecuadorian Navy**

(AD #691193)

The heat transfer characteristics of yawed cylinders was measured in an open induction tunnel in the subsonic range. Two model diameters were tested, 0.50 inches and 0.25 inches. The Reynolds number based on cylinder diameter was varied from 2750 to 33200 for the 0.50 inch diameter model and from 1430 to 16700 for the 0.25 inch diameter model.

The tests showed a good agreement for both models with the experimental results of other investigators for the normal case, or zero yaw case. As yaw angle was increased from the normal position to about 35 degrees, a peaking in the heat transfer was obtained. As yaw angle was increased further the average Nusselt number decreased. This behavior is attributed to the end effect of the models used whose aspect ratio were limited by the size of the test section. At larger yaw angles there is an agreement of the heat transfer data for models with similar aspect ratio.

Master of Science
Mechanical Engineering
April 1969

Advisor: Paul F. Pucci
Department of Mechanical
Engineering

This document has been approved for public release and sale; its distribution is unlimited.

AN APPROACH TO THE NUMERICAL MODELLING
OF CUMULUS-SCALE MOTIONS

Richard Arthur Anawalt
Lieutenant, United States Navy

(AD #691760)

A numerical model which utilizes the isobaric vorticity equation is developed and applied to cumulus-scale data. The model, together with a modified version of the cumulus convection model of Weinstein and Davis, is applied to data obtained from the National Severe Storms Laboratory in Norman, Oklahoma. The calculations yield real time predictions for height, temperature and relative humidity at seven pressure levels, which are then used as input to the cumulus convection model to obtain vertical profiles of various parameters at specified grid points.

Some results of the calculations are presented along with suggestions for further testing and improvement. The results indicate that further modifications to the approach used are necessary in order to provide more accurate forecasts. Values of the individual terms in the vorticity equation are presented as computed from the observed mesoscale data.

Master of Science
Meteorology
June 1969

Advisor: Ronnie L. Alberty
Department of Meteorology

This document has been approved for public release and sale; its distribution is unlimited.

EXPERIMENTS WITH ATMOSPHERIC PRIMITIVE-EQUATION MODELS

Philip Garland Kesel
Lieutenant, United States Navy

(AD #855530)

Two atmospheric prediction models, based upon the meteorological primitive equations, were programmed and tested on the CDC 6500 computer. A frictionless, barotropic model was integrated, using ten-minute time steps, at 500 MBS for periods up to four days. Then, an n-level, baroclinic model for an inviscid, adiabatic atmosphere was integrated for brief test periods at five uniformly-spaced zeta (sigma) surfaces over a smooth earth. Both models were initialized with actual data fields provided by FNWC Monterey.

Acceptability was based on measurements of energy and vorticity parameters, as well as on qualitative assessments of output fields. The barotropic 500 MB height forecasts were found to be comparable to the FNWC (vorticity model) barotropic forecasts. Mean-square-vorticity and kinetic energy were suitably conserved for integrations up to four days. An energy accumulation in the smaller range of scale was increasingly evident beyond two days into the forecast period. No smoothing was performed to control this accumulation. A limited number of test integrations was made with the five-level model. Computational instabilities were observed for forecasts beyond twelve hours. Interim results are presented.

Master of Science
Meteorology
December 1968

Advisors: George J. Haltiner
Roger T. Williams
Department of Meteorology

This document has been approved for public release and sale; its distribution is unlimited.

NUMERICAL EXPERIMENTS WITH HIGH-ORDER
ADVECTIVE EQUATIONS

Dean Russell Morford
Commander, United States Navy

(AD #691763)

Second-order and fourth-order two-dimensional advective equations developed by W. P. Crowley were examined to determine their applicability to atmospheric models.

One second-order and two fourth-order forms were evaluated from their performances on a simple pattern advected by a linear, divergent velocity field. The same equations were substituted for the advection term of a simple barotropic forecast model to determine their performances on more general non-linear conditions.

All forms of the equations remained stable in time and demonstrated the phase and amplitude characteristics predicted by Crowley. The fourth-order "advection" form gave best results.

When substituted in the barotropic model, the fourth-order forms lead to improved trough and low-center movements, but RMSE was slightly larger than that resulting from second-order forms. The better RMSE of the lower order forms apparently resulted from their diffusive characteristics.

Master of Science
Meteorology
December 1968

Advisor: G. J. Haltiner
Department of Meteorology

This document has been approved for public release and sale; its distribution is unlimited.

**THEORETICAL INVESTIGATION OF THE
STRUCTURE OF EASTERLY WAVES**

**Robert Lee Newman
Commander, United States Navy**

(AD #691205)

A simple two-level numerical model using the quasi-geostrophic forecast equations is developed. Equations are linearized and friction is introduced in the surface layer. Solutions are obtained numerically by using the initial value approach. Two wind profiles, $U = -U_0 \tanh y/y_0$ and $U = U_0 \operatorname{sech}^2 y/y_0$, are used and these are known to be unstable. For each wind profile the growth rate is determined as a function of the wave number. Some observed features of easterly waves are reproduced in the numerical solutions.

**Master of Science
Meteorology
April 1969**

**Advisor: Roger T. Williams
Department of Meteorology**

This document has been approved for public release and sale; its distribution is unlimited.

THE SUB-THERMOCLINE DUCT

James Barrington Burrow, Jr.
Lieutenant, United States Navy

(AD #686657)

This thesis describes a method by which near-surface temperature inversions in the ocean may be classified. Although categories of sub-thermocline ducts for sound transmission, formed as a result of these temperature inversions, have been studied in detail in the North Pacific Ocean, classifications are general enough to be applied to ducts in other regions.

A considerable variety of sub-thermocline ducting is present in the North Pacific. This variability shows both a seasonal and a positional dependence which may be explained on a stability basis utilizing data obtained from selected Nansen casts reported for stations throughout the North Pacific.

Master of Science
Oceanography
December 1968

Advisor: Glenn H. Jung
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

ATTENUATION OF SURFACE WAVES IN DEEP WATER

**Michael Stuart Carswell
Lieutenant Commander, United States Navy**

(AD #689729)

The concept, instrumentation, and analytical techniques for the investigation of attenuation of wind generated water surface waves in a small scale real environment by separation of generation and propagation by time in the dying wind situation were developed, and an empirical attenuation function applicable to a wide range of frequencies proposed.

**Master of Science
Oceanography
December 1968**

**Advisor: J. B. Wickham
Department of Oceanography**

This document has been approved for public release and sale; its distribution is unlimited.

**THE SOUTHERN MONTEREY BAY LITTORAL CELL:
A PRELIMINARY SEDIMENT BUDGET STUDY**

**Craig Emery Dorman
Lieutenant, United States Navy**

(AD #683662)

A sediment budget was developed for Southern Monterey Bay, California. This budget is based heavily upon sediment information obtained from field and laboratory studies. These studies included a detailed quasi-synoptic areal sampling to determine distribution of textural patterns, and a time-series study of beach and surf-zone sand samples obtained from local sand-mining companies.

Results from these studies were combined with data on river discharge, the wind and wave regimes, and shoreline changes during the past century to develop quantitative estimates of sediment gains and losses to the cell. It was determined that the major sources of sediment are the discharge from the Salinas River which empties into the northeast corner of the cell, and erosion of Quaternary seacliffs which form the inner bay shore. Major sinks are the Monterey Submarine Canyon, active coastal dune field, the mining companies, and the off shore area.

The recent history of the sediment regime in the southern bay is reviewed, and a forecast of future nearshore changes is made. Recommendations for further work needed to refine the budget computations are presented.

Master of Science
Oceanography
December 1968

Advisor: Warren C. Thompson
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

**INFLUENCES OF LUBRICANTS AND POLYMER COATINGS
ON PENETRATION OF OCEANOGRAPHIC CORING TOOLS**

**Ronald Anton Erchul
Lieutenant, United States Navy**

(AD #845189)

The friction developed on the inner and outer faces of oceanographic coring tubes tends to decrease penetration and gross recovered length and to increase sample disturbance. An effort was made to decrease this friction through use of lubricants and polymer coatings and to thereby increase the penetration of smooth steel surfaces into fine grained sediments. Tests were conducted in the laboratory using steel plates and an Atwood test apparatus, and at sea using gravity corers. In the laboratory tests the lubricants STP, CRC, zinc grease, and lithium grease increased penetration 46, 25, 24, and 20 percent respectively. Tests at sea showed that use of STP lubricant increased corer penetration 18 and 35 percent and gross recovery length of cores 16 percent. Statistical analysis indicated that the above increases were highly significant. Teflon, FEP film, and nylon increased penetration 20 to 30 percent in the laboratory and merit special consideration since these coatings would not contaminate the core sample.

Master of Science
Oceanography
December 1968

Advisor: R. J. Smith
Department of Oceanography

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

TEMPERATURE AND DENSITY STRUCTURE OF WATER
ALONG THE CALIFORNIA COAST

Richard Warren Holly
Lieutenant, United States Navy

(AD #689723)

A synoptic analysis of the temperature field off the California coast for the surface, 10-meter and 100-meter level is provided for the years 1958-1959. Data used are from CCOFI cruises.

These analyses are shown to be adequate for detecting probable upwelling areas. The areas of persistent upwelling are at 29 N, 31 N and 33 N adjacent to the California coast. There appears to be a preference for a steep gradient of the sea floor in these areas. The onset and decay of upwelling appears to depend on latitudinal position of the 11 C isotherm at 100 meters.

Master of Science
Oceanography
December 1968

Advisor: Glen H. Jung
Department of Oceanography

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STABILIZING FINS FOR UNDERWATER CORING TOOLS

David Crosby Honhart
Lieutenant, United States Navy

(AD #692449)

It is essential that the force vector of the weight of a coring tool act along a line that is parallel to the longitudinal axis of the core barrel. Such an alignment enables corers to obtain deeper, less disturbed core samples. The probability of bending the core barrel is furthermore greatly reduced. A fin assembly that provides the maximum righting moment for one shape of coring tool does not necessarily provide the maximum moment for a different shape. The optimum fin design is determined by testing. A fin assembly for a particular coring tool has been devised which reduces the probability of the force vector not acting parallel to the longitudinal axis. The optimum design is a vane-shroud fin assembly. The shape of the shroud is conical. Slotting the shroud by removing longitudinal strips improves the righting capability at higher angles of deviation, but is slightly inferior to the full shroud at lesser angles.

Master of Science
Oceanography
December 1968

Advisor: R. J. Smith
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

**AN INVESTIGATION OF BOTTOM CHANGES
IN MONTEREY HARBOR (1932-1969)**

**Richard John Lennox
Lieutenant, United States Navy**

(AD #706032)

Bottom changes occurring in Monterey Harbor from 1932-1969 were analyzed by numerical computer methods using 15 selected hydrographic surveys. Results of the study indicate that the major portion of the harbor has been shoaling in the mean since 1932. The long-term shoaling rate has been 0.4 to 4.0 feet per decade in the beach and nearshore zones and along the breakwater; and less than 0.25 feet per decade in the stable outer harbor. The accretion rate average 17,500 cubic yards per year from 1932-1969 but only 7,100 cubic yards per year from 1947 to 1969. The shoaling is believed due to the construction of the Coast Guard Breakwater in 1931-1934. It is deduced that prior to 1960 the excess sand was carried into the harbor by littoral transport from Del Monte Beach and by wave currents around the breakwater. Construction of the solid wall on Wharf 2 in 1960 cut off the former sand supply. Local redistribution of sand in the beach and nearshore zones of the harbor is large and results in areas of significant accretion and erosion between surveys. Dredging operations have had only short-term effectiveness because the spoil has been retained within the harbor.

Master of Science
Oceanography
June 1969

Advisor: W. C. Thompson
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

**THE EFFECT OF PRESSURE ON THE IONIC CONDUCTANCE
UNDER THE UPPER 2000 METERS OF THE OCEAN'S WATER COLUMN**

**Michael Everett Mays
Lieutenant, United States Navy**

(AD #686654)

The specific conductivity of 5 different electrolytic solutions over a pressure range of 1 to 200 bars has been measured. The solutions were 0.01N, 0.10N and 1.00N KCl and 2 solutions of sea water. One sea water solution was real sea water, the other artificial. Each solution was tested at 4 temperatures, ranging from 4°C to 18°C. The pressure caused the specific conductivity of all solutions to increase in a non-linear fashion. First, second and third degree least square curves have been fitted to the data for comparisons. The specific conductivity caused by solution concentration changes during compression has been determined and found to be a significant error source. Explanations are offered to account for the conductivity changes considering the manner in which pressure alters the chemical structure of the solution. The areas discussed are solution concentration, applied voltage, interionic reactions and viscosity.

Master of Science
Oceanography
December 1968

Advisor: C. F. Rowell
Department of Material
Science and Chemistry

This document has been approved for public release and sale; its distribution is unlimited.

A DESCRIPTIVE SURVEY OF THE HEAD OF
CARMEL SUBMARINE CANYON

Carl Arthur Moritz, Jr.
Lieutenant, United States Navy

(AD #691383)

Scuba dive observations made in Carmel Submarine Canyon revealed the existence of rock outcrops of granodiorite on both sides of the canyon head. Five distinct bottom types were found: (1) rock outcrops and boulders, (2) coarse sand, (3) fine sand containing benthic organisms, (4) a silty clay layer underlying coarse sand, and (5) an organic sediment mat. Rocky bottomed terraces on both sides of the canyon head are at the same level and appear to have been eroded at a previous lowered sea level. The coarse sand areas, characterized by steep slopes, are considered to be areas of active sand movement. The fine sand bottoms were found to be relatively stationary although dead kelp material moves over its surface. Thin silty clay deposits considered to be of lagoonal or estuarine origin are found underlying sand at the north side of the canyon head. An organic sediment mat of undetermined thickness was found in a swale which appeared to be a slump scar. Mechanical erosion of the rock from both sand movement and the action of encrusting organisms is evident.

Master of Science
Oceanography
December 1968

Advisor: Warren C. Thompson
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

AN INVESTIGATION OF ENVIRONMENTAL FACTORS
AFFECTING THE NEAR-BOTTOM CURRENTS IN
THE MONTEREY SUBMARINE CANYON

Ingmar Joel Njus
Lieutenant, United States Navy

(AD #684787)

Continuous bottom current measurements were taken in the head of Monterey Submarine Canyon in water depths ranging from 80 to 110 fathoms utilizing an in situ Savonius Rotor current measuring system placed approximately 40 feet above the bottom. Concurrent wind, wave, and tidal data were collected with the current measurements. Basic statistical parameters and power spectra were then computed for each time series obtained.

Current speeds in excess of one knot were measured, with the current direction being predominantly along the canyon axis. Water temperature, current speed and direction all exhibit cyclic fluctuations of a periodicity equal to that of the semidiurnal tide. Cold, high-speed currents flow up-canyon (landward) on the falling tide while warmer, slower currents flow down-canyon (seaward) on the rising tide. Wind and wave conditions do not appear to have any significant effects on the near-bottom currents.

Master of Science
Oceanography
December 1968

Advisor: W. Denner
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

**STUDY OF THE OCEANIC POLAR FRONT
IN THE DENMARK STRAIT**

**Silas Oscar Nunn, III
Lieutenant Commander, United States Navy**

(AD #856692)

A computer program is utilized to examine the effect on sound propagation of the oceanic polar front in the Denmark Strait and along the Southeastern coast of Greenland. Ray traces are computed with the source in both the cold and warm current areas for surface thermal gradients of 0.036 C/KM to 1.68 C/KM. These gradients are created by varying horizontal distances between actual oceanographic stations. The results indicate greater trapping angles with the source in cold water. A relationship is reported between the surface thermal gradient and the change in trapping angle difference for pairs of runs.

The location of the oceanic polar front and the effects of environmental influences on its strength and seasonal movement are described.

Master of Science
Oceanography
December 1968

Advisor: Joseph J. Von Schwind
Department of Oceanography

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**THE "MONO" CORER: A WIDE DIAMETER,
GENERAL PURPOSE, GRAVITY CORING TOOL**

**Roger Peter Onorati
Lieutenant, United States Navy**

(AD #694912)

Many gravity corers in use today exhibit inherent problems and short-comings associated with their design. The "MONO" corer is a wide diameter, general purpose, gravity coring tool designed to help alleviate some of these shortcomings. It incorporates several unique features so as to enable coring operations to be carried out with increased reliability and efficiency. Among these features are:

- a. A quick method of attaching the core cutter to the core barrel.
- b. Quick-action clamps used to attach the lower and upper sections of the corer.
- c. A streamlined weightstand which encloses the weight and streamlines the corer, thus offering less drag.
- d. A large-area water vent assembly which prevents a pressure buildup above the core.

Master of Science
Oceanography
December 1968

Advisor: R. J. Smith
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

SURFACE CHARACTERISTICS OF WINDROWS

Ralph William Ortengren, Jr.
Lieutenant, United States Navy

(AD #683803)

Aerial photographs were taken of windrow accumulations in Monterey Bay on 1, 8, 15 and 22 October 1968. A Fairchild T-11 aerial mapping camera was used, with photographs taken approximately every two minutes over 40 to 60 minute periods. Windrows were marked with accumulations of computer cards, wind speed measured by cup anemometer, and wind direction taken with the aid of a MK.6 Smoke Float. Sea surface air temperature measurements were taken concurrently.

An attempt was made to correlate windrow spacing and wind speed, to find mean deflection of windrows relative to the wind, to determine any relationship between row spacing and depth of the thermocline and to find the response time of windrow orientation to a wind shift.

Windrow spacing was found to depend on other factors than wind speed. Deflection angles varied between 20° left and 20° right, with 0° being the most common angle. No correlation was found between depth of the thermocline and row spacing. Response time fell between two and four minutes.

Master of Science
Oceanography
December 1968

Advisor: Noel E. Boston
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

A LABORATORY EXPERIMENT ON SURFACE WAVE
ATTENUATION DUE TO UNDERWATER TURBULENCE

James Edward Paquin
Lieutenant, United States Navy

(AD #686655)

The attenuation of surface waves caused by underwater turbulence was investigated in a wave-tank experiment. The waves studied (frequencies ranging from 1.2 to 12.3 Hertz) were strongly attenuated by a zone of grid-generated turbulence. This attenuation depended on the length of the turbulent region, and on the frequency of the incident wave. The equation governing attenuation was

$$h = h_0 e^{-ax}$$

where h is wave height, h_0 is undisturbed wave height, x is the length of the turbulent region, and a is an attenuation coefficient proportional to the cube root of frequency. It was also noted that the waves were shifted in phase as they passed through the turbulence, and that the magnitude of this shift increased with frequency. The quantitative results of the experiment were obtained from measurements of nearly sinusoidal waves. They were confirmed, qualitatively, for a continuous spectrum of waves by measurement of a wind-generated model sea surface.

Master of Science
Oceanography
December 1968

Advisor: Herman Medwin
Department of Physics

This document has been approved for public release and sale; its distribution is unlimited.

**INVESTIGATION OF TEMPERATURE FLUCTUATIONS
NEAR THE AIR-SEA INTERFACE**

**James Robert Ramzy
Commander, United States Navy**

**Ernest Tillson Young, Jr.
Lieutenant Commander, United States Navy**

(AD #705080)

Measurements of air temperature fluctuations as close as 2.5 cm above the surface of a pond in the presence of wind generated waves were made using fast response thermistors. Temperature fluctuations as large as 5°C in as little as 0.2 seconds were observed, and were shown to be valid.

There was strong correlation between the records of the two thermistors used.

Signal analysis revealed period components of temperature fluctuations associated with the wave action.

**Master of Science
Oceanography
December 1968**

**Advisor: Noel E. Boston
Department of Oceanography**

This document has been approved for public release and sale; its distribution is unlimited.

**COLLECTION AND CHARACTERIZATION OF THE
SURFACE FILM OF WINDROWS IN MONTEREY BAY**

**James Ronald Reed
Lieutenant (Junior grade), United States Navy**

(AD #706699)

A surface film collector was constructed and used to collect the surface film of windrows. The surface film was shown to be a complex mixture of primarily unsaturated esters of variable biological origin. Infrared, visible, and ultraviolet spectra are included.

**Master of Science
Oceanography
June 1969**

**Advisor: C. F. Rowell
Department of Physics**

**This document has been approved for public release and sale; its
distribution is unlimited.**

THE TOPOGRAPHY OF THE MID-PACIFIC MOUNTAINS

Charles Keith Roberts
Lieutenant, United States Navy

(AD #689728)

A recently contoured set of detailed bathymetric charts of the central Pacific Ocean were obtained from the Scripps Institution of Oceanography. The mean topography of the submerged Mid-Pacific Mountain chain was contoured from mean depths calculated for one-degree squares. The hypsometry of this area was determined. A study of the subsidence of the Mid-Pacific Mountains was made using the guyot information available on the charts and in the literature. The guyot data were examined and the dimensions of the 17 most reliable features were studied. The guyot tops are generally deeper in the eastern part of the areas than to the west, with an apparent tilt of about 200 fathoms in 1200 nautical miles. The present topography closely resembles the old topography when the guyots were at the surface. It appears that the tops of the mountains have settled a bit relative to the deeper areas, although this is not proven.

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Master of Science
Oceanography
December 1968

Advisor: Warren C. Thompson
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

THE SEDIMENTS IN THE HEAD
OF CARMEL SUBMARINE CANYON

Steven Russell Wallin
Lieutenant, United States Navy

(AD #693099)

Carmel Submarine Canyon is cut into the Santa Lucia granodiorite formation and is the only canyon on the California coast which is cut in granitic rock. The innermost head of the canyon exhibits a wide, bowl-shaped appearance, not unlike a glacial cirque.

Granodiorite outcrops on the submarine terrace on the north and south sides of the canyon and in the north canyon wall. Much of the terrace and upper canyon sides are covered by coarse sand while the interior of the canyon head is covered with fine sand.

The canyon is actively transporting sediment to deeper water at the present time. The chief source of sediments is coarse sand which is littorally transported from the mouth of Carmel River. This sand enters the canyon by way of three "rivers of sand" which extend over the canyon rim and down the slopes. Additional transport of sediment within the canyon head may be the result of slumps and slides lubricated by decomposition of vegetable matter incorporated in the sediments.

Master of Science
Oceanography
December 1968

Advisor: Warren C. Thompson
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

**THE CORRELATION OF OCEANIC PARAMETERS WITH
LIGHT ATTENUATION IN MONTEREY BAY, CALIFORNIA**

**Lanny Alan Yeske
Lieutenant, United States Navy**

**Richard Dean Waer
Lieutenant, United States Navy**

(AD #686653)

An investigation of the correlation of oceanic parameters with light attenuation in Monterey Bay, California, was conducted during July and August 1968. Measurements of beam transmittance, salinity, temperature, density, and particulate matter, related in time and depth, were obtained during four cruises. Nearly 400 water samples were taken from two stations at depths between 0 and 85 m.

Temperature showed the greatest correlation with beam transmittance. Isopycnals and beam transmittance contours showed a similar good correlation. Although salinity correlations were not clearly defined, isolated salinity pockets often appeared to be associated with transmissivity perturbations. A nearly linear relationship between values of particulate count and beam transmittance was observed. Particle sizes were found to decrease with increased depths. Approximately 96 percent of the particles affecting beam transmittance were less than 13μ in diameter. Beam transmittance isolines generally oscillate with a tidal cycle period, the minimum values usually occurring at low tide. A possible correlation between lunar period, tidal ranges, and turbidity layers was indicated.

Master of Science
Oceanography
December 1968

Advisor: Steven P. Tucker
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

**AN ECONOMIC MODEL
OF THE NAVAL POSTGRADUATE SCHOOL**

**Donald Lewis Abbey
Lieutenant, United States Navy**

(AD #689725)

The increased size and complexity of educational institutions has created a need for an economic model of such institutions as an aid to planning and resource allocation. It is shown that economic theory can be applied to an analysis of the Naval Postgraduate School. A modified activity analysis technique is used to model the school's operation. The mathematical programming structure of the model emphasizes the objective of efficient operation. The necessary conditions of the programming problem are used to characterize decision rules for efficient operations. The decision rules stress the complexity of the problems facing school administrations. Application of the comparative statics technique to the model provides relationships which demonstrate that the total marginal effect of parameter variation can be decomposed. The components of these effects are interpreted as income, substitution, and revaluation effects.

**Master of Science
Operations Research
December 1968**

**Advisor: Carl R. Jones
Department of Operations
Analysis**

This document has been approved for public release and sale; its distribution is unlimited.

AIRCRAFT SURVIVABILITY INDEX FOR LOW ALTITUDE
PENETRATION OF AN AIR DEFENSE COMPLEX

Thomas Harrison Allen, Jr.
Lieutenant Colonel, United States Marine Corps

(AD #700701)

This paper develops a model for computing the probability of kill for an air defense complex composed of anti-aircraft automatic weapons, radar controlled guns, and missile batteries. Two dimensional terrain was used to evaluate the model. The probabilities were determined at major terrain points along the route of approach to the vital area for altitudes of up to 3000 feet above terrain. The curves of probability of kill versus altitude were found to be dependent on terrain, air defense tactics, and weapon system parameters. A survivability index is calculated by combining the probabilities of kill with a pilot visual navigational probability. The resulting curves of survivability index versus altitude were found to be non-linear requiring a nonlinear programming technique to solve for the altitude of optimal survivability index within aircraft flight path constraints. The nonlinear solution was not included in this work.

Master of Science
Operations Research
December 1968

Advisor: W. Peyton Cunningham
Department of Operations
Analysis

This document has been approved for public release and sale; its distribution is unlimited.

**ANALYSIS OF A SYSTEM RELIABILITY
LOWER CONFIDENCE LIMIT ASSUMING GAMMA
AND TRUNCATED NORMAL FAILURE DISTRIBUTIONS**

**John Paul Aucella
Lieutenant, United States Navy**

(AD #855546)

The accuracy of the lower confidence limit procedure in NAVWEPS OD 29304 is analyzed when the failure distributions of the components in the series system are either gamma or truncated normal. Several representations of the accuracy are supplied.

Master of Science
Operations Research
December 1968

Advisor: W. Max Woods
Department of Operations
Analysis

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**ANALYSIS OF CONNECTED REPLENISHMENT OPERATIONAL DATA:
THE DISTRIBUTION OF CONREP SERVICE TIMES**

**John Albert Besecker
Lieutenant Commander, United States Navy**

(AD #688459)

Most analytic and computer simulation models of the Navy's CONREP phase of underway replenishment operations has assumed exponentially distributed service times for two reasons: (1) lack of better estimate of the true distribution, and (2) such an assumption leads to more tractable mathematical solutions.

By analyzing several different combinations of replenishment vessels and combatant ships, it is demonstrated through goodness-of-fit tests that gamma distributions whose parameters can be estimated from actual operational data are more precise estimates of the actual underlying CONREP service time distributions. Furthermore, it is shown that the distribution can be made Erlang by minor adjustments to the parameter estimates of the gamma distribution. Such a procedure might be desirable for analytical models employing Laplace transforms.

The data is subjected to linear regression techniques in an effort to develop meaningful and accurate functional relationships between service time and customer needs. The results indicate that the standard error of the estimating relationships would be too large to be of any practical use in planning an underway replenishment operation.

Master of Science
Operations Research
December 1968

Advisor: Paul R. Milch
Department of Operations
Analysis

This document has been approved for public release and sale; its distribution is unlimited.

**THE FACTORS AFFECTING ANTISUBMARINE WARFARE
INSIDE THE SCREEN (U)**

**David George Clark
Lieutenant, United States Navy**

(AD #851601)

(U) Should the United States Navy be again called upon to undertake the escort of merchant convoys in warfare, it will find many problems which are either unique to this type of surface action, or which were solved when convoys were last employed but the solutions to which have become outdated by the hardware of modern warfare. This paper explores the situation where an attacking submarine has penetrated the escorting screen and is operating in the vicinity of the main body. Some recent studies from other sources are constructively criticized and ideas and models are postulated for future analysis to determine justification for the name "submarine haven" which has been given to this area in the acoustic shadow of the main body.

THIS THESIS IS CONFIDENTIAL

**Master of Science
Operations Research
December 1968**

**Advisor: W. Peyton Cunningham
Department of Operations
Analysis**

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AN ANALYSIS OF THE MARINE DIRECT AIR SUPPORT SYSTEM
REPUBLIC OF VIETNAM, 1 JANUARY - 21 MARCH, 1968 (U)

Richard Fletcher Chenault
Major, United States Marine Corps

(AD #508897)

(U) An investigation of the operation of the Marine Corps direct air support system in Vietnam during the period 1 January - 21 March, 1968, was made to determine the timeliness of on call air support and to find methods of improving system responsiveness. A probabilistic information-flow network model and a computer simulation were developed. Data collected in Vietnam were used as input to the simulation. Methods of reducing system response time were postulated in the areas of aircraft procurement and mission request handling procedures. Using the simulation, three modified system configurations were examined in conjunction with various combinations of aircraft sources. Average mission response time experienced in Vietnam was determined from the data, and, when compared to the desired response time set forth in Navy-Marine Corps doctrine, gave an indication of system timeliness. Simulation results indicated that mission response time could be reduced through the use of either air alert or scheduled launch aircraft, but that the use of air alert aircraft would produce greater reductions in response time while being more efficient in terms of aircraft utilization.

THIS IS CLASSIFIED SECRET

Master of Science
Operations Research
December 1968

Advisor: Alan W. McMasters
Department of Operations
Analysis

In addition to security requirements which must be met, this document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

LOCATING ABSOLUTE 2-CENTERS OF UNDIRECTED GRAPHS

Clarke McKinley Gillespie, Jr.
Captain, U. S. Army

(AD #689120)

This study analyzes the location of vertex and absolute 2-centers of an undirected graph. Under certain assumptions, these locations would constitute optimal positioning of emergency facilities, such as fire stations. A synopsis of Hakimi's procedure for locating an absolute center is given. Vertex multi-centers are defined, and an original procedure for locating them is given. Absolute multi-centers are defined. It is shown that certain combinations of arcs and vertices never contain absolute 2-centers, while certain others will always contain a 2-center which improves on the vertex 2-center. Although no algorithm was found for determining the absolute 2-center of a graph, an algorithm is presented for finding the best 2-centers which exist on arcs incident to the vertex 2-center.

Master of Science
Operations Research
December 1968

Advisor: Alan W. McMasters
Department of Operations
Analysis

This document has been approved for public release and sale; its distribution is unlimited.

ACCURACY OF A PROCEDURE FOR COMPUTING
LOWER CONFIDENCE LIMITS ON
SYSTEM RELIABILITY FOR VARIOUS FAILURE DISTRIBUTIONS

Richard Joseph Girouard
Major, United States Army

(AD #846239)

A statistical model for obtaining a lower $100(1 - \alpha)\%$ confidence limit on system reliability was developed for the Department of Navy Special Projects Office in May 1965. This method is a part of NAVWEPS OD 29304. The accuracy of this model is examined by computer simulation for various failure time distributions. The simulation results are presented and discussed.

Master of Science
Operations Analysis
December 1968

Advisor: W. M. Woods
Department of Operations
Analysis

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

**GUIDANCE FOR COMMANDERS
IN ESTABLISHING CHEMICAL-BIOLOGICAL
DEFENSIVE POLICIES**

**John Frank Henry
Major, United States Army**

(AD #855531)

Soldiers wearing chemical-biological (CB) protective uniforms experience heat stress and may become heat casualties. Current defensive doctrine suggests that commanders may reduce the risk of heat casualties by rotating their troops through varying degrees of protection. Since unprotected troops will likely become CB casualties if an attack occurs, the commander must trade risk of heat casualties for risk of CB casualties. The effects of temperature and work rate on the buildup of heat in protected soldiers are examined. The problem facing the commander is formulated as a queueing theory problem and a computer simulation used to obtain a solution. Graphs show the percent of unprotected personnel within a unit necessary to prevent heat casualties for a range of temperatures and unit work rates.

**Master of Science
Operations Analysis
December 1968**

**Advisor: Gary K. Poock
Department of Operations
Analysis**

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

EVALUATION OF THE ACCURACY OF A RELIABILITY MEASUREMENT
PROCEDURE USING SIMULATION TECHNIQUES

Kenneth Alan Huffman
Lieutenant, United States Navy

(AD #688460)

This study evaluates the accuracy of an established reliability measurement procedure (NAVWEPS OD 29304) by computer simulation. The reliability measurement procedure assumes components fail according to an Exponential Failure Law. This study tests the accuracy of that procedure when components obey a Weibull Failure Law or a Log Normal Failure Law.

Master of Science
Operations Research
December 1968

Advisor: W. Max Woods
Department of Operations
Analysis

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

**A SYSTEMS EFFECTIVENESS MODEL FOR AN
ALTERNATIVE STRUCTURED COMPLEX SYSTEM**

**Clarence Howard Keim
Lieutenant Commander, United States Navy**

(AD #689123)

A complex system envisioned can accomplish a given mission with the aid of any one of several alternative structures. Each of these alternative structures (subsystems), although capable of mission accomplishment, exhibits different levels of performance due to its component inventory. The structures are ordered in preference accordingly. Operation on less-preferred structures is a function of component/structure failure histories in prior structures. Failures are classified by three levels of severity. A system effectiveness model is developed to provide a measure of effectiveness for the overall complex system which encompasses all possible alternative structures.

Master of Science
Operations Research
December 1968

Advisor: W. Max Woods
Department of Operations
Analysis

This document has been approved for public release and sale; its distribution is unlimited.

**A STATISTICAL ANALYSIS OF
THE USMACV HAMLET EVALUATION SYSTEM (U)**

**Edwin Sterling Leland, Jr.
Major, United States Army**

(AD #502656)

THIS THESIS IS CLASSIFIED CONFIDENTIAL

**Master of Science
Operations Analysis
December 1968**

**Advisor: Robert R. Read
Department of Operations
Analysis**

In addition to security requirements which must be met, this document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the U. S. Naval Postgraduate School, Monterey, California 93940 (Code 023).

**COMPARISON OF SOME PARAMETRIC AND NON-PARAMETRIC
DISCRIMINATION PROCEDURES IN NEGATIVE
EXPONENTIAL POPULATIONS**

**Joseph Louis Lockett III
Lieutenant, United States Navy**

(AD #686843)

A brief discussion of the literature concerned with the two-population discrimination problem is presented and several procedures based on the likelihood ratio for discrimination between negative exponentially distributed populations are proposed. The small sample and asymptotic performance of these procedures is compared with that of non-parametric procedures and the classical linear discriminant function. Some guidelines for the use of the procedures discussed are presented.

Master of Science
Operations Research
December 1968

Advisor: J. R. Borsting
Department of Operations
Research

This document has been approved for public release and sale; its distribution is unlimited.

**BLOCKING PROBABILITIES IN
SMALL COMMUNICATION NETWORKS**

**John McGrath
Captain, United States Army**

(AD #696068)

Analytic models of communication networks, combining the desired degree of simplicity and accuracy, are noticeable by their absence from the literature. Modern networks are so large that the combinatorial possibilities impose an overwhelming burden on mathematical model formulation. High speed digital simulations provide one of the only means of solution for the systems planner.

Military communication networks offer more hope for analytical solution. Much smaller than their civilian counterparts, most military systems can be modelled satisfactorily as aggregations of queues. This paper provides approximations to the probability of blocking in 2 terminal, k-channel systems. The probability of blocking is defined as the probability that a vacant channel is available for connecting a caller to his desired party whenever the call is placed.

Master of Science
Operations Research
December 1968

Advisor: Stephen Pollock
Department of Operations
Analysis

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STATISTICS AND THE MILITARY OFFICER IN
COMBAT DEVELOPMENTS EXPERIMENTATION

David Warren Mikkelson
Captain, United States Army

(AD #689122)

The duty performance of military officers whose duties are the planning, conduct, analysis, and evaluation of field experimentation can be improved through a better understanding of experimental statistics. The role of statistics in the field experimentation conducted by the U. S. Army Combat Developments Command Experimentation Center typifies the role of statistics in military field experimentation. Selected officers of USACDCEC were surveyed to determine their understanding of some of the more important concepts of experimental statistics. The survey results indicate that most of these officers lack a basic knowledge of experimental statistics. Based on insights gained from the survey, statistical training of certain USACDCEC officers is recommended. Statistical concepts not well understood by the surveyed officers are defined and discussed. A field experiment conducted by USACDCEC is used to exemplify the applications of statistical techniques and the use of measures of performance in field experimentation.

Master of Science
Operations Research
December 1968

Advisor: J. Bryce Tysver
Department of Research
Analysis

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A DESCRIPTIVE PROGRAMMING ANALYSIS OF
THE NAVAL POSTGRADUATE SCHOOL TEXTBOOK LIBRARY

John Albert Momm
Lieutenant, United States Navy

(AD #707728)

Naval Postgraduate School students utilize the loan services of the school's textbook library for classroom and research book requirements. In this thesis models are presented which describe the three primary elements of the textbook library system: the library itself, the students who use its outputs, and the decision maker whose policies control the entire system operation. These models are used to discuss system efficiency. Applications of the programming production model as an aid in the decision making process are then described in detail.

Master of Science
Operations Research
June 1969

Advisor: Carl R. Jones
Department of Operations
Analysis

This document has been approved for public release and sale; its distribution is unlimited.

**AN ANALYSIS OF ACCURACY OF A PROCEDURE
FOR COMPUTING LOWER CONFIDENCE LIMIT
ON SYSTEM RELIABILITY UTILIZING SUBSYSTEM TEST DATA**

**Maurice Joseph Moran
Lieutenant, United States Navy**

(AD #690449)

Systems which are composed of two or more phases, or subsystems, arranged in logical sequence are found frequently in industry and defense. Standard procedures for computing lower confidence limits on reliability of such systems rely on the use of system data. Engineering to any of these subsystems can effect the invalidation of all existing data, necessitating additional, sometimes extensive, testing. Such changes are not infrequent in complex systems. A need exists for a method of computing lower confidence limits on reliability which uses phase data. Some approximation techniques have become available. One such technique is currently being used by Applied Physics Laboratory, The Johns Hopkins University. Computer simulation techniques are used to analyze the accuracy of this procedure.

Master of Science
Operations Research
December 1968

Advisor: W. Max Woods
Department of Operations
Analysis

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AN ANALYTICAL APPROACH TO THE OPERATION
OF REPLENISHMENT AT SEA

Bernard Leo Patterson III
Lieutenant, United States Navy

(AD #686842)

An analytical approach to the problem of replenishing task forces at sea is investigated utilizing queueing theory concepts and a random walk model. The type of operation considered consists of two different type supply ships servicing L combatants of different type. Replenishment times are assumed to be independent random variables with service rates dependent upon both supply ship and combatant type. The total replenishment time of the task force is derived as the sum of specific individual replenishment times involving idle times of supply ships. With the additional assumption of exponentiality for the replenishment times, the probability density function of the total replenishment time is found in terms of the conditional Laplace transforms of specific type sequences of servicing and the probabilities that these sequences occur. Techniques for the evaluation of these quantities are discussed, however an explicit solution for the general case is not attained. As an example of these techniques, the case of $L = 2$ is discussed.

Master of Science
Operations Research
December 1968

Advisor: Paul R. Milch
Department of Operations
Analysis

This document has been approved for public release and sale; its distribution is unlimited.

ON PRIMAL INTEGER PROGRAMMING METHODS

Howard Thomas Schottle
Lieutenant, United States Navy

(AD #689730)

Advances in the field of integer programming have recently been made by Young and Glover, who have developed primal all integer integer programming algorithms. It is the purpose of this paper to gain computational experience and suggest techniques to improve the efficiency of the algorithm. A first phase procedure is developed to obtain an initial feasible integer solution.

Master of Science
Operations Research
December 1968

Advisor: Harold Greenberg
Department of Operations
Analysis

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A REAL TIME GAMING SYSTEM

Edward Anthony Singer, Jr.
Lieutenant, United States Navy

(AD #689726)

A system is proposed which will support computer gaming in real-time. This system will, when combined with the user's Control Program, monitor all of the functions necessary to provide real-time man/machine interaction with the game. The formal definition of a programming language (RTGS Control Program Command Language) is given; this language, supplemented by Fortran IV and IBM OS/360 Assembler Language is used for coding the user's Control Program. Plans for implementation on an IBM System/360 Model 67 are discussed and a sample program is given.

Master of Science
Operations Research
December 1968

Advisor: G L. Barksdale, Jr.
Department of Mathematics

This document has been approved for public release and sale; its distribution is unlimited.

**A SHORT HISTORY OF OPERATIONS RESEARCH
IN THE UNITED STATES NAVY**

**William Ferguson Story
Lieutenant, United States Navy**

(AD #855532)

This thesis traces the history of the practice of an organization for operations research in the United States Navy. The author points out that operations research was being conducted in the U. S. Navy before operations research became identified as a separate science. From that point its growth, major accomplishments and organizational changes are described. The final part of the thesis outlines the organization through which the Navy conducts its operations research and systems analysis at the present.

**Master of Science
Operations Research
December 1968**

**Advisor: W. P. Cunningham
Department of Operations
Analysis**

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**A GOAL-CONSTRAINT FORMULATION
FOR MULTI-ITEM INVENTORY SYSTEM**

**Albert Paul Tuily
Lieutenant, United States Navy**

(AD #690452)

Historically multi-item inventory control has been modeled by assuming that each item can be treated independently in a variable cost minimization formulation. In this paper independence between items is not assumed. Constraints on total system operating characteristics create inter-item dependencies. Optimal policies are determined from a goal-constraint formulation. This is done without reliance upon unknown parameters such as order cost and carrying cost which the traditional theory leans on heavily. A group of models are presented, with necessary and sufficient conditions for optimal solutions provided for each. In addition, solution algorithms are indicated for the major models. An algorithm for verification of sufficiency conditions for a non-convex objective function is also provided.

Master of Science
Operations Research
December 1968

Advisor: David A. Schradly
Department of Operations
Analysis

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A TEST OF THE HYPOTHESIS THAT THE SECOND PARAMETERS
OF PAIRED BINOMIAL DISTRIBUTIONS ARE PAIRWISE EQUAL

Gene Arthur Venzke
Major, United States Army

(AD #691389)

A test of the hypothesis that the second parameters ("success" probabilities) of a number of paired binomial distributions are pairwise equal is derived under weak assumptions. Computer codes necessary to implement the procedure are given and a case study is used to demonstrate the procedure. Some other procedures for testing the same hypothesis under stronger assumptions are discussed and compared with the given procedure. A rapid approximate procedure is also given.

Master of Science
Operations Research
December 1968

Advisor: Donald R. Barr
Department of Operations
Analysis

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AN ANALYSIS OF EKELUND RANGING ERRORS (U)

John Alden Webster, Jr.
Lieutenant Commander, United States Navy

(AD #509084)

(U) An analysis of the submarine passive sonar "bearings only" technique used for estimating target range - "Ekelund Ranging." sources of error are identified. The analysis concentrates on the effect of sonar equipment random variable bearing error. The magnitude of effect and relationship between source of error and range error is established. Procedures for minimizing range error are investigated. The relative effectiveness of a variety of time-bearing plotting procedures is examined. An optimal (maximum) speed for Ekelund ranging is investigated. For weak targets, speeds above and below the optimal result in magnified errors. A means for determination of "optimal" speed and its tactical significance for individual ships is presented.

THIS THESIS IS CLASSIFIED CONFIDENTIAL

Master of Science
Operations Research
December 1968

Advisor: W. Payton Cunningham
Department of Operations
Analysis

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**PREDICTION OF OPTIMAL FLIGHT PROFILES FOR JET AIRCRAFT
UNDER SHORT RANGE AND LOW FUEL CONDITIONS**

**Frederick John West
Lieutenant, United States Navy**

(AD #698498)

There are many factors, such as aircraft configuration and weight, winds aloft, airspeeds flown, altitude, distance, etc., which affect fuel consumption in turbojet aircraft. For any given combination of these factors a flight path can be determined that will result in the least fuel consumed for a ground distance covered. Under divert conditions from aircraft carriers at sea to fields ashore the choice of the optimal flight path is critical. The many possible combinations of factors lead to the adoption of computer flight planning. Pilots can avail themselves of computer solutions during flight planning and briefing sessions, and after take-off can receive further information via UHF radio. Typical flight handbooks display fuel flow data, etc., in such a manner that the pilot must "guesstimate" entry parameters such as average horizontal weight, or weight prior to descent. Several iterative procedures are developed that provide exact solutions to these important figures. Thus the computer flight planning system will provide more accurate solutions, and free the pilot from this chore so that he may better spend his time briefing tactics.

**Master of Science
Operations Research
December 1968**

**Advisor: Eamon B. Barrett
Department of Operations Analysis**

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distribution is unlimited.**

**EVALUATION OF SEVERAL METHODS OF SCHEDULING
AND CONDUCTING PHYSICAL INVENTORIES**

**Gifford Don Wilson
Major, United States Army**

(AD #856162)

Advanced operations research procedures have provided the inventory manager a set of optimal decision rules for operating his inventory system. However, these decision rules are applied to information from inventory records that may be in error. If the records are in error the decision rules no longer insure optimal operation of the system. This paper addresses the problem of which physical inventory procedures best maintain record accuracy at a satisfactory level. Four physical inventory procedures are discussed and then tested using a Monte Carlo computer simulation of a multiple item, single warehouse, single inventory manager supply system. Discrepancies of various types are introduced into the records reflecting estimates obtained from a large naval supply center. It was found that for high demand items accuracy levels above 30 percent are not feasible. Due to the low cost per item inventories the wall-to-wall inventory was found to be the most economical system in most situations. Suggestions are made for subsequent research.

Master of Science
Operations Research
December 1968

Advisor: David A. Schrady
Department of Operations
Research

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OBJECTIVE DIGITAL ANALYSIS
OF BATHYTHERMOGRAPH TRACES

Eric Francis Grosfils
Lieutenant, United States Navy

(AD #689121)

There is a need for a fast method of analyzing bathythermograph traces and this need is approached by the means of a high-speed digital computer. The theory behind the computer program is outlined. Both synthetic and real data cases are run as examples using both data card decks and magnetic tape inputs. The program has been designed to read digitized bathythermograph traces and then to analyze them objectively by Gaussian and non-Gaussian methods for the top, center, and base of the main thermocline. Additionally, such features as multiple thermoclines, inversions, and thermal transients are identified also and their key points are included in the informational data printout.

Master of Science
Physical Oceanography
December 1968

Advisor: N. E. J. Boston
Department of Oceanography

This document has been approved for public release and sale; its distribution is unlimited.

INVESTIGATIONS IN THE VACUUM ULTRAVIOLET
OF A STEADY STATE NITROGEN PLASMA

James Carlin Beam
Lieutenant Commander, United States Navy

(AD #705081)

In preparation for studies of shock waves in a collisionless plasma, grazing incidence vacuum spectrograph has been used to study the vacuum ultraviolet spectra of a nitrogen plasma. The spectra are formed by a concave grating with a 1-meter radius of curvature and recorded on Kodak SWR (Shortwave-Radiation) Film. Analysis of the spectra was by comparison with helium and argon spectra, with intensity information from densitometric measurement using a Leeds and Northrup recording densitometer. Relative intensity determination provides an electron temperature evaluation technique.

Details on the modification of the Naval Postgraduate School plasma facility to accommodate a theta-pinch shock generation experiment are presented. Revised operating procedures for the new system configuration are included in the appendix.

A total of 735 lines was observed in the range 300-2000 angstroms. Relative intensity measurements indicated electron temperatures in the range 7.3 to 19.7 electron volts. Predicted relative intensities using a variable combination of the Local Thermal Equilibrium and Corona plasma models showed good sensitivity to temperature, but little difference between models.

Master of Science
Physics
June 1969

Advisor: A. W. Cooper
Department of Physics

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**MICROWAVE DIELECTRIC MEASUREMENTS IN
POTASSIUM DIHYDROGEN PHOSPHATE**

**Richard Ward Cole
Lieutenant (junior grade), United States Navy**

(AD #691196)

This thesis describes the construction and operation of an X-band microwave system for measurement of the dielectric constant of ferroelectric materials, and also the construction of a broad band, coaxial sample holder. Preliminary measurements of the dielectric constant of potassium dihydrogen phosphate (KDP) at approximately 9.4 GHz show this to be above the dielectric relaxation frequency of this solid. Extensive measurements made to detect the coupled proton tunneling - soft mode in KDP show that the mode does not reach this low a frequency, which is attributed to the slight first order nature of the transition.

**Master of Science
Physics
June 1969**

**Advisor: Gordon E. Schacher
Department of Physics**

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distribution is unlimited.**

RIEMANNIAN GEOMETRY AS A FIELD OVER ANOTHER GEOMETRY

George Henry Connor, Jr.
Major, United States Army

(AD #844151)

The basic tensors of a Riemannian geometry are found in terms of tensor components by considering the geometry as a field over another arbitrary Riemannian geometry. The approach exhibits symmetries not previously noted. In particular the Riemann tensor of a geometry is found to decompose into a sum of tensors, each with the full symmetry of a Riemann tensor, and each dependent upon only one order of derivative of the metric tensor. Further work to explore the potential value of the approach to general relativity is proposed.

Master of Science
Physics
September 1968

Advisor: K. E. Woehler
Department of Physics

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SPECTROSCOPIC STUDY OF A MAGNETICALLY
CONFINED NITROGEN PLASMA COLUMN

Joseph Robert Cote
Major, United States Army

(AD #690874)

The Plasma Spectrophotometer constructed at the Naval Post-graduate School in 1968 was modified by the addition of a photomultiplier cooling device to improve time resolution and increase the accuracy of the computed values of the relative intensities of the nitrogen spectrum in the magnetically confined nitrogen plasma column.

The relative intensities determined were used to analyze the variation in local electron temperature of the singly and doubly ionized nitrogen atoms with respect to magnetic field. The local electron temperature was found to vary with increasing magnetic field, reaching a peak temperature of 8.1 electron volts at 4200 gauss.

Evaluation of the relative number densities of the two ionic species indicated that the local electron temperature of the column was the local electron temperature of the singly ionized nitrogen atom.

Master of Science
Physics
June 1969

Advisor: Sydney H. Kalmbach
Department of Physics

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ENERGY LOSS OF HIGH ENERGY ELECTRONS
IN ALUMINUM, COPPER, AND LEAD

Rene DeLeuil and James Bruce Raynis
Majors, United States Army

(AD #705062)

The energy distribution of electrons of about 54, 75, and 92 MeV were measured before and after passing through lead absorbers of thicknesses ranging from 0.706 to 2.825 gm/cm², and through copper and aluminum absorbers up to 5.726 gm/cm². The electrons were accelerated by the LINAC of the Naval Postgraduate School. A measurement to determine the optimum location of the absorber indicated that the separation between the scattering foil and absorber should not exceed 6 cm, if geometric difficulties are to be avoided. The most probable energy losses agree with the theory of Blunck and Westphal for all three materials and all thicknesses. The half-widths of the distributions agree with theory up to thicknesses of about 2 gm/cm². For greater thicknesses the experimental half-widths of copper absorbers appear to agree with theory; the experimental half-widths of copper absorbers appear to agree with theory; the experimental half-widths of aluminum are greater than theoretical predictions; and those of lead are smaller than theory predicts.

Master of Science
Physics
June 1969

Advisor: John N. Dyer
Department of Physics

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THE PHASE EQUATION IN POTENTIAL SCATTERING

**Terry Robert Dettmann
Lieutenant (junior grade), United States Navy**

(AD #691197)

The solutions of the phase equation for a potential with the asymptotic properties of an atomic polarization potential are studied with the intention of developing a computer program for direct integration of the phase equation for the s-wave phase shift of an arbitrary potential. Such a program is developed and its limitations are discussed. In addition, an appendix is devoted to the variational principles of Kohn and Schwinger for calculating phase shifts.

**Master of Science
Physics
June 1969**

**Advisor: R. L. Armstead
Department of Physics**

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SCATTERING S-WAVE ELECTRONS OFF ATOMIC HYDROGEN

**Robert Thomae Elsberry
First Lieutenant, United States Air Force**

(AD #705102)

The Kohn variational method of calculating scattering phase shifts has been examined previously, and calculations of the phase shifts of S-wave electrons on atomic hydrogen done, by Schwartz. This paper presents the results of using a trial function somewhat simpler than Schwartz's and compares the two sets of results. In addition this paper presents and compares the results of two different normalizations of the variational principle and gives a somewhat more detailed development of the variational principle used than in most previous papers.

**Master of Science
Physics
June 1969**

**Advisor: Robert L. Armstead
Department of Physics**

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A COMPUTER STUDY OF CHANNELING IN SILICON

Roy Stephen Finno
Captain, United States Army

(AD #707727)

A computer simulation study of channeling in a diamond lattice. The simulation was done for a xenon ion striking the (100), (110) or (111) surface of a silicon target. Potential functions for the Si-Si lattice bond and the Xe-Si interaction are postulated. The electronic stopping cross section for the $\langle 110 \rangle$ channel of silicon is estimated.

This work is a continuation in the development of a computer model formulated at the USNPGS which takes into consideration the displacement of the atoms in the target lattice as well as inelastic energy losses by the primary ion. The lattice was not thermalized and only the repulsive portion of the lattice-lattice potential was utilized. Computer ranges are in good agreement with experimental data.

Master of Science
Physics
June 1969

Advisor: Don E. Harrison, Jr.
Department of Physics

This document has been approved for public release and sale; its distribution is unlimited.

**SIMULATION OF A LIQUID METAL
FAST BREEDER REACTOR ON A HYBRID COMPUTER**

**Charles Lee Keller
Lieutenant Commander, United States Coast Guard**

(AD #692446)

A Liquid Metal Fast Breeder Reactor is simulated on a hybrid computer to study the transient behavior of the neutron density during a controlled reactivity input disturbance.

The nonlinear partial differential equations of heat flow are reduced by a discrete space-continuous time method to ordinary nonlinear differential equations which are readily solved on the analog computer. Use is made of time multiplexing of the analog circuitry in order to reduce the number of components. An open-loop iteration process is employed to solve the closed-loop feedback system.

Recently conducted research with the open-loop iteration method has demonstrated that a large number of iterations are required for convergence. An algorithm is developed which gives an improvement in the convergence rate for early values of time. For times greater than two seconds a stability problem with the converged solution was encountered and is discussed with some observations and comments.

Innovations are introduced in the simulation of the neutron kinetics equations and in the handling of the nonlinear thermal properties of the uranium oxide fuel.

**Master of Science
Physics
June 1969**

**Advisor: A. Gerba, Jr.
Department of Electrical
Engineering**

This document has been approved for public release and sale; its distribution is unlimited.

NEUTRON CHARGE DISTRIBUTION

Nicholas Mark Ferriter
Lieutenant, United States Navy

(AD #690873)

The effect of a neutron charge distribution are considered. It is suggested that the charge distribution is of the form

$$\rho_n(R) = \frac{1}{c^3 \pi^{3/2}} e^{-\frac{R^2}{c^2}} - \frac{1}{f^3 \pi^{3/2}} e^{-\frac{R^2}{f^2}}$$

The effects of this charge distribution for various values of the parameters c and f , on the mean square radius of carbon, and on the charge form factor of carbon at high q are shown. The effect of the neutron becomes appreciable in carbon above the diffraction minimum. The neutron in this range of q^2 adds approximately 50% to the carbon form factor.

Master of Science
Physics
December 1968

Advisor: Fred R. Buskirk
Department of Physics

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**SURFACE WAKE OF A CIRCULAR CYLINDER IN DILUTE
AQUEOUS SOLUTIONS OF POLY(ETHYLENE OXIDE)**

**Michael Henry Fletcher
Lieutenant (junior grade), United States Navy**

(AD #705105)

The wake formed by surface-piercing circular cylinders towed through 0, 100, and 200 parts per million (by weight) aqueous solutions of Poly(ethylene oxide), Polyox WSR-301, was examined photographically. Cylinder diameters ranged from 1/4 in. to 2 in.; Froude numbers from 0.6 to 10. Measurements of spray height and ventilation pocket depth were made. No significant alteration of pocket depth with polymer concentration was observed; however, the spray height was reduced by increasing the Polyox concentration. Qualitative differences between the wakes of cylinders in Polyox solutions and those in water were (1) a serrated separation line characterized the ventilation pocket of the polymer solutions as opposed to the straight separation line of water, (2) the striated appearance of the pocket walls in Polyox instead of the clear, smooth walls in water, (3) the coherence displayed by the spray in Polyox instead of the random character of the spray in water, and (4) the larger and more irregularly shaped bubbles in Polyox as opposed to those in water.

Master of Science
Physics
June 1969

Advisor: J. V. Sanders
Department of Physics

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**THE OSCILLATORY FORCES ON A SEMI-SUBMERGED
CIRCULAR CYLINDER IN WATER AND IN DILUTE
AQUEOUS SOLUTION OF POLY(ETHYLENE OXIDE)**

**Stephen Michael Gensil
Lieutenant (junior grade), United States Navy**

(AD #708046)

The oscillatory forces on towed semi-submerged rigid circular cylinders were measured in water and in 100 and 200 ppm aqueous solutions of Polyox WSR301. Cylinders of half-, one-, and two-inch diameters were towed in a small circular towing-tank and the hydrodynamic forces sensed by a strain gauge and analyzed for the time-dependent frequency spectra. The towing speeds ranged from 59 cm/sec to 253 cm/sec corresponding to Reynolds Numbers from 2×10^4 to 1×10^5 . The Strouhal Numbers based on the dominant frequency of the oscillatory lift were between 0.17 and 0.21 and are in agreement with the existing data for a completely submerged circular cylinder. These frequencies were not influenced by either the airwater interface or the addition of drag reducing polymers. Also independent of the polymer concentration was the amplitude of the lift force. Attempts to interpret the oscillatory drag component proved inconclusive.

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**Advisor: James V. Sanders
Department of Physics**

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**ENERGY LOSS OF HIGH ENERGY ELECTRONS
IN ALUMINUM AND COPPER**

**James Clivie Goodwin, Jr.
Lieutenant Commander, United States Navy**

(AD #691762)

The LINAC at NPGS, Monterey was used to accelerate electrons to energies ranging from 50 - 100 MeV. These were used to study energy losses of high energy electrons in aluminum and copper. The densities of each material ranged from 0.7 to 2.8 gm/cm².

The results agreed with the theory of Blunck and Westphal, unlike previous measurements made by Breuer who found disagreement between his experimental results and his interpretation of the theory of Blunck and Westphal, particularly at energies above 50 MeV and with aluminum of thickness greater than that yielding a density of 1 gm/cm².

**Master of Science
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December 1968**

**Advisor: Fred R. Buskirk
Department of Physics**

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distribution is unlimited.**

**LANGMUIR PROBE DIAGNOSTICS OF
FLUCTUATION IN A REFLEX ARC NITROGEN PLASMA**

**Thomas James Haycraft
Major, United States Army**

(AD #701669)

A reflex arc nitrogen plasma in a longitudinal magnetic field has been investigated by means of cylindrical Langmuir probes. Magnetic fields varying from 2400 gauss to 6600 gauss were studied. A radial profile of electron temperature and space potential was obtained as an aid to understanding the inner and outer rotational fluctuations previously noted to be characteristic of the reflex arc column. The effect of crossed magnetic and electric fields resulting in an $\vec{E} \times \vec{B}$ particle drift has been proposed as the primary mechanism of the outer rotational fluctuation, while the inner rotation mechanism has been proposed to be the $\vec{j} \times \vec{B}$ force of the magneto-hydrostatic equation of a plasma in equilibrium. Diagnostic measurements of a theta pinch device on the plasma column were not successful due to circuit pick-up of electric signals due to the theta pinch current pulse.

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**Advisor: A. W. Cooper
Department of Physics**

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**AUTOMATICS SHIELD CONTROL FOR A MODERATE
TEMPERATURE ADIABATIC CALORIMETER**

**Herbert Weldon Head
Captain, United States Army**

(AD #705059)

An automatic, electronic controller was designed for use with adiabatic calorimeters. The controller employed reset action, and its behavior at different system gains was analyzed using the analytic techniques of feedback control theory. In accord with the analysis satisfactory performance was obtained with a calorimeter characterized by large thermal lags, but marginal performance was obtained with another calorimeter characterized by a rapid thermal response. A second controller, which employs reset and proportional action gave satisfactory results during preliminary testing for both calorimeters.

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**Advisor: W. Reese
Department of Physics**

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**COMPUTER SIMULATION OF
FINITE-AMPLITUDE STANDING WAVES
IN RIGID-WALLED DUCTS**

**Richard Mark Kadlick
Lieutenant (junior grade), United States Navy**

(AD #705061)

The Coppens-Sanders Theory for the one-dimensional, nonlinear, acoustic wave equation with dissipative term describing the viscous and thermal energy losses encountered in a rigid-walled, closed tube of large length-to-diameter ratio was applied to finite-amplitude standing waves by the use of the Fast Fourier Transform. Computer programs were written to determine the amplitudes and phases of the first 255 harmonics. Curves of harmonic distortion as a function of the strength parameter were found to be in excellent agreement with available experimental data, to agree with the Coppens-Sanders perturbation analysis, and to extend the theoretically describable régime closer to strengths leading to the formation of the shock front.

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Advisor: Alan B. Coppens
Department of Physics

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**SIMULATION OF A LIQUID METAL FAST BREEDER REACTOR
ON A HYBRID COMPUTER**

**Charles Lee Keller
Lieutenant Commander, United States Coast Guard**

(AD #692446)

A Liquid Metal Fast Breeder Reactor is simulated on a hybrid computer to study the transient behavior of the neutron density during a controlled reactivity input disturbance.

The nonlinear partial differential equations of heat flow are reduced by a discrete space-continuous time method to ordinary nonlinear differential equations which are readily solved on the analog computer. Use is made of time multiplexing of the analog circuitry in order to reduce the number of components. An open-loop iteration process is employed to solve the closed-loop feedback system.

Recently conducted research with the open-loop iteration method has demonstrated that a large number of iterations are required for convergence. An algorithm is developed which gives an improvement in the convergence rate for early values of time. For times greater than two seconds a stability problem with the converged solution was encountered and is discussed with some observations and comments.

Innovations are introduced in the simulation of the neutron kinetics equations and in the handling of the nonlinear thermal properties of the uranium oxide fuel.

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Advisor: A. Gerba, Jr.
Department of Electrical
Engineering

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**MEASUREMENT OF THE CHARGE FORM
FACTORS FOR LITHIUM-SIX AND
LITHIUM-SEVEN BY ELECTRON SCATTERING**

**William Albert Monson
Lieutenant, United States Coast Guard**

(AD #704484)

The charge form factors of the stable lithium isotopes, lithium-six and lithium-seven, were measured in the experiment. The root-mean-square radius of Li^6 was determined to be 2.43 F. The root-mean-square radius of Li^7 was determined to be 2.33 F.

**Master of Science
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**Advisor: F. B. Buskirk
Department of Physics**

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**Laser Light Scattering as a Plasma
Diagnostic Technique**

**Alfred Anthony Pease
Lieutenant (Junior grade), United States Navy**

(AD #710718)

The effort here was concerned with initiating a long term experimental study to develop the method of laser light scattering as a plasma diagnostic technique. This was done with a ruby laser and a grating spectrometer coupled with sensitive detectors, at the steady state plasma facility at the Naval Postgraduate School. Although attempts to detect the extremely low levels of scattered light failed, excellent progress was made in determining existing apparatus limitations and in recognizing which system parameter may be adjusted in order to detect the scattered light; this will enable the future experimenter to progress with a minimum of overlap.

**Master of Science
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June 1968**

**Advisor: F. Schwirzke
Department of Physics**

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**SOUND RADIATED BY SPHERES FALLING IN
POLY(ETHYLENE OXIDE) SOLUTIONS**

**Joseph Michael Sendek
Lieutenant Commander, United States Navy**

(AD #847671)

Sound radiated by spheres freely falling in aqueous solutions of poly(ethylene oxide) WSR-301 at concentrations 0 and 100 wppm was investigated. In solution of 0 wppm concentration, only those spheres with calculated Reynolds numbers (based on the terminal speed) at or above the critical value radiated sufficient energy to be detected above the background. This sound consisted of frequent, distinct noise bursts. In the 100 wppm solution, all spheres with Reynolds numbers near the critical value displayed an increase in speed and a reduction of radiant sound to below background. The one sphere definitely in the supercritical region did not significantly change in speed, and the radiant sound was not reduced as much as for the other spheres. These observations are consistent with the assumption that the noise burst are produced in the wake associated with laminar separation, and with the previous observation that polymer addition shifts the critical Reynolds number of higher values.

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**Advisor: James V. Sanders
Department of Physics**

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REACTION RATES FOR COLLISIONAL DE-EXCITATION OF THE
 $B^2\Sigma_u^+$ STATE OF N_2^+ AND THE $C^3\Pi_u$ STATE OF N_2

Allan Ray Smelley
Lieutenant, United States Navy

Pure nitrogen and nitrogen-oxygen gas mixtures at pressures from 1 to 860 torr and 300°K were excited by 1.5 MeV protons. Intensity versus pressure data were recorded and plotted for the first negative ($B^2\Sigma_u^+ \rightarrow X^2\Sigma_g^+$) transition ($\lambda = 3914.4 \text{ \AA}$), and second positive ($C^3\Pi_u \rightarrow B^3\Pi_g$) transition ($\lambda = 3371.3 \text{ \AA}$) in nitrogen. Theoretical equations were derived for the intensity as a function of pressure, which were shown to agree quite well with the experimental data. The following reaction rates, k , and de-excitation cross sections, σ , were obtained from the derived theoretical equations and the experimental data: $k = (2.19 \pm 0.29) \times 10^{-10} \text{ cm}^3/\text{sec}$ and $\sigma = (3.25 \pm 0.45) \times 10^{-5} \text{ cm}^2$ for the de-excitation of the $B^2\Sigma_u^+$ state of N_2^+ by N_2 ; $k = (5.70 \pm 0.80) \times 10^{-10} \text{ cm}^3/\text{sec}$ and $\sigma = (8.47 \pm 1.26) \times 10^{-5} \text{ cm}^2$ for the de-excitation of the $B^2\Sigma_u^+$ state of N_2^+ by O_2 ; $k = (7.11 \pm 1.64) \times 10^{-2} \text{ cm}^3/\text{sec}$ and $\sigma = (1.06 \pm 0.25) \times 10^{-6} \text{ cm}^2$ for the de-excitation of the $C^3\Pi_u$ state of N_2 by N_2 ; and $k = (4.62 \pm 0.67) \times 10^{-10} \text{ cm}^3/\text{sec}$ and $\sigma = (6.85 \pm 1.10) \times 10^{-15} \text{ cm}^2$ for the de-excitation of the $C^3\Pi_u$ state of N_2 by O_2 .

Master of Science
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Advisor: Edmund A. Milne
Department of Physics

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THE CROSS SECTION FOR THE FORMATION OF H_2^+
IN THE REACTION OF FAST PROTONS WITH METHANE

Norman Robert Anton Smyth
Captain, Canadian Armed Forces

(AD #700272)

The capture cross section for the formation of H_2^+ in the reaction $H^+ + CH_4 \rightarrow H_2^+ + CH_3$ was measured at incident proton energies of 70, 85, 100, 150 and 200 eV and covering the scattering angles of 43° to 49.5° (lab coordinates). At 100 eV and below the curve of the cross section versus angle shows a sharp peak at about 46° whose position approaches the theoretical limit of 46.9° with increasing energy. Above 100 eV the peak was too small to be observed and only an upper limit can be placed on the value of the cross section. Typical values of the total cross section are $2.0 \times 10^{-21} \text{ cm}^2$ at 70 eV and 7.6×10^{-22} at 100 eV. The magnitude and energy dependence of the cross section as well as the angular position of the peak all are in essential agreement with the classical theory of ion-molecule rearrangement collisions proposed by Bates, Cook and Smith.

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Advisor: Otto Heinz
Department of Physics

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DRAG OF FREE FALLING SPHERES IN DILUTE AQUEOUS
SOLUTIONS OF POLY(ETHYLENE OXIDE) FOR
REYNOLDS NUMBERS ABOVE THE CRITICAL VALUE

Edgar Franklin Woolery
Commander, United States Navy

(AD #689724)

Drag of free-falling spheres in water and in dilute aqueous solutions of poly(ethylene oxide) was measured by ejecting the spheres near terminal velocity in a fluid-filled tank. Polymer additive concentrations tested were 1000 wppm, 200 wppm, and 100 wppm. The results agree with previous investigations, available only for sub-critical Reynolds numbers, in that the drag coefficient decreases with increasing water Reynolds number and decreasing polymer concentration. It is shown that in the polymer solutions abrupt decrease in drag coefficient occurs at about the same Reynolds number (3×10^5) as the critical value in water. For Reynolds numbers greater than the critical value, the drag was still less than in water and increased slightly with increasing polymer concentration. At Reynolds numbers between 7 and 8×10^5 , the drag coefficients for all polymer concentrations, including water, abruptly increased to nearly a common value at the upper limit of this investigation.

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