# The Fibonacci Quarterly

THE OFFICIAL JOURNAL OF THE FIBONACCI ASSOCIATION

VOLUME 21 NUMBER 2



MAY 1983

#### CONTENTS

A Note on the Fibonacci Sequence of Order $K$ and the Multinomial Coefficients Andreas $N$ . Philippou	82
Associated Hyperbolic and Fibonacci Identities E. Ehrhart	87
Sequences Generated by Self-Replicating Systems Wesley A. Darbro & Georg von Tiesenhausen	97
Why Are 8:18 and 10:09 Such Pleasant Times?	107
On Exponential Series Expansions and Convolutions	111
Notes on Fibonacci Trees and Their Optimality	118
A Note on Fibonacci Cubature	129
A Family of Polynomials and Powers of the Secant O.R. Ainsworth & J. Neggers	132
A Variant of Nim and a Function Defined by Fibonacci Representation	139
Kronecker's Theorem and Rational Approximation of Algebraic Numbers	143
Elementary Problems and Solutions Edited by A.P. Hillman	147
Advanced Problems and Solutions Edited by Raymond E. Whitney	153

#### **PURPOSE**

The primary function of **THE FIBONACCI QUARTERLY** is to serve as a focal point for widespread interest in the Fibonacci and related numbers, especially with respect to new results, research proposals, challenging problems, and innovative proofs of old ideas.

#### **EDITORIAL POLICY**

THE FIBONACCI QUARTERLY seeks articles that are intelligible yet stimulating to its readers, most of whom are university teachers and students. These articles should be lively and well motivated, with new ideas that develop enthusiasm for number sequences or the exploration of number facts. Illustrations and tables should be wisely used to clarify the ideas of the manuscript. Unanswered questions are encouraged, and a complete list of references is absolutely necessary.

#### SUBMITTING AN ARTICLE

Articles should be submitted in the format of the current issues of the **THE FIBONACCI QUARTERLY.** They should be typewritten or reproduced typewritten copies, that are clearly readable, double spaced with wide margins and on only one side of the paper. The full name and address of the author must appear at the beginning of the paper directly under the title. Illustrations should be carefully drawn in India ink on separate sheets of bond paper or vellum, approximately twice the size they are to appear in print.

Two copies of the manuscript should be submitted to: GERALD E. BERGUM, EDITOR, THE FIBONACCI QUARTERLY, DEPARTMENT OF MATHEMATICS, SOUTH DAKOTA STATE UNIVERSITY, BOX 2220, BROOKINGS, SD 57007-1297.

Authors are encouraged to keep a copy of their manuscripts for their own files as protection against loss. The editor will give immediate acknowledgment of all manuscripts received.

#### SUBSCRIPTIONS, ADDRESS CHANGE, AND REPRINT INFORMATION

Address all subscription correspondence, including notification of address change, to: RICHARD VINE, SUBSCRIPTION MANAGER, THE FIBONACCI ASSOCIATION, UNIVERSITY OF SANTA CLARA, SANTA CLARA, CA 95053.

Requests for reprint permission should be directed to the editor. However, general permission is granted to members of The Fibonacci Association for noncommercial reproduction of a limited quantity of individual articles (in whole or in part) provided complete references is made to the source.

Annual domestic Fibonacci Association membership dues, which include a subscription to **THE FIBONACCI QUARTERLY** are \$20 for Regular Membership, \$28 for Sustaining Membership I, \$44 for Sustaining Membership II, and \$50 for Institutional Membership; foreign rates, which are based on international mailing rates, are somewhat higher than domestic rates; please write for details. **THE FIBONACCI QUARTERLY** is published each February, May, August and November.

All back issues of THE FIBONACCI QUARTERLY are available in microfilm or hard copy format from UNIVERSITY MICROFILMS INTERNATIONAL, 300 NORTH ZEEB ROAD, DEPT P.R., ANN ARBOR, MI 48106.

1983 by
© The Fibonacci Association
All rights reserved, including rights to this journal issue as a whole and, except where otherwise noted, rights to each individual contribution.

### The Fibonacci Quarterly

Founded in 1963 by Verner E. Hoggatt, Jr. (1921-1980) Br. Alfred Brousseau, and I.D. Ruggles

THE OFFICIAL JOURNAL OF THE FIBONACCI ASSOCIATION
DEVOTED TO THE STUDY
OF INTEGERS WITH SPECIAL PROPERTIES

#### **EDITOR**

GERALD E. BERGUM, South Dakota State University, Brookings, SD 57007

#### **ASSISTANT EDITORS**

MAXEY BROOKE, Sweeny, TX 77480
PAUL F. BYRD, San Jose State University, San Jose, CA 95192
LEONARD CARLITZ, Duke University, Durham, NC 27706
HENRY W. GOULD, West Virginia University, Morgantown, WV 26506
A.P. HILLMAN, University of New Mexico, Albuquerque, NM 87131
A.F. HORADAM, University of New England, Armidale, N.S.W. 2351, Australia DAVID A. KLARNER, University of Nebraska, Lincoln, NE 68588
CALVIN T. LONG, Washington State University, Pullman, WA 99163
JOHN RABUNG, Randolph-Macon College, Ashland, VA 23005
DONALD W. ROBINSON, Brigham Young University, Provo. UT 84602
M.N.S. SWAMY, Concordia University, Montreal H3C 1M8, Quebec, Canada D.E. THORO, San Jose State University, San Jose, CA 95152
THERESA VAUGHAN, University of North Carolina, Greensboro, NC 27412
CHARLES R. WALL, Trident Technical College, Charleston, SC 29411
WILLIAM WEBB, Washington State University, Pullman, WA 99163

## BOARD OF DIRECTORS OF THE FIBONACCI ASSOCIATION

G.L. ALEXANDERSON (President)
University of Santa Clara, Santa Clara, CA 95053
LEONARD KLOSINSKI (Vice-President)
University of Santa Clara, Santa Clara, CA 95053
MAJORIE JOHNSON (Secretary)
Santa Clara Unified School District, Santa Clara, CA 95051
DAVE LOGOTHETTI (Treasurer)
University of Santa Clara, Santa Clara, CA 95053
HUGH EDGAR
San Jose State University, San Jose, CA 95192
ROBERT GIULI
Giuli Microprocessing, Inc., San Jose, CA 95193