



*Seventy-Eighth  
Annual Commencement  
June 9, 1972*

CALIFORNIA INSTITUTE OF TECHNOLOGY

*Seventy-Eighth*  
*Annual*  
*Commencement*

FRIDAY MORNING AT TEN-THIRTY O'CLOCK  
JUNE NINTH, NINETEEN SEVENTY-TWO

# *Academic Procession*

*Chief Marshal*, William H. Corcoran, Ph.D.

*Assistant Marshals*

Donald S. Clark, Ph.D.

Jon Mathews, Ph.D.

Anthonie van Harreveld, Ph.D., M.D.

Rodman Paul, Ph.D.

Frederick Thompson, Ph.D.

## MARCHING ORDER

CANDIDATES FOR THE DEGREE OF BACHELOR OF SCIENCE

CANDIDATES FOR THE DEGREE OF MASTER OF SCIENCE

CANDIDATES FOR THE DEGREE OF ENGINEER

CANDIDATES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

THE FACULTY

THE CHAIRMEN OF DIVISIONS

THE DEANS

THE PROVOST

THE TRUSTEES

THE COMMENCEMENT CHAPLAIN

THE PRESIDENT

THE CHAIRMAN OF THE BOARD OF TRUSTEES

# Program

## CALIFORNIA INSTITUTE OF TECHNOLOGY

### *Seventy-Eighth Annual Commencement*

PRESIDING . . . . . Arnold O. Beckman, Ph.D., LL.D.  
*Chairman of the Board of Trustees*

PRELUDE AND PROCESSIONAL  
James H. Shearer, A.R.C.M., A.R.C.O.  
*Organist*

INVOCATION . . . . . The Reverend Raymond A. Saplis  
*Saint Philip Catholic Church, Pasadena*

COMMENCEMENT ADDRESS  
"Technology, Health, and Human Values"  
John R. Hogness, M.D.  
*President, Institute of Medicine, National Academy of Sciences*

CONFERRING OF DEGREES . Harold Brown, Ph.D., D.Eng., LL.D.  
*President, California Institute of Technology*

PRESENTATION OF CANDIDATES FOR DEGREES  
For the degree of Bachelor of Science . . Robert A. Huttenback, Ph.D.  
*Dean of Students*

For the degree of Master of Science . . . Cornelius J. Pings, Ph.D.  
*Dean of Graduate Studies*

For the degree of Engineer . . . . . Dean Pings

For the degree of Doctor of Philosophy . . . . . Dean Pings

CONCLUDING REMARKS . . . . . President Brown

BENEDICTION . . . . . Reverend Saplis

RECESSIONAL . . . . . Mr. Shearer

*The audience is requested to remain standing until  
the end of the Recessional*

## ACADEMIC DRESS

The costume of those in the academic procession has a specific symbolism which dates back to at least the 14th century. While there have been many changes in the details, the meaning of the various parts of the costume continues to be the same. Academic institutions in the United States adopted a code of academic dress in 1895 which has been revised from time to time. The dress of institutions in other countries varies considerably, but the basic elements are present in all academic costumes.

**GOWNS.** The bachelor's gown has long, pointed sleeves; the master's gown has an oblong sleeve open at the wrists (or some older gowns may be open near the upper part of the arm); the doctor's gown is fuller than the others with velvet panels full length on the front and three velvet crossbars on each sleeve in black or in the color distinctive of the subject to which the owner's degree pertains. The gowns are always black except for the doctor's, which in a few instances is of a color representing the institution which conferred the degree.

**HOODS.** The hood, draped over the shoulders and down the back, indicates the subject to which the degree pertains and the university that conferred the degree. The level of the degree is indicated by the size of the hood. The hood for the bachelor's degree is three feet long; for the master's it is three and one-half feet long; and for the doctor's it is four feet long. The binding of the hood is of colored velvet designating the subject of the degree, and it is two inches, three inches, and five inches wide for the bachelor's, master's and doctor's degrees respectively. The colors associated with some of the subjects are as follows:

Arts, Letters, Humanities, *White*  
Commerce, Accountancy, Business, *Drab*  
Economics, *Copper*  
Education, *Light Blue*  
Engineering, *Orange*  
Fine Arts, including Architecture, *Brown*  
Law, *Purple*  
Medicine, *Green*

Pharmacy, *Olive Green*  
Philosophy, *Dark Blue*  
Public Administration, including Foreign  
Service, *Peacock Blue*  
Public Health, *Salmon Pink*  
Science, *Golden Yellow*  
Theology, *Scarlet*

The lining of the hood is of the color or colors of the institution conferring the degree. When two colors are used, they are usually arranged in a single chevron. The lining of the doctor's hood is revealed more than in the master's, and much less is revealed in the bachelor's hood.

**CAPS.** In the United States, the black mortarboard is most commonly used. The tassel fastened to the center of the cap is normally worn in the left front quadrant of the cap and is black, although it may be of the color appropriate to the subject of the degree. The tassel for a doctor's cap may be of gold thread.

# Candidates for Degrees

## BACHELOR OF SCIENCE

Marc Arnold Aaronson *Los Angeles, California* Astronomy  
Joel Adler *Santa Barbara, California* Mathematics-Economics  
Duncan Carr Agnew *Palos Verdes Estates, California* Astronomy  
Carl Reid Anderson *Dallas, Texas* Physics  
Belal Ehsan Baaquie *Dacca, Bangladesh* Physics  
Steven William Battelle *Los Gatos, California* Biology  
John Condon Bean *Cupertino, California* Applied Physics  
Robert Alan Bell *Yuma, Arizona* Chemistry  
John Wesley Blair *Albuquerque, New Mexico* Engineering and Applied Science  
Richard Watson Blakey *Reno, Nevada* Mathematics  
Carroll Wyatt Boswell *Sweetwater, Texas* Mathematics  
Alan Martin Breakstone *San Pedro, California* Physics  
Alan David Bross *Cranford, New Jersey* Physics  
John Ralph Cameron *Glendale, California* Biology  
Dwight Lee Carey *Baldwin Park, California* Geology  
P. Thomas Carroll, Jr. *Altadena, California* History  
Man Lok Peter Chau *Hong Kong, B.C.C.* Engineering and Applied Science  
Yu-Wen Martin Chen *Taipei, Taiwan* Applied Physics  
Anthony Ming-Wah Cheung *Los Angeles, California* Engineering and Applied Science  
Andrew W. Chow *North Highlands, California* Engineering and Applied Science  
Thomas Mitchell Coates *Inglewood, California* Engineering and Applied Science  
Carl Philip Constanten *Las Vegas, Nevada* Engineering and Applied Science  
Loring G. Craymer III *Oklahoma City, Oklahoma* Biology  
Rudy Johan Dam *Semarang, Indonesia* Astronomy  
Peter Lynn Davis *San Francisco, California* Biology  
Christopher Diamantoukos *Jamaica, New York* Mathematics  
David Neil Dobrin *Altadena, California* Mathematics-English  
Paul Vincent Dressendorfer *Dallas, Texas* Physics  
Robert Charles Dullien *Pasadena, California* Engineering and Applied Science  
William John Earl *Stillwater, New Jersey* Engineering and Applied Science  
Duane Russell Edgington *San Diego, California* Engineering and Applied Science  
Douglas Gordon Fay *Tarzana, California* Engineering and Applied Science  
Norman William Finn *Downey, California* Astronomy  
William Everett Frieze *Durham, North Carolina* Physics-Engineering and Applied Science  
Robert Douglas Frisbee *Los Angeles, California* Mathematics  
James Clark Fuhrman *Racine, Wisconsin* Engineering and Applied Science  
Mark Arnold Gaponoff *Lakewood, California* Geophysics  
Jan Diederik Garmany *Baltimore, Maryland* Astronomy  
Nathan Craig Gates *Sonora, California* Engineering and Applied Science

*Students whose names appear in boldface type are being graduated with honor in accordance with a vote of the faculty.*

BACHELOR OF SCIENCE—Continued

- Roger Halloran Goodspeed** *Santa Barbara, California* Engineering and Applied Science
- Steven A. Grandi** *Santa Monica, California* Astronomy
- Gerard Edward Gryczkowski** *Baltimore, Maryland* Engineering and Applied Science-Economics
- James Gregg Haberly** *Woodland Hills, California* Mathematics
- Robert Stephen Hayes** *Lompoc, California* Engineering and Applied Science
- Thomas Smith Hedges** *Kansas City, Missouri* Engineering and Applied Science
- Tav Frank Heistand** *Walnut Creek, California* Mathematics
- Ratchford Clark Higgins** *Sacramento, California* Biology
- Timothy Kenyon Hight** *Los Angeles, California* Engineering and Applied Science
- Glenn Hightower** *Zweibrucken, Germany* Engineering and Applied Science
- Steven Thomas Hoelke** *Claremont, California* Engineering and Applied Science
- Jeffrey Bishop Hurn** *Northridge, California* Biology
- Jonathan Paul Jacky** *Fond Du Lac, Wisconsin* Biology-Engineering and Applied Science
- Herbert Paul Jacobson III** *Quito, Ecuador* Engineering and Applied Science-Economics
- Jesse Garrett Jernigan, Jr.** *Raleigh, North Carolina* Physics
- Bruce Gordon Johnson** *Eugene, Oregon* Applied Physics
- William Hugh Jordan** *Dallas, Texas* Engineering and Applied Science
- Robert Millard Kaufman** *Los Angeles, California* Mathematics
- James Schuyler Ketcham** *El Cajon, California* Engineering and Applied Science
- Steven Elliot Koonin** *Orangeburg, New York* Physics
- Barry James LaBonte** *Warwick, Rhode Island* Economics
- Sai-Kit Alex Law** *Hong Kong, B.C.C.* Physics
- Geoffrey Michael Lee** *San Mateo, California* Mathematics
- Paul Alan Levin** *Riverside, Illinois* Engineering and Applied Science
- Alan Lance Lewis** *Las Vegas, Nevada* Physics
- Randolph Vance Lewis** *Garland, Wyoming* Chemistry
- Robert Kenneth Lewis** *San Marino, California* Mathematics
- Roger Allen Lighty** *Littleton, Colorado* Chemistry-Biology
- Lee Arlow Lindblom** *Meridian, Idaho* Physics
- Jan Lipson** *Brooklyn, New York* Physics
- Andrew Hin-Yeung Lo** *Hong Kong, B.C.C.* Physics
- Charles Nicholas Ludvik** *St. Louis, Missouri* Chemistry
- David Arthur Luippold** *Long Beach, California* Chemistry
- Franklin Tai-Cheung Luk** *Kowloon, Hong Kong, B.C.C.* Mathematics
- Richard G. M. Marko** *Linden, New Jersey* Engineering and Applied Science
- Rodney Tak Masumoto** *Fowler, California* Engineering and Applied Science
- Thomas Kiyoshi Matoi** *Dinuba, California* Engineering and Applied Science
- Oren Vinson Maxwell, Jr.** *Colorado Springs, Colorado* Physics
- George Adams Meadows** *Washington, D.C.* Physics
- Berill Lieding Mitchell** *Sherman Oaks, California* Chemical Engineering
- Kim Warner Mitchell** *Fairfax, California* Applied Physics
- Paul Raymond Morand** *Tiburon, California* Biology
- Lee Alan Morris** *Los Angeles, California* Economics
- Mark Ray Morris** *Sunnyvale, California* Biology

## BACHELOR OF SCIENCE—Continued

Ira Dennis Moskatel *Beverly Hills, California* Engineering and Applied Science  
David Ray Mosley *Phoenix, Arizona* Astronomy  
James Scott Needham *Overland Park, Kansas* English  
Yiu Cheung Ngan *Hong Kong, B.C.C.* Physics  
George L. Nicolaides *Athens, Greece* Chemical Engineering  
Lance Michael Optican *Denver, Colorado* Independent Study Program  
Thomas Eugene Osheroff *Aberdeen, Washington* Physics  
Robert Joseph Panek *Dracut, Massachusetts* Astronomy  
Norman R. Pendegraft *Fresno, California* Chemistry  
Joseph E. Pendergast, Jr. *Bellport, New York* Mathematics  
Russell Felix Pinizzotto, Jr. *Hammonton, New Jersey* Chemistry  
Ken Donald Pischel *Solvang, California* Biology  
Frank Clifford Porter *Schenectady, New York* Physics  
George Allen Rappolt *Philadelphia, Pennsylvania* Biology  
Paul Bartlett Re *Albuquerque, New Mexico* Physics  
Gary Kevin Reedy *Scottsdale, Arizona* Applied Physics  
Tad Edward Reynales *Long Beach, California* Biology  
Harvey Alan Risch *Los Angeles, California* Biology-Mathematics  
Neil Jay Risch *Los Angeles, California* Mathematics  
Jeffrey Alan Ross *Southfield, Michigan* Mathematics  
Gary Victor Ruby *Levittown, Pennsylvania* Engineering and Applied Science  
Daniel Jay Rudolph *Fort Collins, Colorado* Mathematics  
Craig Leigh Sarazin *Milwaukee, Wisconsin* Physics  
Daniel Lee Scharre *Pasadena, California* Physics  
Brian Sarsfield Seed *Scarsdale, New York* Biology  
Steven Allen Shaiman *Long Beach, California* Mathematics  
John Steven Sheffield *Temple Terrace, Florida* Mathematics  
Robert McKinnon Shelby *Lafayette, California* Chemistry  
David Hugh Shoulders *Grants Pass, Oregon* Engineering and Applied Science  
John Michael Shull *Des Peres, Missouri* Physics  
Scott Gary Siegel *Brooklyn, New York* Physics  
Robert Wayne Siegfried II *Villa Park, Illinois* Physics  
Robert Marc Sills *Drexel Hill, Pennsylvania* Astronomy  
James Pat Simmons, Jr. *Scottsdale, Arizona* Applied Physics  
Dan Alan Sinema *Phoenix, Arizona* Chemical Engineering  
David Andrew Smith *Miraleste, California* Engineering and Applied Science  
David Joseph Smith *Middletown, New York* Mathematics  
Robert McCoy Spencer *McMinnville, Oregon* Chemical Engineering  
Gary Irwin Spivak *Denver, Colorado* Economics  
Gregg Byron Stearns *Pico-Rivera, California* Engineering and Applied Science  
Gary Dean Stormo *Granada Hills, California* Biology  
John Pressley Stuart *Tustin, California* Physics  
Paul Studenski *Oswego, New York* Biology  
Gregory Tarlé *Fresh Meadows, New York* Physics  
Charles Bruce Thoele *St. Louis, Missouri* Economics  
John Richard Trtek *Hillsboro, Oregon* Astronomy  
Harley Yau-Shuin Tse *Wanchai, Hong Kong, B.C.C.* Biology  
Ka-Kit Tung *Los Angeles, California* Engineering and Applied Science  
Bernard D. Unger *North Hollywood, California* Chemical Engineering



BACHELOR OF SCIENCE—*Continued*

**Bruce Alan Waddington** *Long Beach, California* Astronomy  
**Raymond William Waldo** *Glendale, California* Physics  
**James Huang Wei** *South Orange, New Jersey* Physics  
**Thomas Beckwith Wells** *LaGrange, Georgia* Physics  
**Samuel Eric Wheatley** *Winter Park, Florida* Applied Physics  
**Albert Chingkwang Yen** *Palos Verdes, California* Mathematics  
**Sze Chuen Yeung** *Hong Kong, B.C.C.* Physics  
**James Earl York III** *Richmond, Virginia* Geology  
**Charles Yee-Yun Young** *North Point, Hong Kong, B.C.C.* Engineering and Applied  
Science  
**Ralph Gerhard Zimmermann** *Phoenix, Arizona* Engineering and Applied Science  
**Paul Solomon Zygielbaum** *Woodland Hills, California* Engineering and Applied  
Science

## MASTER OF SCIENCE

- Michael Jack Abrams (*Geology*). B.S., California Institute of Technology, 1970.
- William Thomas Almassy (*Mechanical Engineering*). B.A., Occidental College, 1971; B.S., California Institute of Technology, 1971.
- Kiran Ravindra Bakshi (*Chemical Engineering*). B.S., Indian Institute of Technology, Bombay, 1970.
- Anthony Graham Barre (*Engineering Science*). B.S., United States Military Academy, 1970.
- Richard Berry Baxter (*Aeronautics*). B.S., United States Naval Academy, 1971.
- David Floyd Becker (*Environmental Engineering Science*). B.S., B.A., Pennsylvania State University, 1971.
- Robert Alan Bell (*Chemistry*).
- Dan Edgard Bergher (*Civil Engineering*). B.Sc., Israel Institute of Technology, 1968.
- Daniel Robert Berker (*Mathematics*). B.S., Purdue University, 1968; M.S. (EE), California Institute of Technology, 1969.
- Thomas Jay Bicknell (*Electrical Engineering*). B.S., California Institute of Technology, 1970.
- Terry Allen Boardman (*Aeronautics*). A.B., Whitman College, 1971; B.S., California Institute of Technology, 1971.
- Eric Rene Boissaye (*Civil Engineering*). Engineer, Ecole Nationale Supérieure des Mines de Paris, 1971.
- Francois Marcel Bouteille (*Aeronautics*). Engineer, Ecole Centrale des Arts & Manufactures, 1971.
- Nelson Elliott Brestoff (*Environmental Engineering Science*). B.S., University of California, Los Angeles, 1971.
- Michael Welch Burnett (*Geology*). B.S., Boston College, 1968; M.S., 1970.
- Gerald Aldridge Butler (*Aeronautics*). B.S., University of Colorado, 1970.
- Johnnie B. Cannon (*Mechanical Engineering*). B.S., Tuskegee Institute, 1970.
- James Rodney Carl (*Engineering Science*). B.S., Iowa State University, 1970.
- Emmy Tong Chan (*Chemistry*). B.S., San Jose State College, 1970.
- Raymond Yuen-Fong Chan (*Engineering Science*). B.S., California State Polytechnic College, San Luis Obispo, 1971.
- Nim-Kwan Cheung (*Physics*). B.Sc., University of Hong Kong, 1970.
- Wilson Chun-Ling Chin (*Aeronautics*). B.S., New York University, 1971.
- Patrick Elton Clark (*Electrical Engineering*). B.A., San Francisco State College, 1971; B.S., Columbia University, 1971.
- Barry Michael Cohn (*Electrical Engineering*). B.S., University of Washington, 1971.
- Robert John Czarny (*Chemistry*). B.S., Providence College, 1969.
- Yoshiaki Tsuneo Daimon (*Electrical Engineering*). B.S., California Institute of Technology, 1971.
- Gregory John Del Zoppo (*Biology*). B.S., University of Washington, 1969.
- Robert Luther Derham (*Chemical Engineering*). B.S., University of Maine, 1971.
- Scott Wallace Dichter (*Materials Science*). B.S., University of Michigan, 1968.

MASTER OF SCIENCE—Continued

- David Howard Dorn (*Environmental Engineering Science*). B.A., University of California, San Diego, 1970.
- William Karl Faisst (*Environmental Engineering Science*). B.S., University of California, Davis, 1971.
- Robert Allen Farr (*Chemistry*). B.S., Ohio State University, 1970.
- Samuel Robert Maurice Gardiner (*Mechanical Engineering*). B.A.Sc., University of British Columbia, 1971.
- Edward Maurice Gates (*Mechanical Engineering*). B.Sc., University of Alberta, 1971.
- Cheuk Fee Gong (*Electrical Engineering*). B.S., University of Rhode Island, 1971.
- Thomas Joaquin Goreau (*Planetary Science*). S.B., Massachusetts Institute of Technology, 1970.
- James Edward Grover (*Applied Mathematics*). B.S., University of New Mexico, 1970.
- Samuel Furmon Guilbeau (*Geology*). S.B., Massachusetts Institute of Technology, 1967.
- Gregory Prince Hamill (*Applied Physics*). A.B., Boston University, 1971.
- Robert Bruce Hammond (*Applied Physics*). B.S., California Institute of Technology, 1971.
- Joe Marion Harris, Jr. (*Electrical Engineering*). B.S., Lamar State College of Technology, 1970.
- Claude Gabriel Hauviller (*Aeronautics*). Ing. Civ. Aero., Ecole Nationale Supérieure de L'Aeronautique et de l'Espace, 1971.
- Lambertus Hesselink (*Mechanical Engineering*). Bachelor Mechanics, Twente University of Technology, 1970; Bachelor Physics, 1971.
- William Aro Hill (*Biology*). B.A., Cornell University, 1965.
- Thomas Russell Holm (*Environmental Engineering Science*). B.S., Portland State University, 1971.
- Tetsuichi Ito (*Aeronautics*). B.E., Kyushu University, 1966; M.E., 1968.
- Yeeben Jung (*Aeronautics*). B.S., Polytechnic Institute of Brooklyn, 1971.
- Robert Millard Kaufman (*Mathematics*).
- Stuart Ronald Keller (*Engineering Science*). B.S., Purdue University, 1971.
- Frank Kendall III (*Aeronautics*). B.S., United States Military Academy, 1971.
- Michael Braun Kindergan (*Chemistry*). B.A., Wesleyan University, 1969.
- Robert James Kinney (*Chemistry*). B.S., Iowa State University, 1971.
- Peter Douglas Kirkwood (*Environmental Engineering Science*). S.B., Massachusetts Institute of Technology, 1966.
- Doyle Dana Knight (*Aeronautics*). B.A., Occidental College, 1971; B.S., California Institute of Technology, 1971.
- Francois Bruno Koenig (*Mechanical Engineering*). Diploma, Ecole Nationale Supérieure d'Electricité et de Mécanique, 1971.
- John Harrison Konrad (*Aeronautics*). B.S., Oklahoma State University, 1971.
- Nikolas Evangelos Kotsovinos (*Civil Engineering*). Civ. Eng. Diploma, Aristotelion University of Thessaloniki, 1967.

MASTER OF SCIENCE—*Continued*

- Sandor Janos Kovacs, Jr. (*Physics*). B.S., Cornell University, 1969.
- Daniel Sai Wah Kwok (*Physics*). A.B., Princeton University, 1970.
- Glenn Alan Laguna (*Applied Physics*). B.S., State University of New York, Stony Brook, 1971.
- Warren Yiu-cho Lai (*Physics*). B.S., University of California, Berkeley, 1970.
- Jane Elinor Latta (*Biology*). A.B., Goucher College, 1968.
- Kei-Fung Lau (*Applied Physics*). B.S., Stetson University, 1971.
- Amy Shiu Lee (*Biology*). B.A., University of California, Berkeley, 1970.
- Lang Wah Lee (*Engineering Science*). B.S., Tsing Hwa University, 1959; M.S., University of Wyoming, 1969.
- Lou-Chuang Lee (*Physics*). B.S., National Taiwan University, 1969.
- David Donald Mantrom (*Aeronautics*). B.S., Northrop Institute of Technology, 1971.
- Anil Marathe (*Aeronautics*). B. Tech., Indian Institute of Technology, Bombay, 1971.
- Bentson Hayes McFarland (*Biology*). B.S., Yale University, 1970.
- Stephen George McGrath (*Civil Engineering*). B.S., University of New Hampshire, 1968.
- Derek John McKay (*Environmental Engineering Science*). B.Sc., University of Auckland, 1969; B.E., 1971.
- Gary Wayne McLeod (*Astronomy*). B.Ph., University of Minnesota, 1970.
- Dallas J. Meggitt (*Environmental Engineering Science*). B.S., California Institute of Technology, 1965; M.S., 1966.
- Frank Smith Merritt (*Physics*). B.A., Columbia College, 1970.
- Robert Naham Miller (*Applied Mathematics*). A.B., Brown University, 1971.
- Berill Lieding Mitchell (*Chemical Engineering*).
- Mona Mazen Mohsen (*Electrical Engineering*). B.S., Cairo University, 1970.
- Marc Jules Moronval (*Aeronautics*). Diplome d'Ingenieur, Ecole Nationale Supérieure des Arts et Metiers, 1971; Maitrise de Mechanique, Faculte des Sciences, 1971.
- Chaivat Nambenchaphol (*Mechanical Engineering*). B. Eng., Chulalongkorn University, 1970.
- Vard A. Nelson (*Geophysics*). B.S., California Institute of Technology, 1970.
- Dennis Dean Niehoff (*Civil Engineering*). B.S., University of Illinois, 1971.
- Don Nelson Page (*Physics*). A.B., William Jewell College, 1971.
- James Charles Pearce (*Mechanical Engineering*). B.S., California State Polytechnic College, Pomona, 1971.
- William Andrew Phillips (*Geochemistry*). B.A., Haverford College, 1969.
- John Nicholas Power (*Physics*). B.S., Loyola College, 1967.
- Andrea Prosperetti (*Engineering Science*). Laurea in Fisica, University of Milan, 1968.
- Harry Alan Quandt (*Applied Mechanics*). B.S., Polytechnic Institute of Brooklyn, 1971.

MASTER OF SCIENCE—Continued

- Quoc Dung Quang (*Aeronautics*). B.S., University of New Mexico, 1971.
- Thomas Joseph Quinlan (*Biology*). B.S., Ohio State University, 1970.
- Antonio Redondo-Muino (*Applied Physics*). B.S., Utah State University, 1971.
- Philip Joseph William Roberts (*Environmental Engineering Science*). B.Sc., Imperial College, 1968; S.M., Massachusetts Institute of Technology, 1970.
- Christian Allan Rofer (*Mathematics*). B.A., University of California, Santa Barbara, 1969.
- Stewart Francis Sando, Jr. (*Electrical Engineering*). B.S., California Institute of Technology, 1971.
- Gary Carl Scheidt (*Biology*). B.S., Michigan State University, 1967.
- William David Schwaderer (*Applied Mathematics*). B.S., New Mexico State University, 1970.
- Piyush Chimanlal Shah (*Aeronautics*). B. Tech., Indian Institute of Technology, Bombay, 1971.
- Dhiraj Kumar Sharma (*Electrical Engineering*). B. Tech., Indian Institute of Technology, Kanpur, 1971.
- Steven Lee Shuler (*Mechanical Engineering*). B.A., Occidental College, 1971; B.S., California Institute of Technology, 1971.
- Donald Lawrence Smith (*Environmental Engineering Science*). B.S., California Institute of Technology, 1971.
- James George Smith (*Environmental Engineering Science*). B.S., University of California, Davis, 1971.
- Paul Mathew Studenski (*Electrical Engineering*).
- Guaning Su (*Electrical Engineering*). B.Sc., University of Alberta, 1971.
- Margaret MacMorris Swanson (*Biology*). B.A., University of Colorado, 1970.
- Ronald Jon Swanson (*Geology*). B.S., California Institute of Technology, 1971.
- Gregory Ligot Tangonan (*Applied Physics*). B.S., Ateneo de Manila University, 1969; M.S., California State College, Long Beach, 1971.
- Tahsin Tezduyar (*Aeronautics*). Higher Engineering Diploma, Technical University of Istanbul, 1969.
- Robert Ivan Toombs (*Physics*). B.S., University of Washington, 1968.
- Yoshio Tsuchiyama (*Applied Mechanics*). S.B., Kyushu University, 1959.
- Lawrence K. L. Tu (*Materials Science*). B.S., National Taiwan University, 1968; M.S., University of Texas, 1970.
- Ka-Kit Tung (*Aeronautics*).
- Shiram Mahabal Udupa (*Engineering Science*). Bach. of Tech., Indian Institute of Technology, Bombay, 1971.
- Richard Milan Ward (*Mechanical Engineering*). B.S., University of Washington, 1971.
- Greg L. Wojcik (*Aeronautics*). B.S., California State Polytechnic College, San Luis Obispo, 1971.
- Richard Frederic Wright (*Geochemistry*). B.S., Dartmouth College, 1966; M.S., Yale University, 1967.

## MASTER OF SCIENCE—Continued

Gary Hideo Yamamoto (*Environmental Engineering Science*). B.S., University of California, Berkeley, 1971.

George Thomas Yates (*Engineering Science*). B.S., Purdue University, 1971.

Huan-Wun Yen (*Electrical Engineering*). B.S., National Taiwan University, 1970.

Der-Liang Young (*Civil Engineering*). B.S., National Taiwan University, 1968; M.S., 1971.

Erdinc Zana (*Chemical Engineering*). B.S., Tulsa University, 1970.

## ENGINEER

Jean-Pierre Dolait (*Aeronautical Engineer*). Diploma in Mechanical Engineering, Ecole Nationale D'Ingenieurs Arts et Metiers, 1969; M.S., California Institute of Technology, 1970.

Jean Noel Giraudbit (*Aeronautical Engineer*). Mecanique des Milieux Deformables, Faculte des Sciences, 1968; Diplome, Ecole Nationale Superieure des Arts et Metiers, 1969; M.S., California Institute of Technology, 1970.

Gregory Don Hulcher (*Aeronautical Engineer*). B.A., University of Minnesota, 1968; M.S., California Institute of Technology, 1969.

Arun Narayan Kulkarni (*Aeronautical Engineer*). B.E.Mech., College of Engineering, Poona, 1969; M.S., California Institute of Technology, 1970.

Gavien Nobuyuki Miyata (*Aeronautical Engineer*). B.S., California Institute of Technology, 1969; M.S., 1970.

Franciscus Nieuwstadt (*Aeronautical Engineer*). Ir., Technological University, Delft, 1969.

David Edwin Van Dillen (*Aeronautical Engineer*). B.S., Rutgers University, 1967; M.S., California Institute of Technology, 1969.

## DOCTOR OF PHILOSOPHY

- Saul Joseph Adelman (*Astronomy*). B.S., University of Maryland, 1966.  
*Thesis*: A Study of Twenty-One Sharp-Lined Non-Variable Cool Peculiar A Stars.
- Michael Paul Anthony (*Electrical Engineering and Physics*). B.S., California Institute of Technology, 1966; M.S., 1967.  
*Thesis*: Electrical and Optical Properties of Beta-Gallium Oxide.
- Christopher Henry Bajorek (*Electrical Engineering and Economics*). B.S., California Institute of Technology, 1967; M.S., 1968.  
*Thesis*: Spin Wave Resonance in Ferromagnetic Thin Films.
- Mary Baker (*Applied Mechanics*). B.S., University of Wisconsin, 1966; M.S., California Institute of Technology, 1967.  
*Thesis*: Double-Slit Photometric Measurement of Velocity Profiles of Blood in Microvessels and Capillary Tubes.
- George Nick Balanis (*Electrical Engineering and Applied Mathematics*). B.S., California Institute of Technology, 1967; M.S., 1968.  
*Thesis*: Plasma Inverse Scattering Theory.
- Mohsen Mohamed Baligh (*Civil Engineering*). B.Sc., Cairo University, 1966; M.Sc., 1968; M.S., California Institute of Technology, 1969.  
*Thesis*: Applications of Plasticity Theory to Selected Problems in Soil Mechanics.
- Steven Joseph Barker (*Engineering Science and French*). B.S., Harvey Mudd College, 1967; M.S., California Institute of Technology, 1968.  
*Thesis*: Radiated Noise from Turbulent Boundary Layers in Dilute Polymer Solutions.
- Steven Kent Beckendorf (*Biochemistry and Genetics*). A.B., University of California, Los Angeles, 1966.  
*Thesis*: Studies of Bacteriophage T4 Tail Fibers and Tail Fiber Genes.
- Robert Michael Benbow (*Biophysics and Chemistry*). B.S., Yale University, 1967.  
*Thesis*: On the Genetic Recombination of Bacteriophage  $\Phi$ X174 DNA Molecules.
- Kostia Bergman (*Biophysics*). B.A., Johns Hopkins University, 1965.  
*Thesis*: Sensory Responses of *Phycomyces*: I. Blue-Light Control of Sporangiophore Initiation. II. Classification of *mad* Mutants.
- Timothy Charles Betts (*Chemistry*). A.B., Humboldt State College, 1966.  
*Thesis*: Rydberg States of Diatomic and Polyatomic Molecules Using Model Potentials.
- Richard Joseph Blint (*Chemistry*). B.A., St. Mary's College, 1967.  
*Thesis*: I. Orbital Interpretation and Properties of the  $X^1\Sigma^+$ ,  $a^3\Pi$ ,  $A^1\Pi$ , and  $s^2\Sigma^+$  States of BH. II. Gas Phase Reactions of Fluoromethyl Cations with Ethylene and Benzene.
- George Samuel Brockway II (*Applied Mechanics*). B.S., University of Miami, 1966; M.S., Georgia Institute of Technology, 1968.  
*Thesis*: On the Uniqueness of Singular Solutions to Boundary-Initial Value Problems in Linear Elastodynamics.
- Michael Akylas Caloyannides (*Electrical Engineering, Applied Mathematics and Philosophy*). B.S., California Institute of Technology, 1967; M.S., 1968.  
*Thesis*: A Mathematical and Experimental Investigation of Microcycle Spectral Estimates of Semiconductor Flicker Noise.
- Sebastien M. Candel (*Mechanical Engineering and Applied Mathematics*). Ing., Ecole Centrale des Arts et Manufactures, 1968; M.S., California Institute of Technology, 1969.  
*Thesis*: Analytical Studies of Some Acoustic Problems of Jet Engines.

DOCTOR OF PHILOSOPHY—Continued

- Chih-Chieh Chao (*Materials Science and Physics*). B.S., University of Illinois, 1965; M.S., California Institute of Technology, 1966.  
*Thesis*: Lattice Anomalies and Magnetic States in  $\text{Fe}_3\text{Si}_8$  -  $\text{Mn}_3\text{Si}_8$  Alloys.
- Edward Jay Chapyak (*Engineering Science*). B.S., California Institute of Technology, 1968.  
*Thesis*: Surface Effects in Simple Molecular Systems.
- Jay-Chung Chen (*Aeronautics*). B.S., Taiwan Cheng Kung University, 1962; M.S., California Institute of Technology, 1964; Ae.E., 1967.  
*Thesis*: Nonlinear Vibration of Cylindrical Shells.
- Clark Gardner Christensen (*Astronomy*). B.S., Brigham Young University, 1966.  
*Thesis*: The Synthesis of Composite Spectra: A Study of Four Globular Clusters of the Galaxy, Five Globular Clusters of M31, and the Nucleus of NGC 205.
- David Chu (*Physics*). B.S., California Institute of Technology, 1966.  
*Thesis*: An Investigation of the Reaction  $\text{K}^- \text{p} \rightarrow \text{K}^- \text{n}^+ \text{n}$  at  $P_{\text{lab}} = 2 \text{ GeV/c}$ .
- Robert Edward Cohen (*Chemical Engineering*). B.S., Cornell University, 1968; M.S., California Institute of Technology, 1970.  
*Thesis*: Dynamic Mechanical Properties of Block Copolymer Blends — A Study of the Effects of Terminal Chains in Elastomeric Materials.
- Michael Brian D'Amore (*Chemistry*). B.S., Providence College, 1967.  
*Thesis*: Synthesis and Reactions of Bicyclo [3.2.0] hepta-1, 4, 6-triene.
- Joseph Eugene Davis (*Aeronautics and Economics*). B.S., University of Southern California, 1968; M.S. California Institute of Technology, 1969.  
*Thesis*: Non-Planar Wings in Non-Planar Ground Effect.
- Phoebe Kin-Kin Dea (*Chemistry*). B.S., University of California, Los Angeles, 1967.  
*Thesis*: The Nature of the Intramolecular Hydrogen-Bond in the Enol Tautomer of 2, 4-Pentanedione.
- Paul Maurice Debrule (*Engineering Science and Business Economics*). Ing. Physicien, Universite de Liege, 1967; M.S., California Institute of Technology, 1968.  
*Thesis*: Friction and Heat Transfer Coefficients in Smooth and Rough Pipes with Dilute Polymer Solutions.
- David Fielder Eaton (*Chemistry*). B.A., Wesleyan University, 1968.  
*Thesis*: I. Synthesis and Decomposition of Several 2,3-Diazabicyclo[3.1.0]hex-2-enes. II. Wavelength Effects in Piperylene Photoisomerization.
- Sarah Carlisle Roberts Elgin (*Biochemistry and Neurophysiology*). B.A., Pomona College, 1967.  
*Thesis*: Investigations of Nonhistone Chromosomal Proteins.
- Lawrence Curtis Evans (*Physics, Geophysics, Applied Mathematics and Business Economics*). A.B., Pomona College, 1966.  
*Thesis*: Magnetospheric Access of Solar Particles and the Configuration of the Distant Geomagnetic Field.
- Richard Alan Firtel (*Cell Biology and Developmental Biology*). A.B., Dartmouth College, 1966.  
*Thesis*: I. Regulation of Development in the Cellular Slime Mold *Dictyostelium discoideum*. II. Polysomes and RNA Synthesis During Early Development of the Surf Clam *Spisula solidissima*.



DOCTOR OF PHILOSOPHY—*Continued*

- Kenneth William Foster (*Biophysics*). B.Sc., University of Victoria, 1965.  
*Thesis*: The Photoresponse of *Phycomyces*: Analysis Using Manual Techniques and an Automated Machine Which Precisely Tracks and Measures Growth During Programmed Stimuli.
- Ralph Stanley Freese (*Mathematics*). B.A., University of California, Santa Barbara, 1968.  
*Thesis*: Varieties Generated by Modular Lattices of Width Four.
- Dennis Masato Furuike (*Applied Mechanics*). B.A., Occidental College, 1967; B.S., California Institute of Technology, 1967; M.S., 1968.  
*Thesis*: Dynamic Response of Hysteretic Systems with Application to a System Containing Limited Slip.
- Okitsugu Furuya (*Mechanical Engineering*). B.E., University of Tokyo, 1965; M.S., California Institute of Technology, 1969.  
*Thesis*: A Singular Perturbation Method of Calculating the Behavior of Supercavitating Hydrofoils with Rounded Noses.
- Antony Wilfred Goodwin (*Engineering Science*). B.Sc., University of the Witwatersrand, 1967; M.S., California Institute of Technology, 1969.  
*Thesis*: The Oculomotor System: I. Vertical-Horizontal Interaction and Signal Recognition. II. Time Delays and Power Spectra.
- Norton Robert Greenfeld (*Engineering Science*). B.S., California Institute of Technology, 1967; M.S., 1968.  
*Thesis*: Computer System Support for Data Analysis.
- Vincent Peter Gutschick (*Chemistry*). B.S., University of Notre Dame, 1966.  
*Thesis*: I. Ultrasonic Studies of Binary Liquid Structure in the Critical Region. Theory and Experiment for the 2,6-Lutidine/Water System. II Hartree-Fock Calculations of Electric Polarizabilities of Some Simple Atoms and Molecules, and Their Practicality. III. Calculation of Vibrational Transition Probabilities in Collinear Atom-Diatom and Diatom-Diatom Collisions with Lennard-Jones Interaction.
- Christopher John Hamer (*Physics*). B.Sc., University of Melbourne, 1966.  
*Thesis*: The Statistical Bootstrap Model.
- Joseph Leonard Hammack, Jr. (*Civil Engineering*). B.S., North Carolina State University, 1966; M.S., 1968.  
*Thesis*: Tsunamis — A Model of Their Generation and Propagation.
- Thomas Colgrove Hanks (*Geophysics*). B.S., Princeton University, 1966.  
*Thesis*: A Contribution to the Determination and Interpretation of Seismic Source Parameters.
- Olav Louis Hansen (*Planetary Science*). B.Sc., Simon Fraser University, 1968; M.S., California Institute of Technology, 1969.  
*Thesis*: Thermal Radiation from the Galilean Satellites Measured at 10 and 20 Microns.
- Philip Jeffrey Hay (*Chemistry and Physics*). B.A., Franklin and Marshall College, 1967.  
*Thesis*: I. Generalized Valence Bond Theory of Electronic Structure. II. Superexchange in Insulators.

DOCTOR OF PHILOSOPHY—*Continued*

- David Ellis Hiatt (*Biology*). B.A., Harvard University, 1967; M.A., University of Michigan, 1969.  
*Thesis*: Investigations of Operant Conditioning of Single Unit Activity in the Rat Brain.
- Bruce Hoeneisen-Frost (*Electrical Engineering and Physics*). Eng., University of Chile, 1968; M.S., California Institute of Technology, 1970.  
*Thesis*: I. Fundamental Limitations in Microelectronics. II. Power Schottky Diode Design and Comparison with the Junction Diode. III. Permittivity of Strontium Titanate.
- George Chi Hsu (*Chemical Engineering*). B.S., Tunghai University, 1964; M.S., Illinois Institute of Technology, 1967.  
*Thesis*: Estimation of Catalyst Activity Profiles and Deactivation Parameters from Reactor Operating Data with Applications to Naphtha Reforming.
- Wray Hughes Huestis (*Biophysics and Chemistry*). B.A., Macalester College, 1967.  
*Thesis*: Nuclear Magnetic Resonance Studies of Protein Conformation.  
I. Ribonuclease S. II. Hemoglobin.
- William James Hunt (*Chemistry*). B.S., University of Mississippi, 1967.  
*Thesis*: Electronic Wavefunctions for Small Molecules.
- Charles Royal Johnson (*Mathematics and Economics*). B.A., Northwestern University, 1969.  
*Thesis*: Matrices whose Hermitian Part is Positive Definite.
- Gordon Oliver Johnson (*Electrical Engineering*). B.S., Walla Walla College, 1966; M.S., California Institute of Technology, 1967.  
*Thesis*: Effects of Magnetostriction and Superlattice Formation in Ferromagnetic Thin Films.
- Luis Ricardo Kahn (*Chemistry and Physics*). B.S., The City College of New York, 1966.  
*Thesis*: I. *Ab-Initio* Effective Potentials for Use in Molecular Calculations.  
II. The Sternheimer Correction, Perturbation Theory and Approximate Wavefunctions. III. The Theoretical Determination of the  $\text{Li}_2\text{B}^1\pi_u$  Potential Energy Curve.
- Robert Nicholas Kavanagh (*Engineering Science*). B.S., University of Saskatchewan, 1964; M.Sc., 1966.  
*Thesis*: Localization of Sources of Human Evoked Responses.
- James Paul Keener (*Applied Mathematics*). B.S., Case Institute of Technology, 1968; M.S., California Institute of Technology, 1969.  
*Thesis*: Some Modified Bifurcation Problems with Application to Imperfection Sensitivity in Buckling.
- Byung-Koo Kim (*Applied Mechanics*). B.S., University of Michigan, 1968; M.S., California Institute of Technology, 1969.  
*Thesis*: Piecewise Linear Dynamic Systems with Time Delays.
- Jungsoh Park Kim (*Chemistry*). B.S., Seoul National University, 1966.  
*Thesis*: Studies on T-even Bacteriophage DNA.

DOCTOR OF PHILOSOPHY—Continued

- Randall Keenan Kirschman (*Physics and Electrical Engineering*). B.S., University of California, Berkeley, 1966; M.S., California Institute of Technology, 1969.  
*Thesis*: Experimental Studies of Weak Superconductivity.
- Bruce Edward Kirstein (*Chemical Engineering*). B.S., University of Illinois, 1966.  
*Thesis*: The Structure of Liquid Argon as Determined by X-Ray Diffraction.
- Ronald Jerome Konopka (*Biochemistry and Chemistry*). B.S., University of Dayton, 1967.  
*Thesis*: Circadian Clock Mutants of *Drosophila melanogaster*.
- Carol Lee Kornblith (*Biology*). A.B., University of Michigan, 1966; M.A., 1968.  
*Thesis*: Conditioned Responses in the Reticular Formation.
- Lee-Ming Kow (*Neurophysiology*). B.S., National Taiwan University, 1962; M.S., University of Florida, 1968.  
*Thesis*: Study of Ion Movements in Isolated Chicken Retinas During Spreading Depression.
- George Paul Kreishman (*Chemistry*). B.S., University of Wisconsin, 1967.  
*Thesis*: Magnetic Resonance Studies of Ribonucleic Acid Complexes.
- Robert Charles Ladner (*Chemistry*). B.A., Rice University, 1966.  
*Thesis*: Independent-Particle Potential-Energy Surfaces for Chemical Reactions.
- Chi-Yu Gregory Lee (*Chemistry*). B.Sc., National Taiwan University, 1967; M.S., California Institute of Technology, 1971.  
*Thesis*: Tautomerism of Nucleic Acid Bases and PMR Studies of Histones.
- Paul Lung Sang Lee (*Physics*). B.S., California Institute of Technology, 1967; M.S., 1969.  
*Thesis*: Isotope Shift Studies in the Rare Earths and Lead.
- Hong Sup Lim (*Chemistry*). B.S., Seoul National University, 1965; M.S., 1967.  
*Thesis*: Chemical and Electrochemical Investigations of Cobalt Cyanide and Ruthenium Ammine Complexes.
- Michael Jay Lineberry (*Engineering Science and Physics*). B.S., University of California, Los Angeles, 1967; M.S. California Institute of Technology, 1968.  
*Thesis*: Neutron Slowing Down with Inelastic Scattering.
- Raphael Loewy (*Mathematics*). B.S., Technion, Israel Institute of Technology, 1965; M.Sc., 1969.  
*Thesis*: On the Lyapunov Transformation for Stable Matrices.
- Samuel Ernest Logan (*Aeronautics*). B.S., California Institute of Technology, 1968; M.S., 1969.  
*Thesis*: Laser Velocimeter Measurement of Reynolds Stress and Turbulence in Dilute Polymer Solutions.
- Stewart Christian Loken (*Physics*). B.Sc., McMaster University, 1966; M.S., California Institute of Technology, 1969.  
*Thesis*: Inelastic  $K^+p$  Reactions at Incident Momenta from 1.37 to 2.17 GeV/c.
- Cary Lu (*Biology*). A.B., University of California, Berkeley, 1966.  
*Thesis*: The Interaction of Color and Luminance in Stereoscopic Vision.
- John Edward Lupton (*Physics*). A.B., Princeton University, 1966.  
*Thesis*: Solar Flare Particle Propagation—Comparison of a New Analytical Solution with Spacecraft Measurements.

DOCTOR OF PHILOSOPHY—Continued

- Hay Boon Mak (*Physics*). B.Sc., McGill University, 1966.  
*Thesis*: Part I. Total Yield Measurement for the  $^{21}\text{Ne}(\alpha, n)^{24}\text{Mg}$  Reaction.  
 Part II. A Study of the  $^{12}\text{C}(^3\text{He}, p)^{14}\text{N}$  Reaction.
- Michael Leigh Mallary (*Physics*). S.B., Massachusetts Institute of Technology, 1966.  
*Thesis*: CP and the Three Pion Decay of the Neutral K Meson.
- Panagiotis Zissis Marmarelis (*Engineering Science*). B.S., Lehigh University, 1966; M.S., California Institute of Technology, 1967.  
*Thesis*: Nonlinear Dynamic Transfer Functions for Certain Retinal Neuronal Systems.
- Dennis Ludwig Matson (*Planetary Science*). A.B., San Diego State College, 1964.  
*Thesis*: Part I. Astronomical Photometry at Wavelengths of 8.5, 10.5 and 11.6 Microns. Part II. Infrared Emission from Asteroids at Wavelengths of 8.5, 10.5 and 11.6 Microns.
- Kirk Thomas McDonald (*Physics*). B.S., University of Arizona, 1966.  
*Thesis*: Photodisintegration of Helium-3 at Energies from 200 to 600 Mev.
- David Jackson McGinty (*Chemistry*). B.S., Duke University, 1967.  
*Thesis*: Vapor Phase Homogeneous Nucleation and the Thermodynamic Properties of Small Clusters of Argon Atoms.
- Patrick Anthony McGovern (*Electrical Engineering and Physics*). B.E., University of Queensland, 1961; B.Sc., 1962; M.S., California Institute of Technology, 1963.  
*Thesis*: Electromagnetic Fields in Nonuniform Lossless Transmission Lines.
- Paul Stuart Meltzer (*Biochemistry and Developmental Biology*). A.B., Dartmouth College, 1967.  
*Thesis*: Studies on the A Components of *Drosophila* Phenol Oxidase.
- Francois M. M. Morel (*Engineering Science and Business Economics*). Dipl., Institut Polytechnique de Grenoble, 1967; M.S., California Institute of Technology, 1968.  
*Thesis*: I. A Study of Passive Transport Across the Red Cell Membrane Using Ion Specific Electrodes. II. Quantitation of Human Red Blood Cell Fixation by Glutaraldehyde.
- Paul Frederick Morrison (*Chemistry*). B.S., University of Michigan, 1965.  
*Thesis*: X-ray Scattering Behavior of Molecular Fluids.
- Albert Patrick Mortola (*Chemistry*). B.S., Fordham University, 1968; M.S., California Institute of Technology, 1970.  
*Thesis*: Bonding in Transition Metal Compounds.
- John Richard Myers (*Applied Mathematics*). B.S., Michigan State University, 1967.  
*Thesis*: New Variational Principles for Systems of Partial Differential Equations.
- X X Newhall (*Applied Mathematics*). B.S., Stanford University, 1961.  
*Thesis*: Two New Integral Transforms and Their Applications.
- Valdar Oinas (*Astronomy*). A.B., Indiana University 1965.  
*Thesis*: Analysis of Normal and Strong-Lined K-Type Dwarf and Giant Stars.
- Adelbert Owyong (*Electrical Engineering and Physics*). B.S., University of California, Berkeley, 1967; M.S., California Institute of Technology, 1968.  
*Thesis*: The Origins of the Nonlinear Refractive Indices of Liquids and Glasses.
- Karuppagounder Palaniswamy (*Aeronautics*). B.Sc., Nallamuthu Gounder Mahalingam College, 1962; M.S., California Institute of Technology, 1967.  
*Thesis*: Crack Propagation under General Inplane Loading.

DOCTOR OF PHILOSOPHY—*Continued*

- Robert Alan Patenaude (*Mathematics*). B.A., Humboldt State College, 1965; M.A., Syracuse University, 1968.  
*Thesis*: On Duals of Multiplicative Designs.
- Paul David Patent (*Mathematics*). B.A., Oakland University, 1965; M.A., 1966; M.S., California Institute of Technology, 1968.  
*Thesis*: Least Square Polynomial Spline Approximations.
- James Edward Pearson (*Electrical Engineering and Physics*). B.S., California Institute of Technology, 1967; M.S., 1968.  
*Thesis*: Infrared Optical Parametric Fluorescence and Parametric Oscillation.
- Sven Eric Persson (*Astronomy*). B.Sc., McGill University, 1966.  
*Thesis*: Interpretation of the Neutral Helium Triplet Spectrum in Planetary Nebulae.
- Thomas Antone Pucik (*Aeronautics*). B.S., California Institute of Technology, 1965; M.S., 1966.  
*Thesis*: Elastostatic Interaction of Cracks in the Infinite Plane.
- Donald Lewis Robberson (*Biophysics and Chemistry*). B.S., Oklahoma Baptist University, 1963.  
*Thesis*: I. A Study by Electron Microscopy of the RNA and RNA-DNA Hybrids of Hela Mitochondria. II. Replication of Closed Circular DNA in Mouse L Cells.
- Paul Erick Scheffler (*Physics*). S.B., Massachusetts Institute of Technology, 1967.  
*Thesis*:  $\pi^-$  Photoproduction from Deuterium and a Partial Wave Analysis of  $\pi^+$  and  $\pi^-$  Photoproduction in the Energy Region 500 to 1250 MeV.
- Bernard Frederick Schutz, Jr. (*Physics*). B.S., Clarkson College of Technology, 1967.  
*Thesis*: Relativistic Velocity-Potential Hydrodynamics and Stellar Stability.
- Robert Earle Setchell (*Aeronautics*). B.S., University of Colorado, 1967; M.S., 1968.  
*Thesis*: Shock Tube Investigations of Strong Shock Waves in a Convergent Channel.
- William Davidson Seybold (*Biochemistry*). B.Sc., McGill University, 1967.  
*Thesis*: I. Studies on the Activation of *Drosophila* Phenol Oxidase. II. Studies on Serum Insulin in Normal and Diabetic Subjects.
- Gerson Seth Shostak (*Astronomy and Physics*). B.A., Princeton University, 1965.  
*Thesis*: Aperture Synthesis Observations of Neutral Hydrogen in Three Galaxies.
- David Alan Sibley (*Mathematics*). B.S., University of Massachusetts, 1968.  
*Thesis*: On Certain Finite Linear Groups of Prime Degree.
- Charles Allen Smith (*Biophysics and Chemistry*). S.B., Massachusetts Institute of Technology, 1966.  
*Thesis*: Closed Circular DNA in Animal Cells: I. Complex Mitochondrial DNA in Normal and Malignant Tissue and the *in vivo* Effects of Drugs on the Superhelix Density of Mitochondrial DNA. II. Small Polydisperse Circular DNA of HeLa Cells. III. Sequence Heterogeneity in Closed SV40 DNA.
- Joseph Harold Smith (*Chemical Engineering and Business Economics*). B.S., Michigan Technological University, 1959; M.S., University of Washington, 1961.  
*Thesis*: Rheology of Concentrated Suspensions of Spheres.
- Peter Lloyd Smith (*Physics*). B.Sc., University of British Columbia, 1965.  
*Thesis*: Measurement of Absolute Transition Probabilities for Lines of Fe II.
- Richard Ross Smith (*Engineering Science and Physics*). S.B., Massachusetts Institute of Technology, 1967; M.S., California Institute of Technology, 1969.  
*Thesis*: Collective Effects in Three Pulse Cyclotron Echoes.

DOCTOR OF PHILOSOPHY—Continued

- Robert Carroll Smithson (*Physics*). B.S., University of Washington, 1966.  
*Thesis*: A Videomagnetograph Study of Diffusion of Solar Magnetic Fields in Weak Plage Regions.
- Eric Anthony Steinhilper (*Aeronautics*). Sc.B., Brown University, 1965; Sc.M., 1966.  
*Thesis*: Electron Beam Measurements of the Shock Wave Structure. Part I. The Inference of Intermolecular Potentials from Shock Wave Experiments. Part II. The Influence of Accommodation on Reflecting Shock Waves.
- Donald Lionel Patrick Strange (*Physics*). B.Sc., Carleton University, 1966.  
*Thesis*: Radiative Processes in an Intense Magnetic Field.
- Hal Jeffry Strumpf (*Chemical Engineering*). B.S., University of Rochester, 1966.  
*Thesis*: The Viscosity of Fluids in the Critical Region.
- Brent Dalton Taylor (*Civil Engineering*). B.S., University of Utah, 1966; M.S., Northwestern University, 1967.  
*Thesis*: Temperature Effects in Alluvial Streams.
- Wayne Thatcher (*Geophysics*). B.Sc., McGill University, 1964; M.S., California Institute of Technology, 1967.  
*Thesis*: Surface Wave Propagation and Source Studies in the Gulf of California Region.
- A. Thyagaraja (*Applied Mathematics and Physics*). B.Sc., Loyola College, Madras, 1967; M.Sc., Indian Institute of Technology, Madras, 1969.  
*Thesis*: Compressible Flows at Small Reynolds Numbers.
- Clark Joseph Bullock Tibbetts (*Biophysics and Chemistry*). B.A., Amherst College, 1968.  
*Thesis*: *In Vitro* Studies of the Synthesis of Mitochondrial Deoxyribonucleic Acid.
- Jefferson Wright Tilley (*Chemistry*). B.S., Harvey Mudd College, 1968.  
*Thesis*: Investigations Directed Toward the Total Synthesis of Shionone.
- John Charles Trijonis, Jr. (*Environmental Engineering Science and Aeronautics*). B.S., California Institute of Technology, 1966; M.S., 1967.  
*Thesis*: An Economic Air Pollution Control Model—Application: Photochemical Smog in Los Angeles County in 1975.
- Benes Louis Trus (*Chemistry*). B.S., Tulane University of Louisiana, 1968.  
*Thesis*: The Crystal Structures of Some Biologically Interesting Molecules.
- Firdaus Erach Udawadia (*Civil Engineering*). B.Tech., Indian Institute of Technology, Bombay, 1968; M.S., California Institute of Technology, 1969.  
*Thesis*: Investigation of Earthquake and Microtremor Ground Motions.
- Frank D. Uhlig (*Mathematics*). Vordiplom, University of Cologne, 1967; M.S., Ball State University, 1968.  
*Thesis*: A Study of the Canonical Form for a Pair of Real Symmetric Matrices and Applications to Pencils and to Pairs of Quadratic Forms.
- David Charles Viano (*Applied Mechanics*). B.S., University of Santa Clara, 1968; M.S., California Institute of Technology, 1969.  
*Thesis*: Wave Propagation in a Symmetrically Layered Elastic Plate.
- Albert F. Wagner (*Chemistry*). B.S., Boston College, 1966.  
*Thesis*: I. The Classification of Exact Quantum Methods for Nonreactive Scattering. II. Quantum Mechanical Calculations of Rotational-Vibrational Scattering in Homonuclear Diatom-Atom Collisions. III. The Effect of the Potential Well on Vibrational Scattering and the Validity of SSH Theory.

DOCTOR OF PHILOSOPHY—*Continued*

- Patrick Loren Walden (*Physics*). B.Sc., University of British Columbia, 1966.  
*Thesis*: Photo Production of  $\pi^-$  from Deuterium at Laboratory Energies 600 to 1250 MeV and C.M.  $\pi$  Production Angles  $6^\circ$  to  $160^\circ$ .
- John Mark Webb (*Chemistry, Biochemistry and Political Science*). B.Sc., University of Sydney, 1967.  
*Thesis*: Structural Studies of Some Polynuclear Iron Proteins.
- Gene Ward Wester (*Electrical Engineering and Business Economics*). B.A., University of Kansas, 1967; M.S., California Institute of Technology, 1968.  
*Thesis*: Low-Frequency Characterization of Switched dc-dc Converters.
- John Howard Wilson (*Biochemistry and Genetics*). A.B., Wabash College, 1966.  
*Thesis*: Bacteriophage T4 Transfer RNA.
- Robert Gordon Wolcott (*Chemistry*). A.B., University of California, Riverside, 1966.  
*Thesis*: Investigations on the Acetylcholine Receptor.
- Stephen Howard Wolfe (*Geophysics and Geology*). B.A., Cornell University, 1964.  
*Thesis*: Geology and Geochronology of the Manicouagan-Mushalagan Lakes Structure.
- Mark Stephen Wrighton (*Chemistry*). B.S., Florida State University, 1969.  
*Thesis*: Photoprocesses in Metal Containing Molecules.
- Shyue Yuan Wu (*Chemical Engineering*). B.S., National Taiwan University, 1960.  
*Thesis*: Study of Equilibrium Critical Phenomena in Fluid Argon.
- Keikichi Yagii (*Materials Science*). B.S., Osaka University, 1964.  
*Thesis*: Effect of Pressure on the Mechanical Behavior of Filled Elastomers.
- Ka Bing Winson Yip (*Astronomy*). S.B., Massachusetts Institute of Technology, 1965.  
*Thesis*: Synthesis of the Polarization Properties of Cygnus A at 8300 and 9600 Megahertz.
- Kenneth Young (*Physics and Mathematics*). B.S., California Institute of Technology, 1969.  
*Thesis*: Quark Models as Representations of Current Algebra.

# Prizes and Awards

## GEORGE W. GREEN MEMORIAL AWARD

Awarded to the undergraduate student who, in the opinion of the Division Chairmen, has shown outstanding ability and achievement in the field of creative scholarship.

*Steven Elliot Koonin, physics*

## DON SHEPARD AWARD

Awarded to students, the basic costs of whose education have already been met but who would find it difficult, without additional help, to engage in extracurricular activities and in the cultural opportunities afforded by the community. The recipients are selected on the basis of their capacity to take advantage of and to profit from these opportunities rather than on the basis of their scholastic standing.

*David H. Collier, junior*

*Mark Grunwald, sophomore*

*Betty Kwan, sophomore*

*Elizabeth McLeod, freshman*

*Bruce Spalding, sophomore*

## DAVID JOSEPH MacPHERSON PRIZE IN ENGINEERING

Awarded annually to the graduating senior in engineering who best exemplifies excellence in scholarship. The winning student is selected by a faculty committee of three, appointed annually by the chairman of the Division of Engineering and Applied Science.

*Charles Yee-Yun Young*

## DONALD S. CLARK ALUMNI AWARDS

May be awarded annually to a sophomore and a junior in recognition of service to the campus community and good academic performance. Preference is given to students in the Division of Engineering and Applied Science and to those in chemical engineering.

*Charles William Almquist, engineering*

*Gregory Paul Stone, chemical engineering*

## HAREN LEE FISHER MEMORIAL AWARD IN JUNIOR PHYSICS

Awarded annually to a junior physics major, to be selected by a physics faculty committee as demonstrating the greatest promise of future contributions to physics.

*Stanley E. Whitcomb*



## PRIZES AND AWARDS—*Continued*

### SIGMA XI AWARD

Awarded annually to a senior undergraduate student selected for an outstanding piece of original scientific research.

*Alan Lance Lewis, engineering*

### THE MORGAN WARD AWARD

Awarded for the best problems and solutions in mathematics submitted by a freshman or sophomore.

*Steven Pohorsky, freshman*

### MARY A. EARLE McKINNEY PRIZE IN ENGLISH

The purpose of this prize is to cultivate proficiency in writing. The terms under which it is given are decided each year by the faculty in English. It may be awarded for essays submitted in connection with regular English classes, or awarded on the basis of a special essay contest.

*Barry Cipra*

*Leland Smith*

### JACK E. FROELICH MEMORIAL AWARD

Awarded to a junior in the upper five percent of his class who shows outstanding promise for a creative professional career.

*Lawrence Curtis Widdoes, Jr., engineering*

### ERIC TEMPLE BELL UNDERGRADUATE MATHEMATICS RESEARCH PRIZE

Awarded annually to one or more juniors or seniors for outstanding original research in mathematics, the winners being selected by members of the mathematics faculty.

*Daniel Jay Rudolph, senior*

### THE ROYAL SOCIETY FOR THE ENCOURAGEMENT OF ARTS MANUFACTURES AND COMMERCE SILVER MEDAL

Awarded annually to students who are receiving their first degrees from the most important institutions of learning in the United States. Winners are selected on the basis of outstanding academic records and significant participation in student activities.

*Designee: Marc Arnold Aaronson, astronomy*